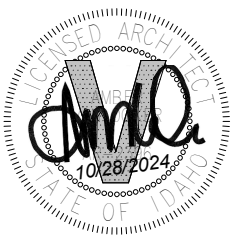
PROJECT MANUAL

LeRoy Craig Jerome Center
College of Southern Idaho

Permit / Bid Issue
Volume Three

Jerome, Idaho
October 28, 2024



PAGE INTENTIONALLY BLANK

LeRoy Craig Jerome Center
College of Southern Idaho
TABLE OF CONTENTS
10/28/2024

NO. OF PAGES

VOLUME 1

Project Architect and Engineers

VOLUME 2

Project Architect and Engineers

DIVISION 01 – GENERAL REQUIREMENTS

DIVISION 03 - CONCRETE

DIVISION 04 – MASONRY

DIVISION 05 - METALS

LeRoy Craig Jerome Center
College of Southern Idaho
TABLE OF CONTENTS
10/28/2024

NO. OF PAGES

DIVISION 06 – WOOD, PLASTICS AND COMPOSITES

DIVISION 07 - THERMAL AND MOISTURE PROTECTION

DIVISION 08 – OPENINGS

DIVISION 09 - FINISHES

NO. OF PAGES

LeRoy Craig Jerome Center
College of Southern Idaho
TABLE OF CONTENTS
10/28/2024

NO. OF PAGES

LeRoy Craig Jerome Center
College of Southern Idaho
TABLE OF CONTENTS
10/28/2024

NO. OF PAGES

DIVISION 33 – UTILITIES

PAGE INTENTIONALLY BLANK

PROJECT TEAM MEMBERS / COLE VALLEY CHRISTIAN SCHOOLS

ARCHITECT	OWNER
LKV Architects	College of Southern Idaho
2400 E. Riverwalk Drive	315 Falls Ave.
Boise, Idaho 83706	Twin Falls, Idaho 83303
Phone: 208-336-3443	Phone: 208-732-6610
Amber Van Ocker, Principal Architect	Theo Schut, Senior Construction Project Manager
Email: amber@lkvarchitects.com	tschut@csi.edu
Ron Polintan, Project Architect	
Email: ron@lkvarchitects.com	

CIVIL ENGINEER	LANDSCAPE ARCHITECT
Breckon Land Design	Breckon Land Design
6661 N. Glenwood St.	6661 N. Glenwood St.
Boise, Idaho 83714	Boise, Idaho 83714
Phone: 208-376-5153	Phone: 208-376-5153
Jon Breckon	Jon Breckon
Email: jbreckon@breckonld.com	Email: jbreckon@breckonld.com

STRUCTURAL ENGINEER	INTERIOR DESIGNER
Lochsa Engineering, LLC	Weston Design Interiors
201 North Maple Grove Road, Suite 100	201 Parkway Drive
Boise, Idaho 83704	Boise, Idaho 83706
Phone: 208-342-7168	Phone: 208-343-7878
Chris Holladay	Diane Weston
Email: CHolladay@lochsaidaho.com	Email: westondesign14@gmail.com

MECHANICAL ENGINEER	ELECTRICAL ENGINEER
Musgrove Engineering	Musgrove Engineering
234 S. Whisperwood Way	645 W. 25th St.
Boise, Idaho 83709	Idaho Falls, Idaho 83402
Phone: 208-384-0585	Phone: 208-523-2862
Bill Carter	Matt Bradley
Email: bill@musgrovepa.com	Email: mattb@musgrovepa.com

CONSTRUCTION MANAGER	
Starr Corporation	
2996 E. 3600 N.	
Twin Falls, Idaho 83303	
Phone: (208) 733-5695	
Michael Arrington	
Email: michaela@starrcorporation.com	

PAGE INTENTIONALLY BLANK

DIVISION 21 – FIRE SUPPRESSION

SECTION 210000 - FIRE SPRINKLER SYSTEMS

PART 1 - GENERAL

1.1 SCOPE:

A. General:
1. Specification Section 220000, Plumbing General Requirements, is to be included as part of this Section of the specification.

B. Work Included:
1. This section covers the work necessary to design and install a complete, satisfactory, and ready to operate wet pipe fire protection system for heated areas and dry pipe fire protection system for non-heated areas (areas subject to freezing). Hazard classification shall be as required by the State Fire Marshal, local City, IBC, IFC, and applicable NFPA Standards.

C. Qualifications of Installer:
1. All work shall be performed by a qualified, competent, licensed Fire Sprinkler Contractor who can furnish a verified list of satisfactory installations of this type and size, for a period of 5 years or more. Fire sprinkler contractor shall be licensed by the Idaho State Fire Marshal, and shall have in his employ an Engineering Technician (Level III), certified by NICET (National Institute for Certification in Engineering Technologies).

D. System Responsibility:
1. All work required for the fire protection system, including design and installation, shall be the responsibility of the Fire Sprinkler Contractor. Coordination with other trades is critical. Contractor shall coordinate his work with all ductwork, piping, electrical, etc., to ensure that all systems can be installed with a minimum of interference. Sprinkler heads shall be located in the center of ceiling tiles in the 2’ dimension and quarter spaced on 12” increments in the 4’ dimension. All piping penetrations through finished walls shall be provided with chrome escutcheons. Submittals which are required are only for the purpose of general coordination. Architect/Engineer assumes no responsibility or liability for the design of the system.
2. All monitoring of valves not shown on the electrical drawings shall be within the scope of work for the fire sprinkler contractor. This shall include, but not be limited to, the following: All conduit and wiring as required to monitor post indicator valves, tamper switches, and any other devices required to be supervised by the fire alarm panel. The sprinkler contractor shall also provide all power, wiring and conduit required for a complete and operational dry-pipe system (if required), unless such electrical is shown on the electrical drawings.
3. All dry piping shall be graded to drain back to the riser, regardless of location or presence of heat. Where not possible, piping may be graded to auxiliary drum drip drains. All locations of drains are to be approved by the Architect/Engineer prior to installation. All exposed piping shall be installed as close to ceilings as possible while maintaining appropriate sprinkler deflector clearances and while providing minimum pipe grade per NFPA 13 requirements. Piping shall be designed and installed in a neat and symmetrical manor and shall be coordinated with all other trades and building features.
4. All wet piping may be installed flat and level but shall be installed so as to minimize the requirements for auxiliary drains. All exposed piping shall be installed as close to ceilings as possible while maintaining appropriate sprinkler deflector clearances. Piping shall be

designed and installed in a neat and symmetrical manor and shall be coordinated with all other trades and building features.

5. Existing buildings without sprinkler systems: If an existing building has not previously had a fire sprinkler system, the Sprinkler Contractor is responsible to consult with a Structural Engineer and verify, in writing, that the existing building structure is capable of supporting the required new active sprinkler system.
6. Submittals are required are only for the purpose of general coordination. Architect/Engineer assumes no responsibility or liability for the design of the system.
7. The fire sprinkler system engineering documents must include as a minimum:
   a. The hazard classification, density, water flow and pressure requirements for the sprinkler system design.
   b. The storage arrangement and classification of commodities to be protected.
   c. Confirmation of adequate water supply based on water purveyor data.
   d. Riser location and feed main routing.

1.2 CODES AND STANDARDS:

A. The sprinkler system is to be designed and installed in accordance with the latest applicable building codes, State and Local Fire Marshals requirements, and all applicable NFPA Standards.

PART 2 - PRODUCTS

2.1 SUBMITTALS:

A. The Engineering Technician shall prepare and submit the following submittal data:
   1. Complete equipment list of all equipment to be installed, including manufacturer's name and catalog number.
   2. Layout drawing of complete sprinkler system indicating relationship of all other overhead items, including ductwork, lights, and structural members.
   3. Complete details and sections as required to clearly define and clarify the design.
   4. Plot plan indicating location of all underground connections, piping, valves, and related items.
   5. Complete building section showing location of piping, sprinklers and applicable equipment in relation to other construction features.
   6. Grooved joint couplings and fittings shall be shown on drawings and product submittals, and be specifically identified with the applicable style or series number.
   7. 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.
   8. Sprinklers valve and equipment model numbers shall be specifically identified on drawings and shall match submittal data provided.

2.2 MATERIALS AND EQUIPMENT:

A. All materials shall be as specified below, or in accordance with applicable NFPA Standards:
   1. Piping shall be black steel per NFPA 13 requirements and shall have a factory applied interior MIC or corrosion resistant coating. Piping shall be new and relatively free of exterior rust or corrosion. Piping with excessive rust or corrosion may be rejected. Threadable, thin wall piping will not be allowed. CPVC is allowed for underground only.
   2. Fittings shall be 125 psi screwed cast or malleable iron for all threaded piping.
   3. Fittings shall be Victaulic FireLock®, Anvil Gruviok, Grinnell or Shurjoint fire protection products for all grooved or plain end piping. Couplings shall consist of two ductile iron

housings conforming to ASTM A536, a pressure responsive elastomer gasket, and zinc electroplated carbon steel bolts and nuts. Rigid type or flexible type where necessary.
   a. Rigid Type: Housings shall be cast to provide system rigidity and support and hanging in accordance with NFPA 13. Tongue and recess rigid type couplings shall only be permitted if the contractor uses a torque wrench for installation. Required torque shall be in accordance with the manufacturer's recommendations. Contractor shall remove and replace any improperly installed joints. 11/4" and Larger: Standard rigid joint equal to Victaulic FireLock® Style 009 or equal.
   b. Flexible Type: Use in seismic areas where required by NFPA 13, Victaulic Style 75 or 77 or equal.
4. Dry pipe valves shall be installed in system risers per local water purveyor requirements.
   a. Dry Pipe Valve: Reliable EX Low Pressure Dry Valve (or preapproved equal, prior to award) shall be provided. Low differential, latched clapper design, black enamel coated ductile iron body, aluminum bronze clapper, with external reset and nitrogen system trim package. Valve internal parts shall be replaceable without removing the valve from the installed position and be externally resettable. Valve shall be pre-trimmed with shut-off valve, 3-way ball valve, and actuator. Required system pressure shall be per manufacturer's requirements. Valve shall have grooved ends for vertical installation only.
   b. Dry pipe systems shall not exceed 750 gallons of total system volume for any reason, regardless of code allowances. The Fire Sprinkler Contractor is to determine how many systems are required and provide the correct number of systems as determined by their design.
5. A nitrogen generator system, as manufactured by Southtech Systems or Engineered Corrosion Solutions (or preapproved equal prior to award), shall be sized and installed to provide system pressure and maintenance for the dry pipe systems. The system shall be equipped with a fire protection air compressor to comply with pressurization requirements of NFPA 13. Where multiple systems are required, the contractor shall properly size the generator system as needed for all cumulative dry pipe systems. Nitrogen monitoring stations shall be provided on each system per the manufactures criteria. Stations shall be located at or near the remote end of each system and shall be readily accessible from the floor level. The final location shall be coordinated with and approved by the Architect/Engineer.
6. Wet pipe risers shall be equipped with a Reliable brand (or equal) alarm valve / system check valve.
7. Butterfly control valves with supervisory tamper devices shall be installed for system control.
8. All materials and equipment shall conform to the requirements of Underwriter Laboratories (UL) or Factory Mutual Global (FMG), and shall be so stamped.
9. Pressure switches (water flow device) shall be installed in each system riser (dry pipe systems).
10. Flow switches (water flow device) shall be installed in each system riser (wet pipe systems).
11. Alarm Bell shall be 10-inch outdoor electric bell. Furnish for installation by the electrical contractor.
12. Sway Bracing, both lateral and longitudinal, shall be required and shall be installed per applicable NFPA Standards.
13. Fire Department Connection shall be provided for each system riser or manifold assembly. Install a 90-degree elbow with drain connection at each fire department connection to allow for system drainage to prevent freezing.
14. Sprinkler heads in main entry type areas and main conference room type areas shall be concealed flush mounted style with white paintable covers. All other sprinkler heads shall be Reliable Designer Model F1, (or equal), recessed with compression type escutcheon, below finished ceilings. Where surface mounted obstructions are installed, two-piece escutcheons and pendent sprinklers may be used, if required. Where sprinkler heads are subject to damage such as gymnasiums or mechanical lofts all sprinkler heads shall be

provided with protective covers. Escutcheons shall be listed, supplied, and approved for use with the sprinkler by the sprinkler manufacturer. Where piping is exposed, install standard bronze upright or pendent sprinklers. Quick response dry sidewall sprinklers shall be used as required to comply with IBC requirements for exterior canopies.

15. Provide 12 extra sprinkler heads mounted together in a suitable cabinet. Include Reliable brand sprinkler head wrenches matching each type of sprinkler head. Include spares of all types of sprinklers installed in the building.
16. Hangers, drains, and Inspectors Test Connections shall be installed in accordance with applicable NFPA Standards.
17. Test and Drain Valve: Globe design valve providing test port with ½" integral orifice and drain port in one unit. Bronze body with copper alloy internals, polycarbonate sight glasses, Nitrile o-rings and EPDM valve seats.
18. Back flow prevention as required by the State and Local Fire Marshall.
19. Post indicator valves as required by the State and Local Fire Marshall, or as shown on plans.
20. All piping penetrations through finished walls shall be provided with chrome escutcheons.

B. Underground piping materials and installation shall comply with N.F.P.A. #24 and local water company specifications.

PART 3 - EXECUTION

3.1 INSPECTION:

A. Upon completion of the system, secure the inspection of the required authorities and perform such tests as may be required to demonstrate compliance with local and state standards. Upon acceptance of the system by the inspecting authority, inform the Architect/Engineer in writing, showing proof of acceptance. Submit all required test certificates to required authorities.

B. The Fire Sprinkler Contractor shall monitor the nitrogen percentages until the system has reached 98% pure nitrogen and shall provide written verification, signed and acknowledged by the Owner's representative of such achievement. This shall occur each time that the system is taken in and out of service for any reason connected to the requirements of the project.

3.2 INSTALLATION:

A. Grooved joint piping systems shall be installed in accordance with the manufacturer's guidelines and recommendations. All grooved couplings, fittings, valves and specialties shall be supplied by a single manufacturer. The gasket style and elastomeric material (grade) shall be verified as suitable for the intended service as specified. Gaskets shall be supplied by grooved pipe manufacturer. Grooved end shall be clean and free from indentations, projections and roll marks in the area from pipe end to groove for proper gasket sealing. Contractor's field personnel shall be properly trained in the installation of the manufacturer's grooved piping products. A Factory trained representative shall periodically review the product installation. Contractor shall remove and replace any improperly installed products.

B. The sprinkler bulb protector must remain in place until the sprinkler is completely installed and before the system is placed in service. Remove bulb protectors carefully by hand after installation. Do not use any tools to remove bulb protectors.

3.3 PROJECT CLOSEOUT

A. Operations & Maintenance Manual:

1. The Contractor shall provide an operations and maintenance manual at least thirty days prior to completion of work. The manual shall be of the three-ring binder type, entitled "Operations and Maintenance Manual", with the job name and year of completion also included. O & M manuals shall be submitted in a single package. In addition, the contractor shall provide two consolidated electronic versions on two separate thumb drives. Individual items will not be accepted independently unless approved by the Engineer. The manual shall be in accordance with NFPA 25 requirements.

END OF SECTION 210000

PAGE INTENTIONALLY BLANK

DIVISION 22 – PLUMBING

SECTION 220000 – PLUMBING GENERAL REQUIREMENTS

PART 1 - GENERAL

1.1 SCOPE:

A. General:

1. The Bidding Requirements, Contract Requirements, and the General Requirements (Division 01) of these specifications shall govern all parts of the work.

B. Work Included:

1. Install work in accordance with these specifications and the accompanying plans. Furnish all labor, material, and equipment together with all incidental items not specifically shown or specified which are required by good practice to provide the complete plumbing systems as described.

C. Coordination and Site Visits:

1. This section of the work requires examination of and reference to all architectural, structural, utility, and electrical drawings for construction conditions that may affect the work. Inspect the building site and existing facilities for verification of existing conditions. Base all measurements from established benchmarks. Any discrepancy between actual measurements and those indicated, which prevents following good practices or the intent of the drawings and specifications, shall be reported to the Architect/Engineer, and work halted until instructions are received from the Architect/Engineer.

1.2 CODES, PERMITS, FEES:

A. Install all work in accordance with applicable codes and standards. Obtain all required permits; pay all required fees including utility connections or extensions, in connection with this portion of the construction. Obtain all required certificates of inspection for the work.

PART 2 - PRODUCTS

2.1 MATERIALS AND WORKMANSHIP:

A. Materials:

1. All materials and equipment shall be of first quality, new, full size and weight, standard in every respect, and suitable for the space required. Use the same manufacturer for products of similar class or service, such as valves and pumps. Protect all materials against loss, theft, or damage before and after installation.

2. Furnish and install all necessary foundations, supports, pads, bases, and piers required for all materials and equipment furnished under this contract.

3. Provide all required firestopping at piping penetrations of fire rated walls, floors, ceilings, and roofs. Firestopping shall be Dow Corning Fire Stop Sealant 2000 or Fire Stop Foam 2001, or approved equal.

4. Provide a heat-expanding fire collar for all non-metallic piping up to 6" size at penetrations of fire rated walls, floors, and ceilings per ASTME 814.

B. Workmanship:

1. All materials and equipment shall be installed in a neat and workmanlike manner by competent specialists for each subtrade. Work shall be installed to the satisfaction of the Architect/Engineer with unsatisfactory work removed and reinstalled to his satisfaction at no extra cost to the Owner.

2. Provide all cutting and patching necessary to install the work specified in this section. Patching shall match adjacent surfaces. No structural members shall be cut without the approval of the Architect/Engineer. Provide all sleeves and inserts required before the floors and walls are built.

3. Locate all equipment that must be serviced in fully accessible positions. Provide clearance for removal of replacement parts and components, and with necessary couplings or flanges to remove the component for maintenance.

2.2 SUBMITTALS AND SUBSTITUTIONS:

A. Prebid Approval:

1. Manufacturer's trade names and catalog numbers stated herein are intended to indicate the quality of equipment or materials desired. All manufacturers not specifically listed require prior approval. Submit catalog data, including specifications, of the proposed equipment to the Architect/Engineer for his approval at least 10 calendar days prior to bid opening. Notice of such approvals will be published in an addendum. Approval of listed alternate equipment manufacturers is for bidding only. Final approval is to be based on requirements of the plans and specifications.

B. Submittals:

1. Within thirty days after award of this contract, provide an electronic copy of a complete list of all materials and equipment proposed for this project. List shall contain make, type, manufacturer's name, and trade designation of all materials and equipment. Submittal shall also include manufacturer's complete specification for each item, including ratings, and dimensions as required to check space requirements. The scheduled equipment is the basis of design for physical size, etc. Alternate manufacturers shall not exceed the weight or physical size. Any changes to the Architectural, Structural and Mechanical systems due to alternate manufactures shall be the responsibility of the Contractor and Supplier. Submittals for fixtures, trim, and other plumbing related items, requiring submittals, shall be submitted in a single complete package. Individual items will not be reviewed independently unless approved by the Engineer.

2. Approval of submittals shall not relieve the contractor from responsibility for deviations from the plans or specifications, unless he has, in writing, called the Architect's /Engineer's attention to deviations at the time of submission, and obtained his written approval. Approval of submittals does not relieve the contractor from responsibility for errors in shop drawings or literature.

C. Equipment Requiring Submittals:

1. Plumbing Fixtures & Trim

2. Valves

3. Cast Iron Soil Piping

PART 3 - EXECUTION

3.1 ACCESSIBILITY & SAFETY:

A. Accessibility:

1. All equipment which must be serviced or operated shall be located in fully accessible position. Minor changes from the drawings may be made to allow for better accessibility. All changes shall be approved prior to actual installation.

2. Access panels shall be provided if required for accessibility. Access panels to be steel, flanged, hinged doors by Cendrex, model AHD, or equal. Size as required for installation. Subcontractor shall furnish the required panels to the General Contractor and the required location for all access panels, unless otherwise specified in the Architectural specifications. Panels shall be installed by the General Contractor.

B. Safety:

1. No water piping shall run immediately over or within a 3-foot plan view clearance of any electrical panel or motor starter. Where piping must be located within these zones, install piping inside a conduit to prevent water access to electrical equipment.

3.2 COORDINATION:

A. Coordinate all work with the various trades involved to provide a complete and satisfactory installation. The exact details of piping and equipment are not shown. No additional compensation will be made for offsets or relocation required in coordination with other trades.

B. Alterations required due to improper supervision by the subcontractor shall be made at no extra cost, to the satisfaction of the Architect/Engineer.

3.3 EXCAVATION & BACKFILL:

A. Excavate trenches required for underground piping to proper elevation and grade. Provide trenches with solid bottoms to allow support of piping along entire length with excavation at bells as required for jointing and inspection. Provide repairing of finished surfaces, and all required shoring, bracing, pumping, and protection for safety of persons and property. Observe all Local or State Safety Codes. Verify that elevations of existing utilities will allow for proper grading of piping connecting to existing utilities.

B. Excavation and Backfill shall be in accordance with the requirements of Division 31, of these specifications.

3.4 IDENTIFICATION AND CODING:

A. General:

1. The Contractor shall use ASME 13 standards for all piping identifications, color coding, and compliance.

B. Painting:

1. All painting of equipment, accessories, and piping shall be furnished and applied under the Architectural section of these specifications. All painting shall be completed before any identification markings are applied.

C. Piping:

1. Identify all piping as to the service of the pipe and the direction of flow. The letters shall be 3/4 inch high on piping two inches or smaller, and 1-1/4 inches high on piping up to six inches. Flow arrows shall be at least six inches long. The letters and flow arrows shall be made by precut stencils and oil base paint, one inch high and black, or factory fabricated plastic pipe markers. Piping shall be identified at 25 foot maximum intervals, on long continuous lines; adjacent to each item of equipment; on each riser and junction, and on both sides of all wall penetrations. Underground piping shall be identified with bright colored continuously printed plastic tape of not less than 6" wide by 4 mil thick, manufactured for direct burial service. Install directly above all buried pipe, 6 to 8 inches below finished grade.

D. Valves:

1. Regardless of size, all valves shall be tagged with a numbered brass tag, 1-1/2 inches by 3 inches minimum in size and 0.051 inch thick. A valve chart indicating valve tag number, location, service, and normal position shall be mounted in a suitable framed and glassed cover in the main mechanical room or as directed. Valve chart shall be duplicated in the Maintenance and Operations Manual.

3.5 TESTING:

A. Piping:

1. All plumbing piping (drainage, water, gas) shall be tested in accordance with the requirements of local adopted plumbing code, latest edition. Other piping systems shall be tested hydrostatically to 1.5 times the operating pressure but not less than 100 psi, for a minimum period of two hours. If the test pressure falls more than 5 percent during the test period, the leak shall be located, repaired, and the test repeated.

2. Piping shall be tested before insulation has been installed. Delicate control mechanisms shall be removed during tests to prevent shock damage. The use of chemicals or compounds to stop leaks shall not be permitted.

3. A test report shall be submitted for each piping system test. Test report forms are part of Specifications Section 220100, or are available from the Engineer.

B. Systems:

1. All plumbing systems shall be tested at the completion of the building to establish that the systems operate as specified and required.

3.6 CLEANING AND ADJUSTING:

A. Thoroughly clean all parts of the system at the completion of the work. Flush all water circulating systems with fresh water and then drain. Clean all strainers and refill system. Adjust all devices for proper operation and lubricate all equipment as required. Repaint any painted surface that has been damaged.

B. All potable water systems shall be flushed and disinfected after tests are completed. Disinfection shall be in accordance with local municipal and State Plumbing Inspector's criteria. In lieu of such criteria, the following procedure shall be followed for disinfection:

1. Completely flush system. Add alkali or acid (hydrochloric) to bring water ph level to between 7.4 and 7.6.

2. Inject chlorine (liquid, powder, tablet, or gas) throughout the system to obtain 50 to 80 mg/L residual.

3. Bleed water from outlets to ensure distribution, and test for residual at a minimum of 15 percent of the outlets.

4. Maintain disinfection in system for 24 hours.

5. If final disinfectant residual tests less than 25 mg/L, repeat treatment.

6. Flush disinfectant from system until residual is equal to that of incoming water, or 1.0 mg/L.

7. Take samples no sooner than 24 hours after flushing, from 10 percent of the outlets and the incoming water.

3.7 PROJECT CLOSEOUT:

A. Operations & Maintenance Manual:

The Contractor shall provide an operations and maintenance manual at least thirty days prior to completion of work. The manual shall be of the three ring binder type, entitled "Operations and Maintenance Manual", with the job name and year of completion also included. O & M manuals shall be submitted in a single package. Individual items will not be accepted independently unless approved by the Engineer. The manual shall include, as a minimum:

1. Maintenance instructions for all equipment, including lubrication requirements.

2. Fixture suppliers names, addresses, and telephone numbers.

3. Fixture catalog cuts, ratings tables, model numbers, serial numbers, and accessories.

4. Parts numbers for all replaceable parts.

5. Valve tagging chart as hereinbefore specified.

6. Guarantee letter as specified below.

7. Any additional information required to enable the Owner to properly maintain the building plumbing system.

8. After approval of the Operations and Maintenance Manual by the Architect/Engineer, the Contractor shall furnish two copies of the manual to the Owner.

B. As-Built-Drawings:

1. Provide two sets of red-line mechanical drawings showing the work as it was actually installed. The drawings shall indicate all departures from the contract drawings and shall locate all underground utility lines with dimensions from established building lines. Make all notations neat and legible, with red indelible pencil. At the completion of the work, these as-built drawings shall be signed and dated by the Plumbing Contractor and returned to the Architect/Engineer.

C. Guarantee:

1. All work furnished under this section shall be guaranteed in writing to be free from defective work or materials for a period of one year after acceptance of the contract. All repairs or replacements because of defective materials or workmanship or noncompliance with code shall be provided without additional cost to the Owner. Contractor shall furnish a letter indicating above guarantee with space for date of acceptance and expiration of guarantee. Letter shall be included in O & M Manual.

END OF SECTION 220000

SECTION 220100 - PLUMBING

PART 1 – GENERAL

1.1. SCOPE:

A. This section covers the work necessary for the plumbing system, complete. The Plumbing General Requirements, Section 220000, are to be included as a part of this section of the specifications.

1.2. CODES:

A. The plumbing system shall be installed in accordance with the requirements of local adopted plumbing code, latest edition, International Fuel Gas Code, latest edition; and all local and State Codes.

1.3. FIXTURES & EQUIPMENT:

A. General:

1. Plumbing fixtures and equipment shall be as listed on the drawings. In addition to those specifically listed, the following manufacturers are approved for bidding only. All other manufacturers require prior approval. Final approval for installation is based on submittal data furnished:
   a. Tank Type Water Closets: American Standard, Kohler, Mansfield, Sloan, Toto, & Zurn.
   b. Flush Valve Water Closets: American Standard, Briggs, Kohler, Mansfield, Sloan & Zurn.
   c. Urinals: American Standard, Briggs, Gerber, Kohler, Mansfield, Sloan, Toto & Zurn.
   d. Vitreous China Sinks: American Standard, Crane, Kohler, Mansfield, Sloan, Toto, & Zurn.
   e. Stainless Steel Sinks: Elkay, Just.
   f. Faucets: American Standard, AMTC, Aquaspec, CHG Encore Saniguard, Chicago Faucets, Delta, Elkay, Gerber, Geberit, Kohler, Moen, T&S Brass, Symmons, Speakman, Sloan & Zurn.
   g. Sensor Faucets: Chicago Faucets, Elkay, Mac Faucets, Symmons, Speakman, Sloan, & T & S Brass.
   h. Valves and Trim: Brasscraft, Dearborn Brass, ProFlo, Sloan & T&S Brass.
   i. Flush Valves: American Standard Selectronic, AMTC, Delta, Kohler, Moen (sensor-operated only) Sloan, & Zurn.
   j. Carriers and Drainage Products: Jay R. Smith, Josam, MIFAB, Neenah Foundry, NDS, Profo, Sun Drainage, Wade, Watts, & Zurn.
   k. Toilet Seats: American Standard, Beneke, Church, Kohler, Plumb Tech & Zurn.
   l. Mixing Valves: Acorn Controls, Lawler, Leonard, Powers, Stingray, Symmons, Watts, & Wilkins.
   m. Fiberglass/ Acrylic Fixtures: Aquatic, Aquaglass, Best Bath, Fiat, Intersan, MAXX, Mustee Praxis-Comfort Designs, & Swan.
   n. Drinking Fountains/ Electric Water Coolers: Elkay, Halsey Taylor, Haws,

Murdock Stern Williams, & Sunroc.

o. Safety Fixtures & Safety Mixing Valves: Acorn, Bradley, Chicago Faucets, Encon, Guardian, Haws, Lawler, Speakman, Speakman, Stingray.
p. Security Fixtures: Acorn, Bradley, Willoughby.
q. Wash Fountains: Acorn, Bradley, Intersan, Sloan, & Willoughby.
r. Service Sinks: Acorn, Fiat, Mustee, Proflo, Stern Williams, & Zurn.
s. Water Heaters (Tank): American, A.O. Smith, Bock, Bradford-White, Heat Transfer-Phoenix, Lochinvar Shield, PVI, & Rheem.
t. Water Heaters (Instantaneous - Gas): A.O. Smith, Bradford-White, Lochinvar, Rheem, & Rinnai.
u. Water Heaters (Instantaneous - Electric): Bradford-White, EeMax, Chronomite, & Rheem.
v. System Valves: Apollo, Nebco & Red-White Valve Corp.
w. Backflow Preventers: Conbraco/Apollo, Watts, & Wilkins.
x. Hose Bibbs: Josam, J.R. Smith, Prier, Woodford, & Zurn.
y. Trench Drains: ABT, ACO, Dura Trench, J.R. Smith, NDS, Strongwell Polycast, Rapid, Wade, & Zurn.
z. Utility Sinks: Fiat, Mustee, & Proflo.

2. Plumbing Fixture Standards:
All plumbing fixtures shall meet or exceed the following standards:
a. ANSI A112.6.1 - Supports for Off-the Floor Plumbing Fixtures for Public Use.
b. ANSI A112.18.1 - Finished and Rough Brass Plumbing Fixture Fittings.
c. ANSI A112.19.1 - Enameled Cast Iron Plumbing Fixtures.
d. ANSI A112.19.2 - Vitreous China Plumbing Fixtures.
e. ANSI A112.19.3 - Stainless Steel Plumbing Fixtures (Designed for Residential Use).
f. ANSI A112.19.4 - Porcelain Enameled Formed Steel Plumbing Fixtures.
g. ANSI A112.19.5 - Trim for Water-Closet Bowls, Tanks, and Urinals.
h. ANSI Z124.1 - Gel-Coated Glass-Fiber Reinforced Polyester Resin Bathtub Units.
i. ANSI Z124.2 - Gel-Coated Glass-Fiber Reinforced Polyester Resin Shower Receptor and Shower Stall Units.
j. ANSI Z358.1 - Emergency Eye Wash and Shower Equipment.
k. ARI 1010 - Drinking Fountains and Self-Contained Mechanically Refrigerated Drinking Water Coolers.
l. AWSI/ASSE 1001 – Atmospheric Vacuum Breaker
m. ANSI/ASSE 1012 - Backflow Preventers with Immediate Atmospheric Vent.
n. ANSI/ASSE 1011 - Hose Connection Vacuum Breakers.
o. ANSI/ASSE 1013 - Backflow Preventers, Reduced Pressure Principle.
p. ANSI/ASSE 1015 – Backflow Preventers, Double Check Principle
q. ANSI/ASSE 1019 - Wall Hydrants, Frost Proof Automatic Draining Anti-Backflow Types.
r. AWSI/ASSE 1020 – Pressure Vacuum Breaker
s. AWSI/ASSE – 1-52 – Hose Connection, Double Check
t. ANSI A112.21.1 - Floor Drains.
u. ANSI A112.21.2 - Roof Drains.
v. ANSI A112.26.1 - Water Hammer Arresters.
w. PDI WH-201 - Water Hammer Arresters.
x. ANSI/AWWA C606 – Grooved and Shouldered Joints
y. NSF/ANSI Standard 61 – Drinking Water System Components – Health Effects

PART 2 - PRODUCTS

2.1. PLUMBING FIXTURES & TRIM:

A. All plumbing fixtures shall be provided complete with all required trim for a complete and operational system. All piping penetrations through finished walls shall be provided with chrome escutcheons. All plumbing fixtures shall be caulked and sealed to surrounding surfaces. All sink traps shall be provided with a cleanout plug in the bottom of the trap. All interior exposed pipe, valves, and fixture trim shall be chrome plated, including kitchen compartment sinks. Braided stainless steel pipe risers are approved for concealed locations only, such as behind casework doors or lav shields. Each fixture shall be provided with stop valves and the stop valves shall be quarter-turn brass ball type. All fixtures and trim must be lead free. All floor drains and floor sinks shall be provided with trap primers (PPP, Zurn or Wade as needed for appropriate use. Provide ball valve type shut-off valve upstream of all trap primer valves).

2.2. PIPING AND FITTINGS:

A. General:

1. Underground sanitary sewer and storm drain lines shall be installed at 1/4" per foot slope, unless otherwise indicated. If such slope is not possible due to existing inverts, approval shall be obtained from the Architect/Engineer and the authority having jurisdiction before any piping is installed at a lesser slope.

2. Connections between piping of dissimilar materials shall be made with dielectric waterway fittings or unions.

3. Provide standard manufactured water hammer arresters at all flush valves. Size and locate per manufacturers recommendations. Provide access panels for access to all water hammer arresters.

B. Domestic & Non-Potable Hot and Cold Water:

1. Piping inside building above slab or above grade in crawl space shall be ASTM B88, Type "L", hard drawn copper. Fittings shall be ANSI/ASME B16.22 cast brass, or ANSI/ASME B16.29 wrought copper. Joints shall be ANSI/ASTM B32 solder, Grade 95-5, lead free.
   a. Cold Water Only Option- ANSI/ASME B16.18 cast bronze, or ANSI/ASME B16.22 wrought copper. Joints shall be copper-tube dimensioned grooved joint couplings, and Flush Seal style gasket. (Gasket shall be UL classified in accordance with ANSI/NSF-61 for potable water service.) Victaulic Style 606, Gruvlok style 6400, Grinnell Universal Tongue and Groove 672, Shurjoint C305, or equal.
   b. Piping Option – Mechanically Formed Extruded Outlets:
      1) Mechanically formed extruded outlets shall be perpendicular to the axis of the run tube (header). They shall be formed by drilling a pilot hole and drawing out the tube surface to form a collar having a height of not less than three times the thickness of the branch wall and shall conform to ASME B31.9 and NFPA 99. T-Drill or approved equal.
      2) Branch tubes shall not restrict the flow in the run tube. To ensure this by conforming the branch tube to the shape of the inner curve of the run tube, a dimple / depth stop shall be formed in the branch tube to ensure that penetration into the collar is of the correct depth. For inspection purposes, a second dimple shall be placed 0.25 inch above the first dimple. Dimples shall be aligned with the tube run.

3) Branches can be formed up to the run tube size as shown in ASTM F 2014. Forming procedures shall be in accordance with the tool manufacturer's recommendations.
4) Joints shall be made with the use of approved brazing alloys BCup2 thru BCup5 (0-15% silver content). Brazed with a filler that has a melting point above 540 deg. Centigrade (1000 deg. F). **Soft soldered joints are not allowed.**
5) K and L copper types allowed.
6) Soft and Hard copper allowed.
7) Each model used for making branch connections shall be permanently marked with manufacturer's name and appropriate model number.
8) Mechanically formed extruded outlets can (but not limited to) be used on commercial and residential buildings.
9) Fitter / Plumber shall be trained and certified to operate the equipment.

2. Piping underground within 5 feet of the building line, smaller than 4 inches, shall be ASTM B88, Type "K", hard drawn copper. Piping below floor slab, smaller than 4 inches, shall be type "K", soft annealed copper. Fittings shall be ANSI/ASME B16.29 wrought copper. Joints shall be ANSI/ASTM B32 solder, Grade 95-5, lead free. No joints shall be installed beneath concrete floor slabs, unless approved by the Engineer. Underground or underslab copper piping shall be provided with a polyethylene jacket, ANSI/AWWA C105, or shall be wrapped with double layer, half-lapped, 10 mil polyethylene tape.
   a. Underground (below slab) Piping Option- ½" to 4", High Density Polyethylene (HDPE) pressure pipe. ASTM D3350, ASTM D3035 & ASTM F714. AWWA C901 & AWWAC906, NSF. Fittings shall be HDPE, solvent weld. Piping shall be rated for not less than 150 psig.
   b. Trap Primer Piping (below floor or concealed only) –
      1) ½" Wirsbo Aquapex Tubing or equal.
      2) ½" type K hard drawn copper, wrapped as indicated above.

3. Piping underground beyond 5 feet from building line shall be Schedule 40 PVC, ASTM D1785 or D2241. Fittings shall be PVC, ANSI/ASTM D2466. Joints shall be solvent weld, ASTM D2855, or gasketed, ASTM F477. Piping shall be rated for not less than 150 psig pressure.

C. Sanitary Sewer and Vent:

1. Piping and fittings shall be Schedule 40 PVC-DWV (cellular core), per ASTM F1488 and ASTM F891, solvent welded per solvent manufacturer's instructions, or ABS Schedule 40 piping and fittings per either ASTM D2661 or ASTM F628 with solvent cement conforming to ASTM D2235. All sewer risers (2 story or more) shall be service weight cast iron, no-hub or single-hub, ASTM A74. All piping penetrations through fire rated walls, floors, or ceilings, and all piping located above ceilings used as return air plenums shall also be cast iron or galvanized steel, ASTM A53. Underground PVC-DWV piping shall be installed per ASTM D-2321.

2. All sanitary waste and grease piping for commercial type kitchens shall be Schedule 40 PVC-DWV (cellular core), per ASTM F1488 and ASTM F891, solvent welded per solvent manufacturer's instructions, or ABS Schedule 40 piping and fittings per either ASTM D2661 or ASTM F628 with solvent cement conforming to ASTM D2235. Cast iron piping shall extend downstream minimum 20 feet from the steam kettle.

3. Piping and fittings beyond 5 feet from the building line shall be PVC, ASTM D3033 or

D3034, SDR 35. Joints shall be ASTM F477 with elastomeric gaskets. Underground piping shall be installed per ASTM D-2321.

4. All 90 degree waste line elbows shall be formed per the latest issue of the adopted plumbing code, latest edition.

5. All exposed vent piping located in occupied areas or rooms, is to be cast iron with cast iron fittings.

6. All flush valve fixtures that are installed back to back shall have offset waste outlet fittings.

7. Cleanouts shall be provided at each horizontal drainage pipe, at its upper terminal, and each run of piping which is more than 100 feet and shall be provided for each 100 feet developed length, or fraction thereof of such piping. An additional cleanout shall be provided for each aggregate horizontal change of direction exceeding one hundred and thirty-five degrees, per applicable plumbing code. This shall be provided regardless of what is shown on the drawings.

8. All floor drains, floor sinks, and hub drains shall be installed with a trap primer.
   a. Flush Valve Primer: Trap primer shall be Precision plumbing products model FVP-1VB with vacuum breaker.
   b. Pressure Activated Primer: Trap primer shall be Precision Plumbing products Model CPO-500 with DU distribution unit if required.
   c. Tail Piece Primer: Trap primer shall be Precision Plumbing Products Model LTP-1500 with ½" clear poly flexible priming make up water line and chrome plated escutcheons plates.

9. All vent's through roof (VTR'S) shall be extended at least 1 foot above the roof surface, or to the top of the closest adjacent parapet wall, whichever is greater.

D. Storm Drains:

1. Piping and fittings shall be Schedule 40 PVC-DWV (cellular core), per ASTM F1488 and ASTM F891, solvent welded per manufacturer's instructions, or ABS Schedule 40 piping and fittings per either ASTM D2661 or ASTM F628 with solvent cement conforming to ASTM D2235. All piping located above ceilings used as return air plenums, and all piping penetrations through fire rated walls, floors, or ceilings shall be service weight cast iron, ASTM888 no-hub or single hub, ASTM A74. Underground piping shall be installed per ASTM D-2321.

2. Piping underground beyond 5 feet from the building line shall be PVC, ASTM D3033 or D3034, SDR 35, with PVC fittings. Joints shall be ASTM F477 with elastomeric gaskets. Underground piping shall be installed per ASTM D-2321.

3. Cleanouts shall be provided at each horizontal drainage pipe, at its upper terminal, and each run of piping 2" size which is more than 50 feet and shall be provided for each 50 feet developed length. 4" size or larger which is more than 100 feet developed length, or fraction thereof of such piping. Contractor shall coordinate with architect as to exact location of all storm water cleanouts as they exit the building, as cleanouts may need to be positioned within certain block elevations. An additional cleanout shall be provided for each aggregate horizontal change of direction exceeding one hundred and thirty-five degrees, per applicable plumbing code. This shall be provided regardless of what is shown on the drawings. Final

determination of cleanout spacing shall be per local jurisdiction and code requirements and shall be installed accordingly.

E. Compressed Air:

1. Piping shall be Schedule 40 black steel pipe, ASTM A53, with black banded 200-pound malleable iron fittings and couplings.

2. Piping 2" and below may be ASTM A-312, Type 304/304L, Schedule 5S stainless steel in lieu of soldered copper.
   a. Fittings shall be precision, cold drawn austenitic stainless steel with elastomer O-ring seals. (O-ring shall be grade "E" EPDM for oil free compressed air, or grade "T" Nitrile for air with oil vapors) Vic-Press 304 or equal.

3. Alternate material - Piping inside building above slab or above grade shall be ASTM B88, Type "L", hard drawn copper. Fittings shall be ANSI/ASME B16.23 cast brass or ANSI/ASME B16.29 wrought copper. Joints shall be ANSI/ASME B32 solder, Grade 95-5, lead free.

F. Natural Gas:

1. Piping shall be Schedule 40 black steel pipe, ASTM A53. Exposed fittings 2 inches and smaller shall be ANSI/ASME B16.3, screwed, black malleable iron.

2. Fittings larger than 2 inches and all underground fittings shall be Schedule 40 steel butt-welded type. Underground piping shall be provided with a polyethylene jacket, ANSI/AWWA C105, or shall be wrapped with double layer, half-lapped, 10 mil polyethylene tape.
   a. Contractors Option for Underground Pipe:
      1) Gastite Type PE flexible corrugated gas piping. NFPA-54 & 56. ASTM D2513 Category 1. ASME D-B31.8-1995.
      2) Piping and fittings underground and outside the building line may be JM Eagle UAC 2000 MDPE, medium-density polyethylene yellow gas pipe or an approved equal. Piping shall be installed in accordance with JM Eagle Publication JME-12B, "Polyethylene Yellow Gas Distribution Installation Guide." JM Eagle's UAC 2000 system can be joined by butt heat fusion, socket fusion, or saddle fusion. Installing contractor shall be licensed for fusion pipe installation of polyethylene pipe. ASTM D2513.

3. All exterior piping exposed to the weather shall be coated with a rust inhibitor – Rustoleum #866 Pro-Guard Primer – yellow or gray color – or approved equal.

G. Acid Waste and Vent- the following are approved piping alternatives: All others must be prior approved by the Engineer.

1. Alt.A: Below grade piping shall be ASTM D4101, schedule 40, non-flame retardant polypropylene acid waste and vent piping. Fittings shall be non-flame retardant polypropylene fittings and joined using electrofusion joint system. Above grade piping shall be ASTM D4101, schedule 40, flame retardant polypropylene acid waste and vent piping. Fittings shall be flame retardant polypropylene fittings and joined using electrofusion joint system. Piping for traps shall be glass acid waste piping. Connections between polypropylene

and other piping materials shall be made using adapters according to manufacturer's recommendations. Polypropylene piping and fittings installed above ceilings used as return air plenums shall be polyvinylidene fluoride (PVDF) ASTM E-84 and UL 723. Fittings shall be joined using electrofusion joint system. Piping and pipe fittings shall be installed in strict accordance with manufacturer's recommendations. Underground piping shall be installed per ASTM D-2321. Installation and testing shall be in accordance with the contract drawings, the manufacturer's recommendations and the local plumbing code. Manufactured by ORION, IPEX, Zurn Fusion Lock, Fuseal, or approved equal.

2. Alt.B: Piping shall be glass waste and vent piping. Glass-to-glass connections shall be made using compression type tetra-fluoro-ethylene lined couplings and using padded hanger supports. Underground piping shall be polypropylene piping as specified above. Connections between glass and other piping materials shall be made using adapters according to manufacturer's recommendations. Piping and pipe fittings shall be installed in strict accordance with manufacturer's recommendations. Installation and testing shall be in accordance with the contract drawings, the manufacturer's recommendations and the local plumbing code.

3. Alt. C: Special drainage systems for corrosive chemical or acid waste shall be manufactured from CPVC Type IV, ASTM Cell Classification 23447. All pipes shall be schedule 40 CPVC manufactured to dimensional requirements of ASTM F441. All pipe markings shall be accompanied by a yellow stripe for identification of CPVC chemical waste system. All fittings shall be CPVC drainage patterns meeting the requirements of ASTM F 2618 and ASTM D3311 and specialty patterns according to the manufacturer's specifications. CPVC system shall be available in sizes 1/1/2 through 24-inch iron pipe size (IPS) dimensions. All pipe, fittings, and cement shall be supplied together as a complete system certified by the NSF International for use in corrosive waste drainage systems as a Special Engineered (SE) Product. Installation shall be in accordance with the manufacturer's instructions and all applicable codes. Special drainage system to be Spears Lab Waste CPVC Corrosive Waste Drainage Systems manufactured by Spears Manufacturing Company, Charlotte ChemDrain manufactured by Charlotte Pipe and Foundry, or approved equal. The system is intended for use in non-pressurized applications with a maximum working temperature of 220 Deg. F.

4. Cleanouts shall be provided at each horizontal drainage pipe, at its upper terminal, and each run of piping which is more than 100 feet and shall be provided for each 100 feet developed length, or fraction thereof of such piping. An additional cleanout shall be provided for each aggregate horizontal change of direction exceeding one hundred thirty five degrees, per applicable code. This shall be provided regardless of what is shown on the drawings.

H. Condensate Drain Piping:

1. Exterior to building (connected to roof mounted equipment): Piping shall be Schedule 40 PVC. A union shall be installed directly at the roof top equipment for ease of replacement in the future.

2. Interior to building or connected to condensing appliances: Piping shall be Type L hard drawn copper, ASTM B88, with solder joints. Copper piping shall not be used on 90% condensing type equipment.

I. Hanger and Supports:

1. Pipe hangers shall be provided to adequately support all piping systems. Hangers shall be

vertically adjustable to provide for proper pitch and drainage. Hangers shall allow for expansion and contraction of the piping system. Reference "General Regulations" of the latest edition of the adopted plumbing code, latest edition.

2. Hangers for pipe sizes 1/2 to 6 inches shall be adjustable clevis type, or unistrut saddles with all-thread hanger rod.

3. Hangers for hot pipe, sizes 6 inches and over shall be adjustable steel yoke, cast iron roll, double hanger type.

4. Vertical pipes shall be supported with steel riser clamps. Spacing interval requirements per "General Regulations" of the latest edition of the adopted plumbing code, latest edition.

5. All insulated piping shall be provided with minimum 18 gauge galvanized insulation shields, 12 inches long, and oversized hangers. Pipe sizes 2 inches and over shall also be provided with 12 inch long calcium silicate insulating blocks between the piping and the galvanized insulation shield.

6. Hanger rod sizing and spacing for pipe shall be as follows:

Pipe Size	Minimum Rod Diameter	Maximum Spacing
To 1-1/4 inches	3/8 inch	6.5 feet
To 2 inches	3/8 inch	10 feet
To 3 inches	1/2 inch	10 feet
To 6 inches	5/8 inch	10 feet
8 to 12 inches	7/8 inch	12 feet
PVC & ABS (all sizes)	3/8 inch	4 feet

7. Provide hangers within 12 inches of each horizontal elbow.

8. Provide hangers with minimum 1-1/2 inches vertical adjustment.

2.3. INSULATION:

A. General:

1. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

2. Fire-Test-Response Characteristics: Insulation and related materials NFPA 255, UL Classified per UL 723 or meeting ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement containers, with appropriate markings of applicable testing and inspecting agency.
   a. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
   b. Insulation Installed Outdoors: Flame=spread index of 75 or less, and smoke-developed index of 150 or less.

B. Piping:

1. All domestic, potable & non-potable, hot and cold water lines and rain drains shall be insulated with preformed insulation.
   a. Fiberglass insulation with a vapor barrier jacket. Insulation shall have a conductivity not exceeding 0.28 Btu-inch/hour-sq. ft.-degrees F. Laps and butt joints shall be sealed with pressure sensitive joint sealing tape of the same finish as the insulation jacket to provide a continuous vapor seal. Fittings and valves shall be insulated with PVC fitting covers and fiberglass insulation inserts, or with hydraulic setting insulating cement and four ounce canvass jacket with vapor barrier adhesive.

   Insulation thicknesses shall be as follows:

System	Pipe Sizes ½" and above
Domestic Cold Water (pot. & non-pot.)	½"
Domestic Hot Water & Recirc. (pot. & non-pot.)	1"
Roof Drain Piping	½"
Overflow Drain Piping	½"

2. Roof and overflow drain sumps shall be insulated with 1/2" thick fiberglass with a vapor barrier, extending 2" onto adjacent insulation.

3. Insulation shall be installed in strict accordance with manufacturer's instructions.

4. Insulation shall be continuous through penetrations.

5. All insulation shall be installed in a neat and workmanlike manner.

2.4. VALVES & STRAINERS:

A. Ball Valves:

1. Valves 2-inches and smaller shall be lead free cast bronze body, chrome-plated brass ball, teflon seats, and lever handle, 600 psi CWP. Valves shall comply with MSS SP-110, NSF/ANSI 61, NSF/ANSI 372 Lead Free. Valves over 2-inches shall be cast steel body, chrome plated steel ball, teflon seats, and lever handle. Victaulic, Anvil Gruvlok, Grinnell, or Shurjoint ball valves are acceptable if grooved piping is used. Valves mounted higher than 7'-0" A.F.F. shall be provided with chain, wheel, and guides. Basis of design: Apollo #77CLF-A Series or equal.

B. Check Valves:

1. Valves 2-inches and smaller shall be bronze body Y-pattern, ASTM B-62, swing check, bronze disc, 200 psi WOG. Valves shall comply with MSS SP-80, NSF/ANSI 61-8 F&G, NSF/ANSI 372 Lead Free. Valves, over 2-inches shall be iron body, ASTM A-126, bronze trim, swing check, renewable disc and seat. Valves shall comply with MSS SP-71. Victaulic, Anvil Gruvlok, Grinnell, or Shurlock check valves are acceptable if grooved piping is used. Basis of design: Apollo # 161T-LF/161S-LF Lead Free Bronze, Apollo # 920F-LF Lead Free Cast Iron, or equal.

2. Swing check valves with outside lever and spring (not center guided) is to be used on sewage ejector or storm-water sump pumps. Basis of design: Apollo # 910FLW-LF Lead Free Cast Iron or equal.

C. Pressure Reducing Valves:

1. Valves 2-inches and smaller shall be bronze body, stainless steel and thermoplastic internal parts, fabric reinforced diaphragm, strainer, and single union end. Basis of design: Apollo # 36ELF Series Lead Free Bronze or equal.

D. Balance Valve:

1. Valve shall have a twin tube 316 S.S. design with blowout proof attachment to station body. Ports shall include ¾" port for thermometer, ¼" port for pressure gauge, air vent, and ½" drain port.

2. The instrument station shall be 120/150-flanged construction.

3. The butterfly valve shall be lug pattern with a rating of 200 WP, 250 deg. F. The valve shall have an infinite. Position operator with memory stop (6" and smaller), worm gear with memory stop (8" and larger).

E. Y-Pattern Strainers:

1. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.

2. End Connections: Threaded ends for NPS 2 (DN 50) and smaller; flanged ends for NPS 2-1/2 (DN 65) and larger.

3. Strainer Screen: 40-mesh startup strainer and perforated stainless-steel basket with 50 percent free area.

4. CWP Rating: 125 psig (862 kPa).

F. Install strainers on inlet side of each control valve, pressure-reducing valve, solenoid valve, inline pump, and elsewhere as indicated. Install NPS ¾ (DN 20) nipple and ball valve in blowdown connection of strainers NPS 2 (DN 50) and larger. Match size of strainer blow-off connection for strainers smaller than NPS (DN50).

PART 3 - EXECUTION

3.1. WORKMANSHIP:

A. General:

1. Install all piping, fixtures, equipment, and accessories as shown, and in strict accordance with the plumbing laws, rules, and regulations of the State and/or City. All work shall be done in a neat and orderly fashion and left in a condition satisfactory to the Architect/Engineer.

B. Piping:

1. All piping shall be run parallel or perpendicular to established building lines. Install piping so as to allow for expansion. Waste and vent piping occurring above floor slab shall be installed true and plumb. Extend vents at least 1 foot above roof, or to the top of the closest adjacent parapet wall, whichever is greater, and provide watertight flashing sleeves. Excavation and backfill shall be in accordance with Section 220000 of these specifications.

C. Fixtures:

1. Install fixtures true and plumb with building walls. Caulk all plumbing fixtures at joints along walls, countertops, and other intersecting surfaces. Locate fixtures as shown and per manufacturer's instructions. Furnish all required trim for fixtures to provide a complete and workable installation.

3.2. TESTS:

A. General:

1. All piping, fixtures, and equipment shall be inspected and approved before concealing or covering. All work shall be tested as required by Section 220000 of these specifications and shall be leak proof before inspection is requested. All tests shall be repeated if required by those making the inspection.

2. All potable water systems shall be flushed and disinfected in accordance with Section 220000 of these specifications. Following disinfection, system shall be flushed and water sampled to show compliance with requirements of public health authority having jurisdiction. If tested water does not meet requirements, disinfecting shall be repeated until water quality meets requirements.

B. Fixtures and Equipment:

1. Fill all plumbing fixtures with water and check for leaks or retarded flow. Repair as required. Adjust each piece of plumbing equipment as required to ensure proper functioning. Leave all fixtures and equipment in first class operating condition.

2. The Plumbing Contractor is responsible for all backflow devices to be inspected by a certified backflow technician before use of the building potable water system.

C. Smoke Test:

1. A smoke test shall be performed on the entire waste and vent system before building occupancy. After all fixtures are permanently connected and traps are filled with water, fill entire drainage systems with smoke under pressure of 1.3 pKa (1 inch of water) with a smoke machine. If leaks are detected, they shall be repaired and the smoke test shall be performed again until no leaks are found.

MUSGROVE ENGINEERING
234 S. Whisperwood Way
Boise, Idaho 83709
E-mail: musgrove@musgrovepa.com
Phone: (208) 384-0765

PIPING SYSTEM TEST REPORT

STRUCTURE/BUILDING: _____ TEST NUMBER: _____

LOCATION: _____ CONTRACT NO._____

DESCRIPTION OF SYSTEM/PIPING BEING TESTED: _____

_____

_____

Description of Test Performed	Test Pressure	Test Duration	Pass/Fail
Hydrostatic: _____	P.S.I.	_____	_____
Inert Gas: _____	P.S.I.	_____	_____
Compressed Air: _____	P.S.I.	_____	_____
Waste & Vent Smoke Test**:** _____	1" Water Column	_____	_____

NAME AND TITLE OF PERSON IN CHARGE OF PERFORMING TEST'S FOR CONTRACTOR:

Name: _____ *Title:* _____

Signature: _____

I hereby certify that the above described system has been tested as indicated above and found to be entirely satisfactory as required in the contract specifications.

Signature of Inspector: _____ *Date:* _____

REMARKS: _____

_____

_____

_____

_____

END OF SECTION 220100

DIVISION 23 – HEATING VENTILATING AND AIR CONDITIONING

SECTION 230000 - HVAC GENERAL REQUIREMENTS

PART 1 - GENERAL

1.1 SCOPE:

A. General:

1. The Bidding Requirements, Contract Requirements, and the General Requirements (Division 1) of these specifications shall govern all parts of the work.

B. Work Included:

1. Install work in accordance with these specifications and the accompanying plans. Furnish all labor, material, and equipment together with all incidental items not specifically shown or specified which are required by good practice to provide the complete mechanical systems as described.

2. The HVAC Contractor(s) and all Sub-tier Contractors shall provide installed equipment cut sheets and purchase orders required for utility rebates.

C. Coordination and Site Visits:

1. This section of the work requires examination of and reference to all architectural, structural, utility, and electrical drawings for construction conditions that may affect the work. Inspect the building site and existing facilities for verification of existing conditions. Base all measurements from established benchmarks. Any discrepancy between actual measurements and those indicated, which prevents following good practices or the intent of the drawings and specifications, shall be reported to the Architect/Engineer, and work halted until instructions are received from the Architect/Engineer.

1.2 CODES, PERMITS, FEES:

A. Install all work in accordance with applicable codes and standards. Obtain all required permits; pay all required fees including utility connections or extensions, in connection with this portion of the construction. Obtain all required certificates of inspection for the work.

PART 2 - PRODUCTS

2.1 MATERIALS AND WORKMANSHIP:

A. Materials:

1. All materials and equipment shall be of first quality, new, full size and weight, standard in

every respect, and suitable for the space required. Use the same manufacturer for products of similar class or service, such as valves, pumps, controls, and air handlers. Protect all materials against loss, theft, or damage before and after installation.

2. Furnish equipment that will operate under all conditions of load without any sound or vibration that is objectionable in the opinion of the Architect/Engineer. Vibration or noise considered objectionable will be corrected by the Subcontractor at his expense.

3. Furnish and install all necessary foundations, supports, pads, bases, and piers required for all materials and equipment furnished under this contract.

4. Provide all required firestopping at duct and piping penetrations of fire rated walls, floors, ceilings, and roofs. Firestopping shall be 3M Fire Barrier Sealant CP 25WB+ or 3M Fire Barrier Rated Foam FIP 1-Step, or approved equal.

5. Piping penetrations through walls, finished floors, and ceilings shall include one-piece stamped-steel escutcheons or one-piece floor plates.

B. Workmanship:

1. All materials and equipment shall be installed in a neat and workmanlike manner by competent specialists for each subtrade. Work shall be installed to the satisfaction of the Architect/Engineer with unsatisfactory work removed and reinstalled to his satisfaction at no extra cost to the Owner.

2. Provide all cutting and patching necessary to install the work specified in this section. Patching shall match adjacent surfaces. No structural members shall be cut without the approval of the Architect/Engineer. Provide sleeves at all piping penetrations of exterior walls and floors on grade. Provide all sleeves and inserts required before new floors and walls are built.

3. Locate all equipment that must be serviced in fully accessible positions. Provide clearance for removal of replacement parts and components, and with necessary couplings or flanges to remove the component for maintenance.

C. Protection of Equipment During Construction:

1. At the end of each shift, all duct openings and open ends shall be covered with a plastic poly sheeting film to protect against dust and construction contamination from entering the ductwork.

2.2 SUBMITTALS AND SUBSTITUTIONS:

A. Prebid Approval:

1. Manufacturer’s trade names and catalog numbers stated herein are intended to indicate the quality of equipment or materials desired. All manufacturers not specifically listed require prior approval. Submit catalog data, including specifications, of the proposed equipment to the Architect/Engineer for his approval at least 10 calendar days prior to bid opening. Notice of such approvals will be published in an addendum. Approval of listed alternate equipment

manufacturers is for bidding only. Final approval is to be based on requirements of the plans and specifications.

B. Submittals:

1. Within thirty days after award of this contract, provide an electronic copy of a complete list of all materials and equipment proposed for this project. List shall contain make, type, manufacturer's name, and trade designation of all materials and equipment. Submittal shall also include manufacturer's complete specification for each item, including capacities, ratings, etc., and dimensions as required to check space requirements. The scheduled equipment is the basis of design for capacity, weights, physical size, etc. Alternate manufacturers shall not exceed the weight or physical size. Any changes to the Architectural, Structural, Mechanical, Electrical, and Control systems due to alternate manufactures shall be the responsibility of the Contractor and Supplier. Submittals for each major trade (i.e., dryside HVAC, wetside HVAC, or Plumbing) shall be submitted in a single complete package. Individual items will not be reviewed independently unless approved by the Engineer.

2. Approval of submittals shall not relieve the contractor from responsibility for deviations from the plans or specifications, unless he has, in writing, called the Architect's /Engineer's attention to deviations at the time of submission, and obtained his written approval. Approval of submittals does not relieve the contractor from responsibility for errors in shop drawings or literature.

C. Equipment Requiring Submittals:

1. All equipment listed on plans

2. DDC Controls

PART 3 - EXECUTION

3.1 ACCESSIBILITY & SAFETY:

A. Accessibility:

1. All equipment which must be serviced or operated shall be located in fully accessible position. Minor changes from the drawings may be made to allow for better accessibility. All changes shall be approved prior to actual installation.

2. Access panels shall be provided if required for accessibility. Access panels to be steel, flanged, hinged doors by Cendrex, or equal. Sized as required for installation. Subcontractor shall furnish the required panels to the General Contractor and the required location for all access panels, unless otherwise specified in the Architectural specifications. Panels shall be installed by the General Contractor.

B. Safety:

1. Subcontractor shall provide guards for all belt drives and rotating machinery.

3.2 COORDINATION:

A. Coordinate all work with the various trades involved to provide a complete and satisfactory installation. The exact details of ductwork and equipment are not shown. No additional compensation will be made for offsets or relocation required in coordination with other trades.

B. Alterations required due to improper supervision by the subcontractor shall be made at no extra cost, to the satisfaction of the Architect/Engineer.

3.3 ELECTRICAL:

A. Electric motors required for equipment specified in this section shall be provided and installed by this Subcontractor. Motor starters, disconnects, relays, pilot lights, etc., are in general, to be furnished and installed by the Electrical Contractor. Starters, relays, controls, etc., which are factory assembled into packaged equipment shall be furnished by the Mechanical Contractor under this section of the specifications.

B. All motors shall be provided with adequate starting and protective equipment as specified or required. Motor capacity shall be sufficient to operate driven device under all conditions of operation and load without overload. Minimum horsepower shall be as specified.

3.4 IDENTIFICATION AND CODING:

A. Painting:

1. All painting of mechanical equipment, accessories and ductwork shall be furnished and applied under the Architectural section of these specifications. All painting shall be completed before any identification markings are applied.

B. Equipment:

1. Identify all equipment with a black Formica label, with white reveal when engraved. Lettering to be 3/16 inch high minimum. In general, identify equipment as to area served in addition to title and code number of the equipment as taken from the plans.

C. Piping:

1. Identify all piping as to the service of the pipe and the direction of flow. The letters shall be 3/4 inch high on piping two inches or smaller, and 1-1/4 inches high on piping up to six inches. Flow arrows shall be at least six inches long. The letters and flow arrows shall be made by precut stencils and oil base paint, one inch high and black, or factory fabricated plastic pipe markers. Piping shall be identified at 25 foot maximum intervals, on long continuous lines; adjacent to each item of equipment; on each riser and junction, and on both sides of all wall penetrations. Underground piping shall be identified with bright colored continuously printed plastic tape of not less than 6" wide by 4 mil thick, manufactured for direct burial service. Install directly above all buried pipe, 6 to 8 inches below finished grade.

3.5 TESTING:

A. Systems:

1. All systems, including heating, ventilating and air conditioning, shall be tested at the completion of the building to establish that the systems operate as specified and required. Testing shall be performed after air balancing is completed.

2. All controls shall be calibrated accurately and all equipment shall be adjusted for satisfactory operation. Excessive vibration or noise from any system shall be corrected.

3. The air conditioning system shall be tested for satisfactory operation when the outside air temperature reaches 60 degrees F. or warmer. All other systems shall be tested at building completion. All tests shall be performed in the presence of the Architect/Engineer or his representative.

3.6 BALANCING:

A. Scope:

1. Prior to final acceptance by the Owners, all air systems shall be balanced to deliver the quantities as specified or directed. The air balance shall be performed by an independent agency specializing in balancing and is certified by the National Environmental Balancing Bureau.

2. Balance contractor's main office shall be located within 50 miles from the project site. Approved balance contractors are Evolve Engineering, NWESI, Building Systems Technologies, and Blue-Sky Commissioning. All other contractors must receive prior approval from the Engineer, in writing, before bidding the project.

3. The Mechanical Contractor shall provide assistance to the Balancing Contractor by identifying all installed mechanical systems and assisting access to all installed mechanical systems. All mechanical systems shall be completely operational and functional prior to the Balancing Contractor performing their specified work.

B. Air balancing:

1. Balancing of the air system shall consist of:
   a. Adjust all air volumes to the quantities shown, with allowable variation of plus 10, minus 10 percent.
   b. Record all system, zone, diffuser, grille, and register C.F.M. Use volume control devices to regulate air quantities only to the extent that adjustments do not create objectionable air motion or sound levels. Balancing Engineer shall work with the Contractor to set minimum & maximum CFM quantities for zone dampers, or zone dampers/heaters.
   c. Test and record all system static pressures, inlet and discharge, on all packaged units, fans, and terminal units. Vary total system air quantities by adjustment of fan speeds. Provide drive changes as necessary. Vary branch air quantities by damper regulation.
   d. Test and record motor full load amps and nameplate amps.
   e. Test and record entering and leaving temperatures at all coils.
   f. Adjust all automatically operated dampers, in cooperation with the Control Contractor, to the required settings. Adjust outside air automatic dampers, outside air, return air,

and exhaust dampers for design conditions within specified tolerances. Where modulating dampers or economizers are provided, take measurements at full return air, minimum outside air, and 100 percent outside air mode of operation.

g. Adjust diffusers and grilles for proper deflection, throw, and coverage. Eliminate drafts and excessive noise where possible.

h. Mark final positions of all balance dampers with a red felt pen.

i. Air systems shall be balanced in accordance with standard procedures and recognized practices of the Associated Air Balance Council, and the Testing Adjusting, and Balancing Bureau.

C. Quality Assurance:

1. The Balancing Contractor shall demonstrate to the Engineer of record, flow verification for at least 10% of the balanced devices as selected by the Engineer. If more than 25% of the tested devices do not meet the designed or balance report, then the entire system balance must be rebalanced.

D. Balance Reports:

1. Submit four copies of the air system balance report to the Architect/Engineer for evaluation and approval. Reports shall be on TABB/SMACNA forms that indicate information addressing each of the testing methods, readings, and adjustments.

3.7 CLEANING AND ADJUSTING:

A. Thoroughly clean all air conditioning units, air handling units, and all associated parts of the system at the completion of the work. Install new, clean air filters in all systems. Adjust all devices for proper operation and lubricate all equipment as required. Repaint any painted surface that has been damaged.

3.8 PROJECT CLOSEOUT:

A. Operations & Maintenance Manual:
The Contractor shall provide an operations and maintenance manual at least thirty days prior to completion of work. The manual shall be of the three-ring binder type, entitled "Operations and Maintenance Manual", with the job name and year of completion also included. O & M manuals shall be submitted in a single package. In addition, the contractor shall provide two consolidated electronic versions on two separate thumb drives. Individual items will not be accepted independently unless approved by the Engineer. The manual shall include, as a minimum:

1. Maintenance instructions for all equipment, including lubrication requirements.

2. Equipment suppliers' names, addresses, and telephone numbers.

3. Equipment catalog cuts, ratings tables, model numbers, serial numbers, and accessories.

4. Parts numbers for all replaceable parts.

5. Air and/or water systems balance report as hereinbefore specified.

6. Control diagram or drawing and operation sequence.

7. Valve tagging chart as hereinbefore specified.

8. Filter chart listing unit callout, size of filters, and quantity of filters.

9. Guarantee letter as specified below.

10. Any additional information required to enable the Owner to properly maintain the building mechanical system.

11. Mechanical Equipment Start-up forms, which are included in this specification, if they are required.

12. After approval of the Operations and Maintenance Manual by the Architect/Engineer, the Contractor shall furnish two copies of the manual to the Owner.

B. Mechanical System Training Period:

1. After the mechanical system is completely installed and operational, the mechanical contractor shall provide a minimum of 20 hours training and instruction time for the building Owner or his representative. During this period, the contractor shall instruct the Owner in the operation and maintenance of all parts of the mechanical system, using the O & M manual where applicable. The contractor shall provide a copy of the Project Owner Mechanical Systems Training Form (attached to this specification), with proper signatures, to the Engineer prior to substantial completion and ensure that a copy is inserted into the project O & M manuals.

2. Video Taping – The mechanical contractor is to perform videotaping of the Owner training and instruction. Provide two (2) CD copies to Owner and one (1) copy to be inserted into the O & M Manuals.

C. As-Built-Drawings:

1. Provide two sets of red-line mechanical drawings showing the work as it was actually installed. The drawings shall indicate all departures from the contract drawings. Make all notations neat and legible, with red indelible pencil. At the completion of the work, these as-built drawings shall be signed and dated by the Mechanical Contractor, and returned to the Architect/Engineer.

D. Guarantee:

1. All work furnished under this section shall be guaranteed in writing to be free from defective work or materials for a period of one year after acceptance of the contract. All repairs or replacements because of defective materials or workmanship or noncompliance with code shall be provided without additional cost to the Owner. Contractor shall furnish a letter indicating above guarantee with space for date of acceptance and expiration of guarantee. Letter shall be included in O & M Manual.

END OF SECTION 230000

NAME OF PROJECT: _____

_____

OWNER MECHANICAL SYSTEM TRAINING FORM

Upon completion of the equipment and systems installation and connections, the contractor shall assemble all required equipment factory representative and subcontractors together for system Owner training.

These people shall assist in Owner training their system(s) and remain at the site until the total system operations is acceptable and understood by the Owner's representative(s), maintenance and/or operation personnel, on operation and maintenance of their equipment. To prove acceptance of operation and instruction by the Owner's representative(s), the contractor shall provide a copy of this form, with proper signatures, to the Engineer prior to substantial completion, and ensure that a copy is inserted into the project Operation and Maintenance manuals.

> "I, the Contractor, associated factory representative and subcontractors, have started each system and the total system(s); and have proven their normal operation to the Owner's representative(s) and maintenance/operation personnel and have instructed him/them _____, hours in the operation and maintenance thereof."

_____	_____
Owner's Representative	Contractor
_____	_____
Signature	Signature
_____	_____
Date	Date

SECTION 230100 - HEATING, VENTILATING, AND AIR CONDITIONING

PART 1 - GENERAL

1.1 SCOPE

A. This section covers the work necessary for the heating, ventilating, and air conditioning system, complete. The HVAC General Requirements, Section 230000, is to be included as a part of this section of the specifications.

1.2 CODES & STANDARDS

A. The heating, ventilating, and air conditioning system shall be installed in accordance with the latest edition of the following codes and standards:

1. International Mechanical Code (IMC)

2. International Building Code (IBC)

3. American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE)

4. National Fire Protection Association (NFPA)

5. Sheet Metal and Air Conditioning Contractors National Association, Inc. (SMACNA)

PART 2 - PRODUCTS

2.1 AIR HANDLING UNITS AND OTHER EQUIPMENT

A. Equipment shall be as scheduled or equal.

B. All RTUs shall be provided with no on-board controls. All controls shall be field applied by DDC contractor.

2.2 AIR DISTRIBUTION

A. Ductwork:

1. Low pressure ductwork shall be fabricated from galvanized sheet metal, unless otherwise indicated. Construction requirements shall be in accordance with SMACNA - HVAC Duct Construction Standards, metal and flexible, latest edition. All sheet metal ductwork shall be sealed with McGill United Sheet Duct Sealer or equal, in accordance with the International Energy Compliance Code, latest edition. Adjustable (twist) elbows are not allowed. Low pressure ductwork shall be constructed to the following SMACNA static pressure standards:
   a. Supply air ductwork = 2" W.G.
   b. Return, Exhaust, Outside Air Intake ductwork = 1" W.G.

2. Ductwork located in exposed ceiling areas, shall be standard galvanized sheet metal with minimum G60 galvanizing, paint-lock spiral ductwork is not acceptable. All ductwork which is to be installed in exposed ceiling areas shall be stored inside from the time of manufacturing to installation; no outside storage shall be acceptable. Sheet metal shall have a clean, uniform color. Joints shall be sealed evenly and in a professional manner with silver silicon. Discolored or damaged ductwork unacceptable to the Engineer shall be replaced at the Contractors expense.
    a. Joints: 0" to 20" diameter, interior slip coupling beaded at center, fastened to duct with screws and with sealing compound applied continuously around joint before assembling and after fastening. Sealing compound shall be applied in an evenly and professional manner.
    b. Joints 22" – 72" diameter, use 3-piece, gasketed, flanged joints consisting of 2 internal flanges (with integral mastic sealant) split to accommodate minor differences in duct diameter, and one external closure band designed to compress gasketing between internal flanges. Manufacturer shall be Ductmate Spiralmate or equal.
    c. All takeoff or branch entrances shall be by means of factory-fabricated fittings. Field taps shall not be allowed.

3. Low pressure ductwork which is exposed or located in mechanical rooms shall be fabricated from galvanized sheet metal. Construction requirements shall be in accordance with SMACNA HVAC Duct Construction Standards, metal and flexible, latest edition.

4. Fume hood exhaust ducts:
    a. Fume hood and lab exhaust ductwork shall be single wall 316L stainless steel, ASTM-A312 built for structural strength. Protect finish with mill applied protective plastic/paper throughout construction. All balancing dampers and other accessories located in the fume hood exhaust duct system shall be 316 stainless steel.
        1) All lab exhaust ductwork except the individual runouts from the main to the fume exhaust hood.
            a) Duct shall be a minimum of 18 gauge.
            b) Elbows and angles shall have the same gauge as ductwork, inside radius not less than width of ductwork.
            c) The duct system shall be fitted with copper grounding straps, connected to the duct and to an effective grounding system.
            d) Provide drains at low points in ductwork.
            e) See fabrication requirements below for ductwork fabrication and assembly requirements.
            f) Note that all fittings, accessories, etc. in the fume hood and laboratory exhaust ductwork system shall be fabricated from 316 stainless steel.
        2) All lab exhaust runouts from the main to fume exhaust hoods.
            a) Duct shall be a minimum of 18 gauge.
            b) Elbows and angles shall have the same gauge as ductwork, inside radius not less than width of ductwork.
            c) The duct system shall be fitted with copper grounding straps, connected to the duct and to an effective grounding system.
            d) Ducts shall be sloped back to their respective hood.
            e) Longitudinal and transverse joints between ductwork and fittings shall be continuous purge welded with Argon gas. Use of spot welds and sealants is prohibited.
            f) Note that all fittings, accessories, etc. in the fume hood and laboratory exhaust ductwork system shall be fabricated from 316 stainless steel.

5. Type – 1 Kitchen Hood exhaust ductwork shall be fabricated from minimum 16 gauge welded steel, and shall be constructed in strict accordance with the latest edition of the International Mechanical Code.

   Type – 2 Kitchen Hood exhaust ductwork shall be fabricated from aluminum sheet metal, in accordance with SMACNA Standards

6. Ductwork penetrating protective elements of fire-rated corridor walls, with no openings into corridor, shall be constructed of minimum 26 gauge galvanized steel.

7. Exterior exposed ductwork shall be fabricated from galvanized sheets. All joints and seams shall be standing-seam type with sealing mastic to provide watertight construction. All ductwork shall be internally insulated as hereinafter specified. All exposed surfaces shall be primed and painted two coats of exterior enamel paint, color as selected by the Architect.

8. Shower and locker room exhaust ductwork shall be constructed of galvanized sheet metal, in accordance with SMACNA standards.

9. Flexible ducts shall be listed per UL-181 standard as Class 1 flexible, acoustical insulated air duct and complying with NFPA Standards 90A and 90B. Ducts shall be insulated with a minimum R-6 value, and shall have a maximum vapor transmission value of .05 perms. Ducts shall be factory made with and composed of: a PE liner duct permanently bonded to a coated spring steel wire helix. Duct shall be chlorine free and carry a ten-year warranty for the labor to replace the duct should there be a factory defect. Low permeability outer vapor barrier of fiberglass bidirectional reinforced metalized laminate shall complete the composite. Pressure rating shall be 6" w.g. and maximum length shall be 6 feet. Attach to duct take-off, diffuser, register, or grille only, with nylon or stainless steel duct clamp or tie. Flexmaster 1-M, or approved equal.

B. Duct Accessories:

1. Turning vanes shall be installed in all rectangular or square elbows. Vanes shall be installed in vane side rails. Vanes shall be single wall vanes, and be fabricated and installed per SMACNA standards.

2. Volume dampers shall be fabricated from galvanized steel in accordance with SMACNA standards. Dampers shall have a continuous galvanized steel shaft on ducts 13” diameter or larger, with damper regulators and end bearings. Dampers located above inaccessible ceilings (hard ceilings) shall be furnished with concealed ceiling damper regulators. Dampers shall be pressure rated equal to the design duct pressure rating. Dampers shall be provided at all diffuser and supply/exhaust grille takeoffs, regardless if indicated on the plans. Dampers are not required on the return air takeoffs unless specifically indicated.

3. Flexible connections shall be provided at all rotating fan equipment. Connectors shall be of fire, water, and weather resistant material.

4. Fire dampers shall be UL-labeled with frame, locking assembly, accordion style folded blades, and fusible link. Dampers shall be Style B with blades stored outside of the air stream. Provide duct inspection door at each fire damper. Minimum size shall be 8" x 8". Inspection door shall be provided with a steel frame with gasketing around periphery, and a hinged panel. Dampers located in moisture laden air conditions shall have all metal parts made of stainless steel.

5. Combination smoke and fire dampers are to be fusible link type with factory sleeve and electric operator located exterior to duct 120 V. operator to be spring return, fail closed with 212 degrees F link and UL label. Provide duct inspection door at each damper. Minimum size shall be 8" x 8". Inspection door shall be provided with a steel frame with gasketing around periphery, and a hinged panel. Dampers located in moisture laden air conditions shall have all metal parts made of stainless steel. Belimo operators/actuators only.

6. Smoke dampers are to be ultra-low leakage (less than 4CFM/ft^2) type with factory sleeve and electric operator located exterior to duct 120 V. operator to be spring return, fail closed and UL label. Provide duct inspection door at each damper. Minimum size shall be 8" x 8". Inspection door shall be provided with a steel frame with gasketing around periphery, and a hinged panel. Dampers located in moisture laden air conditions shall have all metal parts made of stainless steel. Belimo operators/actuators only.

7. A plastic flex elbow support by Flexible Technologies Inc., Titus FlexRight, or approved equal, is required at all flex duct elbows supplying ceiling diffusers & return grilles. Elbow support shall be fully adjustable, or be of universal design, to support flexible diameters 6" – 16", sized to fit flex duct. Elbow supports shall be UL rated for use in return air plenum spaces. At the Contractor's option, a hard elbow may be used in lieu of a flexible elbow.

C. Diffusers, Registers, Louvers, Grilles, Weathercaps:

1. See Drawings for requirement.

D. Duct Cleanliness:

1. Ductwork Delivery To Site
   a. During ductwork being delivered from the premises of the manufacturer, care must be taken to prevent damage during transportation and off-loading.

2. Temporary Storage
   a. Job site duct material storage areas should be clean, dry, and located away from high dust generating processes such as masonry or tile cutters, cutoff saws, drywall sanding, mortar and plaster mixers, roof pitch kettles, portable electric generators, and main walkways that will be constantly broom swept. The general contractor should designate a suitable area for temporary storage.
   b. To prevent ductwork material damage from standing water, storage locations should include pallets or blocking to keep fabricated metal ductwork above the floor surface. If there is a risk of water runoff from above or dusty areas cannot be avoided, coverage should be used to protect stored materials.

3. Installation
   a. Before the installation of individual duct sections, they are to be inspected to ensure that they are free from all debris.
   b. All ductwork risers must be covered to prevent the entry of debris into the duct.
   c. Downward facing and horizontal ductwork openings will not be required to be covered.
   d. Access covers shall be firmly fitted in position on completion of each section of the work. Open ends on completed ductwork and overnight work-in-progress shall be sealed.
   e. The working area should be clean and dry and protected from the elements.
   f. The internal surfaces of the uninsulated ductwork shall be wiped to remove excess dust

immediately prior to installation.

2.3 PIPING SYSTEMS

A. Refrigerant Piping:

1. Refrigerant piping shall be Type L hard drawn copper, ASTM B280, with wrought copper fittings and Silvaloy joints.

2. Provide factory wall outlet Airex Titan Outlet by Airex Manufacturing Inc. or equal. Wall outlet shall be provided with compression gasket and seal and fastened with non-corrosive screws with pre-loaded neoprene washers. Wall outlet shall be provided with an integrated over-molded flexible elastomeric sleeve for sealing, isolating and supporting refrigerant pipes from vibration. The wall outlet must provide for expansion and contraction wall protection features with gaskets and seals. A stainless-steel clamp must be provided and installed to provide a watertight seal.

B. Pipe Hangers and Supports:

1. See Section 220100 for hanger and support requirements for piping systems. See drawings for seismic support requirements for piping systems.

2.4 INSULATION

A. General:

1. All insulation shall have composite fire and smoke hazard ratings, as tested by ASTM E-84, NFPA 255, and UL 723, not exceeding:

Flame Spread	25
Smoke Developed	50

B. Ductwork - External Insulation:

1. Insulation shall be fiberglass insulation with aluminum foil scrim kraft facing. All joints shall be taped with UL listed tape to provide a continuous vapor barrier. The following ducts shall be externally insulated:
   a. Supply ducts in unconditioned spaces (unless internally insulated)
   b. Return ducts in unconditioned spaces (unless internally insulated)
   c. Combustion air ducts
   d. Outside air intake ducts
   e. Exposed ductwork located within conditioned spaces shall not be externally insulated

2. Insulation thickness & "R" values shall be as follows:
   a. R-6 – ducts located in unconditioned spaces (such as above ceiling, but below roof insulation) and outside air intake ducts.
   b. R-12 – ducts located outside of the building's insulation envelope (such as above the attic insulation).

C. Ductwork - Internal Insulation:

1. Insulation shall be flexible fiberglass duct liner. Liner shall be attached with 100% coverage of manufacturers recommended adhesive and welded or mechanically fastened galvanized steel pins. All exposed edges of liner shall be coated with adhesive. Duct dimensions shown are net air side face-to-face of duct liner. The following ducts shall be internally insulated:
   a. Supply and Return ducts within 15'-0" of air handler
   b. Supply and Return ducts in mechanical rooms
   c. 15'-0" downstream of VAV terminal units.
   d. 15'-0" downstream of fan coil units.
   e. Exterior ducts (located outdoors)
   f. Buried ductwork below concrete slab
   g. Ducts as indicated on plans

2. Insulation thickness & "R" values shall be as follows:
   a. R-6 – ducts located in unconditioned spaces (such as above ceiling, but below roof insulation, or buried ductwork) and outside air ducts located outside of the building envelope.
   b. R-12 – ducts located outside of the building's insulation envelope (such as above the roof).

E. Piping Insulation - Refrigerant Piping:

1. Insulation on refrigerant suction piping shall be one-piece preformed flexible formed tubing with built-in closed cell vapor barrier. Seal laps and butt joints with moisture resistant adhesive to provide a continuous vapor seal. Cover all insulated suction lines exposed on the exterior of the building with E-Flex Guard by Airex Manufacturing, Inc. At exterior wall penetration provide Titan outlet by Airex Manufacturing, Inc. or equal with an Insulation thickness as follows:

	Nominal Pipe Diameter		
Refrigerant line set type	1" and less	1" to < 1½"	1 ½" and above
Located with-in the conditioned spaces			
Suction	½"	1"	1"
Liquid	not required		
Discharge (hi/low pressure)	1"	1"	1"
Located outside the conditioned spaces			
Suction	½"	1"	1"
Liquid	not required		
Discharge (hi/low pressure)	1 ½"	1 ½"	2"

F. Piping Insulation - Exterior (Outdoor) Piping:

1. Piping located outdoors shall be insulated as specified above. In-addition piping shall be covered with a weather-proof aluminum alloy 3003 or 3105 jacket meeting ASTM standard B209, minimum 0.016" think, installed per the manufacturers installation requirements. At a minimum the following installation shall occur. The jacketing overlap shall be a minimum of 2". Horizontal piping shall have the jacket seams located at the 3 o'clock or 9 o'clock position with the seam joint openings point downward to shed moisture. Vertical piping shall have the upper jacket seams overlap the lower seam to shed moisture. Valve

handles and gauges shall be positioned on the bottom to help prevent water penetration. Banding shall be used to secure the jacketing; screws, rivets, and all other fasteners capable of penetrating the underlying vapor retarder shall be prohibited. Jacketing sealant shall be applied to all longitudinal and circumferential joints and the sealant shall be located between the aluminum jacket, not at the outer lip.

2.5 VIBRATION ISOLATION

A. General:

1. All rotating equipment and appurtenances connected to rotating equipment shall be vibration isolated from the supporting structure. No metal to metal contact will be permitted between fixed and floating parts. All metal isolators exposed to weather shall be hot dipped galvanized after fabrication. Piping connected to rotating equipment shall be hung with spring hangers for first 50 pipe diameters.

2.6 SEISMIC SUPPORTS

A. All equipment, ductwork, and piping shall be seismically supported as required by the International Building Code, latest edition. Support details shall be as indicated on the Drawings.

2.7 CONTROL SYSTEM

A. General:

1. The Control Contractor shall be responsible for a complete and operable control system, including equipment, installation, and accessories required to perform the functions specified on the drawings. The Control Contractor shall supervise the installation of all control equipment and accessories and shall submit shop drawings of the proposed system for approval.

2. The Control Contractor shall furnish and install all control conduit and wiring. All wiring shall be installed in EMT in accordance with the section Electrical. Provide plastic covered wires of not less than 18-gauge (16-gauge if longer than 50'), with at least one spare circuit at each control device. Control voltage shall not exceed 30 volts, except in starter pilot circuits.

B. Control Equipment and Accessories:

1. Control Dampers:
   a. All control dampers are to be furnished under this section, except those specified to be furnished with the air handling units. Damper blades shall be fabricated of 22-gauge galvanized sheet steel and frames shall be not less than 16-gauge galvanized steel. Blades shall be maximum 10 inches wide, 50 inches long, and shall be provided with neoprene gasketed edges and oilite bronze or nylon bearings. Dampers shall be ultra-low leakage, opposed blade type for proportional action and parallel blade type for two-position action. Leakage performance shall be a maximum of 3 cfm per sq, ft. @ a pressure differential of 1" w.g. Provide damper operators for all motorized dampers and louvers. Belimo or approved equal. Submittals shall include leakage and pressure

drop data for all control dampers. All outside air dampers shall fail closed.

2. Control Valves:
   a. Control valves 2-1/2" and smaller shall be screwed, 3" and larger shall be grooved or flanged. Screwed valves shall be bronze or cast brass, grooved valves shall be ductile iron, and flanged valves shall be cast iron or cast steel. Three way valves shall have contoured plugs for linear flow characteristics and constant total flow throughout the stem travel. Straight-thru valves shall be single seated and have equal percentage characteristics for water service. Flat discs shall be used for on-off control only. All valves shall be stainless steel stems, replaceable seats, and self-adjusting Teflon or rubber packing. All heating control valves shall fail open. Belimo or approved equal.

3. Air Duct Smoke Detector:
   a. Smoke detector shall be products of combustion detector and shall be UL listed. The unit shall be designed for detection of combustion gases, fire, and smoke in air ducts in compliance with NFPA Pamphlet 90A. The sheet metal contractor shall provide a minimum 18”x18” hinged access door, in inaccessible ceilings, for each detector that is furnished. The sheet metal contractor is also responsible for providing all necessary transitions in the ductwork for mounting of the duct detector.

4. Thermostats:
   a. Thermostats shall be 7-day programmable type, with automatic changeover from heating to cooling, be provided with auxiliary contacts.
   b. Thermostats shall be provided with lockable covers.
   c. Thermostats installed on exterior walls shall be mounted on an insulating block, or on foam insulation filled J-box.
   d. All thermostats shall have a mounting height of 46 inches, to the centerline of the device, unless otherwise noted on electrical drawings.

5. Equipment Control Schematics:
   a. See Drawings for schematics and sequence of operations.

PART 3 - EXECUTION

3.1 WORKMANSHIP

A. General:

1. Install all materials and equipment as shown and in strict accordance with the applicable codes for the State and/or city. Plans do not attempt to show exact details of all piping and ductwork, and no extra payment will be allowed for offsets required due to obstructions by other trades. All work shall be done in a neat and orderly fashion and left in a condition satisfactory to the Architect/Engineer.

2. All piping shall be run parallel or perpendicular to established building lines. Install piping so as to allow for expansion. Install all valves with stems horizontal or above. Install air vents at all high points. Provide all piping which passes through walls, floors, or ceilings with standard weight pipe sleeves.

B. Insulation:

1. All piping insulation shall be applied over clean, dry surfaces after system has been pressure tested and any leaks corrected. Finished appearance of all insulation shall be smooth and continuous. Provide coat of insulating cement where needed to obtain this result.

2. Flexible duct insulation shall be secured to duct surface with 4-inch wide bands of adhesive applied on maximum 18-inch centers. Additional galvanized tie-wire support shall be furnished as required and recommended by the insulation manufacturer.

C. Diffusers, Registers and Grilles:

1. All diffusers, grilles, and registers shall be installed tight on their respective mounting surfaces and shall be accurately centered on ceiling tile, recesses, windows, or doors.

D. Ductwork:

1. All sheet metal work shall be done by qualified, experienced mechanics in accordance with the requirements of ASHRAE and the latest edition of the applicable SMACNA Manual. All ductwork shall be installed in a neat and orderly manner, and shall be adequately supported to prevent vibration or sagging. All sheet metal ductwork shall be sealed with United-Sheet Metal Duct Sealer or equal.

E. Air Conditioning Units:

1. Units shall be installed approximately where shown on the plans to provide access space for filter changing, motor, drive and bearing servicing, and fan shaft and coil removing. Pipe drain pan connection through a running trap to floor drain. Unit shall not be operated until filters are installed. Isolate sheet metal ducts from all fans with flexible connectors.

F. Condensing Units/ Heat Pumps:

1. Units located at grade shall be positioned such that they are beyond the roof drip line. Units shall be installed on a 6” concrete pad.

2. Units located on flat rooftops shall be provided with Miro Industries Model HD, or equal, heavy duty galvanized roof support with adjustable legs, sized 6 inches larger, in each direction, than equipment footprint.

END OF SECTION 230100

PAGE INTENTIONALLY BLANK

SECTION 230800 – HVAC COMMISSIONING REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Specification Sections, apply to this Section.

1.2 SUMMARY:

A. This Section includes requirements for commissioning the HVAC system and its subsystems and equipment, including the Direct Digital Control system.

B. The mechanical contractor is responsible to provide evidence of mechanical systems commissioning and completion in accordance to the provisions of this section.

1.3 DEFINITIONS:

A. A. Architect: Includes Architect identified in the Contract for Construction between Owner and Contractor, plus consultant/design professionals responsible for design of HVAC, electrical, communications, controls for HVAC systems, and other related systems.

B. RDP: Registered Design Professional

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

D. TAB: Testing, Adjusting, and Balancing.

1.4 COMMISSIONING DOCUMENTATION:

A. Commissioning Plan: A commissioning plan will be developed by a registered design professional or approved agency and shall include the following items:
   1. A narrative description of the activities that will be accomplished during each phase of commissioning, including the personnel intended to accomplish each of the activities.
   2. A listing of the specific equipment, appliances or systems to be tested and a description of the tests to be performed.
   3. Functions to be tested, including, but not limited to calibrations and economizer controls.
   4. Conditions under which the test will be performed. At a minimum, testing shall affirm winter and summer design conditions and full outside air conditions.
   5. Measurable criteria for performance

B. Test Checklists: RDP, with assistance of Architect/Engineer, shall develop test checklists for each system, subsystem, or equipment including interfaces and interlocks, and include a separate entry, with space for comments, for each item to be tested. Prepare separate checklists for each mode of operation and provide space to indicate whether the mode under test responded as required. Provide space for testing personnel to sign off on each checklist.

1. Name and identification of tested item.
2. Test number.
3. Time and date of test.
4. Indication of whether the record is for a first test or retest following correction of a problem or issue.
5. Date of the test and name of parties involves as applicable.
6. Individuals present for test.
7. Deficiencies/Issues/Results of test.
8. Note if re-test is necessary.

C. Test and Inspection Reports: RDP shall record test data, observations, and measurements on test checklists. Photographs, forms, and other means appropriate for the application shall be included with data. RDP shall compile test and inspection reports and tests and inspection certificates and include them in systems manual and commissioning report.

D. Corrective Action Documents: RDP shall document corrective action taken for systems and equipment that fail tests. Include required modifications to systems and equipment and revisions to test procedures, if any. Retest systems and equipment requiring corrective action and document retest results.

E. Issues Log: RDP shall prepare and maintain an issues log that describes design, installation, and performance issues that are at variance with the Contract Documents. Identify and track issues as they are encountered, documenting the status of unresolved and resolved issues.
   1. Creating an Issues Log Entry:
      a. Identify the issue with unique numeric or alphanumeric identifier by which the issue may be tracked.
      b. Assign a descriptive title of the issue.
      c. Identify date and time of the issue.
      d. Identify test number of test being performed at the time of the observation, if applicable, for cross-reference.
      e. Identify system, subsystem, and equipment to which the issue applies.
      f. Identify location of system, subsystem, and equipment.
      g. Include information that may be helpful in diagnosing or evaluating the issue.
      h. Note recommended corrective action.
      i. Identify commissioning team member responsible for corrective action.
      j. Identify expected date of correction.
      k. Identify person documenting the issue.
   2. Documenting Issue Resolution:
      a. Log date correction is completed or the issue is resolved.
      b. Describe corrective action or resolution taken. Include description of diagnostic steps taken to determine root cause of the issue, if any.
      c. Identify changes to the Contract Documents that may require action.
      d. State that correction was completed and system, subsystem, and equipment is ready for retest, if applicable.
      e. Identify person(s) who corrected or resolved the issue.
      f. Identify person(s) documenting the issue resolution.
   3. 3Issues Log Report: On a periodic basis, but not less than for each commissioning team meeting, RDP shall prepare a written narrative for review of outstanding issues and a status update of the issues log. As a minimum, RDP shall include the following information in the issues log and expand it in the narrative:

      a. Issue number and title.
      b. Date of the identification of the issue.
      c. Name of the commissioning team member assigned responsibility for resolution.
      d. Expected date of correction.

F. Commissioning Report: RDP shall document results of the commissioning process including unresolved issues and performance of systems, subsystems, and equipment. The commissioning report shall indicate whether systems, subsystems, and equipment have been completed and are performing according to the Contract Documents. The commissioning report shall include, but is not limited to, the following:
   1. Lists and explanations of substitutions; compromises; variances in the Contract Documents; record of conditions; and, if appropriate, recommendations for resolution. This report shall be used to evaluate systems, subsystems, and equipment and shall serve as a future reference document during Owner occupancy and operation. It shall describe components and performance that exceed requirements of the Contract Documents. It may also include a recommendation for accepting or rejecting systems, subsystems, and equipment.
   2. Commissioning plan.
   3. System balance reports.
   4. Testing plans and reports.
   5. Corrective modification documentation.
   6. Issues log.
   7. Completed test checklists.
   8. Listing of off-season tests not performed and a schedule for their completion.

G. Systems Manual: RDP shall gather required information and compile systems manual. Systems manual shall include, but is not limited to, the following:
   1. Submittal Data stating equipment size and selected options for each piece of equipment requiring maintenance.
   2. Operation and maintenance data on each piece of equipment requiring maintenance. Required routine maintenance actions shall be clearly identified.
   3. Name and address of at least one service agency.
   4. HVAC controls system maintenance and calibration information.
   5. A narrative of how each system is intended to operate, including recommended setpoints.

PART 2 - PRODUCTS – NOT USED

PART 3 - EXECUTION

3.1 BALANCING:

A. Scope:
   1. Prior to final acceptance by the Owners, all air systems shall be balanced to deliver the quantities as specified or directed. The air balance shall be performed by an independent agency specializing in balancing and is certified by the National Environmental Balancing Bureau.
   2. The Mechanical Contractor shall provide assistance to the Balancing Contractor by identifying all installed mechanical systems and assisting access to all installed mechanical systems. All mechanical systems shall be completely operational and functional prior to the Balancing Contractor performing his specified work.

B. Air balancing:
   1. Balancing of the air system shall consist of:
      a. Adjust all air volumes to the quantities shown, with allowable variation of plus 10, minus 10 percent.
      b. Record all system, zone, diffuser, grille, and register C.F.M. Use volume control devices to regulate air quantities only to the extent that adjustments do not create objectionable air motion or sound levels. Balancing Engineer shall work with the Contractor to set minimum & maximum CFM quantities for zone dampers, or zone dampers/heaters.

c. Test and record all system static pressures, inlet and discharge, on all packaged units, fans, and terminal units. Vary total system air quantities by adjustment of fan speeds. Provide drive changes as necessary. Vary branch air quantities by damper regulation.
d. Test and record motor full load amps and nameplate amps.
e. Test and record entering and leaving temperatures at all coils.
f. Adjust all automatically operated dampers, in cooperation with the Control Contractor, to the required settings. Adjust outside air automatic dampers, outside air, return air, and exhaust dampers for design conditions within specified tolerances. Where modulating dampers or economizers are provided, take measurements at full return air, minimum outside air, and 100 percent outside air mode of operation.
g. Adjust diffusers and grilles for proper deflection, throw, and coverage. Eliminate drafts and excessive noise where possible.
h. Mark final positions of all balance dampers with a red felt pen.
i. Air systems shall be balanced in accordance with standard procedures and recognized practices of the Associated Air Balance Council, and the Testing Adjusting, and Balancing Bureau.

C. Quality Assurance:
1. The Balancing Contractor shall demonstrate to the Engineer of record, flow verification for at least 10% of the balanced devices as selected by the Engineer. If more than 25% of the tested devices do not meet the designed or balance report, then the entire system balance must be rebalanced.

D. Balance Reports:
1. Submit four copies of the air system balance report to the Architect/Engineer for evaluation and approval. Reports shall be on TABB/SMACNA forms that indicate information addressing each of the testing methods, readings, and adjustments.

3.2 3.2 TESTING:

A. Test systems and intersystem performance after test checklists for systems, subsystems, and equipment have been approved.

B. Perform tests using design conditions whenever possible.
1. Simulate conditions by imposing an artificial load when it is not practical to test under design conditions and when written approval for simulated conditions is received from RDP. Before simulating conditions, calibrate testing instruments. Set and document simulated conditions and methods of simulation. After tests, return settings to normal operating conditions
2. Alter set points when simulating conditions is not practical and when written approval is received from RDP.
3. Alter sensor values with a signal generator when design or simulating conditions and altering set points are not practical. Do not use sensor to act as signal generator to simulate conditions or override values.

C. Scope of HVAC Subcontractor Testing.
1. Testing scope shall include entire HVAC installation, from central equipment for heat generation and refrigeration through distribution systems to each conditioned space. It shall include measuring capacities and effectiveness of operational and control functions.
2. Test all operating modes, interlocks, control responses, responses to abnormal or emergency conditions, and verify proper response of building automation system controllers and sensors.

D. Detailed Testing Procedures: RDP, with HVAC Subcontractor, TAB Subcontractor, and HVAC Instrumentation and Control Subcontractor, shall prepare detailed testing plans, procedures,

and checklists for HVAC systems, subsystems, and equipment.

E. HVAC Instrumentation and Control System Testing.
   1. Field testing plans and testing requirements are specified in Division 23 Sections "HVAC Instrumentation and Controls" and "Sequence of Operation." The CxA, HVAC Subcontractor, and the HVAC Instrumentation and Control Subcontractor shall collaborate to prepare testing plans.
   2. CxA shall convene a meeting of appropriate entities to review test report of HVAC instrumentation and control systems.

F. Energy Supply System Testing: HVAC Subcontractor shall prepare a testing plan to verify performance of refrigerant systems and equipment. Plan shall include the following:
   1. Sequence of testing and testing procedures for each equipment item and pipe section to be tested, identified by pipe zone or sector identification marker. Markers shall be keyed to Drawings for each pipe sector showing the physical location of each designated pipe test section. Drawings keyed to pipe zones or sectors shall be formatted to allow each section of piping to be physically located and identified when referred to in system testing plan.
   2. Tracking checklist for managing and ensuring that all pipe sections have been tested.

G. Heat-Generation System Testing: HVAC Subcontractor shall prepare a testing plan to verify performance of auxiliary heating equipment. Plan shall include the following:
   1. Sequence of testing and testing procedures for each item of equipment and section of heat strip to be tested, identified by identification marker. Markers shall be keyed to Drawings for each heating sector showing the physical location of each item of equipment and test section. Drawings shall be formatted to allow each item of equipment and section of heat strip to be physically located and identified when referred to in the system testing plan.
   2. Tracking checklist for managing and ensuring that all heating sections have been tested.

H. Refrigeration System Testing: HVAC Subcontractor shall prepare a testing plan to verify performance of all condensing units, refrigerant compressors and condensers, heat pumps, and other refrigeration systems. Plan shall include the following:
   1. Sequence of testing and testing procedures for each item of equipment and section of pipe to be tested, identified by identification marker. Markers shall be keyed to Drawings showing the physical location of each item of equipment and pipe test section. Drawings shall be formatted to allow each item of equipment and section of piping to be physically located and identified when referred to in the system testing plan.
   2. Tracking checklist for managing and ensuring that all pipe sections have been tested.

I. HVAC Distribution System Testing: HVAC Subcontractor shall prepare a testing plan to verify performance of air, and refrigerant distribution systems; special exhaust; and other distribution systems. Include HVAC terminal equipment and unitary equipment. Plan shall include the following:
   1. Sequence of testing and testing procedures for each item of equipment and section of pipe to be tested, identified by identification marker. Markers shall be keyed to Drawings showing the physical location of each item of equipment and pipe test section. Drawings shall be formatted to allow each item of equipment and section of piping to be physically located and identified when referred to in the system testing plan.
   2. Tracking checklist for managing and ensuring that all pipe sections have been tested.

J. Deferred Testing:

1. If tests cannot be completed because of a deficiency outside the scope of the HVAC system, the deficiency shall be documented and reported to Owner. Deficiencies shall be resolved and corrected by appropriate parties and test rescheduled.
2. If the testing plan indicates specific seasonal testing, appropriate initial performance tests shall be completed and documented and additional tests scheduled.

END OF SECTION 230800

23 09 00 Direct Digital Control System for HVAC

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 Related Sections

A. This Section includes the Building Management System (BMS) control equipment for HVAC systems and components, including open protocol control components for terminal heating and cooling units. Depending on the scope of the project, the complete specification may have numerous sections that interface to this section, including several from Division 25, 26, & 28.

1.3 Standard Terms

A. Standard

1. ASHRAE: American Society Heating, Refrigeration, Air Conditioning Engineers
2. AHU: Air Handling Unit
3. BACnet: Building Automation Controls Network
4. BMS: Building Management System
5. DDC: Direct Digital Control
6. EIA: Electronic Industries Alliance
7. GUI: Graphical User Interface
8. HVAC: Heating, Ventilation, and Air Conditioning
9. IEEE: Institute Electrical Electronic Engineers
10. MER: Mechanical Equipment Room
11. PID: Proportional, Integral, Derivative
12. VAV: Variable Air Volume Box

B. Communications and protocols

1. ARP: Address Resolution Protocol
2. BACnet: Building Automation and Control Networks
3. CORBA: Common Object Request Broker Architecture
4. CSMA/CD: Carrier Sense Multiple Access/Collision Detect
5. DDE: Dynamic Data Exchange
6. FTP: File Transfer Protocol
7. FTT: Free Topology Transceivers
8. HTTP: Hyper Text Transfer Protocol
9. IIOP: Internet Inter-ORB Protocol
10. IP: Internet Protocol
11. LAN: Local Area Network
12. LON: Echelon Communication – Local Operating Network
13. MS/TP: Master Slave Token Passing
14. OBIX: Open Building Information Exchange
15. ODBC: Open Database Connectivity
16. ORB: Object Request Broker
17. SNVT: Standard Network Variables Types
18. SQL: Structured Query Language

19. UDP: User Datagram Protocol
20. XML: eXtensible Markup Language

C. Controllers

1. ASD: Application Specific Device
2. AAC: Advanced Application Controller
3. ASC: Application Specific Controller.
4. CAC: Custom Application Controller.
5. DCU: Distributed Control Unit
6. LCM: Local Control Module
7. MC: MicroControllers
8. MP: Multi-purpose
9. MPC: Multi-purpose Controller
10. MPV: Multi-purpose VAV controller
11. NSC: Network Server Controller
12. PEM: Package Equipment Module
13. PPC: Programmable Process Controller
14. RC: Room controller
15. SDCU: Standalone Digital Control Units
16. SLC: Supervisory Logic Controller
17. UEC: Unitary Equipment Controller
18. VAVDDC: Variable Air Volume Direct Digital Controller

D. Tools and Software

1. AFDD: Automated Fault Detection and Diagnostic
2. APEO: Automated Predictive Energy Optimization
3. DR: Demand Response
4. CCDT: Configuration, Commissioning and Diagnostic Tool
5. BPES: BACnet Portable Engineering Station
6. LPES: LON Portable Engineering Station
7. POT: Portable Operator's Terminal
8. PEMS: Power and Energy Management Software

1.4 Qualifications of Bidder and Pre-bid Submittal

A. Approved bidders for the project is Utah Yamas Controls.

1.5 Scope of Work

A. The Contractor shall furnish and install a complete building automation system including all necessary hardware and all operating and applications software necessary to perform the control sequences of operation as called for in this specification. Network level components of the system – workstations, servers, etc. shall communicate using the BACnet protocol, as defined by ASHRAE Standard 135-2004. No gateways shall be used for communication to controllers furnished under this section.

At a minimum, provide controls for the following:

1. Packaged Air Conditioning Units
2. Dedicated Outside Air Units
3. Ductless Split Systems
4. Exhaust and Supply Fans
5. Fan Coil Units

6. Return Air Fans
7. Supply Fans
8. Unit Heaters
9. Electric Heaters
10. Variable Frequency Drives

B. Except as otherwise noted, the control system shall consist of all necessary Ethernet Network Controllers, Standalone Digital Control Units, Room Controllers, workstations, software, sensors, transducers, relays, valves, dampers, damper operators, control panels, and other accessory equipment, along with a complete system of electrical interlocking wiring to fill the intent of the specification and provide for a complete and operable system. Except as otherwise specified, provide operators for equipment such as dampers if the equipment manufacturer does not provide these. Coordinate requirements with the various Contractors.

C. The BAS contractor shall review and study all HVAC drawings and the entire specification to familiarize themselves with the equipment and system operation and to verify the quantities and types of dampers, operators, alarms, etc. to be provided.

D. All interlocking wiring, wiring and installation of control devices associated with the equipment listed below shall be provided under this Contract. When the BAS system is fully installed and operational, the BAS Contractor and representatives of the Owner will review and check out the system – see System Acceptance and Testing section of this document. At that time, the BAS contractor shall demonstrate the operation of the system and prove that it complies with the intent of the drawings and specifications.

E. Provide services and manpower necessary for commissioning of the system in coordination with the HVAC Contractor, Balancing Contractor and Owner's representative.

F. All work performed under this section of the specifications will comply with all governing codes, laws and governing bodies. If the drawings and/or specifications are in conflict with governing codes, the Contractor, with guidance from the engineer, shall submit a proposal with appropriate modifications to the project to meet code restrictions. If this specification and associated drawings exceed governing code requirements, the specification will govern. The Contractor shall obtain and pay for all necessary construction permits and licenses.

1.6 System Description

A. In accordance to the scope of work, the system shall also provide a graphical, web-based, operator interface that allows for instant access to any system through a standard browser. The contractor must provide PC-based programming workstations, operator workstations and microcomputer controllers of modular design providing distributed processing capability, and allowing future expansion of both input/output points and processing/control functions.

For this project, the system shall consist of the following components:

1. Administration and Programming Workstation(s): The BAS Contractor shall include Operation software and architecture as described in Part 2 of the specification. These workstations must be running the standard workstation software developed and tested by the manufacturer of the network server controllers and the standalone controllers. No third party front-end workstation software will be acceptable. Workstations must conform to the B-OWS BACnet device profile.
2. Web-Based Operator Workstations: The BAS Contractor shall furnish licenses for web connection to the BAS system. Web-based users shall have access to all system points and graphics, shall be able to receive and acknowledge alarms, and shall be able to control setpoints and other parameters. All engineering work, such as trends, reports, graphics, etc. that are accomplished from the WorkStation shall be available for viewing through the web browser interface without additional changes. The web-based interface must conform to the B-OWS BACnet device profile. There will be no need for any additional computer based hardware to support the web-based user interface.
3. Ethernet-based Network Router and/or Network Server Controller(s): The BAS Contractor shall furnish needed quantity of Ethernet-based Network Server Controllers as described in Part 2 of the specification. These controllers will connect directly to the Operator Workstation over Ethernet at a minimum of 100mbps, and provide communication to the Standalone Digital Control Units and/or other Input/Output

Modules. Network Server Controllers shall conform to BACnet device profile B-BC. Network controllers that utilize RS232 serial communications or ARCNET to communicate with the workstations will not be accepted. Network Controllers shall be tested and certified by the BACnet Testing Laboratory (BTL) as BACnet Building Controllers (B-BC).

4. Standalone Digital Control Units (SDCUs): Provide the necessary quantity and types of SDCUs to meet the requirements of the project for mechanical equipment control including air handlers, central plant control, and terminal unit control. Each SDCU will operate completely standalone, containing all of the I/O and programs to control its associated equipment. Each BACnet protocol SDCU shall conform to the BACnet device profile B-AAC. BACnet SDCUs shall be tested and certified by the BACnet Testing Laboratory (BTL) as BACnet Advanced Application Controllers (B-AAC).

B. The Local Area Network (LAN) shall be either a 10 or 100 Mpbs Ethernet network supporting BACnet, Modbus, XML and HTTP for maximum flexibility for integration of building data with enterprise information systems and providing support for multiple Network Server Controllers (NSCs), user workstations and a local host computer system.

C. The Enterprise Ethernet (IEEE 802.3) LAN shall utilize Carrier Sense Multiple/Access/Collision Detect (CSMA/CD), Address Resolution Protocol (ARP) and User Datagram Protocol (UDP) operating at 10 or 100 Mbps.

D. The system shall enable an open architecture that utilizes EIA standard 709.1, the LonTalk™ protocol and/or ANSI / ASHRAE™ Standard 135-2004, BACnet functionality to assure interoperability between all system components. Native support for the LonTalk™ protocol and the ANSI / ASHRAE™ Standard 135-2004, BACnet protocol are required to assure that the project is fully supported by the HVAC open protocols to reduce future building maintenance, upgrade, and expansion costs.

E. The system shall enable an architecture that utilizes a MS/TP selectable 9.6-76.8 KBaud protocol, as a common communication protocol between controllers and integral ANSI / ASHRAE™ Standard 135-2004, BACnet functionality to assure interoperability between all system components. The AAC shall be capable of communicating as a MS/TP device or as a BACnet IP device communicating at 10/100 Mbps on a TCP/IP trunk. The ANSI / ASHRAE™ Standard 135-2004, BACnet protocol is required to assure that the project is fully supported by the leading HVAC open protocol to reduce future building maintenance, upgrade, and expansion costs.

F. LonTalk™ packets may be encapsulated into TCP/IP messages to take advantage of existing infrastructure or to increase network bandwidth where necessary or desired.

1. Any such encapsulation of the LonTalk™ protocol into IP datagrams shall conform to existing LonMark™ guide functionality lines for such encapsulation and shall be based on industry standard protocols.
2. The products used in constructing the BMS shall be LonMark™ compliant.
3. In those instances, in which Lon-Mark™ devices are not available, the BMS contractor shall provide device resource files and external interface definitions for LonMark devices.

G. The software tools required for network management of the LonTalk™ protocol and the ANSI / ASHRAE™ Standard 135-2004, BACnet protocol must be provided with the system. Drawings are diagrammatic only. Equipment and labor not specifically referred to herein or on the plans and are required to meet the functional intent, shall be provided without additional cost to the Owner. BACnet clients shall comply with the BACnet Operator Workstation (B-OWS) device profile; with the ability to support data read and write functionality. Physical connection of BACnet devices shall be via Ethernet IP or MS/TP. Physical connection of LonWorks devices shall be via Ethernet IP or FTT-10A.

H. The system shall provide support for Modbus TCP and RTU protocols natively, and not require the use of gateways.

I. Complete temperature control system to be DDC with electronic sensors and electronic/electric actuation of Mechanical Equipment Room (MER) valves and dampers and electronic actuation of terminal equipment valves and actuators as specified herein. The BMS is intended to seamlessly connect devices throughout the building regardless of subsystem type, i.e. variable frequency drives, low voltage lighting systems, electrical circuit breakers, power metering and card access should easily coexist on the same network channel.

1. The supplied system must incorporate the ability to access all data using HTML5 enabled browsers without requiring proprietary operator interface and configuration programs. The system shall not require JAVA to be enabled in the browser.
2. Data shall reside on a supplier-installed server for all database access.
3. A hierarchical topology is required to assure reasonable system response times and to manage the flow and sharing of data without unduly burdening the customer's internal Intranet network.

J. All work described in this section shall be installed, wired, circuit tested and calibrated by factory certified technicians qualified for this work and in the regular employment of the approved manufacturer's local field office. The approved manufacturer's local field office shall have a minimum of 20 years of installation experience with the manufacturer and shall provide documentation in the bid and submittal package verifying longevity of the installing company's relationship with the manufacturer when requested. Supervision, hardware and software engineering, calibration and checkout of the system shall be by the employees of the approved manufacturer's local field office and shall not be subcontracted. The control contractor shall have an in place support facility within 150 miles of the site with factory certified technicians and engineers, spare parts inventory and all necessary test and diagnostic equipment for the installed system, and the control contractor shall have 24 hours/day, 7 days/week emergency service available.

K. Provide the Commissioning, configuration and diagnostic tool (CCDT), color display personnel computer, software, and interfaces to provide uploading/downloading of High Point Count Controllers (AAC), Unitary Equipment Controllers (UEC) and VAV controllers (VAVDDC), monitoring all BACnet objects, monitoring overrides of all controller physical input/output points, and editing of controller resident time schedules.

1.7 Work by Others

A. The BAS Contractor shall cooperate with other contractors performing work on this project necessary to achieve a complete and neat installation. To that end, each contractor shall consult the drawings and specifications for all trades to determine the nature and extent of others' work.

B. The BAS Contractor shall furnish all Airflow Stations, Control Dampers, Control Valves, Flow Meters, Flow Switches, Sensor Wells and other similar equipment for installation by the Mechanical Contractor and/or others.

C. The BAS Contractor shall provide field supervision to the designated contractor for the installation of the following:
1. Automatic control dampers
2. Blank-off plates for dampers that are smaller than duct size.
3. Sheet metal baffles plates to eliminate stratification.
4. The Electrical Contractor shall provide:
    1. All 120VAC power wiring to motors, heat trace, junction boxes for power to BAS panels.
    2. Furnish smoke detectors and wire to the building fire alarm system. HVAC Contractor to mount devices. BAS Contractor to hardwire to fan shut down.
    3. Auxiliary contact (pulse initiator) on the electric meter for central monitoring of kWh and KW. Electrical Contractor shall provide the pulse rate for remote readout to the BAS. BAS contractor to coordinate this with the electrical contractor.

1.8 Code Compliance

A. Provide BAS components and ancillary equipment, which are UL-916 listed and labeled.

B. All equipment or piping used in conditioned air streams, spaces or return air plenums shall comply with NFPA 90A Flame/Smoke/Fuel contribution rating of 25/50/0 and all applicable building codes or requirements.

C. All wiring shall conform to the National Electrical Code.

D. All smoke dampers shall be rated in accordance with UL 555S.

E. Comply with FCC rules, Part 15 regarding Class A radiation for computing devices and low power communication equipment operating in commercial environments.

F. Comply with FCC, Part 68 rules for telephone modems and data sets.

1.9 Submittals

A. All shop drawings shall be prepared in Visio Professional or AutoCAD software. In addition to the drawings, the Contractor shall furnish a CD containing the identical information. Drawings shall be B size or larger.

B. Shop drawings shall include a riser diagram depicting locations of all controllers and workstations, with associated network wiring. Also included shall be individual schematics of each mechanical system showing all connected points with reference to their associated controller. Typicals will be allowed where appropriate.

C. Submittal data shall contain manufacturer's data on all hardware and software products required by the specification. Valve, damper and air flow station schedules shall indicate size, configuration, capacity and location of all equipment.

D. Software submittals shall contain narrative descriptions of sequences of operation, program listings, point lists, and a complete description of the graphics, reports, alarms and configuration to be furnished with the workstation software. Information shall be bound or in a three ring binder with an index and tabs. Diagrams shall be on 11” by 17” foldouts. If color has been used to differentiate information, the printed copies shall be in color.

E. Submit five (5) copies of submittal data and shop drawings to the Engineer for review prior to ordering or fabrication of the equipment. The Contractor, prior to submitting, shall check all documents for accuracy.

F. The Engineer will make corrections, if required, and return to the Contractor. The Contractor will then resubmit with the corrected or additional data. This procedure shall be repeated until all corrections are made to the satisfaction of the Engineer and the submittals are fully approved.

G. The following is a list of post construction submittals that shall be updated to reflect any changes during construction and re-submitted as “As-Built”.
   1. System architecture drawing.
   2. Layout drawing for each control panel
   3. Wiring diagram for individual components
   4. System flow diagram for each controlled system
   5. Instrumentation list for each controlled system
   6. Sequence of control
   7. Binding map
   8. A matrix sheet detailing all system addresses and communication settings for the following:
      a. All IP network addresses & settings
      b. All BMS device addresses & communication settings
   9. Operation and Maintenance Manuals

H. Information common to the entire system shall be provided. This shall include but not be limited to the following.
   1. Product manuals for the key software tasks.
   2. Operating the system.
   3. Administrating the system.
   4. Engineering the operator workstation.
   5. Application programming.
   6. Engineering the network.
   7. Setting up the web server.
   8. Report creation.
   9. Graphics creation.
   10. All other engineering tasks.
   11. System Architecture Diagram.
   12. List of recommended maintenance tasks associated with the system servers, operator workstations, data servers, web servers and web clients.
   13. Define the task.
   14. Recommend a frequency for the task.
   15. Reference the product manual that includes instructions on executing the task.

16. Names, addresses, and telephone numbers of installing contractors and service representatives for equipment and control systems.
17. Licenses, guarantees, and warranty documents for equipment and systems.
18. Submit one copy for each building, plus two extra copies.

I. Information common to the systems in a single building shall be provided.
1. System architecture diagram for components within the building annotated with specific location information.
2. As-built drawing for each control panel.
3. As-built wiring design diagram for all components.
4. Installation design details for each I/O device.
5. As-built system flow diagram for each system.
6. Sequence of control for each system.
7. Binding map for the building.
8. Product data sheet for each component.
9. Installation data sheet for each component.
10. Submit two copies for each building and two extra copies.

J. Software shall be provided:
1. Submit a copy of all software installed on the servers and workstations.
2. Submit all licensing information for all software installed on the servers and workstations.
3. Submit a copy of all software used to execute the project even if the software was not installed on the servers and workstations.
4. Submit all licensing information for all of the software used to execute the project.
5. All software revisions shall be as installed at the time of the system acceptance.
6. Firmware Files
7. Submit a copy of all firmware files that were downloaded to or pre-installed on any devices installed as part of this project.
8. This does not apply to firmware that is permanently burned on a chip at the factory and can only be replaced by replacing the chip.
9. Submit a copy of all application files that were created during the execution of the project.
10. Submit a copy of all graphic page files created during the execution of the project.

1.10 Coordination

A. Coordinate location of thermostats, humidistats, and other exposed control sensors with plans and room details before installation.

B. Coordinate equipment from other divisions including "Intrusion Detection," "Lighting Controls," "Motor Control Centers," "Panel boards," and "Fire Alarm" to achieve compatibility with equipment that interfaces with those systems.

C. Coordinate supply of conditioned electrical circuits for control units and operator workstation.

D. Coordinate location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3 Section "Cast-in-Place Concrete".

E. Coordinate with the Owner's IT department on locations for NSC's, Ethernet communication cabling and TCP/IP addresses.

1.11 Quality Assurance - System Startup and Commissioning

A. Each point in the system shall be tested for both hardware and software functionality. In addition, each mechanical and electrical system under control of the BAS will be tested against the appropriate sequence of operation specified herein. Successful completion of the system test shall constitute the beginning of the warranty period. A written report will be submitted to the owner indicating that the installed system functions in accordance with the plans and specifications.

B. The BAS contractor shall commission and set in operating condition all major equipment and systems, such as the chilled water, hot water and all air handling systems, in the presence of the equipment manufacturer’s representatives, as applicable, and the Owner and Architect’s representatives.

C. Startup Testing shall be performed for each task on the startup test checklist, which shall be initialed by the technician and dated upon test was completion along with any recorded data

such as voltages, offsets or tuning parameters. Any deviations from the submitted installation plan shall also be recorded.

D. Required elements of the startup testing include:
   1. Measurement of voltage sources, primary and secondary
   2. Verification of proper controller power wiring.
   3. Verification of component inventory when compared to the submittals.
   4. Verification of labeling on components and wiring.
   5. Verification of connection integrity and quality (loose strands and tight connections).
   6. Verification of bus topology, grounding of shields and installation of termination devices.
   7. Verification of point checkout.
   8. Each I/O device is landed per the submittals and functions per the sequence of control.
   9. Analog sensors are properly scaled and a value is reported
   10. Binary sensors have the correct normal position and the state is correctly reported.
   11. Analog outputs have the correct normal position and move full stroke when so commanded.
   12. Binary outputs have the correct normal state and respond appropriately to energize/de-energize commands.
   13. Documentation of analog sensor calibration (measured value, reported value and calculated offset).
   14. Documentation of Loop tuning (sample rate, gain and integral time constant).

E. A performance verification test shall also be completed for the operator interaction with the system. Test elements shall be written to require the verification of all operator interaction tasks including, but not limited to the following.
   1. Graphics navigation.
   2. Trend data collection and presentation.
   3. Alarm handling, acknowledgement and routing.
   4. Time schedule editing.
   5. Application parameter adjustment.
   6. Manual control.
   7. Report execution.
   8. Automatic backups.
   9. Web Client access.

F. A Startup Testing Report and a Performance Verification Testing Report shall be provided upon test completion.

1.12 Warranty and Maintenance

A. All components, system software, and parts furnished and installed by the BMS contractor shall be guaranteed against defects in materials and workmanship for 1 year of substantial completion. Labor to repair, reprogram, or replace these components shall be furnished by the BMS contractor at no charge during normal working hours during the warranty period. Materials furnished but not installed by the BMS contractor shall be covered to the extent of the product only. Installation labor shall be the responsibility of the trade contractor performing the installation. All corrective software modifications made during warranty periods shall be updated on all user documentation and on user and manufacturer archived software disks. The Contractor shall respond to the owner's request for warranty service within 24 standard working hours.

1.13 Training

A. On-site training shall consist of a minimum of (16) hours of hands-on instruction geared at the operation and maintenance of the systems. The curriculum shall include
   1. System Overview
   2. System Software and Operation
   3. System access
   4. Software features overview
   5. Changing setpoints and other attributes
   6. Scheduling
   7. Editing programmed variables

8. Displaying color graphics
9. Running reports
10. Workstation maintenance
11. Viewing application programming
12. Operational sequences including start-up, shutdown, adjusting and balancing.
13. Equipment maintenance

PART 2 - Products

2.1 Pre-approved Manufacturers

A. Subject to compliance with requirements, provide products by one of the following pre-qualified manufacturers:
   1. Electric Components
      1. Schneider-Electric Field Devices
   2. Electronic Components
      1. Schneider-Electric Field Devices
   3. Direct Digital Control Systems Field Controller Devices:
      a. Schneider Electric EcoStruxure Building MP BACnet series, b3 BACnet series, MNB BACnet installed by approved manufacturer's local field office.
      b. None
      c. Or approved equal.

2.2 System Architecture

A. General
   1. The Building Automation System (BAS) shall consist of Network Server/Controllers (NSCs), a family of Standalone Digital Control Units (SDCUs), Administration and Programming Workstations (APWs), and Web-based Operator Workstations (WOWs). The BAS shall provide control, alarm detection, scheduling, reporting and information management for the entire facility, and Wide Area Network (WAN) if applicable.
   2. An Enterprise Level BAS shall consist of an Enterprise Server, which enables multiple NSCs (including all graphics, alarms, schedules, trends, programming, and configuration) to be accessible from a single Workstation simultaneously for operations and engineering tasks.
   3. The Enterprise Level BAS shall be able to host up to 250 servers, or NSCs, beneath it.
   4. For Enterprise reporting capability and robust reporting capability outside of the trend chart and listing ability of the Workstation, a Reports Server shall be installed on a Microsoft Windows SQL based computer. The Reports Server can be installed on the same computer as the Enterprise Server.
   5. The system shall be designed with a top-level 10/100bT Ethernet network, using the BACnet/IP, LonWorks IP, and/or Modbus TCP protocol.

B. Modbus RTU/ASCII (and J-bus), Modbus TCP, BACnet MS/TP, BACnet IP, LonTalk FTT-10A, and WebServices shall be native to the NSCs. There shall not be a need to provide multiple NSCs to support all the network protocols, nor should there be a need to supply additional software to allow all three protocols to be natively supported.

C. A sub-network of SDCUs using the BACnet IP, BACnet MS/TP protocol shall connect the local, stand-alone controllers with Ethernet-level Network Server Controllers/IP Routers.

D. TCP/IP Level
   1. The TCP/IP layer connects all of the buildings on a single Wide Area Network (WAN) isolated behind the campus firewall. Fixed IP addresses for connections to the campus WAN shall be used for each device that connects to the WAN.

E. Fieldbus Level with Standalone Digital Control Units (SDCUs)
   1. The fieldbus layer shall support all of the following types of SDCUs:
      1. BACnet IP SDCU requirements: The system shall consist of one or more BACnet/IP field buses managed by the Network Server Controller. The field bus layer shall consist of up to 50 IP SDCUs in daisy chain topology, or 39 if using RSTP, per layer, with a max of 5 sub networks in daisy chain for a total of 250 SDCUs or 6 sub networks in RSTP for a total of 234 SDCUs.

2. BACnet MS/TP SDCU requirements: The system shall consist of one or more BACnet MS/TP field buses managed by the Network Server Controller. Minimum speed shall be 76.8kbps. The field bus layer consists of an RS485, token passing bus that supports up to 127 Standalone Digital Control Units (SDCUs) for operation of HVAC and lighting equipment. These devices shall conform to BACnet standard 135-2004. The NSCs shall be capable of at least two BACnet MS/TP field buses for a total capability of 254 SDCUs per NSC.

F. BAS LAN Segmentation
1. The BAS shall be capable of being segmented, through software, into multiple local area networks (LANs) distributed over a wide area network (WAN). Workstations can manage a single LAN (or building), and/or the entire system with all portions of that LAN maintaining its own, current database.

G. Standard Network Support
1. All NSCs, Workstation(s) and Servers shall be capable of residing directly on the owner's Ethernet TCP/IP LAN/WAN with no required gateways. Furthermore, the NSC's, Workstation(s), and Server(s) shall be capable of using standard, commercially available, off-the-shelf Ethernet infrastructure components such as routers, switches and hubs. With this design the owner may utilize the investment of an existing or new enterprise network or structured cabling system. This also allows the option of the maintenance of the LAN/WAN to be performed by the owner's Information Systems Department as all devices utilize standard TCP/IP components.

H. System Expansion
1. The BAS system shall be scalable and expandable at all levels of the system using the same software interface, and the same TCP/IP level and fieldbus level controllers. Systems that require replacement of either the workstation software or field controllers in order to expand the system shall not be acceptable.
2. Web-based operation shall be supported directly by the NSCs and require no additional software.
3. The system shall be capable of using graphical and/or line application programming language for the Network Server Controllers.

I. Support For Open Systems Protocols
1. All Network Server Controllers must natively support the BACnet IP, BACnet MS/TP, LonWorks FTT-10, Modbus TCP, Modbus RTU (RS-485 and RS-232), and Modbus ASCII protocols.

2.3 Operator Workstation Requirements

A. General
1. The operator workstation portion of the BAS shall consist of one or more full-powered configuration and programming workstations, and one or more web-based operator workstations. For this project provide a minimum of 2 concurrent operator users and/or 2 concurrent engineering users within the enterprise server.
2. The programming and configuration workstation software shall allow any user with adequate permission to create and/or modify any or all parts of the NSC and/or Enterprise Server database.
3. Web-based workstations (webstations) shall have a minimum of 5 concurrent operator users.
4. All configuration workstations shall be personal computers operating under the Microsoft Windows operating system. The application software shall be capable of communication to all Network Server Controllers and shall feature high-resolution color graphics, alarming, trend charting. It shall be user configurable for all data collection and data presentation functions.
5. A minimum of 1 physical Workstation shall be allowed on the Ethernet network. In this client/server configuration, any changes or additions made from one workstation will automatically appear on all other workstations since the changes are accomplished to the databases within the NSC. Systems with a central database will not be acceptable.

B. Administration/Programming Workstation, Enterprise Server, and Enterprise Central Requirements

1. The Enterprise Central shall consist of the following:
    1. Processor
        1) Minimum: Intel Core i5 @ 2.0 GHz or equivalent
        2) Recommended: Intel Core i5 @ 3.0 GHz or better
    2. Memory
        1) Minimum: 4GB
        2) Recommended: 8GB or higher
    3. Operating systems:
        1) Microsoft Windows 7 32-bit (Professional, Enterprise, or Ultimate)
        2) Microsoft Windows 7 64-bit (Professional, Enterprise, or Ultimate)
        3) Microsoft Windows 8.1 32-bit (Pro, Pro N, Enterprise, or Enterprise N)
        4) Microsoft Windows 8.1 64-bit (Pro, Pro N, Enterprise, or Enterprise N)
        5) Microsoft Windows 10 64-bit (Pro or Enterprise)
        6) Microsoft Windows Server 2008 R2 64-bit (Standard, Enterprise, Datacenter, Web, or Itanium)
        7) Microsoft Windows Server 2012 64-bit (Standard, Datacenter, Essentials, or Foundation)
        8) Microsoft Windows Server 2012 R2 64-bit (Standard, Datacenter, Essentials, or Foundation)
        9) Microsoft Windows Server 2016 R2 64-bit (Standard, Datacenter, Essentials, or Foundation)
    4. 10/100MBPS Ethernet NIC
    5. 100 GB hard disk (minimum)
    6. Required additional software:
        1) Microsoft .Net 4.5

    g. License agreement for all applicable software
2. The workstation shall consist of the following:
    1. Processor
        1) Minimum: 2.0 GHz
        2) Recommended: 3.0 GHz or higher
    2. Memory
        1) Minimum: 4GB
        2) Recommended: 8GB or higher
    3. Operating systems:
        1) Microsoft Windows 7 32-bit (Professional, Enterprise, or Ultimate)
        2) Microsoft Windows 7 64-bit (Professional, Enterprise, or Ultimate)
        3) Microsoft Windows 8.1 32-bit (Pro, Pro N, Enterprise, or Enterprise N)
        4) Microsoft Windows 8.1 64-bit (Pro, Pro N, Enterprise, or Enterprise N)
        5) Microsoft Windows 10 64-bit (Pro or Enterprise)
        6) Microsoft Windows Server 2008 R2 64-bit (Standard, Enterprise, Datacenter, Web, or Itanium)
        7) Microsoft Windows Server 2012 64-bit (Standard, Datacenter, Essentials, or Foundation)
        8) Microsoft Windows Server 2012 R2 64-bit (Standard, Datacenter, Essentials, or Foundation)
    4. Serial port, parallel port, USB port
    5. 10/100MBPS Ethernet NIC
    6. 20 GB hard disk
    7. DVD drive
    8. High resolution (minimum 1280 x 1024), 17” flat panel display
    9. Optical mouse and full function keyboard
    10. Audio sound card and speakers
    11. Required additional software:
        1) Microsoft .Net 4.5
    12. License agreement for all applicable software.

C. Web-Based Operator PC Requirements
    1. Any user on the network can access the system, using the following software:

1. Internet Explorer 11
2. Mozilla Firefox
3. Google Chrome

D. General Administration and Programming Workstation Software
1. System architecture shall be truly client server in that the Workstation shall operate as the client while the NSCs shall operate as the servers. The client is responsible for the data presentation and validation of inputs while the server is responsible for data gathering and delivery.
2. The workstation functions shall include monitoring and programming of all DDC controllers. Monitoring consists of alarming, reporting, graphic displays, long term data storage, automatic data collection, and operator-initiated control actions such as schedule and setpoint adjustments.
3. Programming of SDCUs shall be capable of being done either off-line or on-line from any operator workstation. All information will be available in graphic or text displays stored at the NSC. Graphic displays will feature animation effects to enhance the presentation of the data, to alert operators of problems, and to facilitate location of information throughout the DDC system. All operator functions shall be selectable through a mouse.

E. User Interface:
1. The BAS workstation software shall allow the creation of a custom, browser-style interface linked to the user when logging into any workstation. Additionally, it shall be possible to create customized workspaces that can be assigned to user groups. This interface shall support the creation of “hot-spots” that the user may link to view/edit any object in the system or run any object editor or configuration tool contained in the software. Furthermore, this interface must be able to be configured to become a user’s “PC Desktop” – with all the links that a user needs to run other applications. This, along with the Windows user security capabilities, will enable a system administrator to setup workstation accounts that not only limit the capabilities of the user within the BAS software, but may also limit what a user can do on the PC and/or LAN/WAN. This might be used to ensure, for example, that the user of an alarm monitoring workstation is unable to shutdown the active alarm viewer and/or unable to load software onto the PC.
2. System shall be able to automatically switch between displayed metric vs. imperial units based on the workstation/webstations localization.
3. The BMS workstation/webstations shall be capable of multiple language display, including English, Spanish, German, French, Japanese, Italian, Finnish, Portuguese, Swedish, Russian, and traditional and simplified Chinese. The multiple languages shall not require additional add on software from the standard workstation installer and shall be selectable within said workstation.
4. Webstations shall have the capability to automatically re-direct to an HTTPS connection to ensure more secure communications.
5. Personalized layouts and panels within workstations shall be extended to webstations to ensure consistent user experiences between the two user interfaces.
6. Servers and clients shall have the ability to be located in different time zones, which are then synchronized via the NTP server.
7. Workstation shall indicate at all times the communication status between it and the server.

F. User Security
1. The software shall be designed so that each user of the software can have a unique username and password. This username/password combination shall be linked to a set of capabilities within the software, set by and editable only by, a system administrator. The sets of capabilities shall range from View only, Acknowledge alarms, Enable/disable and change values, Program, and Administer. The system shall allow the above capabilities to be applied independently to each and every class of object in the system. The system must allow a minimum of 256 users to be configured per workstation. Additionally, the software shall enable the ability to add/remove users based upon Microsoft Windows Security Domains that enable the customer IT department to assist in user access.
2. Additional requirements include mandatory change of passwords:

1) At first logon with default credentials
2) Of admin passwords before deploying

3. No general accounts, one account per user
4. Capability to integrate and use Windows Active Directory for user log on credentials
5. Include a timed auto log off feature
6. Use TLS 1.2 encryption or higher
7. Capability to use blacklisted and whitelisted IPs/MAC addresses to gate access
8. All devices and software that support HTTP shall allow disabling the HTTP access and require access via HTTPS.
9. All devices that have web portals for the configuration of IP addresses and other configuration attributes shall have the ability, through commands issued, to disable this service upon completion. A direct connection method with ASCII commands shall enable this service again if changes need to be applied. Loss of power or cycling the device shall not reverse this command. Disabling this web portal eliminates the security risk and the need for updating security patches.
10. All devices shall support SNMP V3 monitoring of network performance and stack statistics for the purpose of managing denial of service attacks
11. The Integrated Control Platform shall support the feature to alarm on a predetermined period of time until the default password for each device is changed from the default factory setting.
12. The Integrated Control Platform shall support encrypted password authentication for all web services whether serving or consuming.

G. Configuration Interface
1. The workstation software shall use a familiar Windows Explorer style interface for an operator or programmer to view and/or edit any object (controller, point, alarm, report, schedule, etc.) in the entire system. In addition, this interface shall present a “network map” of all controllers and their associated points, programs, graphics, alarms, and reports in an easy to understand structure. All object names shall be alphanumeric and use Windows long filename conventions.
2. The configuration interface shall also include support for user defined object types. These object types shall be used as building blocks for the creation of the BAS database. They shall be created form the base object types within the system input, output, string variables, setpoints, etc., alarm algorithms, alarm notification objects, reports, graphics displays, schedules, and programs. Groups of user defined object types shall be able to be set up as a predefined aggregate of subsystems and systems. The configuration interface shall support copying/pasting and exporting/importing portions of the database for additional efficiency. The system shall also maintain a link to all “child” objects created. If a user wishes to make a change to a parent object, the software shall ask the user if he/she wants to update all of the child objects with the change.

H. Color Graphic Displays
1. The system shall allow for the creation of user defined, color graphic displays for the viewing of mechanical and electrical systems, or building schematics. These graphics shall contain point information from the database including any attributes associated with the point (engineering units, etc.). In addition, operators shall be able to command equipment or change setpoints from a graphic through the use of the mouse.
2. Requirements of the color graphic subsystem include:
    1. At a minimum, the user shall have the ability to import .gif, .png, .bmp, .jpeg, .tif, and CAD generated picture files as background displays, and layering shall be possible.
    2. The system shall support HTML5 enabled graphics.
    3. It shall be possible for the user to use JavaScript to customize the behavior of each graphic.
    4. The editor shall use Scalable Vector Graphics (SVG) technology.
    5. A built-in library of animated objects such as dampers, fans, pumps, buttons, knobs, gauges, ad graphs which can be “dropped” on a graphic through the use of a software configuration “wizard”. These objects shall enable operators to interact

with the graphic displays in a manner that mimics their mechanical equivalents found on field installed control panels.

6. Support for high DPI icons shall be included and automatically chosen if viewing on a high definition display such as Retina or 4K displays.
7. Using the mouse, operators shall be able to adjust setpoints, start or stop equipment, modify PID loop parameters, or change schedules.
8. Status changes or alarm conditions must be able to be highlighted by objects changing screen location, size, color, text, blinking or changing from one display to another.
9. Ability to link graphic displays through user defined objects, alarm testing, or the result of a mathematical expression. Operators must be able to change from one graphic to another by selecting an object with a mouse - no menus will be required.
10. It shall be possible to create and save graphical components and JavaScript code in reusable and transferrable, customized libraries.
11. Graphics should rescale based on whatever monitor or viewing device is being used.
12. Be able to create graphics on varying layers that can be moved and repeated.
13. Be able to create graphics within varying window panes that can be moved and/or re-referenced. For example, creating the graphical menu within a pane and referencing it on every graphics page, therefore not rebuilding thus allowing for a single spot for updates that get pushed to all the pages that reference it.
14. The ability to create re-usable cascading menus.
15. The ability to have multiple instances of a graphic and edit one instance to change all.

3. Additionally, the Graphics Editor portion of the Engineering Software shall provide the following capabilities:
    1. Create and save pages.
    2. Group and ungroup symbols.
    3. Modify an existing symbol.
    4. Modify an existing graphic page.
    5. Rotate and mirror a symbol.
    6. Place a symbol on a page.
    7. Place analog dynamic data in decimal format on a page.
    8. Place binary dynamic data using state descriptors on a page.
    9. Create motion through the use of animated .gif files or JavaScript.
    10. Place test mode indication on a page.
    11. Place manual mode indication on a page.
    12. Place links using a fixed symbol or flyover on a page.
    13. Links to other graphics.
    14. Links to web sites.
    15. Links to notes.
    16. Links to time schedules.
    17. Links to any .exe file on the operator work station.
    18. Links to .doc files.
    19. Assign a background color.
    20. Assign a foreground color.
    21. Place alarm indicators on a page.
    22. Change symbol/text/value color as a function of an analog variable.
    23. Change a symbol/text/value color as a function of a binary state.
    24. Change symbol/text/value as a function of a binary state.
    25. All symbols used by Schneider Electric EcoBuilding Business in the creation of graphic pages shall be saved to a library file for use by the owner.

I. Automatic monitoring
    1. The software shall allow for the automatic collection of data and reporting from any controller or NSC. The frequency of data collection shall be user-configurable.

J. Alarm Management

1. The software shall be capable of accepting alarms directly from NSCs or controllers, or generating alarms based on evaluation of data in controllers and comparing to limits or conditional equations configured through the software. Any alarm (regardless of its origination) will be integrated into the overall alarm management system and will appear in all standard alarm reports, be available for operator acknowledgment, and have the option for displaying graphics, or reports.
2. Alarm management features shall include:
    1. A minimum of 1000 alarm notification levels at the NSC, workstation, and webstation levels. At the Enterprise level the minimum number of active and viewable alarms shall be 10,000. Each notification level will establish a unique set of parameters for controlling alarm display, distribution, acknowledgment, keyboard annunciation, and record keeping.
    2. Automatic logging in the database of the alarm message, point name, point value, source device, timestamp of alarm, username and time of acknowledgement, username and time of alarm silence (soft acknowledgement).
    3. Playing an audible sound on alarm initiation or return to normal.
    4. Sending an email page to anyone specifically listed on the initial occurrence of an alarm. The ability to utilize email paging of alarms shall be a standard feature of the software using Simple Mail Transfer Protocol (SMTP) with support for secure email using Simple Mail Transfer Protocol Secure (SMTPS) No special software interfaces shall be required and no email client software must be running in order for email to be distributed. The email notification shall be able to be sent to an individual user or a user group.
    5. Individual alarms shall be able to be re-routed to a user at user-specified times and dates. For example, a critical high temp alarm can be configured to be routed to a Facilities Dept. workstation during normal working hours (7am-6pm, Mon-Fri) and to a Central Alarming workstation at all other times.
    6. An active alarm viewer shall be included which can be customized for each user or user type to hide or display any alarm attributes.
    7. The active alarm viewer can be configured such that an operator must type in text in an alarm entry and/or pick from a drop-down list of user actions for certain alarms.
    8. The active alarm viewer can be configured such that an operator must type in text in an alarm entry and/or pick from a drop-down list of causes for certain alarms. This ensures accountability (audit trail) for the response to critical alarms.
    9. The active alarm viewer can be configured such that an operator must confirm that all of the steps in a check list have been accomplished prior to acknowledging the alarm.
    10. The active alarm viewer shall, if filtered, show the quantity of visible and total number of alarms that are not equal to ‘normal’ and the quantity of disabled and hidden alarms.
    11. The alarm viewer can be configured to auto hide alarms when triggered.
    12. An operator shall have the capability to assign an alarm to another user of the system.
    13. Time schedules shall be able to be used to set control notifications to users.
    14. An operator shall have the capability to save and apply alarm favorites.
    15. Alarm notifications must support multiple distribution methods within one notification.

K. Report Generation
1. The Reports Server shall be able to process large amounts of data and produce meaningful reports to facilitate analysis and optimization of each installation.
2. Reports shall be possible to generate and view from the operator Workstation, and/or Webstation, and/or directly from a reports-only web interface.
3. A library of predefined automatically generated reports that prompt users for input prior to generation shall be available. The properties and configurations made to these reports shall be possible to save as Dashboard reports, so that the configurations are saved for future used.

4. It shall be possible to create reports standard tools, such as Microsoft Report Builder 2.0 or Visual Studio, shall be used for customized reports.
5. Additional reports or sets of reports shall be downloadable, transferrable, and importable
6. All reports shall be able to be set up to automatically run or be generated on demand.
7. Each report shall be capable of being automatically emailed to a recipient in Microsoft Word, Excel, and/or Adobe .pdf format.
8. Reports can be of any length and contain any point attributes from any controller on the network.
9. Image management functionality shall be possible to enable the system administrators to easily upload new logos or images to the system.
10. It shall be possible to run other executable programs whenever a report is initiated.
11. Report Generator activity can be tied to the alarm management system, so that any of the configured reports can be displayed in response to an alarm condition.
12. Minimum supplied reports shall include:
    1. Activities Per Server Report
    2. Activities Per User Report
    3. Alarm Amount by Category Report
    4. Alarm Amount by Type Report
    5. Alarms Per Sever Report
    6. Current Alarm Report
    7. Most Active Alarm Report
    8. System Errors Per Server Report
    9. Top Activities Report
    10. Top Alarms Report
    11. Top System Errors Report
    12. Trend Log Comparison Report
    13. User Logins Report
    14. Users and Groups Reports
13. Minimum Energy Reports shall include:
    a. Energy Monitoring Calendar Consumption Report: Shall provide an interactive report that shows the energy usage on one or multiple selected days.
    b. Energy Monitoring Consumption Breakdown Report: Shall provide a report on energy consumption broken down using sub-metering.
    c. Energy Monitoring Consumption Report: Shall show the energy consumption against a specified target value.
14. Reports Server Hardware Requirements
    a. Processor
        a) Minimum: 2.0 GHz
        b) Recommended: 2.0 GHz or higher
    b. Memory
        a) Minimum: 6 GB
        b) Recommended: 8GB or higher
    c. Hard Disk: 500 GB
15. Reports Server Software Requirements
    a. Operating System:
        a) Microsoft Windows 7 32-bit (Professional)
        b) Microsoft Windows 7 64-bit (Professional)
        c) Microsoft Windows 8.1 32-bit (Pro or Enterprise)
        d) Microsoft Windows 8.1 64-bit (Pro or Enterprise)
        e) Microsoft Windows 10 64-bit (Pro or Enterprise)
        f) Microsoft Windows Server 2008 R2 64-bit (Standard, Enterprise, Datacenter, Web, or Itanium)
        g) Microsoft Windows Server 2012 64-bit (Standard)
        h) Microsoft Windows Server 2012 R2 64-bit (Standard, Datacenter)
    b. SQL Versions:
        a) Microsoft SQL Server 2008 R2 64-bit SP2 (Standard and Express with Advanced Services)

b) Microsoft SQL Server 2012 64-bit (Standard and Express with Advanced Services)

c. Additional required software"

a) Microsoft .Net 4.5

L. Scheduling

1. From the workstation or webstation, it shall be possible to configure and download schedules for any of the controllers on the network.
2. Time of day schedules shall be in a calendar style and viewable in both a graphical and tabular view.
3. Schedules shall be programmable for a minimum of one year in advance.
4. To change the schedule for a particular day, a user shall simply select the day and make the desired modifications.
5. Additionally, from the operator webstations, each schedule will appear on the screen viewable as the entire year, monthly, week and day. A simple mouse click shall allow switching between views. It shall also be possible to scroll from one month to the next and view or alter any of the schedule times.
6. Schedules will be assigned to specific controllers and stored in their local RAM memory. Any changes made at the workstation will be automatically updated to the corresponding schedule in the controller.
7. It shall be possible to assign a lead schedule such that shadow/local schedules are updated based upon changes in the Lead.
8. It shall be possible to assign a list(s) of exception event days, dates, date ranges to a schedule.
9. It shall be possible to view combined views showing the calendar and all prioritized exemptions on one screen.
10. It should accommodate a minimum of 16 priority levels.
11. Values should be able to be controlled directly from a schedule, without the need for special program logic.

M. Programmer's Environment

1. Programming in the NSC shall be either in graphical block format or line-programming format or both.
2. Programming of the NSC shall be available offline from system prior to deployment into the field. All engineering tasks shall be possible, except, of course, the viewing of live tasks or values.
3. The programmer's environment will include access to a superset of the same programming language supported in the SDCUs.
4. NSC devices will support both script programming language as well as the graphical function block programming language. For both languages, the programmer will be able to configure application software for custom program development, and write global control programs. Both languages will have debugging capabilities in their editors.
5. It shall be possible to save custom programs as libraries for reuse throughout the system. A wizard tool shall be available for loading programs from a library file in the program editor.
6. It shall be possible to view graphical programming live and real-time from the Workstation.
7. The system shall be capable of creating 'binding templates' allowing the user to bind multiple points to multiple objects all at once.
8. Key terms should appear when typing (IntelliType).
9. Applications should be able to be assigned different priorities and cycle times for a prioritized execution of different function.
10. The system shall be able to create objects that allow common objects such as power meters, VFD drives, etc. to be integrated into the system with simple import actions without the need of complicated programming or configuration setups.

N. Saving/Reloading

1. The workstation software shall have an application to save and restore NSC and field controller memory files.

2. For the NSC, this application shall not be limited to saving and reloading an entire controller – it must also be able to save/reload individual objects in the controller. This allows off-line debugging of control programs, for example, and then reloading of just the modified information.

O. Audit Trail
1. The workstation software shall automatically log and timestamp every operation that a user performs at a workstation, from logging on and off a workstation to changing a point value, modifying a program, enabling/disabling an object, viewing a graphic display, running a report, modifying a schedule, etc.
2. It shall be possible to view a history of alarms, user actions, and commands for any system object individually or at least the last 5000 records of all events for the entire system from Workstation.
3. The Enterprise server shall be able to store up to 5 million events.
4. The event view shall support viewing of up to 100,000 events.
5. It shall be possible to save custom filtered views of event information that are viewable and configurable in Workstation.
6. It shall be capable to search and view all forced values within the system.

P. Fault Tolerant Enterprise Server Operation (Top level NSC)
1. A single component failure in the system shall not cause the entire system to fail. All system users shall be informed of any detectable component failure via an alarm event. System users shall not be logged off as a result of a system failure or switchover.

Q. Web-based Operator Software
1. General:
    1. Day-to-day operation of the system shall be accessible through a standard web browser interface, allowing technicians and operators to view any part of the system from anywhere on the network.
    2. The system shall be able to be accessed on site via a mobile device environment with, at a minimum, access to overwrite and view system values.
2. Graphic Displays
    1. The browser-based interface must share the same graphical displays as the Administration and Programming Workstations, presenting dynamic data on site layouts, floor plans, and equipment graphics. The browser's graphics shall support commands to change setpoints, enable/disable equipment and start/stop equipment.
    2. Through the browser-based interface, operators must be able to navigate through the entire system, and change the value or status of any point in any controller. Changes are effective immediately to the controller, with a record of the change stored in the system database.
3. Alarm Management
    1. Systems requiring additional client software to be installed on a PC for viewing the webstation from that PC will not be considered.
    2. Through the browser interface, a live alarm viewer identical to the alarm viewer on the Administration and Programming workstation shall be presented, if the user's password allows it. Users must be able to receive alarms, silence alarms, and acknowledge alarms through a browser. If desired, specific operator text must be able to be added to the alarm record before acknowledgement, attachments shall be viewable, and alarm checklists shall be available.

R. Groups and Schedules
1. Through the browser interface, operators must be able to view pre-defined groups of points, with their values updated automatically.
2. Through the browser interface, operators must be able to change schedules – change start and stop times, add new times to a schedule, and modify calendars.

S. User Accounts and Audit Trail
1. The same user accounts shall be used for the browser interface and for the operator workstations. Operators must not be forced to memorize multiple passwords.

2. All commands and user activity through the browser interface shall be recorded in the system's activity log, which can be later searched and retrieved by user, date, or both.

T. Web Services

1. The installed system shall be able to use web services to "consume" information within the Network Server/Controllers (NSCs) with other products and systems. Inability to perform web services within the NSCs will be unacceptable.
    a. Shall be able to "consume" data into the system via SOAP and REST web services.

2.4 Network Server Controllers (NSCs)

A. Network Router Controllers shall combine both network routing functions, control functions, and server functions into a single unit.

B. The BACnet NSC shall be classified as a "native" BACnet device, supporting the BACnet Network Server Controller (B-BC) profile. Controllers that support a lesser profile such as B-SA are not acceptable. NSCs shall be tested and certified by the BACnet Testing Laboratory (BTL) as BACnet Network Server Controllers (B-BC).

C. The Network Server Controller shall provide the interface between the LAN or WAN and the field control devices, and provide global supervisory control functions over the control devices connected to the NRS.

D. The NSCs shall be capable of whitelisting IPs to restrict access to a pre-defined list of hosts or devices.

E. Whitelisting of file extensions for documents shall be capable.

F. Encrypted and authenticated communication shall be configurable for non-open protocol communications using TLS 1.2

G. The NSCs shall support Simple Network Management Protocol version 3 (SNMPv3) for monitoring of the NSCs using a Network Management Tool.

H. The NSCs shall support remote system logging for used by System Information and Event Monitoring (SIEM) software.

I. They shall also be responsible for monitoring and controlling their own HVAC equipment such as an AHU or boiler.

J. They shall also contain graphics, trends, trend charts, alarm views, and other similar presentation objects that can be served to workstations or web-based interfaces. A sufficient number of NSCs shall be supplied to fully meet the requirements of this specification and the attached point list.

K. It shall be capable of executing application control programs to provide:

1. Calendar functions
2. Scheduling
3. Trending
4. Alarm monitoring and routing
5. Time synchronization by means of an Internet site including automatic synchronization
6. Native integration of LonWorks controller data and Modbus controller data or BACnet controller data and Modbus controller data
7. Network Management functions for all LonWorks based devices

L. Hardware Specifications

1. Memory:
    1. The operating system of the controller, application programs, and all other portions of the configuration database, shall be stored in non-volatile, FLASH memory. Servers/Controllers shall contain enough memory for the current application, plus required history logging, plus a minimum of 20% additional free memory.
2. Each NSC shall provide the following on-board hardware for communication:
    1. Two 10/100b Ethernet for communication to Workstations, other NRCs, IP field bus controllers, other SDCUs, and onto the internet.
        1) The two Ethernet ports shall support active switch and BACnet/IP communication protocols.
        2) Support IPv4 addressing
        3) Ethernet port 1 shall support static or DHCP client configuration for communication to Workstation or other NSCs

4) Ethernet port 2 shall support switch mode or DHCP server to set addressing of DHCP client devices
5) It shall be possible to disable Ethernet port 2
6) In DHCP server mode, the Ethernet port 2 shall support 50 BACnet/IP field controllers in daisy chain configuration directly from the port
7) Each NSC shall be able to support a total of 250 IP SDCUs in daisy chain configuration (5 sub networks via switch)
8) If using RSTP (Rapid Spanning Tree Protocol) with a managed switch (with IEEE 802.1W or IEEE 802.1Q-2014 support), Ethernet port 2 shall support up to 39 devices
9) Each NSC shall be able to support a total of 234 IP SDCUs in RSTP configuration (6 sub networks via managed switch)
10) Where a switch is needed, use a Cisco 9000 Catalyst or IE switch, EtherWAN EX63402-01B, or other equal and approved equivalent.

b. Two RS-485 ports for communication to BACnet MSTP bus or serial Modbus (software configurable)
c. One TP/FT port for communication to LonWorks devices.
d. One device USB port
e. One host USB port

3. The NSC shall conform to a small footprint no larger than 100W x 125H x 75D mm (3.94W x 4.92H x 2.95D in).

M. Modular Expandability:
1. The system shall employ a modular I/O design to allow expansion. Input and output capacity is to be provided through plug-in modules of various types. It shall be possible to combine I/O modules as desired to meet the I/O requirements for individual control applications.
2. One shall be able to “hot-change” (hot-swap) the I/O modules preserving the system on-line without any intervention on the software; addressing and configuration shall be automatic.
3. If for any reason the backplane of the modular I/O system were to fail, I/O module addresses will be protected.

N. Hardware Override Switches:
1. All digital outputs shall, optionally, include three position manual override switches to allow selection of the ON, OFF, or AUTO output state. These switches shall be built into the unit and shall provide feedback to the controller so that the position of the override switch can be obtained through software. In addition each analog output shall be equipped with an override potentiometer to allow manual adjustment of the analog output signal over its full range, when the 3 position manual override switch is placed in the ON position.

O. Universal Input Temperatures
1. All universal inputs directly connected to the NSC via modular expansion shall be capable of using the following thermistors for use in the system without any external converters needed.
a. 10 kohm Type I (Continuum)
b. 10 kohm Type II (I/NET)
c. 10 kohm Type III (Satchwell)
d. 10 kohm Type IV (FD)
e. Linearized 10 kohm Type V (FD w/11k shunt)
f. Linearized 10 kohm (Satchwell)
g. 1.8 kohm (Xenta)
h. 1 kohm (Balco)
i. 20 kohm (Honeywell)
j. 2.2 kohm (Johnson)
2. In addition to the above, the system shall be capable of using the below RTD sensors, however it is not required that all universal inputs be compatible with them.
a. PT100 (Siemens)
b. PT1000 (Sauter)

c. Ni1000 (Danfoss)

P. Local Status Indicator Lamps:
1. The NSC shall provide as a minimum LED indication of CPU status, Ethernet LAN status, and field bus status. For each input or output, provide LED indication of the value of the point (On/Off). The LED indication shall support software configuration to set whether the illumination of the LED corresponds to On or Off or whether the color when illuminated is Red or Green.

Q. Real Time Clock (RTC):
1. Each NSC shall include a real time clock, accurate to 10 seconds per day. The RTC shall provide the following: time of day, day, month, year, and day of week. Each NSC will allow for its own UTC offset, depending upon the time zone. When the time zone is set, the NSC will also store the appropriate times for daylight savings time.
2. The RTC date and time shall also be accurate, up to 30 days, when the NSC is powerless.
3. No batteries may be used to for the backup of the RTC.

R. Power Supply:
1. The 24 VDC power supply for the NSCs shall provide 30 watts of available power for the NSC and associated IO modules. The system shall support the use of more than one power supply if heavily power consuming modules are required.
2. The power supply, NSC, and I/O modules shall connect power wise and communication wise via the separate terminal base allowing for ease of replacement and no separate or loose wiring.

S. Automatic Restart After Power Failure:
1. Upon restoration of power after an outage, the NSC shall automatically and without human intervention update all monitored functions, resume operation based on current, synchronize time and status, and implement special start-up strategies as required.

T. Data Retention:
1. During a power failure, the NSC shall retain all programs, configuration data, historical data, and all other data that is configured to be retained. There shall be no time restriction for this retention and it must not use batteries to achieve it.

U. Software Specifications
1. The operating system of the controller, application programs, and all other portions of the configuration database such as graphics, trends, alarms, views, etc., shall be stored in non-volatile, FLASH memory. There will be no restrictions placed on the type of application programs in the system. Each NSC shall be capable of parallel processing, executing all control programs simultaneously. Any program may affect the operation of any other program. Each program shall have the full access of all I/O facilities of the processor. This execution of control function shall not be interrupted due to normal user communications including interrogation, program entry, printout of the program for storage, etc.
2. Each NSC shall have an available capacity of 4 GB of memory. This shall represent 2 GB for application and historical data and 2 GB dedicated for backup storage.

V. User Programming Language:
1. The application software shall be user programmable. This includes all strategies, sequences of operation, control algorithms, parameters, and setpoints. The source program shall be either a script-based structured text or graphical function block based and fully programmable by the user. The language shall be structured to allow for the configuration of control programs, schedules, alarms, reports, telecommunications, local displays, mathematical calculations, and histories. Users shall be able to place comments anywhere in the body of either script or function block programs.
2. Network Server Controllers that use a “canned” program method will not be accepted.

W. Control Software:
1. The NSC shall have the ability to perform the following pre-tested control algorithms:
    1. Proportional, Integral plus Derivative Control (PID)
    2. Two Position Control

3. Digital Filter
4. Ratio Calculator
5. Equipment Cycling Protection

X. Mathematical Functions:
1. Each controller shall be capable of performing basic mathematical functions (+, -, *, /), squares, square roots, exponential, logarithms, Boolean logic statements, or combinations of both. The controllers shall be capable of performing complex logical statements including operators such as >, <, =, and, or, exclusive or, etc. These must be able to be used in the same equations with the mathematical operators and nested up to five parentheses deep.

Y. NSCs shall have the ability to perform any or all of the following energy management routines:
1. Time of Day Scheduling
2. Calendar Based Scheduling
3. Holiday Scheduling
4. Temporary Schedule Overrides
5. Optimal Start
6. Optimal Stop
7. Night Setback Control
8. Enthalpy Switchover (Economizer)
9. Peak Demand Limiting
10. Temperature Compensated Duty Cycling
11. CFM Tracking
12. Heating/Cooling Interlock
13. Hot/Cold Deck Reset
14. Hot Water Reset
15. Chilled Water Reset
16. Condenser Water Reset
17. Chiller Sequencing

Z. History Logging:
1. Each NSC controller shall be capable of LOCALLY logging any input, output, calculated value or other system variable either over user defined time intervals ranging from 1 second to 1440 minutes or based upon a user configurable change of value. A minimum of 1000 logs, with a minimum of 100,000 records, shall be stored. Each log can record either the instantaneous, average, minimum or maximum value of the point. Logged data shall be downloadable to a higher level NSC long term archiving based upon user-defined time intervals, or manual command.
2. For extended trend logging a minimum of 1500 trends shall be capable, with a minimum number of 600,000 records within.
3. Management of a power meter replacement to ensure meter log data is accurate shall be possible in the NSC.
4. Every hardware input and output point, hosted within the NSC and attached I/O modules, shall be trended automatically without the requirement for manual creation, and each of these logs shall log values based upon a change of value and store at least 500 trend samples before replacing the oldest sample with new data.
5. The presentation of logged data shall be built into the server capabilities of the NSC. Presentation can be in time stamped list formats or in a chart format with fully configurable pen colors, weights, scales and time spans.
6. Tooltips shall be present, magnetic, and visible based on users preference.
7. Comments shall be visible whenever viewing the trend log list.
8. System shall give indication of memory usage and be able to alert the user if too many logs are allocated.

AA. Alarm Management:
1. For each system point, alarms can be created based on high/low limits or in comparison to other point values. All alarms will be tested each scan of the NSC and can result in the display of one or more alarm messages or reports.
2. There is no limit to the number of alarms that can be created for any point

3. Alarms can be configured to be generated based upon a single system condition or multiple system conditions.
4. Alarms will be generated based on an evaluation of the alarm conditions and can be presented to the user in a fully configurable order, by priority, by time, by category, etc. These configurable alarm views will be presented to a user upon logging into the system regardless of whether the log in takes place at a WorkStation or a Webstation.
5. The alarm management system shall support the ability to create and select cause and action notes to be selected and associated with an alarm event. Checklists shall also be possible in order to present to an operator a suggested mode of troubleshooting. When acknowledging an alarm, it shall be possible to assign it to a user of the system such that the user is notified of the assignment and is made responsible for the alarm resolution.
6. Alarms must be capable of being routed to any BACnet workstation that conforms to the B-OWS device profile and uses the BACnet/IP protocol.

BB. Embedded Web Server

1. Each NSC must have the ability to serve out web pages containing the same information that is available from the WorkStation. The development of the screens to accomplish shall not require any additional engineering labor over that required to show them at the WorkStation itself.
2. The NSC shall be configurable to logging all Embedded Web Server access attempts
3. The NSC shall have the option to redirect HTTP based Embedded Web Server connections to secure, HTTPS connections.
4. The NSC shall authenticate and authorize all users connecting to the Embedded Web Server
5. The NSC shall provide to ability to configure an automatic logoff for Embedded Web Server users that have not had any activity for an adjustable time period.

2.5 BACnet IP Fieldbus Controllers

A. Controllers – BACnet/IP Protocol

1. All BACnet/IP Fieldbus controllers shall be BACnet Testing Laboratory listed (v12 or later) as specified BACnet Advanced Application Controller (B-AAC)
2. All BACnet/IP Fieldbus controllers shall use the following communication specifications and achieve performance as specified herein:
   a. All controllers shall be able to communicate peer-to-peer without the need for a NSC
   b. Any BACnet/IP Fieldbus controllers on the Ethernet Data Link/Physical layer shall be able to act as a Master to allow for the exchange and sharing of data variables and messages with any other controller connected on the same communication cabling. Slave controllers are not acceptable.

B. The BACnet/IP Fieldbus controllers shall be equipped with 2x 10/100bT Ethernet communication ports with active switch and will support BACnet/IP communication protocols with the following configurations:

1. Supporting IPv4 addressing
2. Supporting Static IP setting, DHCP client and Auto-IP address acquision
3. It shall be possible to disable Ethernet port 2

C. Topologies

1. BACnet/IP Fieldbus controllers shall support daisy chain topology of up to 50 controllers. In case of any disruption to the communication, a system alarm shall notify the NSC/BMS of the point disruption has occurred.
2. BACnet/IP Fieldbus Controllers shall support RSTP loop whereby up to 39 controllers are supported.
   a. In case of any disruption there shall be no communication interruption
   b. In case of any disruption there shall be system alarms that will inform the operator of the disruption

D. Performance

1. Each BACnet/IP Fieldbus Controllers shall have a 32-bit microprocessor operating at 500 MHz and support a BACnet protocol stack in accordance with the ANSI/ASHRAE Standard 135-2008 and the BACnet Device Profile supported.

2. They shall be multi-tasking, real-time digital control processors consisting of communication controllers, controls processing, power supplies with built-in inputs and outputs.

E. Programmability
1. The BACnet/IP Fieldbus controllers shall support both script programming language and graphical that will be consistent with the NSC.
2. The control program will reside within the same enclosure as the input/output circuitry, that reads inputs and controls outputs
3. All control sequences programmed into the BACnet/IP Fieldbus Controllers shall be stored in non-volatile memory, which is not dependent upon the presence of a battery, to be retained.
4. BACnet/IP Fieldbus controllers shall communicate with the Network Server Controller (NSC) via a BACnet/IP connection at a baud rate of not less than 100 Mbps
5. BACnet/IP Fieldbus controllers shall support a dedicated communications port for connecting and supplying power to a matching room temperature and/or humidity sensor and/or CO2 and/or presence detector that does not utilize any of the I/O points of the controller.
6. BACnet/IP Fieldbus controllers (Excluding VAV) shall support an add-on display to supply and provide access in real-time for monitoring inputs and overriding of outputs
7. The override functionality must be supported by a dedicated processor to assure reliable operation (overriding of output)
8. Each BACnet/IP Fieldbus controller shall have sufficient memory, to support its own operating system and databases, including:
    a. Control processes
    b. Energy management applications
    c. Alarm management
    d. Historical/trend data
    e. Maintenance support applications
    f. Custom processes
    g. Manal override monitoring

9. Each BACnet/IP Fieldbus controller shall support local trend data up to 2x the built-in I/O and at a minimum be capable of holding 5 days @ 15 min intervals locally.
10. The BACnet/IP Fieldbus controller analog or universal input shall use a 16 bit A/D converter.
11. The BACnet/IP Fieldbus controller analog or universal output shall use a 10 bit D/A converter.
12. Built-in I/O: each BACnet/IP Fieldbus controllers shall support:
    a. At minimum 8 and up to 20 configurable IO channels to monitor and to control the following types of inputs and outputs without the addition of equipment inside or outside the DDC Controller cabinet.
        1) Universal Inputs – the following thermistors for use in the system without any external converters needed.
            a) 10 kohm Type I (Continuum)
            b) 10 kohm Type II (I/NET)
            c) 10 kohm Type III (Satchwell)
            d) 10 kohm Type IV (FD)
            e) Linearized 10 kohm Type V (FD w/11k shunt)
            f) Linearized 10 kohm (Satchwell)
            g) 1.8 kohm (Xenta)
            h) 1 kohm (Balco)
            i) 20 kohm (Honeywell)
            j) 2.2 kohm (Johnson)
            k) PT100 (Siemens)
            l) PT1000 (Sauter)
            m) Ni1000 (Danfoss)
        2) Analog inputs

a) Current Input - 0-20 mA
b) Voltage Input 0-10 Vdc
3) Digital inputs from dry contact closure, pulse accumulators, voltage sensing.
4) Digital outputs
5) Analog outputs of 4-20 mA and/or 0-10 Vdc

13. Real Time Clock (RTC):
    a. Each BACnet/IP Fieldbus controller shall include a real time clock, accurate to +/-1 minute per month. The RTC shall provide the following: time of day, day, month, year, and day of week.
    b. The RTC date and time shall also be accurate, up to 7 days, when the BACnet/IP Fieldbus controller is powerless.
    c. No batteries may be used to for the backup of the RTC.
14. The BACnet/IP Fieldbus controller for Variable Air Volume (VAV) applications
    a. The BACnet/IP Fieldbus controller for VAV applications shall include a built-in 'flow thru' differential pressure transducer
    b. The VAV differential pressure transducer shall have a measurement range of 0 to 1 in. W.C. and measurement accuracy of ±5% at 0.001 to 1 in. W.C. and a minimum resolution of 0.001 in. W.C., insuring primary air flow conditions shall be controlled and maintained to within ±5% of setpoint at the specified minimum and maximum air flow parameters
    c. The BACnet/IP FieldBus controller for VAV applications shall support a dedicated commissioning tool for air flow balancing
    d. The BACnet/IP Fieldbus controller for VAV applications shall require no programing for air balancing algorithm
    e. All balancing parameters shall be synchronized in NSC
15. Each BACnet/IP Fieldbus controller shall have a minimum of 10% spare capacity for each point type represented on the controller for future point connection
16. Power Requirements.: 24VDC (21 to 33 VDC) and 24 VAC +/-20% with local transformer power

F. Commissioning Tool - The BACnet/IP Fieldbus controller shall be supported via a dedicate mobile based commissioning tool for configuration, programming, air balancing and I/O checkout
    1. The Commissioning Tool shall be supported across: iOS, Android and Windows 10 platforms
    2. The Commissioning Tool shall be available for download on App Store, Google Store and Windows Store
    3. Commissioning Tool Interface to BACnet/IP Fieldbus controllers shall be via a Bluetooth adapter interface through the Intelligent Space Sensor or via a Wi-Fi access point on the LAN
    4. Functionality
        a. Device Configuration – the Commissioning Tool shall be able to set or edit all Network configurations associated with the BACnet/IP Fieldbus controller
        b. Programming – The Commissioning Tool shall be able to load offline engineered applications directly in to the controller directly
        c. Air Balancing
            1) The Commissioning Tool shall allow the air balancer to manually control the action of the actuator including the following function: open VAV damper, close VAV damper, open all VAV dampers, and close all VAV dampers.
            2) The Commissioning Tool shall be able to generate Air Balancing report
        d. IO Checkout
            1) The Commissioning Tool shall be able to support overriding of the outputs and reading value of inputs live
            2) The Commissioning Tool shall be able to support generation of I/O checkout report
        e. There shall be no limit to the number of Commissioning Tools that can be used on a network segment, however, one connection per controller is recommended

G. Intelligent Space Sensors - The BACnet/IP Fieldbus controller shall support a dedicated RJ45 communication port to communicate and power up to 4 intelligent wall mount sensors without the use of on board inputs or outputs
   1. The Intelligent Space Sensor shall communicate with the BACnet/IP Fieldbus controller through the sensor port and via category 5 or category 6 cable
   2. The Intelligent Space Sensor shall provide 2 RJ45 communication ports that will allow communication with parent BACnet/IP Field controller upstream and additional Intelligent Space Sensors downstream
   3. The Intelligent Space Sensor shall provide ambient space condition sensing without the use of hardware I/O

H. Each Intelligent Space Sensor shall provide a color touch display with:
   1. Minimum 61 mm (2.4”) by 61 mm (2.4”) display
   2. Backlit

I. The Intelligent Space Sensor shall be capable of displaying measured space temperature from 0 to 50 °C (32 to 122 °F) with accuracy of ±0.2 °C (±0.4 °F) selectable for 0.1 or 1 degree display resolution of °F or °C
   1. Sensing Element: 10k Type 3 Thermistor
   2. Accuracy of ±0.2 °C (±0.4 °F)
   3. Resolution: 0.1 or 1 degree display resolution
   4. Range: 0 to 50 °C (32 to 122 °F)

J. The Intelligent Space Sensor shall have the option for humidity sensor support sensing humidity from 0 % RH to 100 % RH Digital humidity indication (selectable for 0.1 or 1% RH with selectable display resolution of 0.1 or 1 % RH
   1. Accuracy: ±2 % RH
   2. Resolution: 0.1 or 1 % RH
   3. Range: 0 % RH to 100 % RH

K. The Intelligent Space Sensor shall have the option for support of CO2 sensor with display resolution with 0 to 2000 ppm resolution
   1. Accuracy: ±30 ppm ±2% of measured value
   2. Range: 0 to 2,000 ppm
   3. Operating elevation: 0 to 16,000 ft.
   4. Temperature dependence: 0.11% FS per ˚F
   5. Stability: <2% of FS over life of sensor (15 years)
   6. Sensing method: Non-dispersive infrared (NDIR), diffusion sampling

L. The Intelligent Space Sensor shall have the option for motion sensor

M. Display options: The Intelligent Space Sensor shall be capable of displaying the following elements:
   1. Space temperature
   2. Cooling space temperature set point
   3. Heating space temperature set point
   4. Current heating or cooling mode
   5. Current occupancy mode
   6. Fan speed
   7. Current time

2.6 BACnet Fieldbus and BACnet SDCUs

A. Networking
   1. IP Network: All devices that connect to the WAN shall be capable of operating at 10 megabits per second or 100 megabits per second.
   2. IP To Field Bus Routing Devices
      1. A Network Server Controller shall be used to provide this functionality.
      2. These devices shall be configurable locally with IP crossover cable and configurable via the IP network.
      3. The routing configuration shall be such that only data packets from the field bus devices that need to travel over the IP level of the architecture are forwarded.

B. Field Bus Wiring and Termination

1. The wiring of components shall use a bus or daisy chain concept with no tees, stubs, or free topology.
2. Each field bus shall have a termination resistor at both ends of each segment.
3. The field bus shall support the use of wireless communications.

C. Repeaters
1. Repeaters are required to connect two segments.
2. Repeaters shall be installed in an enclosure. The enclosure may be in an interstitial space.

D. Field Bus Devices
1. General Requirements
1. Devices shall have a light indicating that they are powered.
2. Devices shall be locally powered. Link powered devices (power is furnished from a central source over the field bus cable) are not acceptable.
3. Application programs shall be stored in a manner such that a loss of power does not result in a loss of the application program or configuration parameter settings. (Battery backup, flash memory, etc.)

E. Advance Application Controllers (B-AAC)
1. The key characteristics of a B-AAC are:
1. They have physical input and output circuits for the connection of analog input devices, binary input devices, pulse input devices, analog output devices, and binary output devices. The number and type of input and output devices supported will vary by model.
2. They may or may not provide support for additional input and output devices beyond the number of circuits that are provided on the basic circuit board. Support for additional I/O shall be provided by additional circuit boards that physically connect to the basic controller.
3. The application to be executed by a B-AAC is created by an application engineer using the vendor's application programming tool.
4. If local time schedules are embedded, the B-AAC shall support the editing of time schedule entries from any BACnet OWS that supports the BACnet service for writing of time schedule parameters.
5. If local trend logging is embedded, the B-AAC shall support the exporting of trend log data to any BACnet OWS that supports the read range BACnet service for trending.
6. If local alarm message initiation is embedded, the B-AAC shall:
a. Deliver alarm messages to any BACnet OWS that supports the BACnet service for receiving alarm messages and is configured to be a recipient off the alarm message.
b. Support alarm acknowledgement from any BACnet OWS that supports the BACnet service for executing alarm/event acknowledgement,
7. Shall support the reading of analog and binary data from any BACnet OWS or Building Controller that supports the BACnet service for the reading of data.
8. Shall support the control of the out of service property and assignment of value or state to analog and binary objects from any BACnet OWS that supports writing to the out of service property and the value property of analog and binary objects.
9. Shall support the receipt and response to Time Synchronization commands from a BACnet Building Controller.
10. Shall support the "Who is" and "I am." BACnet services.
11. Shall support the "Who has" and "I have." BACnet services.

2. Analog Input Circuits
1. The resolution of the A/D chip shall not be greater than 0.01 Volts per increment. For an A/D converter that has a measurement range of 0 to 10 VDC and is 10 bit, the resolution is 10/1024 or 0.00976 Volts per increment.
2. For non-flow sensors, the control logic shall provide support for the use of a calibration offset such that the raw measured value is added to the (+/-) offset to create a calibration value to be used by the control logic and reported to the Operator Workstation (OWS).

3. For flow sensors, the control logic shall provide support for the use of an adjustable gain and an adjustable offset such that a two point calibration concept can be executed (both a low range value and a high range value are adjusted to match values determined by a calibration instrument).
4. For non-linear sensors such as thermistors and flow sensors the B-AAC shall provide software support for the linearization of the input signal.

3. Binary Input Circuits
   1. Dry contact sensors shall wire to the controller with two wires.
   2. An external power supply in the sensor circuit shall not be required.
4. Pulse Input Circuits
   1. Pulse input sensors shall wire to the controller with two wires.
   2. An external power supply in the sensor circuit shall not be required.
   3. The pulse input circuit shall be able to process up to 20 pulses per second.
5. True Analog Output Circuits
   1. The logical commands shall be processed by a digital to analog (D/A) converter chip. The 0% to 100% control signal shall be scalable to the full output range which shall be either 0 to 10 VDC, 4 to 20 milliamps or 0 to 20 milliamps or to ranges within the full output range (Example: 0 to 100% creates 3 to 6 VDC where the full output range is 0 to 10 VDC).
   2. The resolution of the D/A chip shall not be greater than 0.04 Volts per increment or 0.08 milliamps per increment.
6. Binary Output Circuits
   1. Single pole, single throw or single pole, double throw relays with support for up to 230 VAC and a maximum current of 2 amps.
   2. Voltage sourcing or externally powered triacs with support for up to 30 VAC and 0.5 amps at 24 VAC.
7. Program Execution
   1. Process control loops shall operate in parallel and not in sequence unless specifically required to operate in sequence by the sequence of control.
   2. The sample rate for a process control loop shall be adjustable and shall support a minimum sample rate of 1 second.
   3. The sample rate for process variables shall be adjustable and shall support a minimum sample rate of 1 second.
   4. The sample rate for algorithm updates shall be adjustable and shall support a minimum sample rate of 1 second.
   5. The application shall have the ability to determine if a power cycle to the controller has occurred and the application programmer shall be able to use the indication of a power cycle to modify the sequence of controller immediately following a power cycle.
8. Local Interface
   1. The controller shall support the connection of a portable interface device such as a laptop computer or vendor unique hand-held device. The ability to execute any tasks other than viewing data shall be password protected. Via this local interface, an operator shall be able to:
      1) Adjust application parameters.
      2) Execute manual control of input and output points.
      3) View dynamic data.

F. Application Specific Devices
   1. Application specific devices shall have fixed function configurable applications.
   2. If the application can be altered by the vendor's application programmable tool, the device is an advanced application controller and not an application specific device.
   3. Application specific devices shall be BTL certified.

2.7 DDC Sensors and Point Hardware

A. Temperature Sensors
   1. Acceptable Manufacturers: Veris Industries

2. All temperature devices shall use precision thermistors accurate to +/- 1 degree F over a range of –30 to 230 degrees F. Space temperature sensors shall be accurate to +/- .5 degrees F over a range of 40 to 100 degrees F.
3. Room Sensor: Standard space sensors shall be available in an [off white] [black] enclosure made of high impact ABS plastic for mounting on a standard electrical box. Basis of Design: Veris TW Series
    a. Where manual overrides are required, the sensor housing shall feature both an optional sliding mechanism for adjusting the space temperature setpoint, as well as a push button for selecting after hours operation.
    b. Where a local display is specified, the sensor shall incorporate an LCD display for viewing the space temperature, setpoint and other operator selectable parameters. Using built in buttons, operators shall be able to adjust setpoints directly from the sensor.
4. Duct Probe Sensor: Sensing element shall be fully encapsulated in potting material within a stainless steel probe. Useable in air handling applications where the coil or duct area is less than 14 square feet. Basis of Design: Veris TD Series
5. Duct Averaging Sensor: Averaging sensors shall be employed in ducts which are larger than 14 square feet. The averaging sensor tube shall contain at least one thermistor for every 3 feet, with a minimum tube length of 6 feet. The averaging sensor shall be constructed of rigid or flexible copper tubing. Basis of Design: Veris TA Series
6. Pipe Immersion Sensor: Immersion sensors shall be employed for measurement of temperature in all chilled and hot water applications as well as refrigerant applications. Provide sensor probe length suitable for application. Provide each sensor with a corresponding pipe-mounted sensor well, unless indicated otherwise. Sensor wells shall be stainless steel for non-corrosive fluids below 250 degrees F and 300 series stainless steel for all other applications. Basis of Design: Veris TI Series
7. Outside Air Sensor: Provide the sensing element on the building's north side. Sensing element shall be fully encapsulated in potting material within a stainless steel probe. Probe shall be encased in PVC solar radiation shield and mounted in a weatherproof enclosure. Operating range -40 to 122 F, Basis of Design: Veris TO Series
8. A pneumatic signal shall not be allowed for sensing temperature.

B. Carbon Dioxide Wall Transmitter:
1. Acceptable Manufacturer: Veris Industries
2. Sensor type shall be Non-dispersive infrared (NDIR).
3. Accuracy shall be ±30 ppm ±2% of measured value with annual drift of ±10 ppm. Minimum five year recommended calibration interval.
4. Repeatability shall be ±20 ppm ±1% of measured value
5. Response Time shall be <60 seconds for 90% step change
6. Outputs shall be field selectable [Analog: 4-20mA or 0-5/0-10VDC] [Protocol: Modbus or BACnet] with [SPDT Relay 1A@30VDC] [temperature setpoint slider]
7. Transmitter shall accept 12-30 VDC or 24 VAC supply power.
8. Temperature Range: [32° to 122°F (CO2 only)] [50° to 95°F (with humidity option)]
9. Output range shall be programmable 0-2000 or 0-5000 ppm
10. Transmitter shall be available in an off white enclosure for mounting on a standard electrical box.
11. Transmitter shall have an option of an LCD display for commissioning and provide additional faceplate to conceal LCD display where occupants may misinterpret CO2 readings.
12. Transmitter shall have option of an integrated temperature sensor and/or humidity sensor
13. Basis of Design: Veris CWL

C. Carbon Dioxide Duct Transmitter:
1. Acceptable Manufacturer: Veris Industries
2. Sensor type shall be Non-dispersive infrared (NDIR).
3. Accuracy shall be ±30 ppm ±2% of measured value with annual drift of ±10 ppm. Minimum five year recommended calibration interval.
4. Repeatability shall be ±20 ppm ±1% of measured value
5. Response Time shall be <60 seconds for 90% step change

6. Outputs shall be field selectable Analog: 4-20mA or 0-5/0-10VDC with SPDT Relay 1A@30VDC
7. Transmitter shall accept 12-30 VDC or 24 VAC supply power.
8. Temperature Range: 32° to 122°F
9. Output range shall be programmable 0-2000 or 0-5000 ppm
10. Enclosure shall not require remote pickup tubes and make use of integrated H-beam probe to channel air flow to sensor.
11. Enclosure lid shall require no screws and make use of snap on features for attachment
12. Enclosure shall be made of high impact ABS plastic
13. Transmitter shall have option of an LCD display
14. Transmitter shall have option of an integrated temperature sensor and/or humidity sensor
15. Basis of Design: Veris CDL

D. Air Pressure Transmitters.
1. Acceptable Manufacturers: Veris Industries
2. Sensor shall be microprocessor profiled ceramic capacitive sensing element
3. Transmitter shall have 14 selectable ranges from 0.1 – 10" WC
4. Transmitter shall be +/- 1% accurate in each selected range including linearity, repeatability, hysteresis, stability, and temperature compensation.
5. Transmitter shall be field configurable to mount on wall or duct with static probe
6. Transmitter shall be field selectable for Unidirectional or Bidirectional
7. Maximum operating pressure shall be 200% of design pressure.
8. Output shall be field selectable 4-20 mA or 0-5/0-10 VDC linear.
9. Transmitter shall accept 12-30 VDC or 24 VAC supply power
10. Response time shall be field selectable T95 in 20 sec or T95 in 2 sec
11. Transmitter shall have an LCD display
12. Units shall be field selectable for WC or PA
13. Transmitter shall have provision for zeroing by pushbutton or digital input.
14. Transmitter shall be available with a certification of NIST calibration
15. Basis of Design: Veris model PXU.

E. Liquid Differential Pressure Transmitters:
1. Acceptable Manufacturer: Veris Industries
2. Transmitter shall be microprocessor based
3. Transmitter shall use two independent gauge pressure sensors to measure and calculate differential pressure
4. Transmitter shall have 4 switch selectable ranges
5. Transmitter shall have test mode to produce full-scale output automatically.
6. Transmitter shall have provision for zeroing by pushbutton or digital input.
7. Transmitter shall have field selectable outputs of 0-5V, 0-10V, and 4-20mA.
8. Transmitter shall have field selectable electronic surge damping
9. Transmitter shall have an electronic port swap feature
10. Transmitter shall accept 12-30 VDC or 24 VAC supply power
11. Sensor shall be 17-4 PH stainless steel where it contacts the working fluid.
12. Performance:
    1. Accuracy shall be ±1% F.S. and ±2% F.S. for lowest selectable range
    2. Long term stability shall be ±0.25%
    3. Sensor temperature operating range shall be -4° to 185°F
    4. Operating environment shall be 14° to 131°F; 10-90% RH noncondensing
    5. Proof pressure shall be 2x max. F.S. range
    6. Burst pressure shall be 5x max. F.S. range
13. Transmitter shall be encased in a NEMA 4 enclosure
14. Enclosure shall be white powder-coated aluminum
15. Transmitter shall be available with a certification of NIST calibration
16. [Transmitter shall be preinstalled on a bypass valve manifold]
17. Basis of Design: Veris PW

F. Current Sensors
1. Current status switches shall be used to monitor fans, pumps, motors and electrical loads. Current switches shall be available in split core models, and offer

either a digital or an analog signal to the automation system. Acceptable manufacturer is Veris Industries

G. Current Status Switches for Constant Load Devices
   1. Acceptable Manufacturer: Veris Industries
   2. General: Factory programmed current sensor to detect motor undercurrent situations such as belt or coupling loss on constant loads. Sensor shall store motor current as operating parameter in non-volatile memory. Push-button to clear memory.
   3. Visual LED indicator for status.
   4. Split core sensor, induced powered from monitored load and isolated to 600 VAC rms. Sensor shall indicate status from 0.5 A to 175 A.
   5. Normally open current sensor output. 0.1A at 30 VAC/DC.
   6. Basis of Design: Veris Model H608.

H. Current Status Switches for Constant Load Devices (Auto Calibration)
   1. Acceptable Manufacturer: Veris Industries.
   2. General: Microprocessor based, self-learning, self-calibrating current switch. Calibration-free status for both under and overcurrent, LCD display, and slide-switch selectable trip point limits. At initial power-up automatically learns average current on the line with no action required by the installer
   3. Split core sensor, induced powered from monitored load and isolated to 600 VAC rms. Sensor shall indicate status from 2.5 A to 200 A.
   4. Display: Backlit LCD; illuminates when monitored current exceeds 4.5A
   5. Nominal Trip Point: ±40%, ±60%, or on/off (user selectable)
   6. Normally open current sensor output. 0.1A at 30 VAC/DC.
   7. Basis of Design: Veris Model H11D.

I. Current Status Switches for Variable Frequency Drive Application
   1. Acceptable Manufacturer: Veris Industries.
   2. General: Microprocessor controlled, self-learning, self-calibrating current sensor to detect motor undercurrent and overcurrent situations such as belt loss, coupling shear, and mechanical failure on variable loads. Sensor shall store motor current as operating parameter in non-volatile memory. Push-button to clear memory and relearn.
   3. Visual LED indicator for status.
   4. Alarm Limits: ±20% of learned current in every 5 Hz freq. band
   5. Split core sensor, induced powered from monitored load and isolated to 600 VAC rms. Sensor shall indicate status from 1.5 A to 150 A and from 12 to 115 Hz.
   6. Normally open current sensor output. 0.1A at 30 VAC/DC.
   7. Basis of Design: Veris Model H614.

J. Liquid Flow, Insertion Type Turbine Flowmeter:
   1. Acceptable Manufacturer: Veris Industries
   2. General: Turbine-type insertion flow meter designed for use in pipe sizes 1 1/2” and greater. Available in hot tap configuration with isolation valves and mounting hardware to install or remove the sensor from pipeline that is difficult to shut down or drain
   3. Performance:
      a. Accuracy ±1% of rate over optimum flow range; ≥10 upstream and ≥5 downstream straight pipe diameters, uninterrupted flow
      b. Repeatability ±0.5%
      c. Velocity Range: 0.3 to 20 FPS
      d. Pressure Drop 0.5 psi or less @ 10 ft/sec for all pipe sizes 1.5” dia and up
      e. Pressure Rating: 1000 psi @ 70°F
   4. Maximum Temperature Rating: 300°F
   5. Materials: Stainless Steel or Brass body; Stainless steel impeller
   6. Transmitter:
      a. Power Supply: 12 - 30VAC or 8 - 35VDC.
         1) Output: [Frequency] [4-20 mA] [Scaled Pulse]
      b. Temperature Range: 14° to 150°F
      c. Display: 8 character 3/8" LCD (Optional)
      d. Enclosure: NEMA 4, Polypropylene with Viton® sealed acrylic cover

7. Basis of Design: Veris SDI series

K. Liquid Flow/Energy Transmitter, Non-invasive Ultrasonic (Clamp-on):
1. Acceptable Manufacturer: Veris Industries
2. General: Clamp-on digital correlation transit-time ultrasonic flow meter designed for clean liquids or liquids containing small amounts of suspended solids or aeration. Optional temperature sensors for BTU calculations.
3. Liquid: water, brine, raw sewage, ethylene, glycol, glycerin, others. Contact manufacturer for other fluid compatibility
4. Pipe Surface Temperature: Pipe dia 1/2" to 2":-40-185°F; Pipe dia > 2": -40-250°F
5. Performance:
   a. Flow Accuracy:
      1) Pipe dia 1/2" to 3/4" 1% of full scale
      2) Pipe dia 1" to 2" 1% of reading from 4-40 FPS
      3) Pipe dia 2" to 100" 1% of reading from 1-40 FPS
   b. Flow Repeatability ±0.01% of reading
   c. Velocity Range: (Bidirectional flow)
      1) Pipe dia 1/2" to 2" 2 to 40 FPS
      2) Pipe dia 2" to 100" 1 to 40 FPS
   d. Flow Sensitivity 0.001 FPS
   e. Temperature Accuracy (energy): 32-212°F; Absolute 0.45°F; Difference 0.18°F
   f. Temperature Sensitivity: 0.05°F
   g. Temperature Repeatability: ±0.05% of reading
6. Transmitter:
   a. Power Supply: 95 to 264 VAC, 47 to 63 Hz or 10 to 28 VDC.
   b. Output: [RJ45] [Modbus TCP/IP] [Ethernet/IP] [BACnet/IP] [Pulse] [4-20 mA] [RS-485 Modbus RTU}
   c. Temperature Range: -40 to +185°F
   d. Display: 2 line backlit LCD with keypad
   e. Enclosure: NEMA 4, (IP65), Powder-coated aluminum, polycarbonate
7. Agency Rating: UL 1604, EN 60079-0/15, CSA C22.2, CSA Class 1 (Pipe > 2")
8. Basis of Design: Veris FST & FSR series

L. Analog Electric/Pneumatic Transducer:
1. Acceptable Manufacturer: Veris Industries
2. General: Micro-controlled poppet valve for high accuracy and with no air loss in the system. Field configurable for pressure sensing in multiple applications.
3. Power Supply: 22-30VDC, 20-30VAC
4. Control Input: 4-20mA, 0-10V, 0-5V; jumper selectable
5. Performance:
   a. Accuracy: 1% full scale; combined linearity, hysteresis, repeatability
   b. Compensated Temperature Range: 25° to 140°F
   c. Temp Coefficient: ±0.05%°C
   d. Operating Environment: 10-90% RH, non-condensing; 25° to 140°F
6. Supply Pressure: 45 psig max.
7. Manual Override: Jumper selectable mode, digital pushbutton adjust
8. Alarm Contact: 100mA@30VAC/DC (Optional)
9. Control Range 0-20 psig or 3-15 psig; jumper selectable
10. Pressure Differential 0.1 psig (supply to branch)
11. Pressure Indication Electronic, 3-1/2 digit LCD
12. Housing: Mounted on standard SnapTrack; Optional clear dust cover
13. Basis of Design: Veris EP Series

M. Control Valves
1. Ball Valves
   a. ½" to ¾" Ball Valve
      1) Forged brass body rated at no less than 600 psi, chrome plated brass ball with blowout proof stem or optional stainless steel ball with blowout proof stem,

2) Valves are to be in two-way and three-way configurations.
3) Connection: Female NPT end fittings, Teflon® PTFE seat, characterizing disc glass filled PEEK providing equal percentage flow curve on two-way valve.
4) Operating Temperature 20…250°F chilled or hot water with up to 60% glycol solution.
5) Two-way and Bypass port should be ANSI Class IV (0.01% of Cv) seat leakage.
6) Rangeability must be at least 300:1.
7) Tool-less actuator connection.
8) System Static Pressure Limit should be 600 psig (4137 Pa)
9) Basis of Design: Schneider Electric VBB/VBS Ball Valves, or approved equal.

b. ½" to 3" 2-way and ½" to 2" 3-way Ball Valves
1) Valves must be for control of hot or chilled water, or solutions of up to 50% glycol.
2) Ball valves must have close-offs of 40…130 psi depending on size.
3) Valves will provide CVs from 0.33…266 depending on size.
4) Valve characterizing insert, is to made of glass-filled Noryl™ and provide equal percentage flow.
5) Valve body is to made of forged brass ASTM B283-06 and rated for static pressure of 360 psi at fluid temperatures of 20…250°F (-7…121°C).
6) All valves are to have balls made of nickel/chromium plated brass with two-way valves having stainless steel balls as an option. All valve stems are to be stainless steel with reinforce Teflon® EPDM O-ring seals.
7) 2-way valves are to be ANSI Class IV (0.01% of Cv) shutoff. 3-way valves are to be ANSI Class IV (0.01% of Cv piped coil-side outlet to the port A only.
8) Fluid (water) temperature are a minimum 20°F (-7°C) and a maximum of 250°F (121°C).
9) Basis of Design: Schneider Electric VB-2000, or approved equal.

2. Globe Valves (Bronze ½" to 2")
a. Control Valves: Factory fabricated, with body material, and pressure class based on maximum pressure and temperature rating of piping system with a body rating of not less than 400 psig at 150°F, 321 psig at 281°F per ANSI B16.15.
b. Valves two way NPS 2" and Smaller: Operator, stem and plug assembly, and spring-loaded PTFE/EPDM valve stem packing cartridge must be removable for future replacement to restore the valves back to their original condition. Material grade properties must meet the fluid temperature and pressure requirements:
1) Standard duty bronze body, 316 stainless steel vertical stem, brass plug, soft seal, and bronze seat, renewable packing cartridge, and screwed/sweat/flared ends. Valves shall have allowable media temperature of 20°F …281°F to assure reliability with dual temperature applications.
2) Heavy duty bronze body, 316 stainless steel vertical stem, 316 stainless steel plug, soft seal, and 316 stainless steel seat, renewable packing cartridge, and screwed ends. Valves shall have allowable media temperature of 20°F …340°F to assure to assure reliability with dual temperature applications.
3) High temperature bronze body, 316 stainless steel vertical stem, 316 stainless steel plug, and 316 stainless steel seat, renewable packing cartridge, and screwed ends. Valves shall have allowable media temperature of 20°F …400°F.
c. Two-way fluid system globe valves shall have the following characteristics:
1) Rangeability: Greater than 100:1 for all valves with flow coefficients of 0.4 and higher to provide stable control under light load conditions.
2) Maximum Allowable Seat Leakage: Standard and heavy duty valves must be designed to meet ANSI Class V (0.0005 ml per minute per "of orifice diameter per psi differential) up to 35 psi close off differential pressure and

ANSI Class IV seat leakage (maximum 0.01% of full open valve capacity) above 35 psi with appropriate actuator. High temperature valves must meet ANSI Class III seat leakage (maximum 0.1% of full open valve capacity).

3) The valve must be able to operate with a full-open operating differential of no less than 87 psi.
4) Flow Characteristics: Modified equal percentage characteristics for standard duty water applications and modified linear for heavy duty and high temperature steam applications with gradual opening for light loads.
5) Sizing:
    a) Two Position Water: Water: Line size or size using a differential pressure of 1 psi.
    b) Modulating Water: 5 PSI or twice the load pressure drop.
    c) Pressure drop across steam valve at a maximum flow of 80 percent of inlet pressure up to 15 psig and 42% of absolute (gage pressure + 14.7) inlet pressure above 15 psig inlet.
    d) 100 psi saturated steam maximum inlet pressure for heavy duty bronze body globe valves ½"…2".
    e) 150 psi saturated steam maximum inlet pressure for high temperature bronze body globe valves ½"…2".
    f) 35 psi saturated steam maximum inlet pressure for standard duty bronze body globe valves ½"…2".

d. Valves 3-Way mixing (two inlets and one outlet) NPS 2" and Smaller:
    1) Operator, stem and plug assembly, and spring-loaded PTFE/EPDM valve stem packing cartridge must be removable for future replacement to restore the valves back to their original condition. Material grade properties must meet the fluid temperature and pressure requirements:
        a) Standard duty bronze body, 316 stainless steel vertical stem, brass plug, and bronze seat, renewable packing cartridge, and screwed or sweat ends. Valves shall have allowable media temperature of 20°F…281°F to assure reliability with dual temperature applications.
        b) Heavy duty bronze body, 316 stainless steel vertical stem, 316 stainless steel plug, and 316 stainless steel seat, renewable disc and packing cartridge, and screwed ends. Valves shall have allowable media temperature of 20°F …340°F to assure reliability with dual temperature applications.
e. 3-Way mixing hydronic system globe valves shall have the following characteristics:
    1) Rangeability: Greater than 100:1 for all valves to provide stable
    2) Maximum Allowable Seat Leakage: A port must be designed to meet ANSI Class V (0.0005 ml per minute per "of orifice diameter per psi differential) up to 35 psi close off differential pressure and ANSI IV seat leakage (maximum 0.01% of full open valve capacity) above 35 psi with appropriate actuator. B port must meet ANSI Class III seat leakage (maximum 0.1% of full open valve capacity).
    3) The valve must be able to operate with a full-open operating differential of 87 psi.
    4) Flow Characteristics: Modified linear characteristics with gradual opening for light loads.
    5) Sizing: Modulating Water: Minimum 5 psi or at least equal to the load pressure drop.
f. Valves 3-Way diverting (one inlet and two outlets) NPS 2" and Smaller:
    1) Operator, stem and plug assembly, and spring-loaded PTFE/EPDM valve stem packing cartridge must be removable for future replacement to restore the valves back to their original condition. Valves must be designed specifically for diverting service, and mixing valves designed for mixing service must not be used for diverting applications. Material grade properties must meet the fluid temperature and pressure requirements:

a) Standard duty bronze body, 316 stainless steel vertical stem, brass plug, and bronze seat, renewable disc and packing cartridge, and screwed ends. Valves shall have allowable media temperature of 20°F …281°F to assure reliability with dual temperature applications.

g. 3-Way diverting hydronic system globe valves shall have the following characteristics:
   1) Rangeability: Greater than 100:1 for all valves to provide stable control under light load conditions.
   2) Maximum Allowable Seat Leakage: ANSI Class III seat leakage (maximum 0.1% of full open valve capacity).
   3) Maximum Allowable Pressure Differential: 35 psi in.an open position.
   4) Flow Characteristics: Modified linear characteristics with gradual opening for light loads.
   5) Sizing:
      a) Modulating Water: Minimum 5 psi or at least equal to the load pressure drop.

h. Required Certifications: Pressure Equipment Directive (PED 97/23/EC), RoHS (Restriction of Hazardous Substances) and REACH (Regulation, Evaluation, Authorization, and Restriction of Chemicals), Canadian Registration Number.

i. Valve and Operator: To assure maximum performance and operation of the valve assembly both the valve and the actuator must be tested and approved by the valve manufacturer to assure compatibility of all components and performance to the specifications.

j. Basis of Design: Schneider Electric Venta VB-7000, or approved equal.

3. Butterfly Valves
   a. Valve body are to be polyester coated iron ASTM A126 lug mating with ANSI class 125/150 flanges.
   b. Disc Type: Ductile iron nylon 11 coated.
   c. Valve Stem:
      1) 2…8” 416 stainless steel double D stem.
      2) 10…12” 316 stainless steel double D stem.
      3) 14” and larger: stainless steel round shaft woodruff key slot.
   d. Valve seat: EPDM tongue and groove seat and molded O-ring flange seat
   e. Flow Characteristics: Modified equal percentage.
   f. Close-Off Pressure Rating: Bubble-tight shutoff (no leakage).
   g. Valve fluid temperature rating: -40…250°F (-40…121°C) 9. Valve will have two (2) inch extended neck (because of heat). 10. Valve must except pneumatic or electric/electronic actuators 11. Valves must have a minimum of a two (2) year warranty.

4. Flanged Valves
   a. Bodies: Shall be American Factory fabricated with ASTM A 126 Class B cast iron body material with the pressure class within the maximum pressure and temperature rating of the piping system. (125 body rating with not less than 200 psig at 150°F, decreasing to 169 psig at 281F per ANSA B16.1)
   b. Serviceability: 2-Way valve operators, stem and plug assemblies and spring-loaded PTFE/EPDM valve stem packing cartridges must be removable for future replacement to restore the valves back to their original condition.
   c. Construction: Material grades must meet the fluid temperature and pressure requirement temperatures of 20°F …281°F to assure reliability throughout all application temperature ranges.
   d. Packings: Shall be cartridges suitable for replacement as units withstanding the full operating temperature ranges, including daily and seasonal fluctuations of water, 60% glycol and steam fluids.
   e. Characteristics
      1) Rangeability: Two way,100:1 and greater for stable control under light load.
      2) Shutoff, 2-Way: Leakage allowed: ANSI Class IV (0.01% of max flow)
      3) 3-Way: Leakage allowed: ANSI Class III (0.1% of max flow)

4) Flow curves: 2-Way modified equal percentage characteristic.
5) Mixing and Diverting: Linear, modified with gradual opening for light loads.

f. Piping
1) Diverting valves, with the common port at the bottom can be used for mixing.
2) Mixing valves with the common port at the end must not be used for diverting applications.

g. Sizing
1) Two Position Water: Line size or size using a differential pressure of 1 psi.
2) Modulating Water: 5 PSI or twice the load pressure drop
3) Steam, 2-Way: maximum pressure drop across the valve at a maximum flow of 80 percent of inlet pressure up to 15 psig. Above 15 psig inlet, 42% of absolute (gage pressure + 14.7) inlet pressure.

h. Certifications for All Models: Pressure Equipment Directive (PED 97/23/EC), RoHS (Restriction of Hazardous Substances) and REACH (Regulation, Evaluation, Authorization, and Restriction of Chemicals

i. Basis of Design: Schneider Electric VB-8000 and VB-9000 valves, or approved equal.

N. Pressure Independent Control Valves
1. NPS 2 and Smaller: PN 16, stainless steel components.
2. NPS 2½ through 10: Class 125 cast iron body per ASME B16.1-2010, Material class B per ASTM A 126-04 (2014), stainless steel components.
3. Accuracy NPS ¾" and Smaller: The control valves shall accurately control the flow from 0…100% rated flow with a differential pressure range of 2.32…58 psi for low and standard flow units, 5…58 psi for high flow units within 5% of set flow value.
4. Accuracy NPS 1 through 1¼: The control valves shall accurately control the flow from 0…100% rated flow with a differential pressure range of 2.9…58 psi for standard flow units, 5…58 psi for high flow units within 5% of set flow value.
5. Accuracy NPS 1½ through 4: The control valves shall accurately control the flow from 0…100% rated flow with a differential pressure range of 4.35…58 psi within 5% of set flow value.
6. Accuracy NPS 5 through 10: The control valves shall accurately control the flow from 0…100% rated flow with a differential pressure range of 5.8…58 psi for standard flow units, 8.7…58 psi for high flow units within 5% of set flow value.
7. Flow Characteristics: Linear Control, selectable to equal percentage at the proportional valve actuator.
8. Field adjustable flow by means of a percentage of rated valve flow.
9. Position feedback output signal integrated into all proportional actuators.
10. 100% authority with modulating below 1% regardless of flow settings.
11. No cartridges requiring replacement or maintenance.
12. Basis of Design: Schneider Electric SmartX PICV, or approved equal.

O. Control Valve Actuators
1. ½" to ¾" Ball Valve Actuators
a. Size for torque required for valve close-off pressure for system design.
b. Coupling: Direct coupled to valve body without use of external devices/tools
c. Auxiliary End Switch (optional) to be SPST 24 Vac/Vdc,101 mA to 5 mA maximum on selected two-position models.
d. Controller Signal Two-position, Floating or Proportional (0…5 Vdc, 0…10 Vdc, 5…10 Vdc, or 4…20 mA dc). Design allows for change via DIP switches without removal of cover.
e. Manual operating lever and position indicator must be standard.
f. Power Requirements: 24 Vac for floating, proportional, and 110…230 Vac for two position multi-voltage types
g. Actuators must be available with either Spring Return (SR) or Non-Spring Return (NSR) models.
h. Wiring (depending on model) Removable Terminal Block, 10 ft. (3.05 m) Plenum Cable, 18 in. (45 cm) Appliance Wire

i. Locations must be rated NEMA 2, IEC IP31. (Indoor Use Only.) Actuators with terminal block or plenum cable leads are plenum rated per UL file number E9429.
j. Agency Listings: ISO 9001, cULus, and CE.
k. Basis of Design: Schneider Electric VBB/VBS, or approved equal.

2. ½" to 3" 2-way and ½" to 2" 3-way Ball Valves Actuators
   a. Size for torque required for valve close-off pressure for system design.
   b. Actuators are to be available in spring return (SR) and non-spring return (NSR) models. Spring Return (SR) actuators are to provide a choice to return direction.
   c. Actuators are to be available in models for two-position, floating and proportional control.
   d. All actuator models are to be equipped with pigtail leads, manual override, and auxiliary switch(es)
   e. Operating temperatures' Floating Non-Spring Return (NSR) with 33 lb.-in. of torque must be -25 to 130 °F (-32 to 55°C). All other actuators are to -22 to 140 °F (-30 to 60 °C)
   f. Actuators must be NEMA 2 rated.
   g. Agency Listings: ISO 9001, cULus, and CE.
   h. Basis of Design: Schneider Electric VB-2000, or approved equal.
3. ½" to 2" Bronze, Linear Globe Valve Actuators/67 or 78 lbs. force
   a. Actuator must have bi-color LED status indication for motion indication, auto calibration and alarm notification.
   b. When the actuator is properly mounted must have a minimum of a NEMA 2 (IP53) rating.
   c. Actuators are to be non-spring return.
   d. Actuators are to be floating (used for two-position) or proportional models.
   e. Proportional models will have optional models with a position output signal with field selectable 2…10 Vdc and 0…10 Vdc input signals and selectable input signal direct or reverse acting.
   f. Actuator must have auto calibration which provides precise control by scaling the input signal to match the exact travel of the valve stem
   g. Actuators must come in models with Pulse Width Modulated (PWM) with field selectable 0.59 to 2.93 sec and 0.1 to 25.5 sec input signal ranges with a position output signal
   h. Actuators must have manual override with automatic release.
   i. Models with position feedback output signal include field selectable 2…10 Vdc or 0…5 Vdc output signal
   j. Removable wiring screw terminal with ½" conduit opening.
   k. Actuator agency Listings: cUL-us LISTED mark, NEMA 2, NEC class 2 FCC part-15 class B, Canadian ICES-003, ESA registered, Plenum rated per UL 20430
   l. Basis of Design: Schneider Electric MG350V, or approved equal.
4. ½" to 2" Bronze, Linear Globe Valve Actuators/105 lbs. force
   a. Actuators must have Two- Position, Floating, and Proportional models.
   b. Proportional models will a controller input signal of either a 0…10 Vdc, 2…10 Vdc, 4…20 mAdc, 0…3 Vdc, or 6…9 Vdc. Control function direct/reverse action is switch selectable on most models.
   c. Actuator force is to be 105 lb. (467 newton) with ½" (13 mm) nominal linear stroke
   d. Power requirements 24 Vac, 120 Vac or 230 Vac depending on model.
   e. Actuator housings rated for up to NEMA 2/ IP54.
   f. Actuator is to have overload protection throughout stroke.
   g. Actuator must automatically set input span to match valve travel.
   h. Actuator must have manual override to allow positioning of valve and preload.
   i. Actuator is to be spring return.
   j. Actuator is to mount directly to valves without separate linkage.
   k. Actuator agency Listings: UL 873, CUL: UL
   l. Basis of Design: Schneider Electric SmartX Mx51-7103, or approved equal
5. ½" to 2" Bronze, Linear Globe Valve Actuators/220 lbs. force

a. Actuators must have Two- Position for a SPST controller, Floating for a SPST controller, and Proportional models will a controller input signal of either a 0…10 Vdc, 2…10 Vdc, 4…20 mAdc, or 6…9 Vdc. Control function direct/reverse action is jumper selectable
b. Actuator is to be spring return.
c. Actuator will have 220 lb. force (979 newton) with ½" (13 mm) or 1" (25 mm) nominal linear stroke
d. Feedback on proportional model with 2…10 Vdc (max. 0.5 mA) output signal or to operate up to four like additional slave actuators.
e. Actuator must automatically set input span to match valve travel
f. Actuator is to have a 24 Vac power supply on Two-position and Proportional models and 120 Vac on Two-position models.
g. Actuator housings rated for up to NEMA 2/ IP54
h. Actuator must have manual override to allow positioning of valve and preload
i. Actuator is to mount directly to vales without separate linkage.
j. Actuator agency Listings: UL 873, CUL: UL
k. Basis of Design: Schneider Electric SmartX Mx51-720x, or approved equal.

6. ½" to 2" Bronze, Linear Globe Valve Actuators with linkage SR
   a. Actuators with 35, 60, 133, or 150 lb.-in of force depending on model.
   b. Actuator housings rated for up to NEMA 2/ IP54 with a 150 lb.-in. rated a NEMA 4.
   c. Actuators are to be spring return.
   d. Actuators are to have Two-position, Floating and Proportional models.
   e. Actuators must have overload protection throughout rotation.
   f. Actuator have an optional built-in auxiliary switch to provide for interfacing or signaling on selected models.
   g. Actuator agency listings: UL-873, C22-2 No.24-83, CUL0
   h. Basis of Design: Schneider Electric SmartX, or approved equal.
7. ½" to 2" Bronze Body, Linear Globe Valve Actuators with linkage SR & NSR
   a. Actuators are to be either floating SPDT control or proportional control 0…10, 2…10 Vdc or 4…20 mA with a 500-ohm resistor included.
   b. Actuators are to be direct/reverse with selectable DIP switches.
   c. Actuators are to have 90 lb. (400N), 180 lb. (800N), or 337 lb. (1500N) of force on Non-Spring Return (NSR) 157 lb. of force on the Spring Return model. Note: Not every actuator is for every valve.
   d. Actuators are to be powered with 24 Vac or 24 Vdc.
   e. All Non-Spring Return (NSR) actuators are to be NEMA 2, vertical mount only. Spring Return (SR) actuators are to have NEMA 4 models.
   f. Actuators must have manual override to allow positioning of the valve.
   g. Actuators must have selectable valve sequencing and flow curves of either equal percentage or linear.
   h. Actuators must have feedback.
   i. Actuators must have internal torque protection throughout stroke.
   j. 90°F (32°C) ambient at 366°F (186°C) fluid temperature
   k. Actuator agency listings (North America) UL873, cULus, RCM, CE
   l. Basis of Design: Schneider Electric Forta M400A-VB, M800A-VB, M900A and M1500x-VB screw mounted on Venta VB7000s, or approved equal.
8. 2 ½" to 6" Cast Iron Flanged Globe Valve Linear Actuators with linkage
   a. Actuators are to be either floating SPDT control or proportional control 0…10, 2…10 Vdc or 4…20 mA with a 500-ohm resistor included.
   b. Actuators are to direct/reverse acting with selectable DIP switch.
   c. Actuators are to have 180 lb. (800N) or 337 lb. (1500N) of force.
   d. Actuators will need a 24 Vac or Vdc power supply.
   e. Actuators are to be rated NEMA 2, vertical mount only.
   f. Actuators must have manual override to allow positioning of the valve.
   g. Actuators must have selectable valve sequencing and flow curves of either equal percentage to linear. A 2…10 Vac feedback.
   h. Actuators must have Internal torque protection throughout stroke.

i. 90°F (32°C) ambient at 366°F (186°C) fluid temperature
j. Actuator agency listings (North America) UL873, cULus, RCM, CE
k. Basis of Design: Schneider Electric Forta M800A and M1500A, or approved equal.

9. 2" to 18" 2-Way and 2" to 16" 3-Way Linear Butterfly Valve Actuator with linkage NSR
   a. The butterfly valve actuators are to be Non-Spring Return (NSR) two-position and proportional taking 0…10 Vdc or 4…20 mA models. All Actuators are to be NEMA 4, manual override (hand wheel) two auxiliary switches, and built-in heater.
   b. Actuator close-offs and CVs must be appropriate for the valve size in a typical HVAC application.
   c. Actuators must be available in 24 Vac and 120 Vac models.
   d. Actuators must have Internal wiring isolation for parallel wiring multiple units that eliminates the risk of feedback from one actuator to another.
   e. Proportional models must have feedback of 0…10 Vdc or 4…20 mA.
   f. Actuator operating temperature shall be -40…150°F (-40…60°C).
   g. Actuator agency listings (North America) UL, CSA and CE
   h. Basis of Design: Schneider Electric S70, or approved equal.
10. 2" to 4" 2-Way and 3-Way Butterfly Valve Actuators SR
   a. The butterfly valve actuators are to be Spring Return (SR) two-position and proportional taking 2…10 Vdc or 4…20 mA models. All Actuators are to be NEMA 2.
   b. Actuator close-offs and CVs must be appropriate for the valve size in a typical HVAC application.
   c. Actuators must be available in 24 Vac models.
   d. Actuators shall have two SPDT auxiliary switch models.
   e. Actuators must have [Internal wiring isolation for parallel wiring multiple units that eliminates the risk of feedback from one actuator to another.
   f. Proportional models must have feedback of 2…10 Vdc or 4…20 mA.
   g. Actuator agency listings (North America) UL, CSA and CE
   h. Basis of Design: Schneider Electric SmartX Mx-41-7153, or approved equal.
11. 2" to 6" 2-Way and 3-Way Butterfly Valve Actuators NSR
   a. The butterfly valve actuators are to be Non-Spring Return (NSR) two-position and proportional taking 0…10 Vdc or 4…20 mA models. All Actuators are to be NEMA 2.
   b. Actuator close-offs and CVs must be appropriate for the valve size in a typical HVAC application.
   c. Actuators must be available in 24 Vac models.
   d. Actuators shall have two SPDT auxiliary switch models.
   e. Actuators must have [Internal wiring isolation for parallel wiring multiple units that eliminates the risk of feedback from one actuator to another.
   f. Proportional models must have feedback of 2…10 Vdc or 4…20 mA.
   g. Actuator agency listings (North America) UL, CSA and CE
   h. Basis of Design: Schneider Electric SmartX NR-22xx-5xx, or approved equal.

P. Dampers
1. Automatic dampers, furnished by the Building Automation Contractor shall be single or multiple blade as required. Dampers are to be installed by the HVAC Contractor under the supervision of the BAS Contractor. All blank-off plates and conversions necessary to install smaller than duct size dampers are the responsibility of the Sheet Metal Contractor.
2. Damper frames are to be constructed of 13 gauge galvanized sheet steel mechanically joined with linkage concealed in the side channel to eliminate noise as friction. Compressible spring stainless steel side seals and acetyl or bronze bearings shall also be provided.
3. Damper blade width shall not exceed eight inches. Seals and 3/8 inch square steel zinc plated pins are required. Blade rotation is to be parallel or opposed as shown on the schedules.
4. For high performance applications, control dampers will meet or exceed the UL Class I leakage rating.

5. Control and smoke dampers shall be Ruskin, or approved equal.
6. Provide opposed blade dampers for modulating applications and parallel blade for two position control.

Q. Damper Actuators
1. Direct-coupled type non-hydraulic designed for minimum 100,000 full-stroke cycles at rated torque.
2. Direct-coupled damper actuators must have a five-year warrantee.
3. Size for torque required for damper seal at maximum design conditions and valve close-off pressure for system design.
4. Overload protected electronically throughout rotation except for selected Floating actuators the have a mechanical clutch.
5. Spring Return Actuators: Mechanical fail safe shall incorporate a spring-return mechanism.
6. Non-Spring Return Actuators shall stay in the position last commended by the controller with an external manual gear release to allow positioning when not powered.
7. Power Requirements: 24Vac/dc [120Vac] [230Vac]
8. Proportional Actuators controller input range from 0…10 Vdc, 2…10 Vdc or 4…20 mA models.
9. Housing: Minimum requirement NEMA type 2
10. Actuators with a microprocessor should not be able to be modified by an outside source (cracked or hacked).
11. Actuators of 133 and 270 lb.-in. of torque or more should be able to be tandem mount or “gang” mount.
12. Agency Listings: ISO 9001, cULus, CE and CSA
13. Basis of Design: Schneider Electric SmartX Actuators, or approved equal.

R. Smoke Detectors
1. Air duct smoke detectors shall be by Air Products & Controls or approved equal. The detectors shall operate at air velocities from 300 feet per minute to 4000 feet per minute.
2. The smoke detector shall utilize a photoelectric detector head.
3. The housing shall permit mechanical installation without removal of the detector cover.
4. The detectors shall be listed by Underwriters Laboratories and meet the requirements of UL 268A.

S. Airflow Measuring Stations
1. Provide a thermal anemometer using instrument grade self heated thermistor sensors with thermistor temperature sensors.
2. The flow station shall operate over a range of 0 to 5,000 feet/min with an accuracy of +/- 2% over 500 feet/min and +/- 10 ft/min for reading less than 500 feet/min.

2.8 Electrical Power Measurement

A. Electrical Power Monitors, Single Point (Easy Install):
1. Acceptable Manufacturer: Veris Industries.
2. General: Consist of three split-core CTs, factory calibrated as a system, hinged at both axes with the electronics embedded inside the master CT. The transducer shall measure true (rms.RMS) power demand real power (kW) consumption (kWh). Conform to ANSI C12.1 metering accuracy standards.
3. Voltage Input: Load capacity as shown on drawings. 208-480 VAC, 60 Hz
4. Maximum Current Input: Up to 2400A
5. Perforbmance:
   a. Accuracy: +/- 1% system from 10% to 100% of the rated current of the CT’s
   b. Operating Temperature Range: 32-140°F, 122°F for 2400A.
6. Output: 4 to 20 mA, Pulse. or Modbus RTU
7. Ratings:
   a. Agency: UL508 or equivalent
   b. Transducer internally isolated to 2000 VAC.
   c. Case isolation shall be 600 VAC.
8. Basis of Design: Similar to Hawkeye Veris H80xx40 series
9. Accessories: [BACnet] [LON] communications gateway

B. Electrical Power Monitors, Single Point (High Accuracy):
   1. Acceptable Manufacturer: Veris Industries.
   2. General: Revenue grade meter. Measures voltage, amperage, real power (kW), consumption (kWh), and reactive power (kVARar), and power factor (PF) per phase and total load for a single load. Factory calibrated as a system using split core CT's. Neutral voltage connection is required.
   3. Voltage Input: 208-480 VAC, 60 Hz
   4. Current Input: Up to 2400A
   5. Performance:
      a. Accuracy: +/- 1% system from 2% to 100% of the rated current of the CT's
      b. Operating Temperature Range: 32-122°F
   6. Output: Pulse, BACnet, Modbus RTU
   7. Display: Backlit LCD
   8. Enclosure: NEMA 1
   9. Agency Rating: UL508 or equivalent
   10. Basis of Design: Veris Industries H81xx00 series.

C. Electrical Power Monitors, Single Point (High Accuracy/Versatility):
   1. Acceptable Manufacturer: Veris Industries.
   2. General: Revenue grade meter. Measures voltage, amperage, real power (kW), consumption (kWh), reactive power (kVAR), apparent power (kVA) and power factor (PF) per phase and total load for a single load. Available with data logging , Bi-directional (4-quadrant) metering, and pulse contact accumulator inputs.
   3. Voltage Input: 90-600 VAC, 50/60 Hz, 125-300 VDC
   4. Current Input: 5A – 32,000A, selectable 1/3V or 1V CT inputs
   5. Performance:
      a. Accuracy shall be +/- [0.2%] [0.5%] revenue grade
      b. Operating Temperature Range: -22-158°F
   6. Output shall be [Pulse] [BACnet] [Modbus RTU] [LON]
   7. Display: Backlit LCD
   8. Enclosure: NEMA 4x optional
   9. Agency Rating: UL508, ANSI C12.20
   10. Basis of Design: Veris E5xxx series.

D. Electrical Power Monitors, Multiple Point (92 loads, High Accuracy):
   1. Acceptable Manufacturer: Veris Industries.
   2. General: Revenue grade meter. Measures volts, amps, power and energy for each circuit. 1/4 amp to 200 amp monitoring. 4 configurable alarm threshold registers
   3. Voltage Input: 90-277 VAC, 60 Hz
   4. Current Input: 5A – 32,000A, 1/3V CT inputs
   5. Performance:
      a. Accuracy: +/- 0.5% meter (split core), +/- 1% system from 1/4-100A (solid core)
      b. Operating Temperature Range: 32-140°F
   6. Output: Modbus RTU
   7. Agency Rating: UL508, ANSI C12.10, IEC Class 1
   8. Basis of Design: Veris E3xxx series.

PART 3 - Execution

3.1 Contractor Responsibilities

A. General
   1. Installation of the building automation system shall be performed by the Contractor or a subcontractor. However, all installation shall be under the personal supervision of the Contractor. The Contractor shall certify all work as proper and complete. Under no circumstances shall the design, scheduling, coordination, programming, training, and warranty requirements for the project be delegated to a subcontractor.

B. Demolition
   1. Remove controls which do not remain as part of the building automation system, all associated abandoned wiring and conduit, and all associated pneumatic tubing. The Owner will inform the Contractor of any equipment which is to be removed that will

remain the property of the Owner. All other equipment which is removed will be disposed of by the Contractor.

C. Access to Site
   1. Unless notified otherwise, entrance to building is restricted. No one will be permitted to enter the building unless their names have been cleared with the Owner or the Owner's Representative.

D. Code Compliance
   1. All wiring shall be installed in accordance with all applicable electrical codes and will comply with equipment manufacturer's recommendations. Should any discrepancy be found between wiring specifications in Division 17 and Division 16, wiring requirements of Division 17 will prevail for work specified in Division 17.

E. Cleanup
   1. At the completion of the work, all equipment pertinent to this contract shall be checked and thoroughly cleaned, and all other areas shall be cleaned around equipment provided under this contract.

3.2 Wiring, Conduit, and Cable

A. All wire will be copper and meet the minimum wire size and insulation class listed below:

Wire Class	Wire Size	Isolation Class
Power	12 Gauge	600 Volt
Class One	14 Gauge Std.	600 Volt
Class Two	18 Gauge Std.	300 Volt
Class Three	18 Gauge Std.	300 Volt
Communications	Per Mfr.	Per Mfr.

B. Power and Class One wiring may be run in the same conduit. Class Two and Three wiring and communications wiring may be run in the same conduit.

C. Where different wiring classes terminate within the same enclosure, maintain clearances and install barriers per the National Electric Code.

D. Where wiring is required to be installed in conduit, EMT shall be used. Conduit shall be minimum 1/2 inch galvanized EMT. Set screw fittings are acceptable for dry interior locations. Watertight compression fittings shall be used for exterior locations and interior locations subject to moisture. Provide conduit seal-off fitting where exterior conduits enter the building or between areas of high temperature/moisture differential.

E. Flexible metallic conduit (max. 3 feet) shall be used for connections to motors, actuators, controllers, and sensors mounted on vibration producing equipment. Liquid-tight flexible conduit shall be use in exterior locations and interior locations subject to moisture.

F. Junction boxes shall be provided at all cable splices, equipment termination, and transitions from EMT to flexible conduit. Interior dry location J-boxes shall be galvanized pressed steel, nominal four-inch square with blank cover. Exterior and damp location JH-boxes shall be cast alloy FS boxes with threaded hubs and gasketed covers.

G. Where the space above the ceiling is a supply or return air plenum, the wiring shall be plenum rated. Teflon wiring can be run without conduit above suspended ceilings. EXCEPTION: Any wire run in suspended ceilings that is used to control outside air dampers or to connect the system to the fire management system shall be in conduit.

H. Fiber optic cable shall include the following sizes; 50/125, 62.5/125 or 100/140.

I. Only glass fiber is acceptable, no plastic.

J. Fiber optic cable shall only be installed and terminated by an experienced contractor. The BAS contractor shall submit to the Engineer the name of the intended contractor of the fiber optic cable with his submittal documents.

3.3 Hardware Installation Practices for Wiring

A. All controllers are to be mounted vertically and per the manufacturer's installation documentation.

B. The 120VAC power wiring to each Ethernet or Remote Site controller shall be a dedicated run, with a separate breaker. Each run will include a separate hot, neutral and ground wire. The ground wire will terminate at the breaker panel ground. This circuit will not feed any other circuit or device.

C. A true earth ground must be available in the building. Do not use a corroded or galvanized pipe, or structural steel.

D. Wires are to be attached to the building proper at regular intervals such that wiring does not droop. Wires are not to be affixed to or supported by pipes, conduit, etc.

E. Conduit in finished areas will be concealed in ceiling cavity spaces, plenums, furred spaces and wall construction. Exception; metallic surface raceway may be used in finished areas on masonry walls. All surface raceway in finished areas must be color matched to the existing finish within the limitations of standard manufactured colors.

F. Conduit, in non-finished areas where possible, will be concealed in ceiling cavity spaces, plenums, furred spaces, and wall construction. Exposed conduit will run parallel to or at right angles to the building structure.

G. Wires are to be kept a minimum of three (3) inches from hot water, steam, or condensate piping.

H. Where sensor wires leave the conduit system, they are to be protected by a plastic insert.

I. Wire will not be allowed to run across telephone equipment areas.

J. Provide fire caulking at all rated penetrations.

3.4 Installation Practices for Field Devices

A. Well-mounted sensors will include thermal conducting compound within the well to insure good heat transfer to the sensor.

B. Actuators will be firmly mounted to give positive movement and linkage will be adjusted to give smooth continuous movement throughout 100 percent of the stroke.

C. Relay outputs will include transient suppression across all coils. Suppression devices shall limit transients to 150% of the rated coil voltage.

D. Water line mounted sensors shall be removable without shutting down the system in which they are installed.

E. For duct static pressure sensors, the high pressure port shall be connected to a metal static pressure probe inserted into the duct pointing upstream. The low pressure port shall be left open to the plenum area at the point that the high pressure port is tapped into the ductwork.

F. For building static pressure sensors, the high pressure port shall be inserted into the space via a metal tube. Pipe the low pressure port to the outside of the building.

3.5 Enclosures

A. For all I/O requiring field interface devices, these devices where practical will be mounted in a field interface panel (FIP). The Contractor shall provide an enclosure which protects the device(s) from dust, moisture, conceals integral wiring and moving parts.

B. FIPs shall contain power supplies for sensors, interface relays and contactors, and safety circuits.

C. The FIP enclosure shall be of steel construction with baked enamel finish; NEMA 1 rated with a hinged door and keyed lock. The enclosure will be sized for twenty percent spare mounting space. All locks will be keyed identically.

D. All wiring to and from the FIP will be to screw type terminals. Analog or communications wiring may use the FIP as a raceway without terminating. The use of wire nuts within the FIP is prohibited.

E. All outside mounted enclosures shall meet the NEMA-4 rating.

F. The wiring within all enclosures shall be run in plastic track. Wiring within controllers shall be wrapped and secured.

3.6 Identification

A. Identify all control wires with labeling tape or sleeves using words, letters, or numbers that can be exactly cross-referenced with as-built drawings.

B. All field enclosures, other than controllers, shall be identified with a Bakelite nameplate. The lettering shall be in white against a black or blue background.

C. Junction box covers will be marked to indicate that they are a part of the BAS system.

D. All I/O field devices (except space sensors) that are not mounted within FIP's shall be identified with name plates.

E. All I/O field devices inside FIP's shall be labeled.

3.7 Existing Controls.

A. Existing controls which are to be reused must each be tested and calibrated for proper operation. Existing controls which are to be reused and are found to be defective requiring replacement, will be noted to the Owner. The Owner will be responsible for all material and labor costs associated with their repair.

3.8 Control System Switch-over

A. Demolition of the existing control system will occur after the new temperature control system is in place including new sensors and new field interface devices.

B. Switch-over from the existing control system to the new system will be fully coordinated with the Owner. A representative of the Owner will be on site during switch-over.

C. The Contractor shall minimize control system downtime during switch-over. Sufficient installation mechanics will be on site so that the entire switch-over can be accomplished in a reasonable time frame.

3.9 Location

A. The location of sensors is per mechanical and architectural drawings.

B. Space humidity or temperature sensors will be mounted away from machinery generating heat, direct light and diffuser air streams.

C. Outdoor air sensors will be mounted on the north building face directly in the outside air. Install these sensors such that the effects of heat radiated from the building or sunlight is minimized.

D. Field enclosures shall be located immediately adjacent to the controller panel(s) to which it is being interfaced.

3.10 Software Installation

A. General.

1. The Contractor shall provide all labor necessary to install, initialize, start-up and debug all system software as described in this section. This includes any operating system software or other third party software necessary for successful operation of the system.

3.11 Database Configuration.

A. The Contractor will provide all labor to configure those portions of the database that are required by the points list and sequence of operation.

3.12 Color Graphic Displays.

A. Unless otherwise directed by the owner, the Contractor will provide color graphic displays as depicted in the mechanical drawings for each system and floor plan. For each system or floor plan, the display shall contain the associated points identified in the point list and allow for setpoint changes as required by the owner.

3.13 Reports.

A. The Contractor will configure a minimum of 4 reports for the owner. These reports shall, at a minimum, be able to provide:

1. Trend comparison data
2. Alarm status and prevalence information
3. Energy Consumption data
4. System user data

3.14 Documentation

A. As built software documentation will include the following:

1. Descriptive point lists
2. Application program listing
3. Application programs with comments.
4. Printouts of all reports.
5. Alarm list.

6. Printouts of all graphics
7. Commissioning and System Startup
8. An electronic copy of all databases, configuration files, or any type of files created specifically for each system.

3.15 Point to Point Checkout.

A. Each I/O device (both field mounted as well as those located in FIPs) shall be inspected and verified for proper installation and functionality. A checkout sheet itemizing each device shall be filled out, dated and approved by the Project Manager for submission to the owner or owner's representative.

B. In case of wireless devices, the signal strength recorded during checkout shall be reported.

3.16 Controller and Workstation Checkout.

A. A field checkout of all controllers and front end equipment (computers, printers, modems, etc.) shall be conducted to verify proper operation of both hardware and software. A checkout sheet itemizing each device and a description of the associated tests shall be prepared and submitted to the owner or owner's representative by the completion of the project.

3.17 System Acceptance Testing

A. All application software will be verified and compared against the sequences of operation.

B. Control loops will be exercised by inducing a setpoint shift of at least 10% and observing whether the system successfully returns the process variable to setpoint. Record all test results and attach to the Test Results Sheet.

C. Test each alarm in the system and validate that the system generates the appropriate alarm message, that the message appears at all prescribed destinations (workstations or printers), and that any other related actions occur as defined (i.e. graphic panels are invoked, reports are generated, etc.). Submit a Test Results Sheet to the owner.

D. Perform an operational test of each unique graphic display and report to verify that the item exists, that the appearance and content are correct, and that any special features work as intended. Submit a Test Results Sheet to the owner.

E. Perform an operational test of each third party interface that has been included as part of the automation system. Verify that all points are properly polled, that alarms have been configured, and that any associated graphics and reports have been completed. If the interface involves a file transfer over Ethernet, test any logic that controls the transmission of the file, and verify the content of the specified information.

END OF SECTION 230900

PAGE INTENTIONALLY BLANK

SECTION 260500 - 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 260500

PAGE INTENTIONALLY BLANK

SECTION 260502 - 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. 260501 – Field Test and Operational Check

B. 262413 - Main Switchboards

C. 262416 – 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 260502

SECTION 260519 - CONDUCTORS AND CABLES

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 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:
   1. 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.
   2. 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.

C. 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.

D. 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.

E. Wire connectors and splices: units of size, ampacity rating, material, type and class suitable for service indicated.

F. 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:

1. 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.
2. The ungrounded conductors contained in the same conduit or raceway.
3. 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 260519

SECTION 260526 - 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 260501.

END OF SECTION 260526

SECTION 260533 - 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 260533

PAGE INTENTIONALLY BLANK

SECTION 260543 - 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 260543

SECTION 260553 - 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 260553

PAGE INTENTIONALLY BLANK

SECTION 260800 - LIGHTING SYSTEMS COMMISSIONING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including agreement between the owner and CM/GC and other Specification Sections, apply to this Section.

1.2 SUMMARY:

A. This Section includes requirements for commissioning the lighting system and its controls.

B. The registered design professional is responsible for providing evidence of lighting systems commissioning and completion in accordance with the provisions of this section.

1.3 DEFINITIONS:

A. Architect: Includes Architect identified in the Contract for Construction between Owner and Contractor, plus consultant/design professionals responsible for design of HVAC, electrical, communications, controls for HVAC systems, and other related systems.

A. RDP: Registered Design Professional

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

1.4 COMMISSIONING DOCUMENTATION:

A. Commissioning Plan: A commissioning plan will be developed by a registered design professional or approved agency and shall include the following items:
   1. A narrative description of the activities that will be accomplished during each phase of commissioning, including the personnel intended to accomplish each of the activities.
   2. A listing of the specific equipment, appliances or systems to be tested and a description of the tests to be performed.
   3. Functions to be tested.
   4. Conditions under which the test will be performed.
   5. Measurable criteria for performance

B. Test Checklists: RDP, with assistance of Architect/Engineer, shall develop test checklists for each system, subsystem, or equipment including interfaces and interlocks, and include a separate entry, with space for comments, for each item to be tested. Prepare separate checklists for each mode of operation and provide space to indicate whether the mode under test responded as required. Provide space for testing personnel to sign off on each checklist.

1. Name and identification of tested item.
2. Test number.
3. Time and date of test.
4. Indication of whether the record is for a first test or retest following correction of a problem or issue.
5. Date of the test and name of parties involves as applicable.
6. Individuals present for test.
7. Deficiencies/Issues/Results of test.
8. Note if re-test is necessary.

C. Test and Inspection Reports: RDP shall record test data, observations, and measurements on test checklists. Photographs, forms, and other means appropriate for the application shall be included with data. RDP shall compile test and inspection reports and tests and inspection certificates and include them in systems manual and commissioning report.

D. Corrective Action Documents: RDP shall document corrective action taken for systems and equipment that fail tests. Include required modifications to systems and equipment and revisions to test procedures, if any. Retest systems and equipment requiring corrective action and document retest results.

E. Issues Log: RDP shall prepare and maintain an issues log that describes design, installation, and performance issues that are at variance with the Contract Documents. Identify and track issues as they are encountered, documenting the status of unresolved and resolved issues.
   1. Creating an Issues Log Entry:
      a. Identify the issue with unique numeric or alphanumeric identifier by which the issue may be tracked.
      b. Assign a descriptive title of the issue.
      c. Identify date and time of the issue.
      d. Identify test number of tests being performed at the time of the observation, if applicable, for cross-reference.
      e. Identify system, subsystem, and equipment to which the issue applies.
      f. Identify location of system, subsystem, and equipment.
      g. Include information that may be helpful in diagnosing or evaluating the issue.
      h. Note recommended corrective action.
      i. Identify commissioning team member responsible for corrective action.
      j. Identify expected date of correction.
      k. Identify person documenting the issue.
   2. Documenting Issue Resolution:
      a. Log date correction is completed, or the issue is resolved.
      b. Describe corrective action or resolution taken. Include description of diagnostic steps taken to determine root cause of the issue, if any.
      c. Identify changes to the Contract Documents that may require action.
      d. State that correction was completed, and system, subsystem, and equipment is ready for retest, if applicable.
      e. Identify person(s) who corrected or resolved the issue.
      f. Identify person(s) documenting the issue resolution.
   3. Issues Log Report: On a periodic basis, but not less than for each commissioning team meeting, RDP shall prepare a written narrative for review of outstanding issues and a status update of the issues log. As a minimum, RDP shall include the following information in the issues log and expand it in the narrative:
      a. Issue number and title.

b. Date of the identification of the issue.
c. Name of the commissioning team member assigned responsibility for resolution.
d. Expected date of correction.

F. Commissioning Report: RDP shall document results of the commissioning process including unresolved issues and performance of systems, subsystems, and equipment. The commissioning report shall indicate whether systems, subsystems, and equipment have been completed and are performing according to the Contract Documents. The commissioning report shall include, but is not limited to, the following:
1. Lists and explanations of substitutions; compromises; variances in the Contract Documents; record of conditions; and, if appropriate, recommendations for resolution. This report shall be used to evaluate systems, subsystems, and equipment and shall serve as a future reference document during Owner occupancy and operation. It shall describe components and performance that exceed requirements of the Contract Documents. It may also include a recommendation for accepting or rejecting systems, subsystems, and equipment.
2. Commissioning plan.
3. Testing plans and reports.
4. Corrective modification documentation.
5. Issues log.
6. Completed test checklists.

G. Systems Manual: RDP shall gather required information and compile systems manual. Systems manual shall include, but is not limited to, the following:
1. Submittal Data stating equipment installed and selected options for each piece of equipment requiring maintenance.
2. Operation and maintenance data on each piece of equipment requiring maintenance. Required routine maintenance actions shall be clearly identified.
3. Name and address of at least one service agency.
4. Lighting controls system maintenance and calibration information.
5. A narrative of how each system is intended to operate, including recommended setpoints.

PART 2 - PRODUCTS – NOT USED

PART 3 - EXECUTION

3.1 TESTING:

A. Testing shall ensure that the control hardware and software are calibrated, adjusted, programmed and in proper working condition in accordance with the construction documents and manufacturers installation instructions.

B. Testing shall ensure that the lighting controls meet all provisions of the applicable energy code.

C. Perform tests using design conditions whenever possible. Where occupant sensors, time switches, programmable schedule control, photosensor’s or daylighting controls are installed, the following procedures shall be performed:

1. Confirm that the placement, sensitivity, and time-out adjustments for occupant sensors yield acceptable performance.
2. Confirm that the time switches and programmable schedule controls are programmed to turn the lights off.
3. Confirm that the placement and sensitivity adjustments for photosensor controls reduce electric light based on the amount of usable daylight in the space as specified.

3.2 COMMISSIONING AGENT COORDINATION

A. Contractor shall coordinate with commissioning agent and complete the following work scope:
   1. The contractor will be responsible for filling out the forms that UNVC creates for pre-functional testing.
   2. The contractor will be responsible for filling out the forms that UNVC creates for Functional testing.
   3. Contractor will be responsible for additional testing if the systems fail during our testing with them.
   4. UNVC will review the O&M Manuals at the end of the project.

END OF SECTION 260800

SECTION 262200 - 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 262200

PAGE INTENTIONALLY BLANK

SECTION 262400 - 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 262400

PAGE INTENTIONALLY BLANK

SECTION 262416 - 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 groun
   g. d 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 262416

PAGE INTENTIONALLY BLANK

SECTION 262726 - 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 262726

SECTION 262813 - 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 262813

PAGE INTENTIONALLY BLANK

SECTION 262815 - 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 262815

SECTION 265100 - INTERIOR 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.

2.4 FIXTURE SUPPORT COMPONENTS

A. Single-Stem Hangers: 1/2-inch steel tubing with swivel ball fitting and ceiling canopy. Finish same as fixture.

B. Twin-Stem Hangers: Two, 1/2-inch steel tubes with single canopy arranged to mount a single fixture. Finish same as fixture.

C. Rod Hangers: 3/16-inch- minimum diameter, cadmium-plated, threaded steel rod.

D. Hook Hangers: Integrated assembly matched to fixture and line voltage and equipped with threaded attachment, cord, and locking-type plug.

E. Aircraft Cable Support: Use cable, anchorages, and intermediate supports recommended by fixture manufacturer.

F. Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated steel, 12 gage (2.68 mm)

2.5 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 265100

SECTION 265200 - 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 265200

PAGE INTENTIONALLY BLANK

SECTION 265600 - EXTERIOR LIGHTING

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 exterior lighting units with luminaires, LED drivers, poles/support structures, and accessories.

B. Related Sections include the following:
   1. Section 260923 - Lighting Control Devices.
   2. Section 265100 - Interior Lighting for interior fixtures, emergency lighting units, and accessories; and for exterior luminaires normally mounted on buildings.

1.3 DEFINITIONS

A. Lighting Unit: A luminaire or an assembly of luminaires complete with a common support, including pole, post, or other structure, and mounting and support accessories.

B. Luminaire (Light Fixture): A complete lighting device consisting of LED(s) and driver(s), when applicable, together with parts designed to distribute light, to position and protect lamps, and to connect lamps to power supply.

1.4 SUBMITTALS

A. Product Data: For each type of lighting unit indicated, arranged in order of lighting unit designation. Include data on features, accessories and finishes.

B. Maintenance data for lighting units.

1.5 QUALITY ASSURANCE

A. Luminaires and Accessories: Listed and labeled as defined in the NEC, Article 100, for their indicated use, location, and installation conditions by a testing agency acceptable to authorities having jurisdiction.

B. Comply with ANSI C2.

C. Comply with the NEC.

1.6 DELIVERY, STORAGE, AND HANDLING OF POLES

A. Retain factory-applied pole wrappings on metal poles until just before pole installation. For poles with nonmetallic finishes, handle with web fabric straps.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Products: As indicated on the drawings.

2.2 LUMINAIRES

A. Metal Parts: Free from burrs, sharp corners, and edges.

B. Sheet Metal Components: Corrosion-resistant aluminum, unless otherwise indicated. Form and support to prevent warping and sagging.

C. Housings: Rigidly formed, weather- and light-tight enclosures that will not warp, sag, or deform in use. Provide filter/breather for enclosed luminaires.

D. Doors, Frames, and Other Internal Access: Smooth operating, free from light leakage under operating conditions, and arranged to permit maintenance without use of tools. Arrange doors, frames, lenses, diffusers, and other pieces to prevent accidental falling during maintenance and when secured in operating position. Provide for door removal for cleaning or replacing lens. Arrange to disconnect LED driver when door opens.

E. Exposed Hardware Material: Stainless steel.

F. Plastic Parts: High resistance to yellowing and other changes due to aging, exposure to heat, and ultraviolet radiation.

G. Lenses and Refractors: Materials as indicated. Use heat- and aging-resistant, resilient gaskets to seal and cushion lens and refractor in luminaire doors.

2.3 LUMINAIRE SUPPORT COMPONENTS

A. Description: Comply with AASHTO LTS-3 for pole or other support structures, brackets, arms, appurtenances, base, and anchorage and foundation.

B. Wind-Load Strength of Total Support Assembly: Adequate to carry support assembly plus luminaires at indicated heights above grade without failure, permanent deflection, or whipping in steady winds of 80 mph with a gust factor of 1.3. Support assembly includes pole or other support structures, brackets, arms, appurtenances, base, and anchorage and foundation.

C. Finish: Match finish of pole/support structure for arm, bracket, and tenon mount materials.

D. Mountings, Fasteners, and Appurtenances: Corrosion-resistant items compatible with support

components.

1. Materials: Will not cause galvanic action at contact points.
2. Mountings: Correctly position luminaire to provide indicated light distribution.
3. Anchor Bolts, Nuts, and Washers: Hot-dip galvanized after fabrication unless stainless-steel items are indicated.
4. Anchor-Bolt Template: Steel.

E. Pole/Support Structure Bases: Anchor type with hold-down or anchor bolts, leveling nuts, and bolt covers.

F. Steel Poles: Tubing complying with ASTM A 500, Grade B, carbon steel with a minimum yield of 46,000 psig; one-piece construction up to 40 feetin length with access handhole in pole wall.

G. Steel Mast Arms: Fabricated from NPS 2black steel pipe, continuously welded to pole attachment plate with span and rise as indicated.

H. Metal Pole Brackets: Match pole metal. Provide cantilever brackets without underbrace, in sizes and styles indicated, with straight tubular end section to accommodate luminaire.

I. Pole-Top Tenons: Fabricated to support luminaire or luminaires and brackets indicated, and securely fastened to pole top.

J. Concrete for Pole Foundations: Comply with Division 3.

2.4 FINISHES

A. Steel: Grind welds and polish surfaces to a smooth, even finish.
   1. Galvanized Finish: Hot-dip galvanize after fabrication to comply with ASTM A 123.
   2. Surface Preparation: Clean surfaces to remove dirt, oil, grease, and other contaminants that could impair paint bond. Remove mill scale and rust, if present, from uncoated steel.
   3. Interior: Apply one coat of bituminous paint on interior of pole, or otherwise treat to prevent corrosion.
   4. Polyurethane Enamel: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.
      a. Color: As indicated on the drawings.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Concrete Foundations: Construct according to Division 3.

B. Install poles as follows:

1. Use web fabric slings (not chain or cable) to raise and set poles.
2. Mount pole to foundation with leveling nuts, and tighten top nuts to torque level recommended by pole manufacturer.
3. Secure poles level, plumb, and square.
4. Grout void between pole base and foundation. Use non-shrinking or expanding concrete grout firmly packed in entire void space.
5. Use a short piece of 1/2-inch-diameter pipe to make a drain hole through grout. Arrange to drain condensation from interior of pole.

C. Luminaire Attachment: Fasten to indicated structural supports.

3.2 CONNECTIONS

A. Ground equipment.
1. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values.

B. Ground metal poles/support structures.

3.3 FIELD QUALITY CONTROL

A. Inspect each installed unit for damage. Replace damaged units.

3.4 CLEANING AND ADJUSTING

A. Clean units after installation. Use methods and materials recommended by manufacturer.

END OF SECTION 265600

SECTION 270533 - 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 270533

PAGE INTENTIONALLY BLANK

SECTION 271101 - 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 271101

DIVISION 27 COMMUNICATIONS

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 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 manufacturer 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

A. 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.

B. Bidder should expect to present quotes based on the following manufacturer's products. 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.

C. Horizontal Workstation Cable – In Building:
1. ABA Industry Inc, CMP, Category 6, 4 twisted pair, 23 AWG, Station Wire for Plenum air return systems

Flame Rating	Jacket	Color	Part No.
CMP Plenum	PVC Alloy	Orange	ABA Industry Inc. TSP2404N70OR

D. Horizontal Workstation Cable – In Training Lab 1 Room 142:
1. ABA Industry Inc, CMP, Category 6, 4 twisted pair, 23 AWG, Station Wire for Plenum air return systems

Flame Rating	Jacket	Color	Part No.
CMP Plenum	PVC Alloy	Blue	ABA Industry Inc. TSP2404N70BL

2. NOTE: Irrespective of air handling space, CSI requires the use of CMP Plenum rated cable for smoke and fire mitigation.

E. Patch Panel Data Termination:

Description	Ports	Part No.
Ortronics	48	OR-PHD66U48

F. Patch Cords:

Description	Length	Part No.
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

G. Faceplate:
1. Port single Gang Stainless steel Faceplate with Label

Description	Ports	Part No.
CommScope	1	M11SP-L

H. Category 6 Jacks - Building:
1. U/UTP 1 – Giga Speed gray color

Description	Ports	Part No.
CommScope	1	MGS400-270-Gray

I. Category 6 Jacks - In Training Lab 1 Room 142:
1. U/UTP 1 – Giga Speed blue color

Description	Ports	Part No.
CommScope	1	MGS400-270-Gray

J. Analog Telephone cabling – Building:
1. ABA Industry Inc, CMP, Category 5e, 4 twisted pair, 24 AWG, Station Wire for Plenum air return systems

Flame Rating	Jacket	Color	Part No.
CMP Plenum	PVC Alloy	White	ABA Industry Inc. TUP2404P03WH

K. Analog Phone Jacks - Building:
1. U/UTP 1 – Ivory

Description	Ports	Part No.
CommScope	1	UNJ500-IV Ivory

L. IT Rack

Description	Part No.
Ortronics	MM107SVR 4 post

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.

B. NOTE: In open ceiling environments, where cable is intentionally or unintentionally exposed to view, the cable shall not be painted,
   1. Cable should be protected from exposure to paint.

C. Paint products may deteriorate the cable sheath and compromise the integrity of cable conductors.

D. 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%.

E. 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.

F. 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. BICSIBuilding 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

DIVISION 28 ELECTRONIC SAFETY AND SECURITY

SECTION 281300 - 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. 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 certification.

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.

B. Contractor shall integrate new Genetec Security Center Synergis access control and security camera system into existing Genetec Security Center Synergis access control and security camera system located in the campus main distribution frame located in the Desert building IT room.

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
      b. 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 Power 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. 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.

   13. 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 to 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 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 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 videos 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 281300

PAGE INTENTIONALLY BLANK

SECTION 282100 - 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
   2. AXIS Communications

2.2 IP SECURITY CAMERAS

A. 5 MP Multidirectional:
   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.
         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.
   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:
            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.

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:
f) Alarm Notification Triggers:
a) Motion detection.
b) Video analytics.
c) Network disconnection.

d) 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.
            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.

2.3 ACCESSORIES

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 282100

SECTION 282300 - 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 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.

B. Contractor shall integrate new Genetec access control server to existing Genetec Security Center Synergis access control and security camera system to the existing campus main distribution frame located in the Desert building IT room.

C. 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.

D. 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.

2.2 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

2.3 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.

2.4 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.

2.5 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.

2.6 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.

2.7 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.

2.8 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).

2.9 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.

2.10 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.

2.11 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.

2.12 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.

2.13 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.

2.14 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.

2.15 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.

2.16 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.

2.17 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).

2.18 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.

2.19 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.

2.20 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.

2.21 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.

2.22 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.

2.23 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.

2.24 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.

2.25 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.

2.26 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.

2.27 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.

2.28 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.

2.29 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.

2.30 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.

2.31 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 282300

SECTION 283100 - 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.

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 pre-action sprinkler system.

K. 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 on a 1/8" = 1'-0" 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 for Silent Knight

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 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.

X. Surge Protection:
   1. 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.
   2. Install surge protectors recommended by FACP manufacturer. Install all system wiring external to the building housing the FACP.

Y. 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

B. 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.
1. 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. CSI has a central monitoring fire alarm system located in the McMannaman Building. Contractor is required to install 12 pair telephone outdoor riser cable from new system in this building and terminate conductors to existing cooper telephone cables located in the Health Science and Human Service Building IT room. Reference electrical site drawings for conduit duct bank location between this building and Health Science and Human Service Building IT room.

B. Contractor shall program / Integrate new digital alarm communicator transmitter signal into existing central monitoring fire alarm system located in the McMannaman Building. Coordinate termination with CSI maintenance staff.

C. Listed and labeled according to UL 632.

D. 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.

E. Secondary Power: Integral rechargeable battery and automatic charger. Battery capacity is adequate to comply with NFPA 72 requirements.

F. 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.
   1. 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

PAGE INTENTIONALLY BLANK

SECTION 310000- GENERAL SITE CONSTRUCTION REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Includes but not limited to general procedures and requirements for Site Work.

1.2 STANDARDS

A. All work shall conform to the most current edition of the ISPWC as modified by the City of Jerome. All references to the ISPWC shall be construed to include City of Jerome.

PART 2 - PRODUCTS – NOT USED

PART 3 - EXECUTION

3.1 PREPARATION

A. Site Verification of Conditions

1. 48 hours minimum prior to performing any work on site, contact local and underground utility locating company to arrange for utility location services.
2. Perform minor, investigative excavations to verify location of various existing underground facilities at sufficient locations to assure that no conflict with the proposed work exists and sufficient clearance is available to avoid damage to existing facilities.
3. Perform investigative excavating 10 days minimum in advance of performing any excavation or underground work.
4. Upon discovery of conflicts or problems with existing facilities, notify Design Professional by phone within 24 hours. Follow telephone or fax notification with letter and diagrams indicating conflict or problem and sufficient measurements and details to evaluate problem.

3.2 PREPARATION

A. Protection

1. Spillage:

a. Avoid spillage by covering and securing loads when hauling on or adjacent to public streets or highways.
b. Remove spillage and sweep, wash, or otherwise clean project, streets and highways.

2. Dust Control:

a. Take precautions necessary to prevent dust nuisance, both on-site and adjacent to public and private properties.
b. Correct or repair damage caused by dust.

3. Erosion Control:

   a. Take precautions necessary to prevent erosion and transportation of soil downstream, to adjacent properties, and into on-site or off-site drainage systems.
   b. Develop, install, and maintain an erosion control plan if required by law.
   c. Repair and correct damage caused by erosion.

B. If specified precautions are not taken or corrections and repairs made promptly, Owner may take such steps as may be deemed necessary and deduct costs of such from monies due to Contractor. Such action or lack of action on Owner's part does not relieve Contractor from responsibility for proper protection of the Work.

3.3 REPAIR/RESTORATION

A. Adjust existing covers, boxes, and vaults to grade.

B. Replace broken or damaged covers, boxes, and vaults.

C. Independently confirm size, location, and number of covers, boxes, and vaults which require adjustment.

3.4 FIELD QUALITY CONTROL

A. Notify Design Professional 48 hours prior to performing excavation or fill work.

B. If work has been interrupted by weather, scheduling, or other reason, notify Architect 24 hours minimum prior to intended resumption of grading or compacting.

C. Owner reserves right to require additional testing to re-affirm suitability of completed work, including compacted soils which have been exposed to adverse weather conditions.

END OF SECTION 310000

SECTION 310120 - TRAFFIC CONTROL REQUIREMENTS

PART 1 - GENERAL

1.1 REQUIREMENTS

A. In accordance with Manual on Uniform Traffic Control Devices for Highways, prepared by the National Joint Committee of Uniform Traffic Control Devices or as per local governing authority.

PART 2 - PRODUCTS - N/A

PART 3 - EXECUTION

3.1 TRAFFIC CONTROL

A. A construction and traffic control schedule indicating areas and type of work to be performed shall be submitted by the Contractor for review by the Architect prior to starting work on the Project. This schedule shall include proposed detours and any necessary traffic control devices and pavement markings.
   1. All traffic control plans shall be in conformance with the Manual on Uniform Traffic Control Devices (MUTCD) for Streets and Highways and the Transportation Department's Standard Details

B. A minimum of two working days notice shall be given before any changes in the schedule is made.

C. The Contractor shall provide an individual or individuals trained in traffic control to maintain and monitor required traffic control. Such individual or individuals shall have traffic control as a primary responsibility and duty and shall be available at all times that work is in progress to perform these duties. The Contractor is responsible for monitoring and maintaining traffic control devices during non-working days and non-working hours. During non-working days the individual shall visit the site at least once per day and perform maintenance of traffic control devices as necessary. The individual responsible need not be on duty but shall be on call during the construction phase and be available by telephone contact to correct problems and perform maintenance.

D. Detours. Detours, such as utilization of one or more traffic lanes for construction or maintenance shall be the responsibility of the Contractor. Costs for these items shall be included in the contract price. A detour plan showing the detour route and all applicable detour signing shall be furnished by the Contractor and approved by the governing authority before starting work on the project. Both lanes of traffic shall be open with appropriate construction signing during all non-working hours.

E. Local and Emergency Traffic. Pedestrian traffic shall be provided access to private properties at all times, except during urgent stages of construction when it is impracticable to carry on the construction and maintain traffic simultaneously.

F. No private driveway may be closed without the approval of the governing authority. No private driveways may be closed for more than eight (8) hours without written approval of the property owner.

G. Emergency traffic such as police, fire, school bus, mail delivery and disaster units shall be provided reasonable access at all times. The Contractor shall be liable for any damages which may result from his failure to provide such reasonable access.

H. The Contractor shall keep emergency vehicle dispatchers up-to-date on road detours and closures at all times.

I. Protection of Pedestrian and Vehicular Traffic. The Contractor shall take every precaution to protect pedestrian and vehicular traffic. Wherever, in the opinion of the Architect/governing authority, the Contractor has not provided sufficient or proper safety precautions and safeguards, he shall do so immediately and to the extent deemed advisable.

J. The posting of advance warning signs, barricades, traffic cones, flashers, etc., shall be in accordance with the current edition of Part VI of the "Manual on Uniform Traffic Control Devices for Streets and Highways" prepared by the National Joint Committee of Uniform Traffic Control Devices.

K. Flagmen. The Contractor shall furnish, at his own expense, all flag persons who may be needed.

L. Dust Control. It shall be the Contractor's responsibility to control dust on the project and on any detour by watering as directed by the Architect. Dust control on the project or on a detour shall be considered incidental to the project. Also see Division 1 requirements.

M. Traffic Control Within and Abutting the Project. The Contractor shall place and maintain all signs, barricades and warning lights within the limits of the project on the approach to the work area so that approaching traffic will be aware of construction. Signs which are required shall be furnished by the Contractor.

N. Barricades shall be furnished by the Contractor. The barricades shall be of a conventional design normally used in road construction work and painted "construction orange" with black stripes.

O. Traffic Control Signs. Standard traffic control signs required for construction will be furnished by the Contractor. He shall maintain them in a neat condition until the need for them has ceased, after which he shall carefully remove the signs.

END OF SECTION 310120

SECTION 311000 - SITE CLEARING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Geotechnical Investigation, College of Southern Idaho, Leroy Craig Jerome Center, Jerome, ID prepared by Atlas Technical Consultants, LLC, July 6, 2023, #T230968g.

1.2 SUMMARY

A. Section Includes:

1. Protecting existing vegetation to remain.
2. Removing existing vegetation.
3. Clearing and grubbing.
4. Stripping and stockpiling topsoil.
5. Removing above- and below-grade site improvements.
6. Disconnecting, capping or sealing, and removing site utilities.
7. Temporary erosion- and sedimentation-control measures.

1.3 DEFINITIONS

A. Subsoil: All soil beneath the topsoil layer of the soil profile and typified by the lack of organic matter and soil organisms.

B. Surface Soil: Soil that is present at the top layer of the existing soil profile at the Project site. In undisturbed areas, the surface soil is typically topsoil; but in disturbed areas such as urban environments, the surface soil can be subsoil.

C. Topsoil: Top layer of the soil profile consisting of existing native surface topsoil or existing in-place surface soil and is the zone where plant roots grow.

D. Topsoil: Top layer of the soil profile consisting of existing native surface topsoil or existing in-place surface soil and is the zone where plant roots grow. Its appearance is generally friable, pervious, and black or a darker shade of brown, gray, or red than underlying subsoil; reasonably free of subsoil, clay lumps, gravel, and other objects more than 2 inches in diameter; and free of subsoil and weeds, roots, toxic materials, or other nonsoil materials.

E. Plant-Protection Zone: Area surrounding individual trees, groups of trees, shrubs, or other vegetation to be protected during construction, and indicated on Drawings.

F. Tree-Protection Zone: Area surrounding individual trees or groups of trees to be protected during construction and indicated on Drawings defined by a circle concentric with each tree with a radius 1.5 times the diameter of the drip line unless otherwise indicated.

G. Vegetation: Trees, shrubs, groundcovers, grass, and other plants.

1.4 MATERIAL OWNERSHIP

A. Except for stripped topsoil and other materials indicated to be stockpiled or otherwise remain Owner's property, cleared materials shall become Contractor's property and shall be removed from Project site.

1.5 SUBMITTALS

A. Existing Conditions: Documentation of existing trees and plantings, adjoining construction, and site improvements that establishes preconstruction conditions that might be misconstrued as damage caused by site clearing.

1. Use sufficiently detailed photographs or videotape.
2. Include plans and notations to indicate specific wounds and damage conditions of each tree or other plants designated to remain.

B. Record Drawings: Identifying and accurately showing locations of capped utilities and other subsurface structural, electrical, and mechanical conditions.

1.6 QUALITY ASSURANCE

A. Pre-installation Conference: Conduct conference at Project site to comply with requirements in Division 1.

1.7 PROJECT CONDITIONS

A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
2. Provide alternate routes around closed or obstructed traffic ways if required by Owner or authorities having jurisdiction.

B. Improvements on Adjoining Property: Authority for performing site clearing indicated on property adjoining Owner's property will be obtained by Owner before award of Contract.

1. Do not proceed with work on adjoining property until directed by Architect.

C. Salvable Improvements: Carefully remove items indicated to be salvaged and store on Owner's premises.

D. Utility Locator Service: Notify utility locator service Call Before You Dig for area where Project is located before site clearing.

E. Do not commence site clearing operations until temporary erosion- and sedimentation-control and plant-protection measures are in place.

F. The following practices are prohibited within protection zones:

1. Storage of construction materials, debris, or excavated material.
2. Parking vehicles or equipment.
3. Foot traffic.
4. Erection of sheds or structures.
5. Impoundment of water.
6. Excavation or other digging unless otherwise indicated.
7. Attachment of signs to or wrapping materials around trees or plants unless otherwise indicated.

G. Do not direct vehicle or equipment exhaust towards protection zones.

H. Prohibit heat sources, flames, ignition sources, and smoking within or near protection zones.

I. Soil Stripping, Handling, and Stockpiling: Perform only when the topsoil is dry or slightly moist.

J. Dust Control: Water sprinkling shall be used to control release of dust during clearing and grubbing.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Satisfactory Soil Material: Requirements for satisfactory soil material are specified in Division 31 Section "Earth Moving."

1. Obtain approved borrow soil material off-site when satisfactory soil material is not available on-site.

B. Antirust Coating: Fast-curing, lead- and chromate-free, self-curing, universal modified-alkyd primer complying with SSPC-Paint 20 or SSPC-Paint 29 zinc-rich coating.

1. Use coating with a VOC content of 420 g/L (3.5 lb/gal.) or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect and maintain benchmarks and survey control points from disturbance during construction.

B. Locate and clearly identify trees, shrubs, and other vegetation to remain. Wrap a 1-inch blue vinyl tie tape flag around each tree trunk at 54 inches above the ground.

C. Protect existing site improvements to remain from damage during construction.

1. Restore damaged improvements to their original condition, as acceptable to Owner.

3.2 TEMPORARY EROSION AND SEDIMENTATION CONTROL

A. Provide temporary erosion- and sedimentation-control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to erosion- and sedimentation-control Drawings and requirements of authorities having jurisdiction.

B. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross protection zones.

C. Inspect, maintain, and repair erosion- and sedimentation-control measures during construction until permanent vegetation has been established.

D. Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

3.3 TREE AND PLANT PROTECTION

A. Repair or replace trees, shrubs, and other vegetation indicated to remain or be relocated that are damaged by construction operations, in a manner approved by Landscape Architect.

3.4 UTILITIES

A. Locate, identify, disconnect, and seal or cap utilities indicated to be removed or abandoned in place.

1. Arrange with utility companies to shut off indicated utilities.
2. Owner will arrange to shut off indicated utilities when requested by Contractor.

B. Locate, identify, and disconnect utilities indicated to be abandoned in place.

C. Interrupting Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:

1. Notify Architect not less than two days in advance of proposed utility interruptions.
2. Do not proceed with utility interruptions without Architect's written permission.

D. Excavate for and remove underground utilities indicated to be removed.

E. Removal of underground utilities is included in Division 26 and Division 33 Sections.

3.5 CLEARING AND GRUBBING

A. Remove obstructions, trees, shrubs, and other vegetation to permit installation of new construction.

1. Do not remove trees indicated to remain.
2. Grind down stumps and remove roots, obstructions, and debris to a depth of 18 inches below exposed subgrade and final finish grade whichever is greater.
3. Use only hand methods for grubbing within protection zones.
4. Chip removed tree branches and stockpile in areas approved by Architect.

B. Fill depressions caused by clearing and grubbing operations with satisfactory soil material unless further excavation or earthwork is indicated.

1. Place fill material in horizontal layers not exceeding a loose depth of 8 inches, and compact each layer to a density equal to adjacent original native soils or as directed by the geotechnical engineer or geologist.

3.6 TOPSOIL STRIPPING

A. Remove sod and grass before stripping topsoil.

B. Strip topsoil to whatever depths are encountered (approximately 12 inches) in a manner to prevent intermingling with underlying subsoil or other waste materials.

1. Remove subsoil and non-soil materials from topsoil, including clay lumps, gravel, and other objects more than 2 inches in diameter; trash, debris, weeds, roots, and other waste materials.

C. Stockpile topsoil away from edge of excavations without intermixing with subsoil. Grade and shape stockpiles to drain surface water. Cover to prevent windblown dust and erosion by water.

1. Limit height of topsoil stockpiles to 72 inches.
2. Do not stockpile topsoil within tree protection zones.
3. Dispose of surplus topsoil onsite as indicated or directed. Surplus topsoil is that which exceeds quantity indicated to be stockpiled or reused.
4. Stockpile surplus topsoil to allow for respreading deeper topsoil.

3.7 SITE IMPROVEMENTS

A. Remove existing above and below-grade improvements as indicated and necessary to facilitate new construction.

B. Remove all unsuitable soils as directed by the geotechnical engineer.

C. Remove fence posts/ footings, slabs, paving, curbs, gutters, and aggregate base as indicated.

1. Unless existing full-depth joints coincide with line of demolition, neatly saw-cut a long line of existing pavement to remain before removing adjacent existing pavement. Saw-cut faces vertically.

2. Fill depressions caused by clearing and grubbing operations with satisfactory soil material unless further excavation or earthwork is indicated.
    a. Place fill material in horizontal layers not exceeding a loose depth of 6 inches, and compact each layer to a density equal to adjacent original ground or required improvements to be installed over removed improvements.

3.8 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Remove surplus soil material, unsuitable topsoil, obstructions, demolished materials, and waste materials including trash and debris, unsuitable subsoils, and legally dispose of them off Owner's property.

B. Separate recyclable materials produced during site clearing from other nonrecyclable materials. Store or stockpile without intermixing with other materials and transport them to recycling facilities. Do not interfere with other Project work.

END OF SECTION 311000

SECTION 312000 - EARTH MOVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. References
1. AASHTO M147-65 - Materials for Aggregate and Soil-Aggregate.
2. AASHTO T180 - Moisture-Density Relations of Soils Using a 10-lb (4.54 kg) Rammer and an 18-inch Drop.
3. ASTM C 136 –Method for Sieve Analysis of Fine and Course Aggregates.
4. ASTM D 698 ASTM D 698 - Test Methods for Moisture-Density Relations of Soil and Soil-Aggregate Mixtures using 5.5 lb. Rammer and 12-inch Drop.
5. ASTM C 2922 - Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
6. ASTM D 3017 - Test Methods for Moisture Content of Soil and Soil-Aggregate Mixtures.
7. ASTM D 1557 – Test Methods for Moisture- Density Relations of Soil and Soil-Aggregate Mixtures using 10 lbs (4.54 kg) Rammer and 18” (457 mm) Drop.
8. **Geotechnical Investigation, College of Southern Idaho, Leroy Craig Jerome Center, Jerome, ID prepared by Atlas Technical Consultants, LLC, July 6, 2023, #T230968g.**
9. **I.S.P.W.C. – Idaho Standards for Public Works Construction, current edition.**
10. **City of Jerome, Supplemental Specifications, current edition.**

1.2 SUMMARY

A. Section Includes:

1. Preparing subgrades for slabs-on-grade walks pavements turf and grasses and plants.
2. Excavating and backfilling for buildings and structures.
3. Drainage course for concrete slabs-on-grade.
4. Subbase course for concrete walks and pavements.
5. Subbase course and base course for asphalt paving.
6. Subsurface drainage backfill for walls and trenches.
7. Excavating and backfilling trenches for utilities and pits for buried utility structures.

B. Related Sections:

1. Division 01 Section "Construction Progress Documentation Photographic Documentation" for recording pre-excavation and earth moving progress.
2. Division 03 Section "Cast-in-Place Concrete" for granular course if placed over vapor retarder and beneath the slab-on-grade.

3. Divisions 21, 22, 23, 26, 27, 28, and 33 Sections for installing underground mechanical and electrical utilities and buried mechanical and electrical structures.
4. Division 31 Section "Site Clearing" for site stripping, grubbing, stripping and stockpiling topsoil, and removal of above- and below-grade improvements and utilities.
5. Division 32 Section "Turf and Grasses" for finish grading in turf and grass areas, including preparing and placing planting soil for turf areas.
6. Division 32 Section "Plants" for finish grading in planting areas and tree and shrub pit excavation and planting.

1.3 DEFINITIONS

A. Backfill: Soil material or controlled low-strength material used to fill an excavation.

1. Initial Backfill: Backfill placed beside and over pipe in a trench, including haunches to support sides of pipe.
2. Final Backfill: Backfill placed over initial backfill to fill a trench.

B. Base Course: Aggregate layer placed between the subbase course and hot-mix asphalt paving.

C. Bedding Course: Aggregate layer placed over the excavated subgrade in a trench before laying pipe.

D. Borrow Soil: Satisfactory soil imported from off-site for use as fill or backfill.

E. Drainage Course: Aggregate layer supporting the slab-on-grade that also minimizes upward capillary flow of pore water.

F. Excavation: Removal of material encountered above subgrade elevations and to lines and dimensions indicated.

1. Authorized Additional Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions as directed by Design Professional. Authorized additional excavation and replacement material will be paid for according to Contract provisions for unit prices.
2. Bulk Excavation: Excavation more than 10 feet in width and more than 30 feet in length.
3. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions without direction by Design Professional. Unauthorized excavation, as well as remedial work directed by Design Professional, shall be without additional compensation.

G. Fill: Soil materials used to raise existing grades.

H. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.

I. Subbase Course: Aggregate layer placed between the subgrade and base course for hot-mix asphalt pavement, or aggregate layer placed between the subgrade and a cement concrete pavement or a cement concrete or hot-mix asphalt walk.

J. Subgrade: Uppermost surface of an excavation or the top surface of a fill or backfill immediately below subbase, drainage fill, drainage course, or topsoil materials.

K. Utilities: On-site underground pipes, conduits, ducts, and cables, as well as underground services within buildings.

1.4 SUBMITTALS

A. Product Data: For each type of the following manufactured products required:
   1. Controlled low-strength material, including design mixture.
   2. Warning tapes.

B. Samples for Verification: For the following products, in sizes indicated below:
   1. Warning Tape: 12 inches long; of each color.

C. Qualification Data: For qualified testing agency.

D. Material Test Reports: For each on-site and borrow soil material proposed for fill and backfill as follows:

   1. Classification according to ASTM D 2487.
   2. Laboratory compaction curve according to ASTM D 698 ASTM D 1557.

E. Pre excavation Photographs or Videotape: Show existing conditions of adjoining construction and site improvements, including finish surfaces, that might be misconstrued as damage caused by earth moving operations. Submit before earth moving begins.

F. Contractor shall submit a detailed materials stockpile plan to the architect's representative and the owner for approval prior to any earthwork operations.

1.5 QUALITY ASSURANCE

A. Geotechnical Testing Agency Qualifications: Qualified according to ASTM E 329 and ASTM D 3740 for testing indicated.

B. Preexcavation Conference: Conduct conference at Project site to comply with requirements in Division 1.

C. Aggregates: **Idaho Standards for Public Works Construction, current edition.**

D. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted in writing by Architect and then only after arranging to provide temporary utility services according to requirements indicated.
   1. Notify Design Professional not less than two days in advance of proposed utility interruptions.
   2. Do not proceed with utility interruptions without Architect's written permission.
   3. Contact utility-locator service for area where Project is located before excavating.

E. Demolish and completely remove from site existing underground utilities indicated to be removed. Coordinate with utility companies to shut off services if lines are active.

F. All gravel, subbase, and other imported fill materials other than topsoil shall only be stockpiled in proposed impervious areas. No gravel or rock materials shall be stock piled or temporarily placed in proposed landscape or swale basin areas in order to prevent landscape contamination with rock materials.

1.6 PROJECT CONDITIONS

A. Verify survey benchmark and intended elevations for the work are as indicated.

B. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during earth moving operations.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
2. Provide alternate routes around closed or obstructed traffic ways if required by Owner or authorities having jurisdiction.

C. Improvements on Adjoining Property: Authority for performing earth moving indicated on property adjoining Owner's property will be obtained by Owner before award of Contract.

1. Do not proceed with work on adjoining property until directed by Architect.

D. Utility Locator Service: Notify utility locator service "Call Before You Dig" for area where Project is located before beginning earth moving operations.

E. Do not commence earth moving operations until temporary erosion- and sedimentation-control measures, specified in Division 01.

F. Do not commence earth moving operations until plant-protection measures specified on drawings are in place.

G. The following practices are prohibited within protection zones:

1. Storage of construction materials, debris, or excavated material.
2. Parking vehicles or equipment.
3. Foot traffic.
4. Erection of sheds or structures.
5. Impoundment of water.
6. Excavation or other digging unless otherwise indicated.
7. Attachment of signs to or wrapping materials around trees or plants unless otherwise indicated.

H. Do not direct vehicle or equipment exhaust towards protection zones.

I. Prohibit heat sources, flames, ignition sources, and smoking within or near protection zones.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

A. General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.

B. Satisfactory Soils: Soil Classification Groups GW, GP, GM, SW, SP, ML, and SM according to ASTM D 2487, or a combination of these groups; free of rock or gravel larger than 3 inches in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter.

C. Unsatisfactory Soils: Soil Classification Groups GC, SC, CL, OL, CH, MH, OH, and PT according to ASTM D 2487, or a combination of these groups.

1. Unsatisfactory soils also include satisfactory soils not maintained within 2 percent of optimum moisture content at time of compaction.

D. Subbase Material: Naturally or artificially graded mixture of natural or crushed gravel or stone consisting of 6-inch minus select, clean, granular soil with no more than 50 percent oversize (greater than 3/4-inch) material and no more than 12 percent fines (passing No. 200 sieve), except that the maximum material diameter is no more than 2/3 the component thickness. These fill materials should be placed in layers not to exceed 6 inches in loose thickness and must be compacted a minimum of 95 percent of the maximum dry density as determined by ASTM D 698. Material must be moisture conditioned to achieve optimum moisture content prior to compaction.

E. Base Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 95 percent passing a 1-1/2-inch sieve and not more than 8 percent passing a No. 200 sieve. Material must comply with **ITD Standard Specifications for Highway construction sections 303 and 703** for aggregates.

F. Bedding Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; except with 100 percent passing a 1-inch sieve and not more than 8 percent passing a No. 200 sieve.

G. Drainage Course: Narrowly graded mixture of washed crushed stone, or crushed or uncrushed gravel; ASTM D 448; coarse-aggregate grading Size 57; with 100 percent passing a 1-1/2-inch sieve and 0 to 5 percent passing a No. 8 sieve.

H. Filter Material: Narrowly graded mixture of natural or crushed gravel, or crushed stone and natural sand; ASTM D 448; coarse-aggregate grading Size 67; with 100 percent passing a 1-inch sieve and 0 to 5 percent passing a No. 4 sieve.

I. Sand: ASTM C 33; fine aggregate.

J. Impervious Fill: Clayey gravel and sand mixture capable of compacting to a dense state.

2.2 ACCESSORIES

A. Detectable Warning Tape: Acid- and alkali-resistant, polyethylene film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches wide and 4 mils thick, continuously inscribed with a description of the utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep; colored as follows:

1. Red: Electric.
2. Yellow: Gas, oil, steam, and dangerous materials.
3. Orange: Telephone and other communications.
4. Blue: Water systems.
5. Green: Sewer systems.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earth moving operations.

B. Protect and maintain erosion and sedimentation controls during earth moving operations.

C. Protect subgrades and foundation soils from freezing temperatures and frost. Remove temporary protection before placing subsequent materials.

3.2 DEWATERING

A. Prevent surface water and ground water from entering excavations, from ponding on prepared subgrades, and from flooding Project site and surrounding area.

B. Protect subgrades from softening, undermining, washout, and damage by rain or water accumulation.

1. Reroute surface water runoff away from excavated areas. Do not allow water to accumulate in excavations. Do not use excavated trenches as temporary drainage ditches.

3.3 EXCAVATION, GENERAL

A. Unclassified Excavation: Excavate to subgrade elevations regardless of the character of surface and subsurface conditions encountered. Unclassified excavated materials may include rock, soil materials, and obstructions. No changes in the Contract Sum or the Contract Time will be authorized for rock excavation or removal of obstructions.

1. If excavated materials intended for fill and backfill include unsatisfactory soil materials and rock, replace with satisfactory soil materials.

3.4 EXCAVATION FOR STRUCTURES

A. Excavate to indicated elevations and dimensions within a tolerance of plus or minus 1 inch. If applicable, extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, and for inspections.

1. Excavations for Footings, Foundations, and Slab on Grade: Excavated under footings and slab on grade and within 12 inches of bottom of footings, place 12-inches of structural fill base course in 8-inch lifts, provide compaction testing. Do not disturb bottom of excavation. Excavate by hand to final grade just before placing concrete reinforcement. Trim bottoms to required lines and grades to leave solid base to receive other work.
2. Excavation for Underground Tanks, Basins, and Mechanical or Electrical Utility Structures: Excavate to elevations and dimensions indicated within a tolerance of plus or minus 1 inch. Do not disturb bottom of excavations intended as bearing surfaces.

B. Excavations at Edges of Tree- and Plant-Protection Zones:

1. Excavate by hand to indicated lines, cross sections, elevations, and subgrades. Use narrow-tine spading forks to comb soil and expose roots. Do not break, tear, or chop exposed roots. Do not use mechanical equipment that rips, tears, or pulls roots.
2. Cut and protect roots according to requirements in Division 01 and as shown on drawings.

3.5 EXCAVATION FOR WALKS AND PAVEMENTS

A. Excavate surfaces under walks and pavements to indicated lines, cross sections, elevations, and subgrades.

3.6 EXCAVATION FOR UTILITY TRENCHES

A. Excavate trenches to indicated gradients, lines, depths, and elevations.

1. Beyond building perimeter, excavate trenches to allow installation of top of pipe below frost line.

B. Excavate trenches to uniform widths to provide the following clearance on each side of pipe or conduit. Excavate trench walls vertically from trench bottom to 12 inches higher than top of pipe or conduit unless otherwise indicated.

1. Clearance: 12 inches each side of pipe or conduit.

C. Trench Bottoms: Excavate and shape trench bottoms to provide uniform bearing and support of pipes and conduit. Shape subgrade to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits. Remove projecting stones and sharp objects along trench subgrade.

1. For pipes and conduit less than 6 inches in nominal diameter, hand-excavate trench bottoms and support pipe and conduit on an undisturbed subgrade.

2. For pipes and conduit 6 inches or larger in nominal diameter, shape bottom of trench to support bottom 90 degrees of pipe or conduit circumference. Fill depressions with tamped sand backfill.
3. For flat-bottomed, multiple-duct conduit units, hand-excavate trench bottoms and support conduit on an undisturbed subgrade.
4. Excavate trenches 6 inches deeper than elevation required in rock or other unyielding bearing material to allow for bedding course.

D. Trench Bottoms: Excavate trenches 4 inches deeper than bottom of pipe and conduit elevations to allow for bedding course. Hand-excavate deeper for bells of pipe.

1. Excavate trenches 6 inches deeper than elevation required in rock or other unyielding bearing material to allow for bedding course.

E. Trenches in Tree- and Plant-Protection Zones:

1. Hand-excavate to indicated lines, cross sections, elevations, and subgrades. Use narrow-tine spading forks to comb soil and expose roots. Do not break, tear, or chop exposed roots. Do not use mechanical equipment that rips, tears, or pulls roots.
2. Do not cut main lateral roots or taproots; cut only smaller roots that interfere with installation of utilities.
3. Cut and protect roots according to requirements in Division 01 Section "Temporary Tree and Plant Protection."

3.7 SUBGRADE INSPECTION

A. Notify Design Professional and Geotechnical Engineer when excavations have reached required subgrade.

B. If Geotechnical Engineer determines that unsatisfactory soil is present, continue excavation and replace with compacted backfill or fill material as directed.

C. Proof-roll subgrade below the building slabs and pavements with a pneumatic-tired and loaded 10-wheel, tandem-axle dump truck weighing not less than 15 tons to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.

1. Completely proof-roll subgrade in one direction, repeating proof-rolling in direction perpendicular to first direction. Limit vehicle speed to 3 mph.
2. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Architect, and replace with compacted backfill or fill as directed.

D. Authorized additional excavation and replacement material will be paid for according to Contract provisions for unit prices.

E. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by Architect, without additional compensation.

3.8 UNAUTHORIZED EXCAVATION

A. Fill unauthorized excavation under foundations or wall footings by extending bottom elevation of concrete foundation or footing to excavation bottom, without altering top elevation. Lean concrete fill, with 28-day compressive strength of 2500 psi, may be used when approved by Architect.

1. Fill unauthorized excavations under other construction, pipe, or conduit as directed by Architect.

3.9 STORAGE OF SOIL MATERIALS

A. Stockpile borrow soil materials and excavated satisfactory soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.

1. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.

3.10 BACKFILL

A. Place and compact backfill in excavations promptly, but not before completing the following:

1. Construction below finish grade including, where applicable, subdrainage, dampproofing, waterproofing, and perimeter insulation.
2. Surveying locations of underground utilities for Record Documents.
3. Testing and inspecting underground utilities.
4. Removing concrete formwork.
5. Removing trash and debris.
6. Removing temporary shoring and bracing, and sheeting.
7. Installing permanent or temporary horizontal bracing on horizontally supported walls.

B. Place backfill on subgrades free of mud, frost, snow, or ice.

3.11 UTILITY TRENCH BACKFILL

A. Place backfill on subgrades free of mud, frost, snow, or ice.

B. Place and compact bedding course on trench bottoms and where indicated. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.

C. Trenches under Footings: Backfill trenches excavated under footings and within 12 inches of bottom of footings with structural fill soil; fill with concrete to elevation of bottom of footings. Concrete is specified in Division 03 Section "Cast-in-Place Concrete."

D. Backfill voids with satisfactory soil while removing shoring and bracing.

E. Place and compact initial backfill of satisfactory soil, free of particles larger than 1 inch in any dimension, to a height of 12 inches over the pipe or conduit.

1. Carefully compact initial backfill under pipe haunches and compact evenly up on both sides and along the full length of piping or conduit to avoid damage or displacement of piping or conduit. Coordinate backfilling with utilities testing.

F. Controlled Low-Strength Material: Place initial backfill of controlled low-strength material to a height of 12 inches over the pipe or conduit. Coordinate backfilling with utilities testing.

G. Place and compact final backfill of satisfactory soil to final subgrade elevation.

H. Controlled Low-Strength Material: Place final backfill of controlled low-strength material to final subgrade elevation.

I. Install warning tape directly above utilities, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.

3.12 SOIL FILL

A. Plow, scarify, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so fill material will bond with existing material.

B. Place and compact fill material in layers to required elevations as follows:

1. Under grass and planted areas, use satisfactory soil material.
2. Under walks and pavements, use satisfactory soil material.
3. Under steps and ramps, use engineered fill.
4. Under building slabs, use engineered fill.
5. Under footings and foundations, use engineered fill.

C. Place soil fill on subgrades free of mud, frost, snow, or ice.

3.13 SOIL MOISTURE CONTROL

A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill soil layer before compaction to within 2 percent of optimum moisture content.

1. Do not place backfill or fill soil material on surfaces that are muddy, frozen, or contain frost or ice.
2. Remove and replace, or scarify and air dry, otherwise satisfactory soil material that exceeds optimum moisture content by 2 percent and is too wet to compact to specified dry unit weight.

3.14 COMPACTION OF SOIL BACKFILLS AND FILLS

A. Place backfill and fill soil materials in layers not more than 8 inches in loose depth for material compacted by heavy compaction equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers.

B. Place backfill and fill soil materials evenly on all sides of structures to required elevations, and uniformly along the full length of each structure.

C. Compact soil materials to not less than the following percentages of maximum dry unit weight according to ASTM D 698 and ASTM D 1557:

1. Under structures, building slabs, steps, and pavements, scarify and recompact top 12 inches of existing subgrade and each layer of backfill or fill soil material at 95 percent.
2. Under walkways, scarify and recompact top 6 inches below subgrade and compact each layer of backfill or fill soil material at 95 percent.
3. Under turf or unpaved areas, scarify and recompact top 6 inches below subgrade and compact each layer of backfill or fill soil material at 85 percent.
4. For utility trenches, compact each layer of initial and final backfill soil material at 95 percent.

3.15 GRADING

A. General: Uniformly grade areas to a smooth surface, free of irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.

1. Provide a smooth transition between adjacent existing grades and new grades.
2. Cut out soft spots, fill low spots, and trim high spots to comply with required surface tolerances.

B. Site Rough Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to required elevations within the following tolerances:

1. Turf or Unpaved Areas: Plus or minus 1 inch.
2. Walks: Plus or minus 1 inch.
3. Pavements: Plus or minus 1/2 inch.

C. Grading inside Building Lines: Finish subgrade to a tolerance of 1/2 inch when tested with a 10-foot straightedge.

3.16 SUBBASE AND BASE COURSES UNDER PAVEMENTS AND WALKS

A. Place subbase course and base course on subgrades free of mud, frost, snow, or ice.

B. On prepared subgrade, place subbase course and base course under pavements and walks as follows:

1. Install separation geotextile on prepared subgrade according to manufacturer's written instructions, overlapping sides and ends.
2. Place base course material over subbase course under hot-mix asphalt pavement.
3. Shape subbase course and base course to required crown elevations and cross-slope grades.
4. Place subbase course and base course 6 inches or less in compacted thickness in a single layer.
5. Place subbase course and base course that exceeds 6 inches in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches thick or less than 3 inches thick.

6. Compact subbase course and base course at optimum moisture content to required grades, lines, cross sections, and thickness to not less than 95 percent of maximum dry unit weight according to ASTM D 698 and ASTM D 1557.

C. Pavement Shoulders: Place shoulders along edges of subbase course and base course to prevent lateral movement. Construct shoulders, at least 12 inches wide or per plans, of satisfactory soil materials and compact simultaneously with each subbase and base layer to not less than 95 percent of maximum dry unit weight according to ASTM D 698 and ASTM D 1557.

3.17 FIELD QUALITY CONTROL

A. Special Inspections: Owner will engage a qualified special inspector to perform the following special inspections:

1. Determine prior to placement of fill that site has been prepared in compliance with requirements.
2. Determine that fill material and maximum lift thickness comply with requirements.
3. Determine, at the required frequency, that in-place density of compacted fill complies with requirements.

B. Testing Agency: Owner will engage a qualified geotechnical engineering testing agency to perform tests and inspections.

C. Allow testing agency to inspect and test subgrades and each fill or backfill layer. Proceed with subsequent earth moving only after test results for previously completed work comply with requirements.

D. Footing Subgrade: At footing subgrades, at least one test of each soil stratum will be performed to verify design bearing capacities. Subsequent verification and approval of other footing subgrades may be based on a visual comparison of subgrade with tested subgrade when approved by Architect.

E. Testing agency will test compaction of soils in place according to ASTM D 1556, ASTM D 2167, ASTM D 2922, and ASTM D 2937, as applicable. Tests will be performed at the following locations and frequencies:

1. Paved and Building Slab Areas: At subgrade and at each compacted fill and backfill layer, at least one test for every 2000 sq. ft. or less of paved area or building slab, but in no case fewer than three tests.
2. Foundation Wall Backfill: At each compacted backfill layer, at least one test for every 100 feet or less of wall length, but no fewer than two tests.
3. Trench Backfill: At each compacted initial and final backfill layer, at least one test for every 150 feet or less of trench length, but no fewer than two tests.

F. When testing agency reports that subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil materials to depth required; recompact and retest until specified compaction is obtained.

3.18 PROTECTION

A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.

B. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.

1. Scarify or remove and replace soil material to depth as directed by Design Professional; reshape and recompact.

C. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.

1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

3.19 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Remove surplus unsatisfactory soil and waste materials, including unsatisfactory soil, trash, and debris, and legally dispose of them off Owner's property.

B. Transport surplus satisfactory soil to designated storage areas on Owner's property. Stockpile or spread soil as directed by Design Professional.

1. Remove waste materials, including unsatisfactory soil, trash, and debris, and legally dispose of them off Owner's property.

END OF SECTION 312000

PAGE INTENTIONALLY BLANK

SECTION 315000 - EXCAVATION SUPPORT AND PROTECTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes temporary excavation support and protection systems.

B. Related Sections:

1. Division 01 Section "Construction Progress Documentation Photographic Documentation" for recording preexisting conditions and excavation support and protection system progress.
2. Division 01 Section "Temporary Facilities and Controls" for temporary utilities and support facilities.
3. Division 31 Section "Dewatering" for dewatering system for excavations.

1.3 PERFORMANCE REQUIREMENTS

A. Design, furnish, install, monitor, and maintain excavation support and protection system capable of supporting excavation sidewalls and of resisting soil and hydrostatic pressure and superimposed and construction loads.

1. Delegated Design: Design excavation support and protection system, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
2. Prevent surface water from entering excavations by grading, dikes, or other means.
3. Install excavation support and protection systems without damaging existing buildings, structures, and site improvements adjacent to excavation.
4. Monitor vibrations, settlements, and movements.

1.4 SUBMITTALS

A. Shop Drawings: For excavation support and protection system.

B. Delegated-Design Submittal: For excavation support and protection system indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

C. Coordinate first paragraph below with qualification requirements in Division 01 Section "Quality Requirements."Qualification Data: For qualified land surveyor and professional engineer.

D. Other Informational Submittals:

1. Photographs or Videotape: Show existing conditions of adjacent construction and site improvements that might be misconstrued as damage caused by the absence of, the installation of, or the performance of excavation support and protection systems. Submit before Work begins.
2. Record Drawings: Identifying and locating capped utilities and other subsurface structural, electrical, or mechanical conditions.

    a. Note locations and capping depth of wells and well points.

1.5 QUALITY ASSURANCE

A. Preinstallation Conference: Conduct conference at Project site.

1. Review methods and procedures related to excavation support and protection system including, but not limited to, the following:

    a. Geotechnical report.
    b. Existing utilities and subsurface conditions.
    c. Proposed excavations.
    d. Proposed equipment.
    e. Monitoring of excavation support and protection system.
    f. Working area location and stability.
    g. Coordination with waterproofing.
    h. Abandonment or removal of excavation support and protection system.

1.6 PROJECT CONDITIONS

A. Interruption of Existing Utilities: Do not interrupt any utility serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility according to requirements indicated:

1. Notify Architect no fewer than two days in advance of proposed interruption of utility.
2. Do not proceed with interruption of utility without Architect's written permission.

B. Project-Site Information: A geotechnical report has been prepared for this Project and is available for information only. The opinions expressed in this report are those of geotechnical engineer and represent interpretations of subsoil conditions, tests, and results of analyses conducted by geotechnical engineer. Owner will not be responsible for interpretations or conclusions drawn from the data.

1. Make additional test borings and conduct other exploratory operations necessary for excavation support and protection.
2. The geotechnical report is referenced elsewhere in the Project Manual.

C. Survey Work: Engage a professional land surveyor to survey adjacent existing buildings, structures, and site improvements; establish exact elevations at fixed points to act as benchmarks. Clearly identify benchmarks and record existing elevations.

1. During installation of excavation support and protection systems, regularly resurvey benchmarks, maintaining an accurate log of surveyed elevations and positions for comparison with original elevations and positions. Promptly notify Architect if changes in elevations or positions occur or if cracks, sags, or other damage is evident in adjacent construction.

PART 2 - PRODUCTS

2.1 MATERIALS

A. General: Provide materials that are either new or in serviceable condition.

B. Structural Steel: ASTM A 36/A 36M, ASTM A 690/A 690M, or ASTM A 992/A 992M.

C. Steel Sheet Piling: ASTM A 328/A 328M, ASTM A 572/A 572M, or ASTM A 690/A 690M; with continuous interlocks.

1. Corners: Site-fabricated mechanical interlock.

D. Wood Lagging: Lumber, mixed hardwood, nominal rough thickness of size and strength required for application 3 inches.

E. Tiebacks: Steel bars, ASTM A 722/A 722M.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards that could develop during excavation support and protection system operations.

1. Shore, support, and protect utilities encountered.

B. Install excavation support and protection systems to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.

C. Locate excavation support and protection systems clear of permanent construction so that forming and finishing of concrete surfaces are not impeded.

D. Monitor excavation support and protection systems daily during excavation progress and for as long as excavation remains open. Promptly correct bulges, breakage, or other evidence of movement to ensure that excavation support and protection systems remain stable.

E. Promptly repair damages to adjacent facilities caused by installing excavation support and protection systems.

3.2 SOLDIER PILES AND LAGGING

A. Install steel soldier piles before starting excavation. Extend soldier piles below excavation grade level to depths adequate to prevent lateral movement. Space soldier piles at regular intervals not to exceed allowable flexural strength of wood lagging. Accurately align exposed faces of flanges to vary not more than 2 inches from a horizontal line and not more than 1:120 out of vertical alignment.

B. Install wood lagging within flanges of soldier piles as excavation proceeds. Trim excavation as required to install lagging. Fill voids behind lagging with soil, and compact.

C. Install wales horizontally at locations indicated on Drawings and secure to soldier piles.

3.3 SHEET PILING

A. Before starting excavation, install one-piece sheet piling lengths and tightly interlock to form a continuous barrier. Accurately place the piling, using templates and guide frames unless otherwise recommended in writing by the sheet piling manufacturer. Limit vertical offset of adjacent sheet piling to 60 inches. Accurately align exposed faces of sheet piling to vary not more than 2 inches from a horizontal line and not more than 1:120 out of vertical alignment. Cut tops of sheet piling to uniform elevation at top of excavation.

3.4 TIEBACKS

A. Tiebacks: Drill, install, grout, and tension tiebacks. Test load-carrying capacity of each tieback and replace and retest deficient tiebacks.

1. Test loading shall be observed by a qualified professional engineer responsible for design of excavation support and protection system.
2. Maintain tiebacks in place until permanent construction is able to withstand lateral soil and hydrostatic pressures.

3.5 BRACING

A. Bracing: Locate bracing to clear columns, floor framing construction, and other permanent work. If necessary to move brace, install new bracing before removing original brace.

1. Do not place bracing where it will be cast into or included in permanent concrete work unless otherwise approved by Architect.
2. Install internal bracing, if required, to prevent spreading or distortion of braced frames.
3. Maintain bracing until structural elements are supported by other bracing or until permanent construction is able to withstand lateral earth and hydrostatic pressures.

3.6 REMOVAL AND REPAIRS

A. Remove excavation support and protection systems when construction has progressed sufficiently to support excavation and bear soil and hydrostatic pressures. Remove in stages to avoid disturbing underlying soils or damaging structures, pavements, facilities, and utilities.

1. Remove excavation support and protection systems to a minimum depth of 48 inches below overlaying construction and abandon remainder.
2. Fill voids immediately with approved backfill compacted to density specified in Division 31 Section "Earth Moving."
3. Repair or replace, as approved by Architect, adjacent work damaged or displaced by removing excavation support and protection systems.

B. Leave excavation support and protection systems permanently in place.

END OF SECTION 315000

PAGE INTENTIONALLY BLANK

SECTION 321216 - ASPHALT PAVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 REFERENCES

A. The Asphalt Institute - Manual MS-4 - The Asphalt Handbook.

B. The Asphalt Institute - Manual MS-13 - Asphalt Surface Treatments for Asphalt Penetration Macadam.

C. ASTM D 692 - Specification for Coarse Aggregate for Bituminous Paving Mixtures.

D. ASTM D 946 - Specification for Penetration-Graded Asphalt Cement for Use in Pavement Construction.

E. ASTM D 1073 - Fine Aggregates for Bituminous Paving Mixtures.

F. ASTM D 3381 - Specification for Viscosity-Graded Asphalt Cement for use in Pavement Construction.

G. ASTM D 3515 - Specification for Hot-Mixed, Hot-Laid Bituminous Paving Mixtures.

H. ISPWC - Section 800 - Aggregate/Asphalt Idaho Standard Public Works Construction, current edition.

I. ASTM D 1557 – Test Methods for Moisture-Density Relations of Soil and Soil-Aggregate Mixtures using 10 lbs (4.54 kg) Rammer and 18” (457 mm) Drop.

J. **City of Jerome** Supplemental Specifications, current edition.

K. Geotechnical Investigation, College of Southern Idaho, Leroy Craig Jerome Center, Jerome, ID prepared by Atlas Technical Consultants, LLC, July 6, 2023, #T230968g.

1.3 SUMMARY

A. Section Includes:
   1. Hot-mix asphalt patching.
   2. Hot-mix asphalt paving.
   3. Hot-mix asphalt paving overlay.
   4. Asphalt surface treatments.
   5. Pavement-marking paint.

B. Related Sections:
   1. Division 31 Section "Earth Moving" for aggregate subbase and base courses and for aggregate pavement shoulders.
   2. Division 32 Section "Concrete Paving Joint Sealants" for joint sealants and fillers at paving terminations.

1.3 DEFINITION

A. Hot-Mix Asphalt Paving Terminology: Refer to ASTM D 8 for definitions of terms.

B. **I.S.P.W.C.: Idaho Standards for Public Works Construction**.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated. Include technical data and tested physical and performance properties.

   1. Job-Mix Designs: Certification, by authorities having jurisdiction, of approval of each job mix proposed for the Work.
   2. Job-Mix Designs: For each job mix proposed for the Work.

B. Samples: For each paving fabric, 12 by 12 inches minimum.

C. Samples for Verification: For the following products, in manufacturer's standard sizes unless otherwise indicated:

   1. Each paving fabric, 12 by 12 inches minimum.

D. Qualification Data: For qualified manufacturer and Installer.

E. Material Certificates: For each paving material, from manufacturer.

F. Material Test Reports: For each paving material.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: A paving-mix manufacturer registered with and approved by authorities having jurisdiction and the Idaho Standards for Public Works Construction. Engage a firm experienced in manufacturing hot-mix asphalt paving material similar to that indicated for this project with a five-year record of successful in-service performance.

B. Installer Qualifications: Asphalt manufacturer's authorized installer who is trained and approved for installation of asphalt required for this Project. Engage an experienced installer who has completed hot-mix asphalt paving similar in material similar to that indicated for this project with a five-year record of successful in-service performance.

C. Testing Agency Qualifications: Qualified according to ASTM D 3666 for testing indicated.

D. Regulatory Requirements: Comply with materials, workmanship, and other applicable requirements of Idaho Standards for Public Works Construction, **City of Jerome** supplemental specifications for work within the right-of-way. Comply with ASTM D 3515.

E. Obtain materials from same source throughout.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver pavement-marking materials to Project site in original packages with seals unbroken and bearing manufacturer's labels containing brand name and type of material, date of manufacture, and directions for storage.

B. Store pavement-marking materials in a clean, dry, protected location within temperature range required by manufacturer. Protect stored materials from direct sunlight.

1.7 PROJECT CONDITIONS

A. Environmental Limitations: Do not apply asphalt materials if subgrade is wet or excessively damp, if rain is imminent or expected before time required for adequate cure, or if the following conditions are not met:

1. Prime Coat: Minimum surface temperature of 60 deg F.
2. Tack Coat: Minimum surface temperature of 60 deg F.
3. Slurry Coat: Comply with weather limitations in ASTM D 3910.
4. Asphalt Base Course: Minimum surface temperature of 40 deg F and rising at time of placement.
5. Asphalt Surface Course: Minimum surface temperature of 60 deg F at time of placement.
6. Wind less than 10 per hour.
7. Do not place during rainfall, sand or dust storms, or before any imminent storms that might damage the construction.
8. Place bitumen mixture when temperature is not more than 15 F degrees below bitumen supplier's bill of lading and not more than maximum specified temperature.

B. Pavement-Marking Paint: Proceed with pavement marking only on clean, dry surfaces and at a minimum ambient or surface temperature of 40 deg F for oil-based materials 55 deg F for water-based materials, and not exceeding 95 deg F.

PART 2 - PRODUCTS

2.1 AGGREGATES

A. General: Use materials and gradations that have performed satisfactorily in previous installations.

B. Coarse Aggregate: ASTM D 692, sound; angular crushed stone, crushed gravel, or cured, crushed blast-furnace slag.

C. Fine Aggregate: ASTM D 1073 or AASHTO M 29, sharp-edged natural sand or sand prepared from stone, gravel, cured blast-furnace slag, or combinations thereof.

1. For hot-mix asphalt, limit natural sand to a maximum of 20 percent by weight of the total aggregate mass.

D. Mineral Filler: ASTM D 242 or AASHTO M 17, rock or slag dust, hydraulic cement, or other inert material.

2.2 ASPHALT MATERIALS

A. Asphalt Binder: AASHTO M 320 or AASHTO MP 1a, PG 58-28.

B. Asphalt Cement: ASTM D 3381 for viscosity-graded material ASTM D 946 for penetration-graded material.

C. Prime Coat: ASTM D 2027, medium-curing cutback asphalt, MC-250.

D. Prime Coat: Asphalt emulsion prime coat complying with Idaho Standards for Public Work Construction requirements.

E. Tack Coat: ASTM D 977 or AASHTO M 140 emulsified asphalt, or ASTM D 2397 or AASHTO M 208 cationic emulsified asphalt, slow setting, diluted in water, of suitable grade and consistency for application.

F. Water: Potable.

2.3 AUXILIARY MATERIALS

A. Herbicide: Commercial chemical for weed control, registered by the EPA. Provide in granular, liquid, or wetable powder form.

B. Sand: ASTM D 1073 or AASHTO M 29, Grade Nos. 2 or 3.

C. Paving Geotextile: AASHTO M 288, nonwoven polypropylene; resistant to chemical attack, rot, and mildew; and specifically designed for paving applications.

D. Joint Sealant: ASTM D 6690 or AASHTO M 324, hot-applied, single-component, polymer-modified bituminous sealant.

E. Pavement-Marking Paint: Latex, waterborne emulsion, lead and chromate free, ready mixed, complying with FS TT-P-1952, Type II, with drying time of less than 45 minutes.

1. Color: White Yellow Blue As indicated on plans.

2.4 MIXES

A. Hot-Mix Asphalt: Dense, hot-laid, hot-mix asphalt plant mixes approved by authorities having jurisdiction and designed according to procedures in AI MS-2, "Mix Design Methods for Asphalt Concrete and Other Hot-Mix Types."

1. Provide mixes with a history of satisfactory performance in geographical area where Project is located.
2. Provide mixes complying with composition, grading, and tolerance requirements in ASTM D 3515 for the following nominal, maximum aggregate sizes:
   a. Surface Course: 1/2 inch.

B. Emulsified-Asphalt Slurry: ASTM D 3910, Type 1.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that subgrade is dry and in suitable condition to begin paving.

B. Proof-roll subgrade below pavements with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.

1. Completely proof-roll subgrade in one direction, repeating proof-rolling in direction perpendicular to first direction. Limit vehicle speed to 3 mph.
2. Proof roll with a loaded 10-wheel, tandem-axle dump truck weighing not less than 15 tons.
3. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Geotechnical Engineer, and replace with compacted backfill or fill as directed.

C. Proceed with paving only after unsatisfactory conditions have been corrected.

D. Verify that utilities, traffic loop detectors, and other items requiring a cut and installation beneath the asphalt surface have been completed and that asphalt surface has been repaired flush with adjacent asphalt prior to beginning installation of imprinted asphalt.

3.2 PATCHING

A. Hot-Mix Asphalt Pavement: Saw cut perimeter of patch and excavate existing pavement section to sound base. Excavate rectangular or trapezoidal patches, extending 12 inches into adjacent sound pavement, unless otherwise indicated. Cut excavation faces vertically. Remove excavated material. Recompact existing unbound-aggregate base course to form new subgrade.

B. Portland Cement Concrete Pavement: Break cracked slabs and roll as required to reseat concrete pieces firmly.

1. Pump hot undersealing asphalt under rocking slab until slab is stabilized or, if necessary, crack slab into pieces and roll to reseat pieces firmly.

2. Remove disintegrated or badly cracked pavement. Excavate rectangular or trapezoidal patches, extending into adjacent sound pavement, unless otherwise indicated. Cut excavation faces vertically. Recompact existing unbound-aggregate base course to form new subgrade.

C. Tack Coat: Apply uniformly to vertical surfaces abutting or projecting into new, hot-mix asphalt paving at a rate of 0.05 to 0.15 gal./sq. yd.

1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.

D. Patching: Fill excavated pavements with hot-mix asphalt base mix for full thickness of patch and, while still hot, compact flush with adjacent surface.

E. Patching: Partially fill excavated pavements with hot-mix asphalt base mix and, while still hot, compact. Cover asphalt base course with compacted, hot-mix surface layer finished flush with adjacent surfaces.

3.3 REPAIRS

A. Leveling Course: Install and compact leveling course consisting of hot-mix asphalt surface course to level sags and fill depressions deeper than 1 inch in existing pavements.

1. Install leveling wedges in compacted lifts not exceeding 3 inches thick.

B. Crack and Joint Filling: Remove existing joint filler material from cracks or joints to a depth of 1/4 inch.

1. Clean cracks and joints in existing hot-mix asphalt pavement.
2. Use emulsified-asphalt slurry to seal cracks and joints less than 1/4 inch wide. Fill flush with surface of existing pavement and remove excess.
3. Use hot-applied joint sealant to seal cracks and joints more than 1/4 inch wide. Fill flush with surface of existing pavement and remove excess.

3.4 SURFACE PREPARATION

A. General: Immediately before placing asphalt materials, remove loose and deleterious material from substrate surfaces. Ensure that prepared subgrade is ready to receive paving.

B. Herbicide Treatment: Apply herbicide according to manufacturer's recommended rates and written application instructions. Apply to dry, prepared subgrade or surface of compacted-aggregate base before applying paving materials.

1. Mix herbicide with prime coat if formulated by manufacturer for that purpose.

C. Tack Coat: Apply uniformly to surfaces of existing pavement at a rate of 0.05 to 0.15 gal./sq. yd.

1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.

2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.

3.5 HOT-MIX ASPHALT PLACING

A. Machine place hot-mix asphalt on prepared surface, spread uniformly, and strike off. Place asphalt mix by hand to areas inaccessible to equipment in a manner that prevents segregation of mix. Place each course to required grade, cross section, and thickness when compacted.

1. Place hot-mix asphalt base course in number of lifts and thicknesses indicated.
2. Place hot-mix asphalt surface course in single lift.
3. Spread mix at minimum temperature of 250 deg F.
4. Begin applying mix 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 paving in consecutive strips not less than 10 feet wide unless infill edge strips of a lesser width are required.

1. After first strip has been placed and rolled, place succeeding strips and extend rolling to overlap previous strips. Complete a section of asphalt base course before placing asphalt surface course.

C. Promptly correct surface irregularities in paving course behind paver. Use suitable hand tools to remove excess material forming high spots. Fill depressions with hot-mix asphalt to prevent segregation of mix; use suitable hand tools to smooth surface.

3.6 JOINTS

A. Construct joints to ensure a continuous bond between adjoining paving sections. Construct joints free of depressions, with same texture and smoothness as other sections of hot-mix asphalt course.

1. Clean contact surfaces and apply tack coat to joints.
2. Offset longitudinal joints, in successive courses, a minimum of 6 inches.
3. Offset transverse joints, in successive courses, a minimum of 24 inches.
4. Construct transverse joints at each point where paver ends a day's work and resumes work at a subsequent time. Construct these joints using either "bulkhead" or "papered" method according to AI MS-22, for both "Ending a Lane" and "Resumption of Paving Operations."
5. Compact joints as soon as hot-mix asphalt will bear roller weight without excessive displacement.
6. Compact asphalt at joints to a density within 2 percent of specified course density.

3.7 COMPACTION

A. General: Begin compaction as soon as placed hot-mix paving will bear roller weight without excessive displacement. Compact hot-mix paving with hot, hand tampers or with vibratory-plate compactors in areas inaccessible to rollers.

1. Complete compaction before mix temperature cools to 185 deg F.

B. Breakdown Rolling: Complete breakdown or initial rolling immediately after rolling joints and outside edge. Examine surface immediately after breakdown rolling for indicated crown, grade, and smoothness. Correct lay down and rolling operations to comply with requirements.

C. Intermediate Rolling: Begin intermediate rolling immediately after breakdown rolling while hot-mix asphalt is still hot enough to achieve specified density. Continue rolling until hot-mix asphalt course has been uniformly compacted to the following density:
1. Average Density: 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 hot-mix asphalt is still warm.

E. Edge Shaping: While surface is being compacted and finished, trim edges of pavement to proper alignment. Bevel edges while asphalt is still hot; compact thoroughly.

F. Repairs: Remove paved areas that are defective or contaminated with foreign materials and replace with fresh, hot-mix asphalt. Compact by rolling to specified density and surface smoothness.

G. Protection: After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened.

H. Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked.

3.8 INSTALLATION TOLERANCES

A. Pavement Thickness: Compact each course to produce the thickness indicated within the following tolerances:

1. Base Course: Plus or minus 1/2 inch.
2. Surface Course: Plus 1/4 inch, no minus.

B. Pavement Surface Smoothness: Compact each course to produce a surface smoothness within the following tolerances as determined by using a 10-foot straightedge applied transversely or longitudinally to paved areas:

1. Base Course: 1/4 inch.
2. Surface Course: 1/8 inch.
3. Crowned Surfaces: Test with crowned template centered and at right angle to crown. Maximum allowable variance from template is 1/4 inch.

3.9 PAVEMENT MARKING

A. Do not apply pavement-marking paint until layout, colors, and placement have been verified with Architect.

B. Allow paving to age for 30 days before starting pavement marking.

C. Sweep and clean surface to eliminate loose material and dust.

D. Apply paint with mechanical equipment to produce pavement markings, of dimensions indicated, with uniform, straight edges. Apply at manufacturer's recommended rates to provide a minimum wet film thickness of 15 mils.

3.10 WHEEL STOPS

A. Install wheel stops in bed of adhesive as recommended by manufacturer.

B. Securely attach wheel stops to pavement with not less than two galvanized-steel dowels embedded at one-quarter to one-third points. Securely install dowels into pavement and bond to wheel stop. Recess head of dowel beneath top of wheel stop.

3.11 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Thickness: In-place compacted thickness of hot-mix asphalt courses will be determined according to ASTM D 3549.

C. Surface Smoothness: Finished surface of each hot-mix asphalt course will be tested for compliance with smoothness tolerances.

D. In-Place Density: Testing agency will take samples of uncompacted paving mixtures and compacted pavement according to ASTM D 979 or AASHTO T 168.

1. Reference maximum theoretical density will be determined by averaging results from four samples of hot-mix asphalt-paving mixture delivered daily to site, prepared according to ASTM D 2041, and compacted according to job-mix specifications.
2. In-place density of compacted pavement will be determined by testing core samples according to ASTM D 1188 or ASTM D 2726.

    a. One core sample will be taken for every 1000 sq. yd. or less of installed pavement, with no fewer than 3 cores taken.
    b. Field density of in-place compacted pavement may also be determined by nuclear method according to ASTM D 2950 and correlated with ASTM D 1188 or ASTM D 2726.

E. Replace and compact hot-mix asphalt where core tests were taken.

F. Remove and replace or install additional hot-mix asphalt where test results or measurements indicate that it does not comply with specified requirements.

G. Protection: Immediately after placement, protect pavement from mechanical injury for 2 days or until surface temperature is less than 140 degrees F.

H. Special Testing: The contractor shall flood test the finished asphalt surface to identify potential areas for correction. The contractor shall notify the Project Manager and Landscape Architect for review of the flood testing. Areas that do not drain and pool water deeper than the depth of a nickel shall be identified and corrected as required.

3.12 DISPOSAL

A. Except for material indicated to be recycled, remove excavated materials from Project site and legally dispose of them in an EPA-approved landfill.

1. Do not allow milled materials to accumulate on-site.

2. Remove excess base rock from edges of asphalt.

END OF SECTION 321216

SECTION 321313 - CONCRETE PAVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Curbs and gutters.
   2. Walks.
   3. Mow strips.

B. Related Sections:

   1. Division 03 Section "Cast-in-Place Concrete" for general building applications of concrete.

C. References:
   1. ACI 301 - Specifications for Structural Concrete for Buildings.
   2. ACI 304 - Recommended Practice for Measuring, Mixing, Transporting and Placing Concrete.
   3. ASTM A 615 - Specification for Deformed and Plain Billet-Steel for Concrete Reinforcement.
   4. ASTM C 33 - Specification for Concrete Aggregates.
   5. ASTM C 94 - Specification for Ready Mix Concrete.
   6. ASTM C 150 - Specification for Portland Cement
   7. ASTM C 260 - Specification for Air-Entraining Admixtures for Concrete.
   8. ASTM C 309 - Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
   9. ASTM C 494 - Specification for Chemical Admixtures for Concrete.
   10. ASTM C 143 - Test Method for Slump of Portland Cement Concrete
   11. **International Building Code – 2018 edition**.
   12. I.S.P.W.C. - Section 700 – Concrete. Idaho Standard Public Works Construction, current edition.
   13. Geotechnical Investigation, College of Southern Idaho, Leroy Craig Jerome Center, Jerome, ID prepared by Atlas Technical Consultants, LLC, July 6, 2023 #T230968g.

1.3 DEFINITIONS

A. Cementitious Materials: Portland cement alone or in combination with one or more of blended hydraulic cement, fly ash and other pozzolans, and ground granulated blast-furnace slag.

1.4 SUBMITTALS

A. Submit under provisions of Division 1.

B. Product Data: Provide data on joint filler, admixtures and curing compounds.

C. Submit shop drawings of reinforcing steel under provisions of Division 1.

D. Indicate reinforcement sizes, spacing, locations and quantities of reinforcing steel, bending and cutting schedules, splicing, and supporting and spacing devices.

E. Submit concrete slab control and expansion joint layout.

F. Product Data: For each type of product indicated.

G. Design Mixtures: For each concrete paving mixture. Include alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

H. Qualification Data: For qualified Installer of detectable warnings ready-mix concrete manufacturer and testing agency.

I. Material Certificates: For the following, from manufacturer:

1. Cementitious materials.
2. Steel reinforcement and reinforcement accessories.
3. Fiber reinforcement.
4. Admixtures.
5. Curing compounds.
6. Applied finish materials.
7. Bonding agent or epoxy adhesive.
8. Joint fillers.

J. Material Test Reports: For Aggregates. Include service-record data indicating absence of deleterious expansion of concrete due to alkali-aggregate reactivity.

K. Field quality-control reports.

L. Minutes of pre-installation conference.

1.5 QUALITY ASSURANCE

A. Detectable Warning Installer Qualifications: An employer of workers trained and approved by manufacturer.

B. Perform work in accordance with ACI 301 requirements and State of Idaho Public Works Standards, Section 700.

C. Obtain cementitious materials from same source throughout.

D. Conform to **the City of Jerome** supplemental specifications for paving work within right-of-way.

E. Ready-Mix-Concrete Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.

1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities" (Quality Control Manual - Section 3, "Plant Certification Checklist").

F. Testing Agency Qualifications: Qualified according to ASTM C 1077 and ASTM E 329 for testing indicated.

1. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-1 or an equivalent certification program.

G. Concrete Testing Service: Engage a qualified testing agency to perform material evaluation tests and to design concrete mixtures.

H. ACI Publications: Comply with ACI 301 unless otherwise indicated.

I. Preinstallation Conference: Contractor shall Conduct conference at Project site prior to any form placement. Contact the landscape architect to schedule the conference.

1. Review methods and procedures related to concrete paving, including but not limited to, the following:

a. Concrete mixture design.
b. Quality control of concrete materials and concrete paving construction practices.

2. Require representatives of each entity directly concerned with concrete paving to attend, including the following:

a. Contractor's superintendent.
b. Independent testing agency responsible for concrete design mixtures.
c. Concrete paving subcontractor.

1.6 PROJECT CONDITIONS

A. Traffic Control: Maintain access for vehicular and pedestrian traffic as required for other construction activities.

PART 2 - PRODUCTS

2.1 FORMS

A. Form Materials: Plywood, metal, metal-framed plywood, or other approved panel-type materials to provide full-depth, continuous, straight, and smooth exposed surfaces.

1. Use flexible or uniformly curved forms for curves with a radius of 100 feet or less. Do not use notched and bent forms.

B. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and that will not impair subsequent treatments of concrete surfaces.

2.2 STEEL REINFORCEMENT

A. Recycled Content: Provide steel reinforcement with an average recycled content of steel so postconsumer recycled content plus one-half of preconsumer recycled content is not less than 25 percent.

B. Plain-Steel Welded Wire Reinforcement: ASTM A 185/A 185M, fabricated from as-drawnsteel wire into flat sheets.

C. Deformed-Steel Welded Wire Reinforcement: ASTM A 497/A 497M, flat sheet.

D. Epoxy-Coated Welded Wire Reinforcement: ASTM A 884/A 884M, Class A, plain steel.

E. Reinforcing Bars: ASTM A 615/A 615M, Grade 60; deformed.

F. Galvanized Reinforcing Bars: ASTM A 767/A 767M, Class II zinc coated, hot-dip galvanized after fabrication and bending; with ASTM A 615/A 615M, Grade 60 deformed bars.

G. Epoxy-Coated Reinforcing Bars: ASTM A 775/A 775M or ASTM A 934/A 934M; with ASTM A 615/A 615M, Grade 60 deformed bars.

H. Steel Bar Mats: ASTM A 184/A 184M; with ASTM A 615/A 615M, Grade 60, deformed bars; assembled with clips.

I. Plain-Steel Wire: ASTM A 82/A 82M, as drawn.

J. Deformed-Steel Wire: ASTM A 496/A 496M.

K. Joint Dowel Bars: ASTM A 615/A 615M, Grade 60 plain-steel bars; zinc coated (galvanized) after fabrication according to ASTM A 767/A 767M, Class I coating. Cut bars true to length with ends square and free of burrs.

L. Epoxy-Coated, Joint Dowel Bars: ASTM A 775/A 775M; with ASTM A 615/A 615M, Grade 60, plain-steel bars.

M. Tie Bars: ASTM A 615/A 615M, Grade 60, deformed.

N. Hook Bolts: ASTM A 307, Grade A, internally and externally threaded. Design hook-bolt joint assembly to hold coupling against paving form and in position during concreting operations, and to permit removal without damage to concrete or hook bolt.

O. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars, welded wire reinforcement, and dowels in place. Manufacture bar supports according to CRSI's "Manual of Standard Practice" from steel wire, plastic, or precast concrete of greater compressive strength than concrete specified, and as follows:

1. Equip wire bar supports with sand plates or horizontal runners where base material will not support chair legs.
2. For epoxy-coated reinforcement, use epoxy-coated or other dielectric-polymer-coated wire bar supports.

P. Epoxy Repair Coating: Liquid, two-part, epoxy repair coating, compatible with epoxy coating on reinforcement.

Q. Zinc Repair Material: ASTM A 780.

2.3 CONCRETE MATERIALS

A. Cementitious Material: Use the following cementitious materials, of same type, brand, and source throughout Project:

1. Portland Cement: ASTM C 150, gray portland cement Type I. Supplement with the following:

   a. Fly Ash: ASTM C 618, Class C.
   b. Ground Granulated Blast-Furnace Slag: ASTM C 989, Grade 100 or 120.

B. Normal-Weight Aggregates: ASTM C 33, Class 4S, uniformly graded. Provide aggregates from a single source with documented service-record data of at least 10 years' satisfactory service in similar paving applications and service conditions using similar aggregates and cementitious materials.

1. Maximum Coarse-Aggregate Size: 1 inch nominal.
2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.

C. Water: Potable and complying with ASTM C 94/C 94M.

D. Air-Entraining Admixture: ASTM C 260.

E. Chemical Admixtures: Admixtures certified by manufacturer to be compatible with other admixtures and to contain not more than 0.1 percent water-soluble chloride ions by mass of cementitious material.

1. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.
2. Retarding Admixture: ASTM C 494/C 494M, Type B.
3. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
4. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.
5. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
6. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II.

2.4 CURING MATERIALS

A. Absorptive Cover: AASHTO M 182, Class 3, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. dry.

B. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.

C. Water: Potable.

D. Evaporation Retarder: Waterborne, monomolecular, film forming, manufactured for application to fresh concrete.

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

a. Axim Italcementi Group, Inc.; Caltexol CIMFILM.
b. BASF Construction Chemicals, LLC; Confilm.
c. ChemMasters; Spray-Film.
d. Conspec by Dayton Superior; Aquafilm.
e. Dayton Superior Corporation; Sure Film (J-74).
f. Edoco by Dayton Superior; BurkeFilm.
g. Euclid Chemical Company (The), an RPM company; Eucobar.
h. Kaufman Products, Inc.; VaporAid.
i. Lambert Corporation; LAMBCO Skin.
j. L&M Construction Chemicals, Inc.; E-CON.
k. Meadows, W. R., Inc.; EVAPRE.
l. Metalcrete Industries; Waterhold.
m. Nox-Crete Products Group; MONOFILM.
n. Sika Corporation, Inc.; SikaFilm.
o. SpecChem, LLC; Spec Film.
p. Symons by Dayton Superior; Finishing Aid.
q. TK Products, Division of Sierra Corporation; TK-2120 TRI-FILM.
r. Unitex; PRO-FILM.
s. Vexcon Chemicals Inc.; Certi-Vex EnvioAssist.

E. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, dissipating.

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

a. Anti-Hydro International, Inc.; A-H Curing Compound #2 DR WB.
b. ChemMasters; Safe-Cure Clear.
c. Conspec by Dayton Superior; DSSCC Clear Resin Cure.
d. Dayton Superior Corporation; Day-Chem Rez Cure (J-11-W).
e. Edoco by Dayton Superior; DSSCC Clear Resin Cure.
f. Euclid Chemical Company (The), an RPM company; Kurez W VOX.
g. Kaufman Products, Inc.; Thinfilm 420.
h. Lambert Corporation; AQUA KURE - CLEAR.
i. L&M Construction Chemicals, Inc.; L&M CURE R.
j. Meadows, W. R., Inc.; 1100-CLEAR SERIES.
k. Nox-Crete Products Group; Resin Cure E.
l. SpecChem, LLC; PaveCure Rez.
m. Symons by Dayton Superior; Resi-Chem Clear.
n. Tamms Industries, Inc., Euclid Chemical Company (The); TAMMSCURE WB 30C.

o. TK Products, Division of Sierra Corporation; TK-2519 WB.
p. Vexcon Chemicals Inc.; Certi-Vex Enviocure 100.

2.5 RELATED MATERIALS

A. Joint Fillers: ASTM D 1751, asphalt-saturated cellulosic fiber or ASTM D 1752, cork or self-expanding cork in preformed strips.

B. Bonding Agent: ASTM C 1059, Type II, non-redispersible, acrylic emulsion or styrene butadiene.

C. Epoxy Bonding Adhesive: ASTM C 881/C 881M, two-component epoxy resin capable of humid curing and bonding to damp surfaces; of class suitable for application temperature, of grade complying with requirements, and of the following types:

1. Types I and II, non-load bearing, for bonding hardened or freshly mixed concrete to hardened concrete.

D. Chemical Surface Retarder: Water-soluble, liquid, set retarder with color dye, for horizontal concrete surface application, capable of temporarily delaying final hardening of concrete to a depth of 1/8 to 1/4 inch.

1. Products: Subject to compliance with requirements, provide the following provide one of the following:

a. ChemMasters; Exposee.
b. Conspec by Dayton Superior; Delay S.
c. Dayton Superior Corporation; Sure Etch (J-73).
d. Edoco by Dayton Superior; True Etch Surface Retarder.
e. Euclid Chemical Company (The), an RPM company; Surface Retarder Formula S.
f. Kaufman Products, Inc.; Expose.
g. Meadows, W. R., Inc.; TOP-STOP.
h. Metalcrete Industries; Surftard.
i. Nox-Crete Products Group; CRETE-NOX TA.
j. Scofield, L. M. Company; LITHOTEX Top Surface Retarder.
k. Sika Corporation, Inc.; Rugasol-S.
l. SpecChem, LLC; Spec Etch.
m. TK Products, Division of Sierra Corporation; TK-6000 Concrete Surface Retarder.
n. Unitex; TOP-ETCH Surface Retarder.
o. Vexcon Chemicals Inc.; Certi-Vex Envioset.

2.6 DETECTABLE WARNING MATERIALS

A. Detectable Warning Products:

1. Cast-in-Tact by Masco, or approved equal.

2.7 WHEEL STOPS

A. Wheel Stops: Precast, air-entrained concrete, 2500-psi minimum compressive strength, 5 inches high by 9 inches wide by 72 inches long. Provide chamfered corners and drainage slots on underside and holes for anchoring to substrate.

1. Dowels: Galvanized steel, 3/4 inch in diameter, 24-inch minimum length.

2.8 CONCRETE MIXTURES

A. Prepare design mixtures, proportioned according to ACI 301, for each type and strength of normal-weight concrete, and as determined by either laboratory trial mixtures or field experience.

1. Use a qualified independent testing agency for preparing and reporting proposed concrete design mixtures for the trial batch method.
2. When automatic machine placement is used, determine design mixtures and obtain laboratory test results that meet or exceed requirements.

B. Proportion mixtures to provide normal-weight concrete with the following properties:

1. Compressive Strength (28 Days): 4500 psi.
2. Maximum Water-Cementitious Materials Ratio at Point of Placement: 0.45.
3. Slump Limit: 4 inches, plus or minus 1 inch.

C. Add air-entraining admixture at manufacturer's prescribed rate to result in normal-weight concrete at point of placement having an air content as follows:

1. Air Content: 5-1/2 percent plus or minus 1.5 percent for 1-1/2-inch nominal maximum aggregate size.
2. Air Content: 6 percent plus or minus 1.5 percent for 3/4-inch nominal maximum aggregate size.

D. Limit water-soluble, chloride-ion content in hardened concrete to 0.15 percent by weight of cement.

E. Chemical Admixtures: Use admixtures according to manufacturer's written instructions.
1. Use water-reducing and retarding admixture when approved by Architect and required by high temperatures, low humidity, or other adverse placement conditions.

F. Cementitious Materials: Limit percentage by weight of cementitious materials other than portland cement according to ACI 301 requirements for concrete exposed to deicing chemicals. as follows:

1. Fly Ash or Pozzolan: 15 percent.
2. Ground Granulated Blast-Furnace Slag: 50 percent.
3. Combined Fly Ash or Pozzolan, and Ground Granulated Blast-Furnace Slag: 50 percent, with fly ash or pozzolan not exceeding 25 percent.

2.9 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, and mix concrete materials and concrete according to ASTM C 94/C 94M and ASTM C 1116/C 1116M. Furnish batch certificates for each batch discharged and used in the Work.

1. When air temperature is between 85 and 90 deg F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.

B. Project-Site Mixing: Measure, batch, and mix concrete materials and concrete according to ASTM C 94/C 94M. Mix concrete materials in appropriate drum-type batch machine mixer.

1. For concrete batches of 1 cu. yd. or smaller, continue mixing at least 1-1/2 minutes, but not more than 5 minutes after ingredients are in mixer, before any part of batch is released.
2. For concrete batches larger than 1 cu. yd., increase mixing time by 15 seconds for each additional 1 cu. yd..
3. Provide batch ticket for each batch discharged and used in the Work, indicating Project identification name and number, date, mixture type, mixing time, quantity, and amount of water added.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine exposed subgrades and subbase surfaces for compliance with requirements for dimensional, grading, and elevation tolerances.

B. Proof-roll prepared subbase surface below concrete paving to identify soft pockets and areas of excess yielding.

1. Completely proof-roll subbase in one direction. Limit vehicle speed to 3 mph.
2. Proof-roll with a pneumatic-tired and loaded, 10-wheel, tandem-axle dump truck weighing not less than 15 tons.
3. Correct subbase with soft spots and areas of pumping or rutting exceeding depth of 1/2 inch according to requirements in Division 31 Section "Earth Moving."

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Remove loose material from compacted subbase surface immediately before placing concrete.

3.3 EDGE FORMS AND SCREED CONSTRUCTION

A. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides to required lines, grades, and elevations. Install forms to allow continuous progress of work and so forms can remain in place at least 24 hours after concrete placement.

B. Clean forms after each use and coat with form-release agent to ensure separation from concrete without damage.

3.4 STEEL REINFORCEMENT

A. General: Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.

B. Clean reinforcement of loose rust and mill scale, earth, ice, or other bond-reducing materials.

C. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement. Maintain minimum cover to reinforcement.

D. Install fabricated bar mats in lengths as long as practicable. Handle units to keep them flat and free of distortions. Straighten bends, kinks, and other irregularities, or replace units as required before placement. Set mats for a minimum 2-inch overlap of adjacent mats.

E. Install bar where indicated on plans and details.

3.5 JOINTS

A. General: Form construction, isolation, and contraction joints and tool edges true to line, with faces perpendicular to surface plane of concrete. Construct transverse joints at right angles to centerline unless otherwise indicated.

1. When joining existing paving, place transverse joints to align with previously placed joints unless otherwise indicated.

B. Construction Joints: Set construction joints at side and end terminations of paving and at locations where paving operations are stopped for more than one-half hour unless paving terminates at isolation joints.

1. Continue steel reinforcement across construction joints unless otherwise indicated. Do not continue reinforcement through sides of paving strips unless otherwise indicated.
2. Provide tie bars at sides of paving strips where indicated.
3. Butt Joints: Use epoxy bonding adhesive at joint locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
4. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or coat with asphalt one-half of dowel length to prevent concrete bonding to one side of joint.

C. Isolation Joints: Form isolation joints of preformed joint-filler strips abutting concrete curbs, catch basins, manholes, inlets, structures, walks, building columns, other fixed objects, and where indicated.

1. Locate expansion joints at intervals of 40 feet unless otherwise indicated.
2. Extend joint fillers full width and depth of joint.
3. Place top of joint filler flush with finished concrete surface if joint sealant is not indicated.
4. Furnish joint fillers in one-piece lengths. Where more than one length is required, lace or clip joint-filler sections together.
5. During concrete placement, protect top edge of joint filler with metal, plastic, or other temporary preformed cap. Remove protective cap after concrete has been placed on both sides of joint.

D. Contraction Joints: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of the concrete thickness, as follows:

1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint with grooving tool to a 3/8-inch radius. Repeat grooving of contraction joints after applying surface finishes. Eliminate grooving-tool marks on concrete surfaces.

   a. Tolerance: Ensure that grooved joints are within 3 inches either way from centers of dowels.

2. Doweled Contraction Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or coat with asphalt one-half of dowel length to prevent concrete bonding to one side of joint.

E. Edging: After initial floating, tool edges of paving, gutters, curbs, and joints in concrete with an edging tool to a 3/8-inch radius. Repeat tooling of edges after applying surface finishes. Eliminate edging-tool marks on concrete surfaces.

3.6 CONCRETE PLACEMENT

A. Before placing concrete, inspect and complete formwork installation, steel reinforcement, and items to be embedded or cast-in.

B. Remove snow, ice, or frost from subbase surface and steel reinforcement before placing concrete. Do not place concrete on frozen surfaces.

C. Moisten subbase to provide a uniform dampened condition at time concrete is placed. Do not place concrete around manholes or other structures until they are at required finish elevation and alignment.

D. Comply with ACI 301 requirements for measuring, mixing, transporting, and placing concrete.

E. Do not add water to concrete during delivery or at Project site.

F. Do not add water to fresh concrete after testing.

G. Deposit and spread concrete in a continuous operation between transverse joints. Do not push or drag concrete into place or use vibrators to move concrete into place.

H. Consolidate concrete according to ACI 301 by mechanical vibrating equipment supplemented by hand spading, rodding, or tamping.

1. Consolidate concrete along face of forms and adjacent to transverse joints with an internal vibrator. Keep vibrator away from joint assemblies, reinforcement, or side forms. Use only square-faced shovels for hand spreading and consolidation. Consolidate with care to prevent dislocating reinforcement dowels and joint devices.

I. Place concrete in two operations; strike off initial pour for entire width of placement and to the required depth below finish surface. Lay welded wire fabric or fabricated bar mats immediately in final position. Place top layer of concrete, strike off, and screed.

1. Remove and replace concrete that has been placed for more than 15 minutes without being covered by top layer, or use bonding agent if approved by Architect.

J. Screed paving surface with a straightedge and strike off.

K. Commence initial floating using bull floats or darbies to impart an open-textured and uniform surface plane before excess moisture or bleed water appears on the surface. Do not further disturb concrete surfaces before beginning finishing operations or spreading surface treatments.

L. Curbs and Gutters: When automatic machine placement is used for curb placement, submit revised mix design and laboratory test results that meet or exceed requirements. Produce curbs and gutters to required cross section, lines, grades, finish, and jointing as specified for formed concrete. If results are not approved, remove and replace with formed concrete.

M. Slip-Form Paving: When automatic machine placement is used for pavement, submit revised mix design and laboratory test results that meet or exceed requirements. Produce paving to required thickness, lines, grades, finish, and jointing as required for formed pavement.

1. Compact subbase and prepare subgrade of sufficient width to prevent displacement of slip-form paving machine during operations.

N. When adjoining pavement lanes are placed in separate pours, do not operate equipment on concrete until pavement has attained 85 percent of its 28-day compressive strength.

O. Cold-Weather Placement: Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing, or low temperatures. Comply with ACI 306.1 and the following:

1. When air temperature has fallen to or is expected to fall below 40 deg F, uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 deg F and not more than 80 deg F at point of placement.
2. Do not use frozen materials or materials containing ice or snow.
3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in design mixtures.

P. Hot-Weather Placement: Comply with ACI 301 and as follows when hot-weather conditions exist:

1. Cool ingredients before mixing to maintain concrete temperature below 90 deg F at time of placement. Chilled mixing water or chopped ice may be used to control temperature,

provided water equivalent of ice is calculated in total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.

2. Cover steel reinforcement with water-soaked burlap so steel temperature will not exceed ambient air temperature immediately before embedding in concrete.
3. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade moisture uniform without standing water, soft spots, or dry areas.

3.7 FLOAT FINISHING

A. General: Do not add water to concrete surfaces during finishing operations.

B. Float Finish: Begin the second floating operation when bleed-water sheen has disappeared and concrete surface has stiffened sufficiently to permit operations. Float surface with power-driven floats or by hand floating if area is small or inaccessible to power units. Finish surfaces to true planes. Cut down high spots and fill low spots. Refloat surface immediately to uniform granular texture.

1. Medium-to-Fine-Textured Broom Finish: Draw a soft-bristle broom across float-finished concrete surface perpendicular to line of traffic to provide a uniform, fine-line texture.
2. Medium-to-Coarse-Textured Broom Finish: Provide a coarse finish by striating float-finished concrete surface 1/16 to 1/8 inch deep with a stiff-bristled broom, perpendicular to line of traffic.

3.8 DETECTABLE WARNINGS

A. Blockouts: Form blockouts in concrete for installation of detectable paving units as shown on plans.

1. Tolerance for Opening Size: Plus 1/4 inch, no minus.

3.9 CONCRETE PROTECTION AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.

B. Comply with ACI 306.1 for cold-weather protection.

C. Evaporation Retarder: Apply evaporation retarder to concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete but before float finishing.

D. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.

E. Curing Methods: Cure concrete by moisture curing moisture-retaining-cover curing curing compound or a combination of these as follows:

1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:

a. Water.
b. Continuous water-fog spray.
c. Absorptive cover, water saturated and kept continuously wet. Cover concrete surfaces and edges with 12-inch lap over adjacent absorptive covers.

2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover, placed in widest practicable width, with sides and ends lapped at least 12 inches and sealed by waterproof tape or adhesive. Immediately repair any holes or tears occurring during installation or curing period using cover material and waterproof tape.
3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas that have been subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating, and repair damage during curing period.

3.10 PAVING TOLERANCES

A. Comply with tolerances in ACI 117 and as follows:

1. Elevation: 1/4 inch.
2. Thickness: Plus 3/8 inch, minus 1/4 inch.
3. Surface: Gap below 10-foot- long, unleveled straightedge not to exceed 1/2 inch.
4. Alignment of Tie-Bar End Relative to Line Perpendicular to Paving Edge: 1/2 inch per 12 inches of tie bar.
5. Lateral Alignment and Spacing of Dowels: 1 inch.
6. Vertical Alignment of Dowels: 1/4 inch.
7. Alignment of Dowel-Bar End Relative to Line Perpendicular to Paving Edge: 1/4 inch per 12 inches of dowel.
8. Joint Spacing: 3 inches.
9. Contraction Joint Depth: Plus 1/4 inch, no minus.
10. Joint Width: Plus 1/8 inch, no minus.

3.11 WHEEL STOPS

A. Install wheel stops in bed of adhesive applied as recommended by manufacturer.

B. Securely attach wheel stops to paving with not less than two galvanized-steel dowels located at one-quarter to one-third points. Install dowels in drilled holes in the paving and bond dowels to wheel stop. Recess head of dowel beneath top of wheel stop.

3.12 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Testing Services: Testing of composite samples of fresh concrete obtained according to ASTM C 172 shall be performed according to the following requirements:

1. Testing Frequency: Obtain at least one composite sample for each 5000 sq. ft.] or fraction thereof of each concrete mixture placed each day.

    a. When frequency of testing will provide fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.

2. Slump: ASTM C 143/C 143M; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.
3. Air Content: ASTM C 231, pressure method; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
4. Concrete Temperature: ASTM C 1064/C 1064M; one test hourly when air temperature is 40 deg F and below and when it is 80 deg F and above, and one test for each composite sample.
5. Compression Test Specimens: ASTM C 31/C 31M; cast and laboratory cure one set of three standard cylinder specimens for each composite sample.
6. Compressive-Strength Tests: ASTM C 39/C 39M; test one specimen at seven days and two specimens at 28 days.

    a. A compressive-strength test shall be the average compressive strength from two specimens obtained from same composite sample and tested at 28 days.

C. Strength of each concrete mixture will be satisfactory if 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.

D. Test results shall be reported in writing to Architect, concrete manufacturer, and Contractor 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.

E. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Architect but will not be used as sole basis for approval or rejection of concrete.

F. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Architect.

G. Remove and replace concrete paving where test results indicate that it does not pass tests and inspections.

H. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

I. Prepare test and inspection reports.

3.13 REPAIRS AND PROTECTION

A. Remove and replace concrete paving that is broken, damaged, or defective or that does not comply with requirements in this Section. Remove work in complete sections from joint to joint unless otherwise approved by Architect.

B. Drill test cores, where directed by Architect, when necessary to determine magnitude of cracks or defective areas. Fill drilled core holes in satisfactory paving areas with portland cement concrete bonded to paving with epoxy adhesive.

C. Protect concrete paving from damage. Exclude traffic from paving for at least 14 days after placement. When construction traffic is permitted, maintain paving as clean as possible by removing surface stains and spillage of materials as they occur.

D. Maintain concrete paving free of stains, discoloration, dirt, and other foreign material. Sweep paving not more than two days before date scheduled for Substantial Completion inspections.

END OF SECTION 321313

SECTION 321373 - CONCRETE PAVING JOINT SEALANTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Cold-applied joint sealants.
2. Hot-applied joint sealants.

B. Related Sections:

1. Division 07 Section "Joint Sealants" for sealing non-traffic and traffic joints in locations not specified in this Section.
2. Division 32 Section "Asphalt Paving" for constructing joints between concrete and asphalt pavement.
3. Division 32 Section "Concrete Paving" for constructing joints in concrete pavement.

1.3 PRECONSTRUCTION TESTING

A. Preconstruction Compatibility and Adhesion Testing: Submit to joint-sealant manufacturers, for testing indicated below, Samples of materials that will contact or affect joint sealants.

1. Use **ASTM C 1087** to determine whether priming and other specific joint-preparation techniques are required to obtain rapid, optimum adhesion of joint sealants to joint substrates.
2. Submit no fewer than **eight** pieces of each type of material, including joint substrates, shims, joint-sealant backings, secondary seals, and miscellaneous materials.
3. Schedule sufficient time for testing and analyzing results to prevent delaying the Work.
4. For materials failing tests, obtain joint-sealant manufacturer's written instructions for corrective measures including use of specially formulated primers.
5. Testing will not be required if joint-sealant manufacturers submit joint-preparation data that are based on previous testing, not older than 24 months, of sealant products for compatibility with and adhesion to joint substrates and other materials matching those submitted.

1.4 SUBMITTALS

A. Product Data: For each joint-sealant product indicated.

B. Samples for Verification: For each kind and color of joint sealant required, provide Samples with joint sealants in 1/2-inch- wide joints formed between two 6-inch- long strips of material matching the appearance of exposed surfaces adjacent to joint sealants.

C. Pavement-Joint-Sealant Schedule: Include the following information:

1. Joint-sealant application, joint location, and designation.
2. Joint-sealant manufacturer and product name.
3. Joint-sealant formulation.
4. Joint-sealant color.

D. Qualification Data: For qualified **Installer**.

E. Product Certificates: For each type of joint sealant and accessory, from manufacturer.

F. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for joint sealants.

G. Preconstruction Compatibility and Adhesion Test Reports: From joint-sealant manufacturer, indicating the following:

1. Materials forming joint substrates and joint-sealant backings have been tested for compatibility with and adhesion to joint sealants.
2. Interpretation of test results and written recommendations for primers and substrate preparation needed for adhesion.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.

B. Source Limitations: Obtain each type of joint sealant from single source from single manufacturer.

C. Product Testing: Test joint sealants using a qualified testing agency.

1. Testing Agency Qualifications: An independent testing agency qualified according to ASTM C 1021 to conduct the testing indicated.

D. Pre-installation Conference: Conduct conference on site.

1.6 PROJECT CONDITIONS

A. Do not proceed with installation of joint sealants under the following conditions:

1. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer **or are below 40 deg F**.
2. When joint substrates are wet.
3. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.

4. Where contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Compatibility: Provide joint sealants, backing materials, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer based on testing and field experience.

B. Colors of Exposed Joint Sealants: **As selected by Architect from manufacturer's full range**.

2.2 COLD-APPLIED JOINT SEALANTS

A. Single-Component, Nonsag, Silicone Joint Sealant for Concrete: ASTM D 5893, Type NS.

1. Products: Subject to compliance with requirements, **provide one of the following** or approved equal:

a. Crafco Inc., an ERGON company; RoadSaver Silicone.
b. Dow Corning Corporation; 888.
c. Pecora Corporation; 301 NS.

B. Single-Component, Self-Leveling, Silicone Joint Sealant for Concrete: ASTM D 5893, Type SL.

1. Products: Subject to compliance with requirements, **provide one of the following** or approved equal:

a. Crafco Inc., an ERGON company; RoadSaver Silicone SL.
b. Dow Corning Corporation; 890-SL.
c. Pecora Corporation; 300 SL.

C. Multicomponent, Pourable, Traffic-Grade, Urethane Joint Sealant for Concrete: ASTM C 920, Type M, Grade P, Class 25, for Use T.

1. Products: Subject to compliance with requirements, **provide one of the following** or approved equal:

a. Pecora Corporation; Urexpan NR-200.

2.3 HOT-APPLIED JOINT SEALANTS

A. Hot-Applied, Single-Component Joint Sealant for Concrete: ASTM D 3406.

1. Products: Subject to compliance with requirements, **provide one of the following** or approved equal:

    a. Crafco Inc., an ERGON company; Superseal 444/777.

B. Hot-Applied, Single-Component Joint Sealant for Concrete and Asphalt: ASTM D 6690, Types I, II, and III.

1. Products: Subject to compliance with requirements, **provide one of the following** or approved equal.

    a. Meadows, W. R., Inc.; **Sealtight Hi-Spec**
    b. Right Pointe; D-3405 Hot Applied Sealant.

2.4 JOINT-SEALANT BACKER MATERIALS

A. General: Provide joint-sealant backer materials that are non-staining; are compatible with joint substrates, sealants, primers, and other joint fillers; and are approved for applications indicated by joint-sealant manufacturer based on field experience and laboratory testing.

B. Round Backer Rods for Cold- and Hot-Applied Joint Sealants: ASTM D 5249, Type 1, of diameter and density required to control sealant depth and prevent bottom-side adhesion of sealant.

C. Round Backer Rods for Cold-Applied Joint Sealants: ASTM D 5249, Type 3, of diameter and density required to control joint-sealant depth and prevent bottom-side adhesion of sealant.

D. Backer Strips for Cold- and Hot-Applied Joint Sealants: ASTM D 5249; Type 2; of thickness and width required to control joint-sealant depth, prevent bottom-side adhesion of sealant, and fill remainder of joint opening under sealant.

2.5 PRIMERS

A. Primers: Product recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting joint-sealant performance.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions.

B. Joint Priming: Prime joint substrates where indicated or where recommended in writing by joint-sealant manufacturer, based on preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.

3.3 INSTALLATION OF JOINT SEALANTS

A. General: Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated unless more stringent requirements apply.

B. Joint-Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.

C. Install joint-sealant backings of kind indicated to support joint sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.

1. Do not leave gaps between ends of joint-sealant backings.
2. Do not stretch, twist, puncture, or tear joint-sealant backings.
3. Remove absorbent joint-sealant backings that have become wet before sealant application and replace them with dry materials.

D. Install joint sealants using proven techniques that comply with the following and at the same time backings are installed:

1. Place joint sealants so they directly contact and fully wet joint substrates.
2. Completely fill recesses in each joint configuration.
3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.

E. Tooling of Non-sag Joint Sealants: Immediately after joint-sealant application and before skinning or curing begins, tool sealants according to the following requirements to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint:

1. Remove excess joint sealant from surfaces adjacent to joints.
2. Use tooling agents that are approved in writing by joint-sealant manufacturer and that do not discolor sealants or adjacent surfaces.

F. Provide joint configuration to comply with joint-sealant manufacturer's written instructions unless otherwise indicated.

3.4 CLEANING

A. Clean off excess joint sealant or sealant smears adjacent to joints as the Work progresses, by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.

3.5 PROTECTION

A. Protect joint sealants, during and after curing period, from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealants immediately and replace with joint sealant so installations in repaired areas are indistinguishable from the original work.

3.6 PAVEMENT-JOINT-SEALANT SCHEDULE

A. Joint-Sealant Application: Joints within cement concrete pavement.

1. Joint Location:

    a. Expansion and isolation joints in cast-in-place concrete pavement.
    b. Contraction joints in cast-in-place concrete slabs.
    c. Other joints as indicated.

2. Silicone Joint Sealant for Concrete: **Single component, self-leveling**.
3. Urethane Joint Sealant for Concrete: **Multicomponent, pourable, traffic-grade**.
4. Hot-Applied Joint Sealant for Concrete: **Single component**.
5. Joint-Sealant Color: **As selected by Architect from manufacturer's full range**.

B. Joint-Sealant Application: Fuel-resistant joints within cement concrete pavement.

1. Joint Location:

    a. Expansion and isolation joints in cast-in-place concrete pavement.
    b. Contraction joints in cast-in-place concrete slabs.
    c. Other joints as indicated.

2. Joint-Sealant Color: **As selected by Architect from manufacturer's full range**.

C. Joint-Sealant Application: Joints between cement concrete and asphalt pavement.

1. Joint Location:

    a. Joints between concrete and asphalt pavement.
    b. Joints between concrete curbs and asphalt pavement.
    c. Other joints as indicated.

2. Hot-Applied Joint Sealant for Concrete and Asphalt: **Single component**
3. Joint-Sealant Color: **As selected by Architect from manufacturer's full range**.

D. Joint-Sealant Application: Fuel-resistant joints between cement concrete and tar-concrete pavement.

1. Joint Location:

   a. Joints between concrete and tar-concrete pavement.
   b. Joints between concrete curbs and tar-concrete pavement.
   c. Other joints as indicated.

2. Hot-Applied, Jet-Fuel-Resistance Joint Sealant for Concrete and Tar Concrete: **Single component**.
3. Joint-Sealant Color: **As selected by Architect from manufacturer's full range**.

END OF SECTION 321373

PAGE INTENTIONALLY BLANK

SECTION 321723 - PAVEMENT MARKINGS

PART 1 – GENERAL

1.1 CONDITIONS AND REQUIREMENTS

A. Refer to the General Conditions, supplementary Conditions, and Division I General Requirements.

1.2 SECTION INCLUDES

A. Paint on pavement for traffic and parking.

1.3 RELATED SECTIONS

A. Section 321216: Asphalt Concrete paving.

1.4 REFERENCES

A. Standards listed below, with their designation in parenthesis, apply where designation is cited in this Section. Where the applicable year of adoption or revision is not listed below, the latest edition applies.

B. Federal Specifications (Fed. Spec.) :
   1. TT-P-110……Paint, Traffic, Black (Non-Reflectorized)
   2. TT-P-115……Paint, Traffic, Highway, White, and Yelllow.

C. Federal Standards 595a.

D. Idaho Standards for Public Works Construction (ISPWC) latest edition.

E. **City of Jerome** Supplemental Specifications and Details.

1.5 SUBMITTALS

A. Submit the following under the provisions of Section 013300.

B. Product data.
   1. Manufacturer's Certification and data for paint.

PART 2 – PRODUCTS

2.1 MATERIALS

A. Paint for Marking Pavement: Fed. Spec. TT-P-115, color as shown.

2.2 EQUIPMENT

A. Paint Applicator: Apply all marking with mechanical equipment able to produce stripes of uniform quality conforming to the specified standards. The striping machine shall comply with CSS 84-3.04. Equipment must be capable of applying the marking widths as indicated. Provide pneumatic spray guns for hand application of paint in areas where a striping machine cannot be used.

PART 3 – EXECUTION

3.1 SURFACE PREPARATION

A. Allow new pavement surfaces to cure for a period of not less than 14 days before application of marking materials.

B. Place all painting equipment and operations under the control of an experienced technician thoroughly familiar with the equipment, materials and marking layouts.

C. Thoroughly clean all surfaces to be marked before application of paint. Remove dust, dirt, and other granular surface deposits by sweeping, blowing with compressed air, rinsing with water or a combination of these methods as required. Completely remove rubber deposits, existing paint markings, and other coatings adhering to the pavement with scrapers, wire brushing, sandblasting, approved chemicals, or mechanical abrasion as directed by the Owner's Representative.

D. Apply pavement markings soon after the surface has been cleaned and dried, but not until the surface has been inspected and permission to proceed is given by the Owner's Representative and the City of Nampa Engineering Department.

E. Establish control points for markings and provide templates to control paint application by type and color, at necessary intervals. Preserve and apply marking in conformance with the control points so established.

3.2 APPLICATION

A. Apply uniformly painted pavement marking of required color(s), length and width with true, sharp edges and ends on properly cured and prepared dried surfaces.

B. Traffic stripes shall conform to the dimensions and details shown on the plans. Alignment of lines shall have a tolerance of plus or minus one inch. The length and width of lines shall have a tolerance of plus or minus two inches and plus or minus one-eighth inch (one-fourth inch on curves), respectively. In the case of broken-line markings, the tolerance for the length of intervals shall not exceed the line length tolerance.

C. Atmospheric temperatures during painting operations shall be above 50 degrees F and rising and less than 95 degrees F.

D. Apply the paint at a wet film thickness of 0.015 inch (15 mils).

E. Apply paint in one coat. At the direction of the Owner's Representative and the **City of Jerome Engineering Department**, markings showing light spots may receive additional coats.

F. Follow the maximum drying time requirements of the paint manufacturer to prevent undue softening of the asphalt and pick-up, displacement, or discoloration of the markings by traffic. If there is a deficiency in drying of the marking, discontinue paint operations until the cause of the slow drying is determined and corrected. Remove and replace marking applied at less than the minimum application rates that deviate from true alignment or exceed stipulated length and width tolerances. Light spots, smears, or other deficiencies or irregularities will not be allowed.

3.3 PROTECTION

A. Conduct operations so that vehicular traffic can move effectively. Provide for safe pedestrian access where required.

B. Protect the newly painted markings so that paint will not be picked up by the tires of passing vehicles. Place warning signs at the beginning of wet lines, and at points well in advance of the marking equipment to alert approaching traffic from both directions.

C. Remove and replace damaged portions of markings at no additional cost to the Owner.

3.4 DETAIL PAVEMENT MARKING

A. Detail Pavement Marking is marking, exclusive of actual traffic lane marking, at parking stalls and at such other locations as shown on the Drawings.

B. Place detail pavement markings of the colors, widths and lengths, at the locations and of the design pattern shown on the Drawings. For additional details, refer to the latest edition of the **I.S.P.W.C. and City of Jerome** Supplemental Specifications and Details.

3.5 FINAL CLEAN-UP

A. Remove all debris, rubbish and excess material from project site.

END OF SECTION 321723

PAGE INTENTIONALLY BLANK

SECTION 321726 - TACTILE WARNING SURFACING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Cast-in-place detectable warning tiles.

B. Related Requirements:

1. Section 321313 "Concrete Paving" for concrete walkways serving as substrates for tactile warning surfacing.
2. Section 321400 "Unit Paving" for unit paving installations incorporating detectable warning unit pavers specified in this Section.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples for Initial Selection: For each type of exposed finish requiring color selection.

C. Samples for Verification: For each type of tactile warning surface, in manufacturer's standard sizes unless otherwise indicated, showing edge condition, truncated-dome pattern, texture, color, and cross section; with fasteners and anchors.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance Data: For tactile warning surfacing, to include in maintenance manuals.

1.5 QUALITY ASSURANCE

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

1. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.6 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at **Project site**.

1.7 PROJECT CONDITIONS

A. Cold-Weather Protection: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen subgrade or setting beds. Remove and replace unit paver work damaged by frost or freezing.

B. Weather Limitations for Adhesive Application:

1. Apply adhesive only when ambient temperature is above 50 deg F (10 deg C) and when temperature has not been below 35 deg F (2 deg C) for 12 hours immediately before application. Do not apply when substrate is wet or contains excess moisture.

C. Weather Limitations for Mortar and Grout:

1. Cold-Weather Requirements: Comply with cold-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.
2. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602. Provide artificial shade and windbreaks, and use cooled materials as required. Do not apply mortar to substrates with temperatures of 100 deg F (38 deg C) and higher.

    a. When ambient temperature exceeds 100 deg F (38 deg C), or when wind velocity exceeds 8 mph (13 km/h) and ambient temperature exceeds 90 deg F (32 deg C), set unit pavers within 1 minute of spreading setting-bed mortar.

1.8 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of tactile warning surfaces that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

    a. Deterioration of finishes beyond normal weathering and wear.
    b. Separation or delamination of materials and components.

2. Warranty Period: **Five** years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 TACTILE WARNING SURFACING, GENERAL

A. Accessibility Requirements: Comply with applicable provisions in **the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines for Buildings and Facilities and ICC A117.1** for tactile warning surfaces.

1. For tactile warning surfaces composed of multiple units, provide units that when installed provide consistent side-to-side and end-to-end dome spacing that complies with requirements.

B. Source Limitations: Obtain each type of tactile warning surfacing **joint material**, **setting material, anchor, and fastener** from single source with resources to provide materials and products of consistent quality in appearance and physical properties.

2.2 DETECTABLE WARNING TILES

A. Cast-in-Place Detectable Warning Tiles: Accessible truncated-dome detectable warning tiles **with replaceable surface** configured for setting flush in new concrete walkway surfaces, with slip-resistant surface treatment on domes and field of tile.
1. Material: **Cast-fiber-reinforced polymer concrete tile** or **Molded glass- and carbon-fiber-reinforced polyester or approved equal**.
2. Color: **As selected by Architect from manufacturer's full line**.
3. Shapes and Sizes:
    a. Rectangular panel, **24 by 24 inches or 24 by 48 inches.**
    b. Radius panel, nominal 24 inches (610 mm) deep by length per plan.
4. Dome Spacing and Configuration: **Manufacturer's standard compliant spacing** pattern.
5. Mounting:
    a. Permanently embedded detectable warning tile wet-set into freshly poured concrete.

B. Cast-in-Place Detectable Warning Metal Tiles: Accessible truncated-dome detectable warning metal tiles configured for setting flush in new concrete walkway surfaces, with slip-resistant surface treatment on domes and field of tile.
1. Material:
    a. Stainless-Steel Plate and Sheet: ASTM A 240/A 240M or ASTM A 666, **Type 304**.
        1) Finish and Color:
            a) Manufacturer's standard powder coat, **color as selected by Architect from manufacturer's full line**.
            b) Mill finish.
    b. Cast Iron: Gray iron, ASTM A 48/A 48M, CL 35.
2. Shapes and Sizes:
    a. Rectangular panel, **24 by 24 inches or 24 by 48 inches.**
    b. Radius panel, nominal 24 inches (610 mm) deep by **outside radius indicated on Drawings**.

3. Dome Spacing and Configuration: **Manufacturer's standard compliant spacing** pattern.
4. Mounting:

    a. Permanently embedded detectable warning tile wet-set into freshly poured concrete.

2.3 ACCESSORIES

A. Fasteners and Anchors: Manufacturer's standard as required for secure anchorage of tactile warning surfaces, noncorrosive and compatible with each material joined, and complying with the following:

1. Furnish stainless-steel fasteners for exterior use.
2. Fastener Heads: For nonstructural connections, use flathead or oval countersunk screws and bolts with tamper-resistant heads, colored to match tile.

B. Adhesive: As recommended by manufacturer for adhering tactile warning surfacing unit to pavement.

C. Sealant: As recommended by manufacturer for sealing perimeter of tactile warning surfacing unit.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that pavement is in suitable condition to begin installation according to manufacturer's written instructions. Verify that installation of tactile warning surfacing will comply with accessibility requirements upon completion.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF TACTILE WARNING SURFACING

A. General: Prepare substrate and install tactile warning surfacing according to manufacturer's written instructions unless otherwise indicated.

B. Place tactile warning surfacing units in dimensions and orientation indicated. Comply with location requirements of AASHTO MP 12.

3.3 INSTALLATION OF DETECTABLE WARNING TILES

A. Cast-in-Place Detectable Warning Tiles:

1. Concrete Paving Installation: Comply with installation requirements in Section 321313 "Concrete Paving." Mix, place, and finish concrete to conditions complying with

detectable warning tile manufacturer's written requirements for satisfactory embedment of tile.

2. Set each detectable warning tile accurately and firmly in place and completely seat tile back and embedments in wet concrete by tamping or vibrating. If necessary, temporarily apply weight to tiles to ensure full contact with concrete.
3. Set surface of tile flush with surrounding concrete and adjacent tiles, with variations between tiles and between concrete and tiles not exceeding plus or minus 1/8 inch (3 mm) from flush.
4. Protect exposed surfaces of installed tiles from contact with wet concrete. Complete finishing of concrete paving surrounding tiles. Remove concrete from tile surfaces.
5. Clean tiles using methods recommended in writing by manufacturer.

3.4 CLEANING AND PROTECTION

A. Remove and replace tactile warning surfacing that is broken or damaged or does not comply with requirements in this Section. Remove in complete sections from joint to joint unless otherwise approved by Architect. Replace using tactile warning surfacing installation methods acceptable to Architect.

B. Protect tactile warning surfacing from damage and maintain free of stains, discoloration, dirt, and other foreign material.

END OF SECTION 321726

PAGE INTENTIONALLY BLANK

SECTION 323113 - CHAIN LINK FENCES AND GATES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Chain-link fences.
2. Swing gates.
3. Horizontal-slide gates.

B. Related Requirements:

1. **Section 033000 "Cast-in-Place Concrete"** for cast-in-place concrete **post footings**.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at the **Project site**.

1. Inspect and discuss electrical roughing-in, equipment bases, and other preparatory work specified elsewhere.
2. Review sequence of operation for each type of gate operator.
3. Review coordination of interlocked equipment specified in this Section and elsewhere.
4. Review required testing, inspecting, and certifying procedures.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for the following:

a. Fence and gate posts, rails, and fittings.
b. Chain-link fabric, reinforcements, and attachments.
c. Gates and hardware.

B. Shop Drawings: For each type of fence and gate assembly.

1. Include plans, elevations, sections, details, and attachments to other work.
2. Include accessories, hardware, gate operation, and operational clearances.

C. Delegated-Design Submittal: For structural performance of chain-link fence and gate frameworks, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.5 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each type of chain-link fence and gate.

B. Product Test Reports: For framework strength according to ASTM F 1043, for tests performed by **a qualified testing agency**.

C. Field quality-control reports.

D. Sample Warranty: For special warranty.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: For testing fence grounding; member company of NETA or an NRTL.

1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

B. Emergency Access Requirements: According to requirements of authorities having jurisdiction for gates with automatic gate operators serving as a required means of access.

1.7 FIELD CONDITIONS

A. Field Measurements: Verify layout information for chain-link fences and gates shown on Drawings in relation to property survey and existing structures. Verify dimensions by field measurements.

1.8 WARRANTY

A. Special Warranty: **Installer agrees** to repair or replace components of chain-link fences and gates that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Failure to comply with performance requirements.
b. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
c. Faulty operation of gate operators and controls.

2. Warranty Period: **Five** years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Structural Performance: Chain-link fence and gate frameworks shall withstand the design wind loads and stresses for fence height(s) and under exposure conditions indicated according to **ASCE/SEI 7**.

1. Design Wind Load: 90 mph.

a. Minimum Post Size: Determine according to ASTM F 1043 for post spacing not to exceed **10 feet** for Material **Group IA, ASTM F 1043, Schedule 40 steel pipe**.
b. Minimum Post Size and Maximum Spacing: Determine according to CLFMI WLG 2445, based on mesh size and pattern specified.

B. Lightning Protection System: Maximum resistance-to-ground value of 25 ohms at each grounding location along fence under normal dry conditions.

2.2 CHAIN-LINK FENCE FABRIC

A. General: Provide fabric in one-piece heights measured between top and bottom of outer edge of selvage knuckle or twist according to "CLFMI Product Manual" and requirements indicated below:

1. Fabric Height:
   a. 6’-0” Perimeter Fence.
2. Steel Wire for Fabric:
   a. Wire Diameter: **0.148 inch (9 gauge)**
   b. Mesh Size:
      1) Perimeter Fence: **2 inches (50 mm)**.
   c. Zinc-Coated Fabric: ASTM A 392, Type II, **Class 1, 1.2 oz./sq. ft. (366 g/sq. m)** with zinc coating applied **before** weaving.
   d. Powder-Coated Fabric: ASTM A 392, Type II, **Class 1, 1.2 oz./sq. ft. (366 g/sq. m)** with powder coating applied **before** weaving.

   e. Coat selvage ends of metallic-coated fabric before the weaving process with manufacturer's standard clear protective coating.

3. Selvage: **Knuckled at both selvages**.

2.3 FENCE FRAMEWORK

A. Posts and Rails: ASTM F 1043 for framework, including rails, braces, and line; terminal; and corner posts. Provide members with minimum dimensions and wall thickness according to ASTM F 1043 based on the following:

1. Fence Height:
   a. **Perimeter Fence: 72 inches**.

2. Light-Industrial-Strength Material: **Group IC-L, round steel pipe, electric-resistance-welded pipe**.

    a. Line Post:
        1) Up to 5’-0” height: **1.9 inches** in diameter.
        2) 5’-0” to 12’-0” height: **2.375 inches** in diameter.
    b. End, Corner, and Pull Posts:
        1) Up to 5’-0” height: **2.375 inches (60 mm** in diameter.
        2) 5’-0” to 12’-0” height: **2.875 inches (73 mm)** in diameter.

3. Heavy-Industrial-Strength Material: **Group IA, round steel pipe, Schedule 40**.

    a. Line Post over 12’-0” height: **4.0 inches (102 mm) in diameter**.
    b. End, Corner, and Pull over 12’-0” height: **4.0 inches (102 mm) in diameter**.

4. Horizontal Framework Members for fence height over 6’-0”: **Intermediate, top, and bottom** rails according to ASTM F 1043.
5. Horizontal Framework Members for fence height of 6’-0” and below: Top rails and bottom tension wire according to ASTM F 1043.

    a. Top Rail: **1.66 inches (42 mm) in diameter**.

6. Brace Rails: ASTM F 1043.
7. Coating for Steel Framework:
    a. Powder coating, color per Architect from manufacturer’s standard colors.
8. Metallic Coating for Steel Framework:

    a. Type A: Not less than minimum 2.0-oz./sq. ft. (0.61-kg/sq. m) average zinc coating according to ASTM A 123/A 123M or 4.0-oz./sq. ft. (1.22-kg/sq. m) zinc coating according to ASTM A 653/A 653M.
    b. Type B: Zinc with organic overcoat, consisting of a minimum of 0.9 oz./sq. ft. (0.27 kg/sq. m) of zinc after welding, a chromate conversion coating, and a clear, verifiable polymer film.
    c. External, Type B: Zinc with organic overcoat, consisting of a minimum of 0.9 oz./sq. ft. (0.27 kg/sq. m) of zinc after welding, a chromate conversion coating, and a clear, verifiable polymer film. Internal, Type D, consisting of 81 percent, not less than 0.3-mil- (0.0076-mm-) thick, zinc-pigmented coating.
    d. Type C: Zn-5-Al-MM alloy, consisting of not less than 1.8-oz./sq. ft. (0.55-kg/sq. m) coating.
    e. Coatings: Any coating above.

2.4 TENSION WIRE

A. Powder-Coated Steel Wire: 0.177-inch- (4.5-mm-) diameter, marcelled tension wire according to ASTM A 817 or ASTM A 824.
    a. Class 4: Not less than 1.2 oz./sq. ft. (366 g/sq. m) of uncoated wire surface.

B. Metallic-Coated Steel Wire: 0.177-inch- (4.5-mm-) diameter, marcelled tension wire according to ASTM A 817 or ASTM A 824, with the following metallic coating:

1. Type II: Zinc coated (galvanized) by **hot-dip** process, with the following minimum coating weight:
    a. Class 4: Not less than 1.2 oz./sq. ft. (366 g/sq. m) of uncoated wire surface.

2.5 SWING GATES

A. General: ASTM F 900 for gate posts and **single** and **double** swing gate types.

1. Gate Leaf Width: **As indicated** on plans.
2. Framework Member Sizes and Strength: Based on gate fabric height **of 72 inches (1830 mm) or less**.

B. Pipe and Tubing:

1. Powder Coated Steel: ASTM F 1043 and ASTM F 1083; **finish to match fence framework**.
2. Gate Posts: **Round tubular steel**.
3. Gate Frames and Bracing: **Round tubular steel**.

C. Frame Corner Construction: **assembled with corner fittings**.

D. Hardware:

1. Hinges: **360-degree inward and outward** swing.
2. Latch: Permitting operation from both sides of gate **with provision for padlocking accessible from both sides of gate**.
3. Lock: **Manufacturer's standard** internal device.
4. Closer: **Manufacturer's standard**.

E. Pipe and Tubing:

1. Powder-Coated Steel: **Protective coating and finish to match fence framework**.

2. Zinc-Coated Steel: **Protective coating and finish to match fence framework**.
3. Gate Posts: ASTM F 1184. Provide **round tubular steel** posts.
4. Gate Frames and Bracing: **Round tubular steel**.

F. Frame Corner Construction: **assembled with corner fittings**.

G. Hardware:

1. Hangers, Roller Assemblies, and Stops: Fabricated from **powder coated steel** or **galvanized steel location per plan**.
2. Latch: Permitting operation from both sides of gate **with provision for padlocking accessible from both sides of gate**.
3. Lock: **Manufacturer's standard** internal device allow for future card reader control assembly.

2.6 HORIZONTAL SLIDE GATES

A. General: ASTM F 900 for gate posts and **single** and **double** horizontal slide gate types.

1. Gate Leaf Width: **As indicated** on plans.
2. Framework Member Sizes and Strength: Based on gate fabric height **of 72 inches (1830 mm) or less**.

B. Pipe and Tubing:

1. Powder Coated Steel: ASTM F 1043 and ASTM F 1083; **finish to match fence framework**.
2. Gate Posts: **Round tubular steel**.
3. Gate Frames and Bracing: **Round tubular steel**.

C. Frame Corner Construction: **assembled with corner fittings**.

D. Hardware:
1. Latch: Permitting operation from both sides of gate **with provision for padlocking accessible from both sides of gate**.
2. Lock: **Manufacturer's standard** internal device.
3. Closer: **Manufacturer's standard**.

E. Pipe and Tubing:

1. Powder-Coated Steel: **Protective coating and finish to match fence framework**.

2. Zinc-Coated Steel: **Protective coating and finish to match fence framework**.
3. Gate Posts: ASTM F 1184. Provide **round tubular steel** posts.
4. Gate Frames and Bracing: **Round tubular steel**.

F. Frame Corner Construction: **assembled with corner fittings**.

G. Hardware:

1. Hangers, Roller Assemblies, and Stops: Fabricated from **powder coated steel** or **galvanized steel finish location per plan**.
2. Latch: Permitting operation from both sides of gate **with provision for padlocking accessible from both sides of gate**.
3. Lock: **Manufacturer's standard** internal device allow for future card reader control assembly.

2.7 FITTINGS

A. Provide fittings according to ASTM F 626.

B. Post Caps: Provide for each post.

1. Provide line post caps with loop to receive tension wire or top rail.

C. Rail and Brace Ends: For each gate, corner, pull, and end post.

D. Rail Fittings: Provide the following:

1. Top Rail Sleeves: **Pressed-steel or round-steel tubing** not less than 6 inches (152 mm) long.
2. Rail Clamps: Line and corner boulevard clamps for connecting **intermediate and bottom** rails to posts.

E. Tension and Brace Bands: **Pressed steel**.

F. Tension Bars: **Steel** length not less than 2 inches (50 mm) shorter than full height of chain-link fabric. Provide one bar for each gate and end post, and two for each corner and pull post, unless fabric is integrally woven into post.

G. Truss Rod Assemblies: **Steel, powder coated or Steel, hot-dip galvanized (location per plan) after threading** rod and turnbuckle or other means of adjustment.

H. Tie Wires, Clips, and Fasteners: According to ASTM F 626.

1. Standard Round Wire Ties: For attaching chain-link fabric to posts, rails, and frames, according to the following:

a. Powder coated Steel: **0.148-inch (11 gauge)** diameter wire**; powder coating thickness matching coating thickness of chain-link fence fabric**.

b. Hot-Dip Galvanized Steel: **0.148-inch (11 gauge)** diameter wire**; galvanized coating thickness matching coating thickness of chain-link fence fabric**.

I. Finish (location per plans):

1. Powder Coating for Pressed Steel or Cast Iron: Not less than 1.2 oz./sq. ft.

2. Metallic Coating for Pressed Steel or Cast Iron: Not less than 1.2 oz./sq. ft. (366 g/sq. m) of zinc.

2.8 GROUT AND ANCHORING CEMENT

A. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107/C 1107M. Provide grout, recommended in writing by manufacturer, for exterior applications.

B. Anchoring Cement: Factory-packaged, nonshrink, nonstaining, hydraulic-controlled expansion cement formulation for mixing with water at Project site to create pourable anchoring, patching, and grouting compound. Provide formulation that is resistant to erosion from water exposure without needing protection by a sealer or waterproof coating, and that is recommended in writing by manufacturer for exterior applications.

2.9 GROUNDING MATERIALS

A. Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

B. Connectors and Grounding Rods: Listed and labeled for complying with UL 467.

1. Connectors for Below-Grade Use: Exothermic welded type.
2. Grounding Rods: Copper-clad steel, 5/8 by 96 inches (16 by 2440 mm).

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for **a certified survey of property lines, legal boundaries, and irrigation ditch easements,** site clearing, earthwork, pavement work, and other conditions affecting performance of the Work. Contractor shall be responsible to provide recorded documents of all property lines, legal boundaries, and easements to establish and verify fencing locations prior to any fencing installation. Contact Architect immediately if encroachment or discrepancies exist between any legal boundaries and fencing locations.

1. Do not begin installation before final grading is completed unless otherwise permitted by Architect.
2. Do not begin installation before boundary and easement work is completed.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Stake locations of fence lines, gates, and terminal posts. Do not exceed intervals of 500 feet (152 m) or line of sight between stakes. Indicate locations of utilities, lawn sprinkler system, underground structures, benchmarks, and property monuments.

3.3 CHAIN-LINK FENCE INSTALLATION

A. Install chain-link fencing according to ASTM F 567 and more stringent requirements specified.

1. Install fencing on established boundary lines inside property line.

B. Post Excavation: Drill or hand-excavate holes for posts to diameters and spacings indicated, in firm, undisturbed soil.

C. Post Setting: Set posts **in concrete** at indicated spacing into firm, undisturbed soil.

1. Verify that posts are set plumb, aligned, and at correct height and spacing, and hold in position during setting with concrete or mechanical devices.
2. Concrete Fill: Place concrete around posts to dimensions indicated and vibrate or tamp for consolidation. Protect aboveground portion of posts from concrete splatter.

a. Exposed Concrete: Extend 2 inches (50 mm) above grade; shape and smooth to shed water.

b. Concealed Concrete: Place top of concrete **2 inches (50 mm)** below grade to allow covering with surface material.

D. Terminal Posts: Install terminal end, corner, and gate posts according to ASTM F 567 and terminal pull posts at changes in horizontal or vertical alignment of **15 degrees or more**. For runs exceeding 500 feet (152 m), space pull posts an equal distance between corner or end posts.

E. Line Posts: Space line posts uniformly at **10 feet (3 m)** o.c.

F. Post Bracing and Intermediate Rails: Install according to ASTM F 567, maintaining plumb position and alignment of fence posts. Diagonally brace terminal posts to adjacent line posts with truss rods and turnbuckles. Install braces at end and gate posts and at both sides of corner and pull posts.

1. Locate horizontal braces at midheight of fabric 72 inches (1830 mm) or higher, on fences with top rail, and at two-third fabric height on fences without top rail. Install so posts are plumb when diagonal rod is under proper tension.

G. Tension Wire: Install according to ASTM F 567, maintaining plumb position and alignment of fence posts. Pull wire taut, without sags. Fasten fabric to tension wire with 0.120-inch- (3.05-mm-) diameter hog rings of same material and finish as fabric wire, spaced a maximum of 24 inches (610 mm) o.c. Install tension wire in locations indicated before stretching fabric. Provide horizontal tension wire at the following locations:

H. Top Rail: Install according to ASTM F 567, maintaining plumb position and alignment of fence posts. Run rail continuously through line post caps, bending to radius for curved runs and terminating into rail end attached to posts or post caps fabricated to receive rail at terminal posts. Provide expansion couplings as recommended in writing by fencing manufacturer.

I. Intermediate and Bottom Rails: Secure to posts with fittings.

J. Chain-Link Fabric: Apply fabric to **outside** of enclosing framework. Leave **1-inch (25-mm)** bottom clearance between finish grade or surface and bottom selvage unless otherwise indicated. Pull fabric taut and tie to posts, rails, and tension wires. Anchor to framework so fabric remains under tension after pulling force is released.

K. Tension or Stretcher Bars: Thread through fabric and secure to end, corner, pull, and gate posts, with tension bands spaced not more than 15 inches (380 mm) o.c.

L. Tie Wires: Use wire of proper length to firmly secure fabric to line posts and rails. Attach wire at one end to chain-link fabric, wrap wire around post a minimum of 180 degrees, and attach other end to chain-link fabric according to ASTM F 626. Bend ends of wire to minimize hazard to individuals and clothing.

1. Maximum Spacing: Tie fabric to line posts at 12 inches (300 mm) o.c. and to braces at 24 inches (610 mm) o.c.

M. Fasteners: Install nuts for tension bands and carriage bolts on the side of fence opposite the fabric side. **Peen ends of bolts or score threads to prevent removal of nuts.**

3.4 GATE INSTALLATION

A. Install gates according to manufacturer's written instructions, level, plumb, and secure for full opening without interference. Attach fabric as for fencing. Attach hardware using tamper-resistant or concealed means. Install ground-set items in concrete for anchorage. Adjust hardware for smooth operation.

3.5 GATE-OPERATOR INSTALLATION

A. Install gate operators according to manufacturer's written instructions, aligned and true to fence line and grade.

B. Excavation: Hand-excavate holes for posts, pedestals, and equipment bases/pads, in firm, undisturbed soil to dimensions and depths and at locations according to gate-operator component manufacturer's written instructions and as indicated.

3.6 GROUNDING AND BONDING

A. Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

B. Fence, and Gate Grounding:

1. Ground for fence and fence posts shall be a separate system from ground for gate and gate posts.
2. Install ground rods and connections at maximum intervals of **1500 feet (450 m)**]. If less than 1500 feet distance provide a minimum of one grounding rod.
3. Fences within 100 Feet (30 m) of Buildings, Structures, Walkways, and Roadways: Ground at maximum intervals of **750 feet (225 m)**.
4. Ground fence on each side of gates and other fence openings.

    a. Bond metal gates to gate posts.
    b. Bond across openings, with and without gates, except openings indicated as intentional fence discontinuities. Use No. 2 AWG wire and bury it at least 18 inches (457 mm) below finished grade.

C. Protection at Crossings of Overhead Electrical Power Lines: Ground fence at location of crossing and at a ground rod located a maximum distance of 150 feet (45 m) on each side of crossing.

D. Fences Enclosing Electrical Power Distribution Equipment: Ground according to IEEE C2 unless otherwise indicated.

E. Grounding Method: At each grounding location, drive a grounding rod vertically until the top is 6 inches (152 mm) below finished grade. Connect rod to fence with No. 6 AWG conductor. Connect conductor to each fence component at grounding location.

F. Connections:

1. Make connections with clean, bare metal at points of contact.
2. Make aluminum-to-steel connections with stainless-steel separators and mechanical clamps.

3. Make aluminum-to-galvanized-steel connections with tin-plated copper jumpers and mechanical clamps.
4. Make above-grade ground connections with mechanical fasteners.
5. Make below-grade ground connections with exothermic welds.
6. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

G. Bonding to Lightning Protection System: Ground fence and bond fence grounding conductor to lightning protection down conductor or lightning protection grounding conductor according to NFPA 780.

H. Comply with requirements in Section 264113 "Lightning Protection for Structures."

3.7 FIELD QUALITY CONTROL

A. Testing Agency: **Engage** a qualified testing agency to perform tests.

B. Grounding Tests: Comply with requirements in Section 264113 "Lightning Protection for Structures."

C. Prepare test reports.

3.8 ADJUSTING

A. Gates: Adjust gates to operate smoothly, easily, and quietly, free of binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, or malfunction, throughout entire operational range. Confirm that latches and locks engage accurately and securely without forcing or binding.

B. Lubricate hardware and other moving parts.

3.9 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain chain-link fences and gates.

END OF SECTION 323113

PAGE INTENTIONALLY BLANK

SECTION 323119 - ARCHITECTURAL METAL PRIVACY FENCES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Light gauge metal-framed, prefinished metal-panel privacy fencing, located at loading area.

B. Exclusions: Vehicle gates are by others. Coordinate locations and positions of fence terminal posts with gate posts by others.

C. Related Requirements:

1. Section 033000 “Cast-in-Place Concrete" for concrete post footing material requirements.

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. Shop Drawings and Installation Instructions: Include plans, elevations, sections, details, and attachments to other work. Provide complete assembly instructions for assembly of fence frame and attachment of metal panels.

C. Samples: For each fence material and for each color specified.

1. Provide Samples 12 inches (300 mm) in length by width of panel.

1.5 INFORMATIONAL SUBMITTALS

A. Color chart indicting full range of metal panel pre-finish colors.

B. Concrete post footing size requirements.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: Graffiti removal recommendations.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: Trained and approved by fabricator of products.

B. Mockup: Build mockup to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for fabrication and installation.

1. Include 10-foot (3-m) length of fence complying with requirements.
2. Subject to compliance with requirements, approved mockup may become part of the completed Work.

C. Documentation indicating that fence system has been tested and is able to withstand up to 95 mph. wind loading.

1.8 EXTRA MATERIALS

A. Provide to Owner extra metal panels equivalent to 3 percent of each panel type installed, and extra framing components equivalent to 2 percent of each framing component type installed.

PART 2 - PRODUCTS

2.1 ARCHITECTURAL METAL PRIVACY FENCING

A. Integrated, light gauge metal-framed, prefinished metal-panel, privacy fencing system.

1. Manufacturer: Berridge Manufacturing Company.

B. Posts: Rectangular channels 2-1/2 by 3-1/2 inches formed from 16 gauge galvanized steel.

C. Track: 1-9/16 by 3-9/16 inches formed from 24 gauge galvanized steel.

D. Studs (Rails):

1. 3-1/2 by 1-1/2 inches formed from 24 gauge galvanized formed steel.

E. Blocking: 3-1/2 by 24 inch lengths formed from 24 gauge galvanized steel.

F. Cap Flashing: Gable-shaped 24 gauge steel cap, pre-finished to match fence panels.

G. Fasteners: Manufacturer's standard corrosion-resistant, color-coated fasteners matching fence components.

H. Metallic-Coated Steel Sheet: 22 gauge galvanized-steel sheet with Kynar 500 finish.

1. Panel Type B: Berridge HR-16; 22 gauge, 7/8”, smooth fluted panels, for concealed fasteners.

I. Finish / Color: Kynar 500 finish. Color to be selected by Architect from manufacturer’s full range of standard colors.

J. Height: 8’-0” refer to Drawings for locations.

2.2 MISCELLANEOUS MATERIALS

A. Concrete: Normal-weight, air-entrained, ready-mix concrete complying with requirements in Section 033000 "Cast-in-Place Concrete" with a minimum 28-day compressive strength of 3000 psi (20 MPa), 4-inch (75-mm) slump, and 3/4-inch (25-mm) maximum aggregate size.

2.3 GROUNDING MATERIALS

A. Grounding Conductors: Bare, solid wire for No. 6 AWG and smaller; stranded wire for No. 4 AWG and larger.

1. Material above Finished Grade: Copper.
2. Material on or below Finished Grade: Copper.
3. Bonding Jumpers: Braided copper tape, 1 inch (25 mm) wide, woven of No. 30 AWG bare copper wire, terminated with copper ferrules.

B. Grounding Connectors and Grounding Rods: Comply with UL 467.

1. Connectors for Below-Grade Use: Exothermic-welded type.
2. Grounding Rods: Copper-clad steel.

a. Size: 5/8 by 96 inches (16 by 2440 mm).

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for site clearing, earthwork, pavement work, construction layout, and other conditions affecting performance of the Work.

B. Do not begin installation before final grading is completed unless otherwise permitted by Architect.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Stake locations of fence lines, terminal posts, and gates by others. Do not exceed intervals of 500 feet (152.5 m) or line of sight between stakes. Indicate locations of utilities, lawn sprinkler system, underground structures, benchmarks, and property monuments.

3.3 DECORATIVE FENCE INSTALLATION

A. Install fences according to manufacturer's written instructions.

B. Install fences by setting posts as indicated and assembling metal framework between posts.

C. Post Hole Excavation: Drill or hand-excavate holes for posts in firm, undisturbed soil. Excavate holes to a diameter of not less than 4 times post size and a depth of not less than 36 inches (600 mm) or as recommended by manufacturer for project specific conditions.

D. Post Setting: Set posts in concrete at indicated spacing into firm, undisturbed soil.

1. Verify that posts are set plumb, aligned, and at correct height and spacing, and hold in position during setting with concrete or mechanical devices.
2. Concrete Fill: Place concrete around posts and vibrate or tamp for consolidation. Protect aboveground portion of posts from concrete splatter.

    a. Exposed Concrete: Extend 1 inch above grade. Finish and slope top surface to drain water away from post.

3. Posts Set in Concrete: Extend post to within 6 inches (150 mm) of specified excavation depth, but not closer than 3 inches (75 mm) to bottom of concrete.

3.4 GROUNDING AND BONDING

A. Fence Grounding: Install at maximum intervals of 1500 feet (450 m).

1. Fences within 100 Feet (30 m) of Buildings, Structures, Walkways, and Roadways: Ground at maximum intervals of 750 feet (225 m)

B. Grounding Method: At each grounding location, drive a grounding rod vertically until the top is 6 inches (150 mm) below finished grade. Connect rod to fence with No. 6 AWG conductor. Connect conductor to each fence component at grounding location.

C. Connections: Make connections so possibility of galvanic action or electrolysis is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact are galvanically compatible.

1. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer in order of galvanic series.
2. Make connections with clean, bare metal at points of contact.
3. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

D. Bonding to Lightning-Protection System: If fence terminates at lightning-protected building or structure, ground the fence and bond the fence grounding conductor to lightning-protection down conductor or lightning-protection grounding conductor, complying with NFPA 780.

3.5 FENCE ASSEMBLY

A. Assemble fence framework per approved shop drawings and manufacturer's written instructions.

B. Install metal panels on both sides of framework with specified fasteners in concealed fashion. Install specified metal fence cap and end trim.

C. Clean metal panels of dirt, grime, fingerprints, etc. upon completion of installation.

END OF SECTION 323119

PAGE INTENTIONALLY BLANK

SECTION 323150 - SITE SIGNAGE

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 the following:
   1. Traffic control signage. Signs shall be constructed of aluminum sheeting and shall be reflectorized.
   2. Signage furnished and installed per drawings and in accordance with the current edition of the Manual for Uniform Traffic Control Design (MUTCD).

1.3 SUBMITTALS

A. See Section 013300 – Project Management and Coordination for submittal procedures.

B. Product Data: Provide Manufacturer's (catalog) product information.

C. Provide Shop drawings for review and approval which indicate graphic features and font style and size of signage and location where signage is to be installed.

1.4 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than three years of documented experience.

B. Installer Qualifications: Company specializing in performing the work of this section with a minimum of three (3) years experience.

1.5 PROJECT CONDITIONS

A. Coordinate sign installation with size, location and installation of service utilities.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Best Sign Systems

B. ASI Sign Systems Inc.

C. Charleston Industries, Inc.

D. Substitutions under provisions of Section 016000.

2.2 MATERIALS

A. Sheet aluminum shall be 6060-T6 Alloy, .080" thick.

B. Reflective sign facing shall consist of spherical lens elements either embedded within a transparent plastic or adhered to a synthetic resin and encapsulated by a transparent plastic.

C. Post shall be perforated 2" x 2" galvanized steel post, square section. Provide caps where detailed.

D. Signs and posts shall be assembled with 5/16" x 3-1/4" galvanized machine screws and 1" O.D. nylon washers, locknuts with nylon inserts, two screws per sign.

E. Galvanized steel sign post sockets shall be provided which fit the sign post profile and permit replacement of damaged sign posts.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that the finish grade level has been determined for signage location prior to installation.

3.2 INSTALLATION

A. Traffic sign post sockets shall have 3'-0" embedded below the finish site grade.
   1. Sign post sockets shall be cast into Portland cement concrete, the surface finished to form a 12" diameter cap that directs water away from the post, post sockets installed in Portland cement concrete paving areas shall be installed with similar detail created during concrete placement and finishing.

B. Install sign posts plumb, signs level. Make corrections if required at direction of Landscape Architect.

3.3 ERECTION TOLERANCES

A. Maximum Variation from Plumb: ¼".

END OF SECTION 323150

SECTION 323300 - SITE FURNISHINGS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Trash Receptacles.
B. Hand Rail Skate Stopper.
C. Bicycle Racks.
D. Tree Grates.

1.2 REFERENCES

A. ASTM A 53/A 53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless; 2000.
B. ASTM A 283/A 283M - Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates; 2000.
C. ASTM A 325 - Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength; 2000.
D. ASTM A 325M - Standard Specification for High-Strength Bolts for Structural Steel Joints (Metric); 2000.
E. AWS D1.1 - Structural Welding Code - Steel; American Welding Society; 2000.

1.3 SUBMITTALS

A. Submit under provisions of Division 1.
B. Product Data: Manufacturer's data sheets on each product specified, including detailed installation diagrams and recommended installation methods.
C. Selection Samples: For each product specified, two complete sets of chips representing manufacturer's full range of colors and finishes.

1.4 QUALITY ASSURANCE

A. Furnish paint for touch-up as required
B. Install pre-manufactured items, poured-in-place or pre-cast items, and all related materials required to complete the work indicated on the drawings and/or specified.
C. Substitutions: The intent of these specifications is to describe pre-manufactured items of minimum acceptability with regard to materials, construction, size, configuration, and finish. Substitutions will be accepted under provisions and shall be compatible with overall design theme.
D. Materials Inspection: The Contractor shall inspect all items upon delivery to ensure no damage to material or finish. Minor repairs and/or touch up shall be accepted only upon prior authorization form the Architect and shall conform, at minimum, to manufacturer's standard.

PART 2 - PRODUCTS

2.1 MANUFACTURERS- NOT USED

2.2 MATERIALS

A. Steel Structural Supports:
   1. Steel Plate: ASTM A 283/A 283M.
   2. Steel Pipe: ASTM A 53, Grade B Schedule 40, hot-dip galvanized finish.
   3. Bolts, Nuts, and Washers: ASTM A 325 (ASTM A 325M).
B. Welding Materials: AWS D1.1; type required for materials being welded.

2.3 SITE FURNISHINGS

A. Trash Receptacles:
32 Gallon Perforated steel receptacle by DuMor, Inc., or approved equal. Install with flat lid option. Model no. 170-32 http://dumor.com/ . Quantity: One. Color: By Architect.

B. Handrail Skate Stopper:
HR series, cast aluminum with clear anodized coating. Spacing is generally symmetric to vertical post at approximately 30”centers or approved equal. http://www.skatestoppers.com/

C. Bicycle Racks:
Single loop bike rack by DuMor, Inc., or approved equal. Model number 83-00/S-1, embed mounted, powder coated http://dumor.com/. Quantity: Four. Color: By Architect.

D. Tree Grates:
Per City of Jerome Streetscape Standards grates will be a natural raw iron finish and shall be ADA compliant. The grates shall be Urban Accessories “Kiva”, square, and a minimum of 5’ x 5’. Quantity: Five.

2.4 FABRICATION

A. Shop assemble site furnishings for delivery to site in units easily handled and to permit shipment without disassembly.

2.5 ACCESSORIES

A. Provide all anchorage devices and materials required for complete installation.

PART 3 -EXECUTION

3.1 EXAMINATION

A. Do not begin installation until substrates have been properly prepared.
B. If substrate preparation is the responsibility of another installer, notify Landscape Architect of unsatisfactory preparation before proceeding.

3.2 INSTALLATION

A. Install in accordance with manufacturer's instructions.

3.3 ADJUSTING

A. Upon completion of the installation of site furnishings, check each items and verify that all equipment is properly installed; verify that all trim is in place; adjust all components as necessary to ensure proper operation; remove all labels from equipment.

B. Make necessary adjustments for safe, efficient and smooth operation.

3.4 CLEANING

A. Remove all packing materials from job site.
B. Clean or restore marred surfaces.

3.5 PROTECTION

A. Protect installed products until completion of project.
B. Touch-up, repair or replace damaged products after Substantial Completion.

END OF SECTION 323300

PAGE INTENTIONALLY BLANK

SECTION 328400 - LANDSCAPE IRRIGATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes
   1. Pipe and fittings, valves, sprinkler heads, accessories, and connections to water source.
   2. Control system.
B. System Description
   1. Electric solenoid controlled automatic underground irrigation system.
C. Related Sections
   1. Division 16 Sections for electrical power materials and installations.

1.2 DEFINITIONS

A. Pipe sizes used in this Section are nominal pipe size (NPS) in inches. Tube sizes are Standard size in inches.
B. Pressure Piping Main Line: Piping downstream from supply piping to and including control valves. Piping is under irrigation system pressure. Piping in this category includes backflow preventers.
C. Circuit Piping Lateral Lines: Piping downstream from control valves to irrigation system sprinklers. Piping is under pressure (less than pressure piping) during flow.
D. Control Valve: Automatic (electrically operated) valve for control water flow to irrigation system zone.

1.3 SYSTEM PERFORMANCE REQUIREMENTS

A. Location of Sprinklers and Devices: Design location is approximate. Make minor adjustments necessary to avoid plantings and obstructions such as signs and light standards.
B. Minimum Water Coverage: Not less than:
   1. Turf Areas: 100 percent.
   2. Other Planting Areas: 100 percent.
C. All flow velocities, within the entire irrigation system, shall not exceed 5 feet per second.

1.4 SUBMITTALS

A. Product data including pressure rating, rated capacity, settings, and electrical data of selected models for the following:
   1. Backflow preventers, including test equipment.
   2. Valves, including general-duty, underground, automatic control, and quick-coupler types, isolation and valve boxes.
   3. Sprinklers.
   4. Irrigation Controller, including controller wiring diagrams.
   5. Wiring.
   6. Irrigation system record drawings.
   7. Pipe fittings.

B. Wiring diagrams for electrical controllers, valves, and devices. Valve numbers shall reflect station numbers within the controller and shall be noted on the as-builts.

C. Maintenance data for inclusion in "Operating and Maintenance Manual" specified in Division 1 Section "Contract Closeout" for the following:

1. Seasonal activities of start-up, shut-down and winterization, including blow-out operation of sprinkler system with compressed air.
2. Backflow preventers, including instructions for testing.
3. Automatic control valves.
4. Sprinklers.
5. Controllers.
6. Irrigation system record drawings.

1.5 QUALITY ASSURANCE

A. Comply with requirements of utility supplying water for prevention of backflow and backsiphonage. Comply with appropriated water rights.

B. Installer Qualifications: **(To be provided at time of bid opening):** Engage an experienced Installer with a minimum of five years experience and who has completed irrigation systems similar in material, design, and extent to that indicated for Projects that have resulted in construction with a record of successful in-service performance.

1. Professional Membership: Installer shall be a member in good standing of the Irrigation Association.
2. Experience: Company specializing in performing the work of this section with minimum five (5) years of documented experience and experience in the installation of a minimum of three (3) projects of similar nature and scope in addition to requirements in Division 01 Section "Quality Requirements.". The installer shall have at least one supervisor responsible for the project who is a Certified Irrigation Contractor as recognized by the Irrigation Association. The installer may be asked to provide references for verification of experience and quality of service.
3. Installer's Field Supervision: Require Installer to maintain an experienced full-time English speaking supervisor on the Project site when irrigation work is in progress.
4. Personnel Certifications: Installer's field supervisor shall have certification in one of the following categories from the Irrigation Association:
   a. Certified Irrigation Technician.
   b. Certified Landscape Irrigation Auditor.
   c. Certified Irrigation Contractor.
   d. Certified Irrigation Water Manager.

C. Listing/Approval Stamp, Label, or Other Marking: On equipment, specialties, and accessories made to specified standards.

D. Listing and Labeling: Equipment, specialties, and accessories that are listed and labeled.
1. The Terms "Listed" and "Labeled": As defined in "National Electrical Code," Article 100.
2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" (NRTL) as defined in OSHA Regulation 1910.7.

E. Product Options: Irrigation system piping, specialties, and accessories are based on specific types, manufacturers, and models indicated. Components with equal performance characteristics produced by other manufacturers may be considered, provided deviations in dimensions, operation, and other characteristics do not change design concept or intended performance as judged by the Landscape Architect. The burden of proof of product equality is on the Contractor. Any substitutions must be approved by the Architect in writing prior to installation per section 1.10.

1.6 PROJECT CONDITIONS

A. Perform site survey, research public utility records, and verify existing utility locations. Verify that irrigation system piping may be installed in compliance with original design and referenced standards. Verify that pump and domestic supply perform as specified.

1.7 SEQUENCING AND SCHEDULING

A. Maintain uninterrupted water service to building during normal working hours. Arrange for temporary water shutoff with Owner.
B. Maintain Uninterrupted existing irrigation system during construction. Arrange for temporary water shutoff with owner. Provide alternate water source for irrigation if water is to be shut off for more than three (3) days.
C. Coordinate irrigation systems work with landscape work specified in “Plants” Section ".

1.8 EXTRA MATERIALS

A. Deliver extra materials to Owner. Furnish extra materials matching products installed as described below. Package them with protective covering for storage and label clearly describing contents.
   1. Quick Couplers: Furnish quantity of units equal to 2 percent of amount of each size installed.
   2. Sprinklers: Furnish quantity of units equal to 5 percent of amount of each type installed.
   3. Valve Keys: Furnish quantity of tee-handle units equal to 2 percent of amount of each type key-operated, control valve installed.
   4. Quick-Coupler Hose Swivels: Furnish one for each quick coupler installed.
   5. Quick-Coupler Operating Keys: Furnish one for each quick coupler installed.

1.9 IRRIGATION RECORD DRAWINGS

A. Record accurately, on one set of black and white prints of the site plan **(to be on site at all times during installation),** all installed work including both pressure and non-pressure lines and pipe sizes.
B. Upon completion of each increment of work, transfer all such information and dimensions to the print. The dimensions shall be recorded in a legible and workmanlike manner. Maintain as-built drawings on site at all times. Make all notes on drawing in pencil (no ball point pen). When the work has been completed, transfer all information from the field record print to a set of reproducible drawings.
C. Dimension from two permanent points of reference (buildings, monuments, sidewalks, curbs, pavements, etc.). Locations shown on as-built drawings shall be kept day to day as the project is being installed. All dimension text noted on drawings shall be 1/8 inch in size (minimum).
D. Show locations and depths of the following items:
   1. Point of connection, including Flow Sensor Assembly
   2. Routing of sprinkler pressure lines
   3. Gate valves
   4. Sprinkler control valves
   5. Quick coupling valves
   6. Routing of control wires, including Flow Sensor Assembly wires
   7. Sprinkler heads
   8. Other related equipment

1.10 SUBSTITUTIONS

A. Coordinate substitutions per Division One.
B. Substitutions to the specified equipment will be permitted with the express written approval of the Landscape Architect. Substitutions will be approved only when the substituted item is equivalent or better in quality and performance than the item originally specified. The final determination for "equivalents" rests with the Landscape Architect. Their decision shall be final and binding.

1.11 WARRANTY

A. Warranty system against defects of installation and material for a period of 1 year after final completion of the irrigation system. Guarantee shall also cover repair or damage to any part of the premises resulting from leaks or other defects in material, equipment and workmanship to the satisfaction of the Architect. Repairs, if required, shall be done promptly upon notification by the Owner, and, at no cost to the Owner.
B. As part of the warranty, the Contractor shall be responsible for deactivating and winterizing the system prior to the onset of the freezing season and for reactivating the system at the onset of the spring growing season; each event must be accomplished once during the warranty period. In the event the system is completed in a season when it will not be in use, the Contractor shall winterize the system upon completion of testing (and approval by the Landscape Architect) and reactivate the system in the spring. The Contractor shall SUBMIT a letter to the Landscape Architect certifying that the system was winterized and drained and indicate the date such action was accomplished. The Contractor shall be responsible for any damage resulting from failure to comply. Contractor shall instruct and demonstrate winterization and startup techniques for Owner.

PART 2 - PRODUCTS

2.1 SUMMARY

A. All materials used throughout the system shall be new, unused, and in perfect condition. Refer to the irrigation materials legend, notes, detail drawings and these specifications for specific equipment to be used. Equipment or materials installed or furnished without prior approval of the Architect may be rejected and the Contractor required to remove such materials from the site at his own expense.
B. Substitutions: Under provisions of Division 1 and 328400, paragraph 1.10.

2.2 BRASS PIPE AND ACCESSORIES

A. Pipe: ASTM B43, Schedule 40; domestic manufacture
B. Fittings: Medium brass, screwed, 125-pound class.

2.3 PLASTIC PIPE AND ACCESSORIES

A. Pipe
   1. Pipe walls shall be uniform, smooth, glossy, and free of interior or exterior extrusion marks; pre-belled or straight to receive solvent-weld couplings; 20 foot standard lengths.
   2. Pipe shall be marked with manufacturer's name, class of pipe, NSF seal, and date/shift of manufacturing run.
   3. PVC Pipe: ASTM D1785, D2241
B. Fittings: PVC - ASTM D2464, D2466.

C. Irrigation System Plastic Pipe
   1. Mainline: 3-inch pipe and larger: PVC class 200 with SDR21 rubber gasket fittings. 2 ½ inch pipe and smaller: PVC schedule 40 pipe with SDR21 solvent weld fittings.
   2. Laterals: 3-inch pipe and larger: PVC class 200 with SDR21 rubber gasket fittings. 2 ½ inch pipe and smaller: PVC schedule 40 pipe with SDR21 solvent weld fittings.
   3. Sleeving: ASTM D 1785, schedule 40, polyvinyl chloride (PVC) plastic pipe; ASTM D 2466, Schedule 40, PVC plastic, socket-type fittings; and solvent-cemented joints.
   4. Refer to Part 3 Article "Piping Applications" for identification of systems where pipe and tube materials specified below are used.
   5. Polyvinyl Chloride (PVC) Plastic Pipe: ASTM D 1785; PVC 1120, SDR 21, 200 psig (1380 kPa) minimum pressure rating, with plain ends. Schedule 40 upstream from controls, as noted on the drawings; schedule 40 downstream.

D. Pipe and Tube Fittings
   1. Refer to Part 3 Article "Piping Applications" for identification of systems where pipe and tube fitting materials specified below are used.
   2. Polyvinyl Chloride (PVC) Plastic Pipe Fittings: ASTM D 2464, Schedule 80, threaded.
   3. Polyvinyl Chloride (PVC) Plastic Pipe Fittings: ASTM D 2467, Schedule 40, socket-type.
   4. “Leemco” Push-on joint Ductile Fittings or approved equal: for all pipes 2 ½” and larger.
   5. Dielectric Fittings: Assembly or fitting with insulating material isolating joined dissimilar metals to prevent galvanic action and stop corrosion. These devices are a combination of copper alloy and ferrous metal; threaded- and solder-end types, matching piping system materials.
      a. Dielectric Unions: Factory-fabricated, union assembly, designed for 250 psig (1725 kPa) minimum working pressure at 180 deg F (82 deg C). Include insulating material isolating dissimilar metals and ends with inside threads according to ASME B1.20.1.
      b. Transition Fittings: Manufactured assembly or fitting, with pressure rating at least equal to that of system and with ends.

2.4 JOINING MATERIALS

A. Solvent Cement: ASTM F 656 primer and ASTM D 2564 solvent cement in color other than orange.

2.5 VALVES

A. General: Valves are for general-duty and underground applications. Refer to "Valve Applications" Article for locations of various valve types specified in this Article. Refer to "Control Valves" Article for control valves and accessories.

2.6 CONTROL VALVES

A. Description: Manufacturer's standard control valves for circuits, of type and size indicated on Drawing, and as follows:
   1. Angle Valves: Bronze construction, non-rising stem, inside screw threaded ends and as noted on the Drawings.
   2. Automatic Control Valves: Diaphragm-type, normally closed, with manual flow adjustment, and operated by 24-volt-a.c. solenoid.

3. Quick-Couplers: Factory-fabricated, 2-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.
    a. Locking Top : Include vandal-resistant, locking feature with 2 matching keys.
4. Drain Valve: As noted on the Drawings.
5. Isolation Gate Valves: 150# gate valve, epoxy-coated, ductile iron, resilient wedge valve with non-rising stem and inside screw with threaded ends. Mechanical joint or push-on. "Waterous", "American Flow Control" or "Nibco" gate valves or approved equal prior to bidding. Size to match line size. Install in valve box, size adequate for maintenance access. Minimum 15" x 21".
6. "Air Release Valve: 2" air release valve from "Crispin", "Ames", or "Waterman", install in valve box.
7. Master Valve/ Flow Sensor Assembly: Netafim Hydrometer, size to match main line, or approved equal.
8. "Leemco" Ductile Iron Lateral Connection System or approved equal.

B. Control Valve Boxes and Cover: Thermo-plastic valve boxes with lockable, snap-top lids. Size as required for application or as noted on drawings, maximum one (1) valve per box. All boxes shall have purple lids labeled "DO NOT DRINK".
1. Drainage Backfill: Cleaned gravel or crushed stone, graded from 3 inches (75 mm) maximum to 3/4 inch (19 mm) minimum. Cover gravel with layer of filter fabric.

C. Service Boxes for Key-Operated Control Valves: Size and type as shown on Drawings.
1. Include valve key, 48 inches (915 mm) long with tee handle and key end to fit valve.

D Irrigation System Controls
1. Controller: As noted on the Drawings. All control wiring that is above ground shall be installed in conduit. Electrical wiring shall be installed according to local code. Provide surge protectors install controllers.
2. Controller Housing: Weatherproof, watertight, with lockable access door.
3. Valves: Electric Solenoid type and size of control valves as noted on the Drawings, including required fittings and accessories.
4. Wire: Color coded, copper conductor direct burial, UF-UL listed as noted on the drawings.

2.7 SPRINKLERS

A. Description: Manufacturer's standard sprinklers designed to provide uniform coverage over entire area of spray shown on Drawings at available water pressure, as follows:
1. Housings: Plastic, except where material is specified.
2. Pop-Up, Spray: Fixed pattern, with screw-type flow adjustment and stainless-steel retraction spring.
3. Pop-Up, Rotary Spray: Gear drive, full-circle and adjustable part-circle type.
4. All sprinkler heads shall have purple non-potable water caps.

2.8 AUTOMATIC CONTROL SYSTEM

A. Description: Low-voltage controller system, made for control of irrigation system automatic control valves. Controller operates on 120 volts a.c. building power system, provides 24 volts a.c. power to control valves, and includes stations for at least the number of control valves indicated. Size and type as shown on Drawing.

B. Control Enclosures: Weatherproof enclosure with locking cover and 2 matching keys. Enclosure construction complies with NFPA 70 and NEMA 250, Type 4, and includes provision for grounding. All control wiring that is above ground shall be installed in conduit. Electrical wiring shall be installed according to local code. Provide surge protectors in all controllers.
   1. AG 240 V Surge Arrester: As noted on the drawing. Install in approved J-box next to controller. Install per manufacturer recommendations.
   2. Stainless Steel Wall Mounted Enclosure by Strong Box Item #B-16SSW or approved equal.

C. Transformer: Internal-type, and suitable for converting 120 volts a.c. building power to 24 volts a.c. power.

D. Controller Stations for Automatic Control Valves: Each station is variable from approximately 1 to 60 minutes. Include switch for manual or automatic operation of each station.

E. Timing Device: Adjustable, 24-hour, 14-day clock to operate any time of day. Include provision for the following settings:
   1. Setting to skip operation any day in timer period.
   2. Setting for operation every other day.
   3. Settings for operation 2 or more times daily.
   4. Include manual or semi-automatic operation without disturbing preset automatic operation.
   5. Provide NI-CAD battery and trickle charger to automatically power the timing device during power outages.

F. Wiring: UL 493, solid copper conductor, insulated cable, suitable for direct burial.
   1. Splicing Materials: Pressure-sensitive, waterproof, thermoplastic wire connectors and other materials required to make specified connections. Locate all splice within valve boxes.
   2. Decoder Wire to be size # 14 not to exceed 10,000 Linear feet before sizing up to #12 wire.

G. Communication Cable.
   1. All cable required for the 2-wire paths and from Controller to flow sensor shall be REA Pe-39, 19 gauge, conductor-solid annealed uncoated copper conforming to ASTM-B3; insulated with expanded polyolefin surrounded by solid polymer to ensure low loss long transmission capability. Communication cable shall be of a type and size manufactured for use with Baseline hardware and approved by Baseline for installation of this type.
   2. Cable for the 2-wire paths shall be installed with no underground splices. All cable shall be laid in trenches (“pulling-in” of cable for installation without trenching will not be allowed unless pre-approved by the Landscape Architect) and shall be carefully back-filled to avoid any damages to the cable insulation or cable conductors themselves. In rocky areas, the trench shall have a 6” layer of clean sand on the bottom before the cable is laid into the trench and back-filled. If rocky back-fill is being used, the cable shall have an additional 6” layer of sand on top of it before back-filling is started. The cable shall have a minimum of 18” of cover.
   3. All 2-wire shall be installed in a PVC schedule 40 conduit and a sleeve (where passed under paving, walls or any other paved areas) of proper size required for the number of cables to be placed in it. The 2-wire path is permitted to be laid in the same trench with the 117 VAC cable as much as possible by laying each in opposite sides of the trench.

2.9 VALVE BOXES

A. Carson Industries or approved equal green body with locking lid. Standard rectangular box, model L series 1220-12 with T-cover, for all electrical control valves, 1419-12B. 10" round box for all mainline ball valves, gate valves, and hose bibs. All boxes shall have purple lids labeled "Do not Drink".

PART 3 - EXECUTION

3.1 EXAMINATION

A. Investigate and determine available water supply water pressure and flow characteristics.
B. Insure that new pump station is providing necessary performance. Notify Landscape Architect of any deviations from design performance.

3.2 PREPARATION

A. Set stakes to identify proposed sprinkler locations. Obtain Irrigation Designer's approval before excavation.

3.3 PAVING WORK

A. Install piping in sleeves where crossing sidewalks, roadways, parking lots, playgrounds and railroads.
   1. Install piping sleeves by boring or jacking under existing paving, where possible.
   2. If it is necessary to cut pavement sections, pavement shall be replaced in cut areas per I.S.P.W.C. standards and requirements.

3.4 PIPING APPLICATIONS

A. Refer to Part 2 of this Section for detailed specifications for pipe and fittings products listed below. Use pipe, tube, fittings, and joining methods according to the following applications. Piping in pits and aboveground may be joined with flanges instead of joints indicated.
B. Use pipe, tube, fittings, and joining methods according to the following applications.
C. Pressure Piping Underground: Use the following:
   1. 2 ½ Inches (DN 80) and Smaller: ASTM D 2467, Schedule 40, PVC plastic, socket-type pipe fittings; and solvent-cemented joints.
   2. 3-Inches (DN 100) and Larger: ASTM D 2241, SDR 21 rubber gasketed Class 200, polyvinyl chloride (PVC) plastic pipe; ASTM A 536 push on ductile iron fittings.
D. Circuit Piping: Use the following:
   1. All Sizes: ASTM D 2241, ASTM D 2466, Schedule 40, polyvinyl chloride (PVC) plastic, socket-type fittings; and solvent-cemented joints.
E. Sleeves: ASTM D 2466, Schedule 40, polyvinyl chloride (PVC) PVC plastic, socket-type fittings; and solvent-cemented joints. Sleeve diameter shall be two sizes larger than pipe installed in sleeve with minimum sleeve size being 4". Extend sleeves 12" minimum beyond walk or pavement edge.

3.5 JOINT CONSTRUCTION

A. Threaded Joints: Thread pipes with tapered pipe threads according to ASME B1.20.1, apply tape or joint compound, and apply wrench to valve ends into which pipes are being threaded.

B. Polyvinyl Chloride (PVC) Piping Solvent-Cemented Joints: Construct joints according to ASTM D 2672 and ASTM D 2855.
   1. Handling of Solvent Cements, Primers, and Cleaners: Comply with procedures in ASTM F 402 for safe handling when joining plastic pipe and fittings with solvent cements.
C. Dissimilar Materials Piping Joints: Construct joints using adapters that are compatible with both piping materials, outside diameters, and system working pressure. Refer to "Piping Systems - Common Requirements" Article for joining dissimilar metal piping.
D. Provide “Leemco” joint restraints at all gasket fittings where a change of direction occurs, or approved equal. Install all joint restraints per manufacturer’s recommendations.

3.6 PIPING SYSTEMS - COMMON REQUIREMENTS

A. General Locations and Arrangements: Drawings indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, and in other design considerations. Install piping as indicated, except where deviations to layout are approved on coordination drawings.
B. Install components having pressure rating equal to or greater than system operating pressure.
C. Install piping free of sags and bends. Deflections angles shall not exceed manufacturer’s recommendations.
D. Locate groups of pipes parallel to each other, spaced to permit valve servicing.
E. Install fittings for changes in direction and branch connections.
F. Piping Connections: Except as otherwise indicated make piping connections as specified below.
   1. Install unions, in piping 2 inches (DN 50) and smaller, adjacent to each valve and at final connection to each piece of equipment having 2-inch (DN 50) or smaller threaded pipe connection.
   2. Install flanges, in piping 2-1/2 inches (DN 65) and larger, adjacent to flanged valves and at final connection to each piece of equipment having flanged pipe connection.
   3. Install dielectric fittings to connect piping of dissimilar metals.

3.7 PIPING INSTALLATION

A. Install underground polyvinyl chloride (PVC) plastic pipe according to ASTM D 2774.
B. Lay piping on solid subbase, uniformly sloped without humps or depressions.
   1. Install polyvinyl chloride (PVC) plastic pipe in dry weather when temperature is above 40 deg F (4 deg C). Allow joints to cure at least 24 hours at temperature above 40 deg F (4 deg C) before testing, unless otherwise recommended by manufacturer.
C. Minimum Cover: Provide following minimum cover over top of buried piping:
   1. Pressure Piping: 18 inches.
   2. Circuit Piping: 12 inches.
   3. Sleeves: 24 inches.
D. Boring
   1. Locations: Boring shall be used to route pipe, wiring or both under concrete structures such as walks or curbs where trenching is impractical. Sleeves shall be installed in all bored holes.
   2. Method: Boring shall be accomplished with a drill, auger, water jet, or any other instrument approved by the Owner’s Representative capable of producing a precise hole. Boring shall not disturb overlaying structures or cause settlement and damage to those structures. Repair or replace any pavement damaged during boring procedures.

E. Install piping under sidewalks and paving in sleeves.

F. Back-filling

1. Inspection: The trenching shall not be backfilled until inspection and pressure testing has been completed and the pipe installation, including the grade, alignment and jointing has been found to be in compliance with the requirements of the plans and specifications.
2. Around and Over Pipe:
   a. Select backfill material consisting of sand, fine gravel or select earth, free of large lumps or rocks larger than 1/2 inch shall be used in backfilling around and over the installed pipe.
   b. The select material shall be obtained from the excavation material removed from the trench and shall be processed by screening, sifting, or selective sorting, so as to produce the type of backfill herein specified. The Contractor may at his option and own expense provide an acceptable imported material.
   c. Backfill material shall be carefully deposited around and over the pipe in layers not more than 6 inches thick, loose measurement, wetted to optimum moisture content and uniformly compacted to at least 95 percent of the maximum density obtainable at optimum moisture content as determined by AASHTO T99 Method A or D (latest revision), until the pipe has a cover depth of at least 12 inches.
3. Remainder of Trench Backfill:
   a. The remaining depth of the trench shall be backfilled to existing finish grade, with excavation material removed from the trench, which shall be wetted or dried to near optimum moisture content.
   b. Contractor shall be required to repair any settling problems which occur in the trench locations for the duration of the warranty period.

G. Pipe fittings

1. All piping 3” diameter or greater shall use “Leemco” ductile iron push on type fittings. Provide “Leemco” joint restraints at all gasket fittings where change of direction occurs. See drawings for details.
2. All piping less than 3” diameter shall use Schedule 40 socket type fittings.

3.8 VALVE APPLICATIONS

A. **Hunter ICV-G-R** with adjustable Dial pressure regulating module, size per plans.

3.9 VALVE INSTALLATION

A. Valves: Install underground valves in valve boxes as shown on Drawings.

B. Control Valves: Install in valve control valve boxes, arranged for easy adjustment and removal. Install union on downstream side. Maximum (1) valve per valve box.

C. Place 6 inches minimum of gravel below control valves for drainage. Maintain 4 inches minimum between bottom of valves and top of gravel. Place filter fabric barrier between gravel and valves. Valve box shall be free of dirt and debris.

3.10 SPRINKLER INSTALLATION

A. Sprinklers: Flush circuit piping with full head of water and install sprinklers after hydrostatic test is completed.

1. Install lawn sprinklers at manufacturer's recommended heights.
2. Install shrubbery sprinklers at heights indicated.

3. Locate part-circle sprinklers to maintain a minimum distance of 12 inches from walls and 2 inches (50 mm) from other boundaries, unless otherwise indicated.
4. Sprinkler Head Risers: Rotor pop-up sprinkler shall have an adjustable riser assembly (triple swing joint Rain Bird SA Series or approved equal). Stationary spray pop-up heads or shrubs spray heads shall have an adjustable riser assembly (triple swing joint) or low-density polyethylene flex pipe as shown on Drawings details. Triple swing joint fittings shall be of Schedule 80 PVC. Flex pipe shall be 12 inch long minimum and 18 inch maximum linear low-density polyethylene pipe with spiral barb fittings and 90 degree ell as shown on details on Drawing.
5. Quick coupling valves shall be installed with an adjustable riser assembly (triple swing joint) and a Leemco quick coupler stabilizer, size as necessary.

3.11 AUTOMATIC CONTROL SYSTEM INSTALLATION

A. Install controllers and controller pedestal according to manufacturer's written instructions and as indicated.
B. Install control wiring in same trench with piping. Where wiring leaves from piping trenches, install wiring in conduits.
C. Install control wiring in accordance with Specifications. Provide 10 inches expansion coil At each valve to which controls are connected, and at 100 foot intervals. Bury wire beside mainline pipe. Where wire leaves pipe, enclose in conduit. Use waterproof wire connectors. Use white or gray color for common wires and black or red colors for all other wires. No control wires shall be placed in thrust blocks. Locate wires on opposite side of thrust blocks.

3.12 TRENCHING

A. Trench Size:
1. Minimum Depth: as necessary to provide 18” of cover for mainline, sleeves, and wires.
2. Minimum Depth: as necessary to provide 12” of cover for all lateral lines.
3. Minimum Width: 4-inch pipe and larger – 12 inches.
4. Minimum Width: 3-inch pipe and smaller – 9 inches.
B. Trench to accommodate grade changes and slope to drains.
C. Maintain trenches free of debris, material, or obstructions that may damage pipe.

3.13 CONNECTIONS

A. Connect piping to sprinklers, devices, valves, control valves, specialties, and accessories.
B. Connect water supplies to irrigation systems. Include reduced pressure back-flow preventers on potable water supplies.
C. Electrical Connections: Connect to power source, controllers, and automatic control valves.

3.14 FIELD QUALITY CONTROL

A. Testing: Perform test of piping and valves before back-filling trenches. Piping may be tested in sections to expedite work. Owner’s representative must be present for testing.
1. Make all necessary provisions for thoroughly bleeding the line of air and debris.
2. Before testing, fill the line with water for a period of at least 24 hours.
3. **After valves have been installed, test all live water lines, (main line and lateral lines) for leaks at a pressure of <u>100 psi for a period of one hour</u>, with all couplings exposed and with all pipe sections center loaded.**
4. Furnish all necessary testing equipment and personnel.
5. Correct all leaks and retest until acceptance by the Landscape Architect.

B. Field inspection and testing will be performed under provisions of Division 1.

C. Installer's Field Service
   1. Prepare and start systems under provisions of Division 1.
   2. Provide one complete spring start-up and a fall shutdown, including winterization to blow out entire system with compressed air.
D. Adjust work under provisions of Division 1.
C. Change and/or adjust head types for full water coverage as directed.
D. Adjust nozzle spray pattern as required to avoid water spray on building walls, roads or sidewalks.
E. Have all backflow preventers tested by appropriate agency.

3.15 CLEANING AND ADJUSTING

A. Flush dirt and debris from piping before installing sprinklers and other devices.
B. Adjust automatic control valves to provide flow rate of rated operating pressure required for each sprinkler circuit.
C. Carefully adjust lawn sprinklers so they will be flush with, or not more than 2-inch (13 mm) above, finish grade after completion of landscape work. Adjust so that sprinklers do not spray on buildings or walls.
D. Adjust settings of controllers and automatic control valves to insure proper watering of all landscaping.

3.16 COMMISSIONING

A. Starting Procedures: Follow manufacturer's written procedures. If no procedures are prescribed by manufacturers, proceed as follows:
   1. Verify that specialty valves and their accessories have been installed correctly and operate correctly.
   2. Verify that specified tests of piping are complete.
   3. Check that sprinklers and devices are correct type.
   4. Check that damaged sprinklers and devices have been replaced with new materials.
   5. Check that potable water supplies have correct type back-flow preventers.
   6. Energize circuits to electrical equipment and devices.
   7. Adjust operating controls.
B. Operational Testing: Perform operational testing after hydrostatic testing is completed, backfill is in place, and sprinklers are adjusted to final position.

3.17 DEMONSTRATION

A Provide irrigation system demonstration under provisions of Division 1.
B. Demonstrate to Owner: that system meets coverage requirements and that automatic control functions properly.
C. Demonstrate to Owner's maintenance personnel operation of equipment, sprinklers, specialties, and accessories. Review operating and maintenance information including start up and winterization procedures.
D. Provide 7 days written notice in advance of demonstration.

END OF SECTION 328400

SECTION 328450 - IRRIGATION CENTRAL CONTROL

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 valves, specialties, controls, and wiring.

B. Furnishing and installing irrigation system components is specified in Section 328400 “Landscape Irrigation” of this Specification.

1.3 SUBMITTALS

A. Product Data: Include pressure rating, rated capacity, settings, and electrical data of selected models for the following:
   1. Specialties. Include flow sensors and flow meters, surge protectors
   2. Controllers. Include wiring diagrams, controller, power supply, and surge protectors.Maintenance Data: To include in maintenance manuals specified in Section 328400 “Landscape Irrigation” of this Specification. Include data for the following:
   4. All components of Central Control System.

1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction.

B. Comply with NFPA 70, “National Electrical Code,” for electrical connections between wiring and electrically operated devices.

1.5 PROJECT CONDITIONS

A. Cut pavement and patch per drawings as to route wire to specified location in building. All wire not buried shall be installed in rigid conduit per local codes.

1.6 SEQUENCING AND SCHEDULING

A. Coordinate irrigation control work with work specified in Section 328400 “Landscape Irrigation”.

B. Coordinate irrigation central control work with utility work.

PART 2 - PRODUCTS

2.1 VALVES

A. Master Valve: Refer to Flow Sensor Assembly.

2.2 SPECIALTIES

A. Flow Sensor Assembly: As per manufacturer's recommendations. Provide all control wiring as necessary.

2.3 CONTROLLERS

A. Automatic Irrigation Controller: As specified on plans. This controller shall include strong box, controller, pulse transmitter, remote control, receiver card, and ethernet connection up as specified.

B. Automatic Control Wiring between Controller and Automatic Valves, including Master Valve: As per Section 328400 "Landscape Irrigation".

C. Provide all equipment necessary for properly operating Irrigation Central Control System according to manufacturer's recommendations and as per plans.

2.4 AUTOMATIC IRRIGATION CONTROL SYSTEM WITH MOISTURE SENSORS

A. Description: Low-voltage controller system, made for control of irrigation system automatic control valves. Controller operates on 120 volts a.c. building power system, provides 24 volts a.c. power to control valves, and includes stations for at least the number of control valves indicated. Size and type as shown on the drawing. Control system will work in conjunction with a central control system. The controller will have an integrated two-wire system with decoders and sensors. The controller will be capable of being operated via remote control, cell phone, or remote PC. The two-wire decoders will be sealed and capable of being buried. They will have no electrical contact with the soil. They will be capable of powering standard AC solenoids and will shut down any solenoid in a high solenoid current situation. Manufactured with LED displays on two wire and valve side. The computer will have software capable of controlling up to 200 zones, with watering based on feedback from the sensors. The system will have full mapping capabilities that are user input and user adjusted. Maps will have icons representing decoders/valves, sensors, master valves and icons will be user placable. In addition, most system functions will be controllable directly from the map. The controller will have remote control capabilities including cell phone control, land line control and remote PC control (through commercially available communications software). The controller will have all the capabilities of advanced timed systems including but not limited to: future event restrictions, multiple timed watering by zone, soak cycle watering, programs with programmable global restricted time by day, hour and zone, blockout times by hour and day, municipal watering restictions with a simple graphic calendar input function, all forms of manual operation including manual walk around and se-

quential activation by group of zones, etc. The system will support flow meters, air temperature sensors capable of shutting the system down if the air temperature approaches freezing. The controller will have extensive diagnostic capabilities including individual valve current testing, system wide component testing, automatic listing of all attached devices and reporting of any anomolies or component malfunctions. The controller will determine the voltage loss due to wiring for each device in the two-wire system. The system will perform a self diagnostic each day testing the integrity of all valve solenoids, sensors and wiring. Failures and issues will be prominently displayed. The controller will support remote pause buttons allowing the programs to be paused for various activities without providing access to the controller.

B. Control Enclosures: Weatherproof enclosure with locking cover and 2 matching keys. Enclosure construction complies with NFPA 70 and NEMA 250, Type 4, and includes provision for grounding. All control wires that are above ground shall be installed in conduit. Electrical wiring shall be installed according to local code. Provide surge protectors in all controllers.
   1. AG 240 V Surge Arrester: Install in approved J-box next to controller. Install per manufacturer recommendations.

C. Transformer: Internal-type, and suitable for converting 120 volts a.c. building power to 24 volts a.c. power.

D. Controller Stations for Automatic Control Valves: Each station is variable from approximately 1 to 60 minutes. Include switch for manual or automatic operation of each station.

E. Wiring: UL 493, solid copper conductor, insulated cable, suitable for direct burial.
   1. Decoder Wiring shall be installed for the entire length of the mainline loop and to the irrigation controller location. Install Paige Electric (P7313) 12 AWG/2c twisted for the loop and install Paige Electric (P7313) 10 AWG/2c twisted from controller to the closest valve.
   2. Splicing Materials: Paige Electric DBM or 3M DBY Connectors. Locate all splices within valve boxes.
   3. Use white color for common wire and red color for all other additional wiring.
      a. Wire to be size # 14 not to exceed 1500 Linear feet before sizing up to #12 wire.
      b. Install one 14 AWG red wire from every valve to the pump station location. Install one 12 AWG white common wire for the entire length of the mainline to the pump station location. Cap all wires with a waterproof connection and install a minimum 10’ of extra wire bundle in a new valve box located adjacent to existing conduit at pump station pad.

F. Communication Cable.
   1. All cable required for the 2-wire paths and from Controller to flow sensor shall be REA Pe-39, 19-gauge, conductor-solid annealed uncoated copper conforming to ASTM-B3; insulated with expanded polyolefin surrounded by solid polymer to ensure low loss long transmission capability. Communication cable shall be of a type and size manufactured for use with Rainbird hardware and approved by Rainbird for installation of this type.
   2. Cable for the 2-wire paths shall be installed with no underground splices. All cable shall be laid in trenches (“pulling-in” of cable for installation without trenching will not be allowed) and shall be carefully back-filled to avoid any damages to the cable insulation or cable conductors themselves. In rocky areas, the trench shall have a 6” layer of clean sand on the bottom before the cable is laid into the trench and back-filled. If rocky back-fill is being used, the cable shall have an additional 6” layer of sand on top of it before back-filling is started. The cable shall have a minimum of 18” of cover.

3. All 2-wire shall be installed in a 1" PVC schedule 40 conduit and a sleeve (where passed under paving, walls or any other paved areas) of proper size required for the number of cables to be placed in it. The 2-wire path is permitted to be laid in the same trench with the 117 VAC cable as much as possible by laying each in opposite sides of the trench.

2.5.1 IDENTIFICATION

A. Install solid yellow film with metallic core and continuously printed black-letter caption, "CAUTION-ELECTRICAL LINE BURIED BELOW" above all buried wiring.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Prior to all work in this Section, carefully inspect the installed Work of all other trades and verify that all such Work is complete to the point where this installation may properly commence and will not interfere or conflict.

B. Verify that the irrigation central control system may be installed in strict accordance with all pertinent codes and regulations, the original design, the references standards, and the manufacturer's recommendations prior to beginning of construction. Notify Landscape Architect immediately of discrepancies.

3.2 DISCREPANCIES

A. In the event of discrepancy, immediately notify the Owner's Representative.

B. Do not proceed with installation in areas of discrepancy until all such discrepancies have been fully resolved.

3.3 FIELD MEASUREMENTS

A. Make all necessary measurements in the field to ensure precise fit of items in accordance with the original design.

3.4 TRENCHING AND BACKFILL

A. Perform all trenching as per Section 328400 "Landscape Irrigation".

3.5 INSTALLATION OF CONTROL WIRES

A. General: Layout the wiring system in strict accordance with Section 328400.

B. Installation: Install all wiring per Section 328400.

C. All wires shall be in conduit.

3.6 INSTALLATION OF EQUIPMENT

A. Controllers:
   1. Mount controller and all related equipment as indicated on the Drawings and per manufacturer's recommended installation.
   2. The resistance of the ground to controller shall not exceed 5 ohms. Ground controller as needed.
   3. Do not splice central control wiring. Provide 10 inch round boxes 250 feet on center maximum with a 36 inch loop in each box.
   4. In the event a splice must be made to central control wiring make a splice per recommendations of Paige Electric. Run separate isolated common wires from master valve to controller assembly.
   5. Ground all equipment as per manufacturer's recommendations.

3.7 TESTING AND INSPECTION

A. General:
   1. Test and flush all piping as per Section 328400 "Landscape Irrigation."
   2. Testing Central Control System: Conduct on-site post-installation meeting with Owner's Representative and Manufacturer's Representative to thoroughly check the operation of the equipment that was installed and provide feedback acknowledging that the equipment is installed correctly and ready for a final walk-through. This check is required to initiate the warranty.

B. Final Inspection:
   1. Thoroughly clean, adjust and balance all systems.

3.8 INSTRUCTIONS

A. Record Drawings:
   1. Record accurately on a reproducible print the site plan and all installed work including both pressure and non-pressure lines.
   2. Maintain as-built drawings on site at all times.

B. Operation and Maintenance
   1. Provide operation and maintenance manuals per Section 328400 "Landscape Irrigation".

3.9 GUARANTEE PERIOD

A. Guarantee:
   1. The entire irrigation central control system shall be guaranteed to give satisfactory service for a period of **two** years from the date of acceptance by the Owner.
   2. Should any trouble develop within the time specified above due to inferior or faulty materials or workmanship, the trouble shall be corrected at no expense to the Owner.
   3. Any and all damages resulting from faulty materials or workmanship shall be repaired by the Contractor to the satisfaction of the Owner, at no cost to the Owner.

END OF SECTION 328450

PAGE INTENTIONALLY BLANK

SECTION 328500 - LANDSCAPE GRADING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes

1. Final grade topsoil for finish landscaping.

B. Related Sections

1. Specification Section 311000: Site Clearing.
2. Specification Section 312000: Earthmoving

1.2 SUBMITTALS

A. Submit under provisions of Division 1.

1.4 QUALITY ASSURANCE

A. Provide analysis of existing and imported topsoil fill under provisions of Division 1.

B. Topsoil Analysis: Furnish a soil analysis if existing and imported topsoil made by a qualified independent soil-testing agency stating percentages of organic matter, inorganic matter (silt, clay and sand), deleterious material, pH, and mineral and plant-nutrient content of topsoil.

C. Report suitability of topsoil for growth of applicable planting material. Contractor shall state in writing the recommended quantities of nitrogen, phosphorus, and potash nutrients and any limestone, aluminum, sulfate, or other soil amendments to be added to produce topsoil meeting the requirements listed in this section. Soil amendment quantities are called out in Sections 329200 and 329300 but are for bid purposes only. The results of the soils tests as reviewed by the Landscape Architect determine the proper amendments.

D. All finish grades shall be approved by Landscape Architect prior to landscape installation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS - NOT USED.

2.2 MATERIALS – NOT USED

2.3 TOPSOIL

A. Topsoil: ASTM D 5268, pH range of 5.5 to 7, 2.5% organic material minimum, free of stones 1 inch (25mm) or larger in any dimension, and other extraneous materials harmful to plant growth.

1. Existing Topsoil Source: Reuse surface topsoil stockpiled on the site. Verify suitability of surface soil to produce topsoil meeting requirements and amend when necessary. Approved by Landscape Architect. Supplement with imported topsoil when quantities are insufficient. Clean topsoil of roots, plants, sods, stones, clay lumps, and other extraneous materials harmful to plant growth.
2. Imported Topsoil Source: Import topsoil from off-site sources. Provide new topsoil that is fertile, friable, natural loam, surface soil, reasonably free of subsoil, clay lumps, brush, weeds and other litter, and free of roots, stumps, stones larger than 1 inch in any dimension, and other extraneous or toxic matter harmful to plant growth.
    a. Obtain topsoil from local sources or from areas having similar soil characteristics to that found at project site. Obtain topsoil only from naturally, well-drained site where topsoil occurs in a depth of not less than four inches. Do not obtain from bogs or marshes.
    b. Representative samples shall be tested for acidity, fertility and general texture by a recognized commercial or government agency and copies of the testing agency's findings and recommendations shall be furnished to the Architect's representative by the contractor. No topsoil shall be delivered in a frozen or muddy condition. Acidity/alkalinity range – pH 5.5 to 7.6.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify trench backfilling have been inspected.

B. Verify substrate base has been contoured and compacted and topsoil has been placed to design grades per the plans.

C. Beginning work of this section means acceptance of rough grading, topsoil placement, and existing conditions.

3.2 PREPARATION

A. Substrate

1. Eliminate uneven areas and low spots.
2. Remove debris, roots, branches, stones, in excess of 1 inch in size. Remove subsoil contaminated with petroleum products.
3. Scarify subsurface to depth of 6 inches where topsoil is scheduled. Scarify in areas where equipment used for hauling and spreading topsoil has compacted subsoil. Scarify on multiple passes in intersecting directions to break up, cut and mix subsurface to provide a homogenous mixture.

3.3 EXECUTION

A. Place topsoil in areas where required to obtain thickness as scheduled. Place topsoil during dry weather.

B. Fine grade topsoil to eliminate rough or low areas. Maintain profiles and contour of subgrade.

C. Finish grade of lawn or plant bed areas prior to planting shall be:

1. Seeded Areas – 3/4 inch below top of adjacent pavement of any kind.
2. Sodding Areas – 1½ inch below top of adjacent pavement of any kind.
3. Planter Bed Areas - 3 inches below top of adjacent pavement of any kind.

D. Remove roots, weeds, rocks, and foreign material while spreading, and remove from site.

E. Manually spread topsoil close to plant life and paving to prevent damage.

F. Lightly compact placed topsoil.

G. Remove surplus subsoil and topsoil from site.

H. Leave site clean and raked, ready to receive landscaping.

I. Tolerances

1. Top of Topsoil: Plus or minus ½ inch.

3.4 FIELD QUALITY CONTROL - NOT USED.

3.5 ADJUSTING - NOT USED.

3.6 CLEANING - NOT USED.

3.7 DEMONSTRATION - NOT USED.

3.8 PROTECTION

A. Protect landscaping and other features remaining as final work.

B. Protect existing structures, fences, sidewalks, and paving.

3.9 SCHEDULES

A. Compacted topsoil thickness at the following areas:

1. Seeded Grass: 12 inches.
2. Planter Beds: 18 inches.
3. Sod: 12 inches

END OF SECTION 328500

SECTION 329113 - SOIL PREPARATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes planting soils specified by composition of the mixes.

B. Related Requirements:
   1. Section 329200 "Turf and Grasses" for placing planting soil for turf and grasses.
   2. Section 329300 "Plants" for placing planting soil for plantings.

1.3 DEFINITIONS

A. AAPFCO: Association of American Plant Food Control Officials.

B. Backfill: The earth used to replace or the act of replacing earth in an excavation. This can be amended or unamended soil as indicated.

C. CEC: Cation exchange capacity.

D. Compost: The product resulting from the controlled biological decomposition of organic material that has been sanitized through the generation of heat and stabilized to the point that it is beneficial to plant growth.

E. Duff Layer: A surface layer of soil, typical of forested areas, that is composed of mostly decayed leaves, twigs, and detritus.

F. Imported Soil: Soil that is transported to Project site for use.

G. Layered Soil Assembly: A designed series of planting soils, layered on each other, that together produce an environment for plant growth.

H. Manufactured Soil: Soil produced by blending soils, sand, stabilized organic soil amendments, and other materials to produce planting soil.

I. NAPT: North American Proficiency Testing Program. An SSSA program to assist soil-, plant-, and water-testing laboratories through interlaboratory sample exchanges and statistical evaluation of analytical data.

J. Organic Matter: The total of organic materials in soil exclusive of undecayed plant and animal tissues, their partial decomposition products, and the soil biomass; also called "humus" or "soil organic matter."

K. 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.

L. RCRA Metals: Hazardous metals identified by the EPA under the Resource Conservation and Recovery Act.

M. SSSA: Soil Science Society of America.

N. 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.

O. 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.

P. 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.

Q. USCC: U.S. Composting Council.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at the **Project site prior to soil preparation**. Schedule preinstallation conference with the landscape architect.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include recommendations for application and use.
2. Include test data substantiating that products comply with requirements.
3. Include sieve analyses for aggregate materials.
4. Material Certificates: For each type of **imported soil and soil amendment and fertilizer** before delivery to the site, according to the following:

    a. Manufacturer's qualified testing agency's certified analysis of standard products.
    b. Analysis of fertilizers, by a qualified testing agency, made according to AAPFCO methods for testing and labeling and according to AAPFCO's SUIP #25.
    c. Analysis of nonstandard materials, by a qualified testing agency, made according to SSSA methods, where applicable.

B. Samples: For each bulk-supplied material, **1-quart** volume of each in sealed containers labeled with content, source, and date obtained. Each Sample shall be typical of the lot of material to be furnished; provide an accurate representation of composition, color, and texture.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For each testing agency.

B. Preconstruction Test Reports: For preconstruction soil analyses specified in "Preconstruction Testing" Article.

C. Field quality-control reports.

1.7 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.

1. Multiple Laboratories: At Contractor's option, work may be divided among qualified testing laboratories specializing in physical testing, chemical testing, and fertility testing.

1.8 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: **Engage** a qualified testing agency to perform preconstruction soil analyses on **imported soil**.

1. Notify Landscape Architect **seven** days in advance of the dates and times when laboratory samples will be taken.

B. Preconstruction Soil Analyses: For each unamended soil type, perform testing on soil samples and furnish soil analysis and a written report containing soil-amendment and fertilizer recommendations by a qualified testing agency performing the testing according to "Soil-Sampling Requirements" and "Testing Requirements" articles.

1. Have testing agency identify and label samples and test reports according to sample collection and labeling requirements.

1.9 SOIL-SAMPLING REQUIREMENTS

A. General: Extract soil samples according to requirements in this article.

B. Sample Collection and Labeling: Have samples taken and labeled by C**ontractor in presence of the Architect** under the direction of the testing agency.

1. Number and Location of Samples: Minimum of **three** representative soil samples **from varied locations** for each soil to be used or amended for landscaping purposes.
2. Procedures and Depth of Samples: **According to USDA-NRCS's "Field Book for Describing and Sampling Soils."**
3. Division of Samples: Split each sample into two, equal parts. Send half to the testing agency and half to Owner for its records.
4. Labeling: Label each sample with the date, location keyed to a site plan or other location system, visible soil condition, and sampling depth.

1.10 TESTING REQUIREMENTS

A. General: Perform tests on soil samples according to requirements in this article.

B. Physical Testing:

1. Soil Texture: Soil-particle, size-distribution analysis by **one of** the following methods according to SSSA's "Methods of Soil Analysis - Part 1-Physical and Mineralogical Methods":

   a. Sieving Method: Report sand-gradation percentages for very coarse, coarse, medium, fine, and very fine sand; and fragment-gradation (gravel) percentages for fine, medium, and coarse fragments; according to USDA sand and fragment sizes.
   b. Hydrometer Method: Report percentages of sand, silt, and clay.

2. Total Porosity: Calculate using particle density and bulk density according to SSSA's "Methods of Soil Analysis - Part 1-Physical and Mineralogical Methods."
3. Water Retention: According to SSSA's "Methods of Soil Analysis - Part 1-Physical and Mineralogical Methods."
4. Saturated Hydraulic Conductivity: According to SSSA's "Methods of Soil Analysis - Part 1-Physical and Mineralogical Methods"; at 85% compaction according to ASTM D 698 (Standard Proctor).

C. Chemical Testing:

1. CEC: Analysis by sodium saturation at pH 7 according to SSSA's "Methods of Soil Analysis - Part 3- Chemical Methods."
2. Clay Mineralogy: Analysis and estimated percentage of expandable clay minerals using CEC by ammonium saturation at pH 7 according to SSSA's "Methods of Soil Analysis - Part 1- Physical and Mineralogical Methods."
3. Metals Hazardous to Human Health: Test for presence and quantities of RCRA metals including aluminum, arsenic, barium, copper, cadmium, chromium, cobalt, lead, lithium, and vanadium. If RCRA metals are present, include recommendations for corrective action.
4. Phytotoxicity: Test for plant-available concentrations of phytotoxic minerals including aluminum, arsenic, barium, cadmium, chlorides, chromium, cobalt, copper, lead, lithium, mercury, nickel, selenium, silver, sodium, strontium, tin, titanium, vanadium, and zinc.

D. Fertility Testing: Soil-fertility analysis according to standard laboratory protocol of **SSSA NAPT NCR-13** including the following:

1. Percentage of organic matter.
2. CEC, calcium percent of CEC, and magnesium percent of CEC.
3. Soil reaction (acidity/alkalinity pH value).
4. Buffered acidity or alkalinity.
5. Nitrogen ppm.
6. Phosphorous ppm.
7. Potassium ppm.
8. Manganese ppm.
9. Manganese-availability ppm.
10. Zinc ppm.
11. Zinc availability ppm.

12. Copper ppm.
13. Sodium ppm **and sodium absorption ratio**.
14. Soluble-salts ppm.
15. Presence and quantities of problem materials including salts and metals cited in the Standard protocol. If such problem materials are present, provide additional recommendations for corrective action.
16. Other deleterious materials, including their characteristics and content of each.

E. Organic-Matter Content: Analysis using loss-by-ignition method according to SSSA's "Methods of Soil Analysis - Part 3- Chemical Methods."

F. Recommendations: Based on the test results, state recommendations for soil treatments and soil amendments to be incorporated to produce satisfactory planting soil suitable for healthy, viable plants indicated. Include, at a minimum, recommendations for nitrogen, phosphorous, and potassium fertilization, and for micronutrients.

1. Fertilizers and Soil Amendment Rates: State recommendations in weight **per 1000 sq. ft. for 6-inch depth of soil**.
2. Soil Reaction: State the recommended liming rates for raising pH or sulfur for lowering pH according to the buffered acidity or buffered alkalinity in weight **per 1000 sq.ft. for 6-inch depth of soil**.

1.11 DELIVERY, STORAGE, AND HANDLING

A. Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and compliance with state and Federal laws if applicable.

B. Bulk Materials:

1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
2. Provide erosion-control measures to prevent erosion or displacement of bulk materials, discharge of soil-bearing water runoff, and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
3. Do not move or handle materials when they are wet or frozen.
4. Accompany each delivery of bulk fertilizers and soil amendments with appropriate certificates.

PART 2 - PRODUCTS

2.1 PLANTING SOILS SPECIFIED BY COMPOSITION

A. General: Soil amendments, fertilizers, and rates of application specified in this article are guidelines that may need revision based on testing laboratory's recommendations after preconstruction soil analyses are performed.

B. 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: 3 cubic yards per **1000 sq. ft.** per **6 inches** of soil depth.

C. 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 **agricultural land,** 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 **4** 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 **inches** 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: 3 cubic yards per **1000 sq. ft.** per **6 inches** of soil depth.

D. Planting-Soil Type: Manufactured soil consisting of manufacturer's basic **topsoil, sandy loam according to USDA textures,** 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 4 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: 3 cubic yards per **1000 sq. ft.** per **6 inches** of soil depth.

2.2 INORGANIC SOIL AMENDMENTS

A. Lime: ASTM C 602, agricultural liming material containing a minimum of 80 percent calcium carbonate equivalent and as follows:

1. Class: T, with a minimum of 99 percent passing through a No. 8 sieve and a minimum of 75 percent passing through a No. 60 sieve.
2. Class: O, with a minimum of 95 percent passing through a No. 8 sieve and a minimum of 55 percent passing through a No. 60 sieve.
3. Form: Provide lime in form of ground **dolomitic limestone or approved equal.**

B. Sulfur: Granular, biodegradable, and containing a minimum of 90 percent elemental sulfur, with a minimum of 99 percent passing through a No. 6 sieve and a maximum of 10 percent passing through a No. 40 sieve.

C. Iron Sulfate: Granulated ferrous sulfate containing a minimum of 20 percent iron and 10 percent sulfur.

D. Perlite: Horticultural perlite, soil amendment grade.

E. Agricultural Gypsum: Minimum 90 percent calcium sulfate, finely ground with 90 percent passing through a No. 50 sieve.

F. Sand: Clean, washed, natural or manufactured, free of toxic materials, and according to **ASTM C 33/C 33M**.

2.3 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 7.**
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. Sphagnum Peat: Partially decomposed sphagnum peat moss, finely divided or of granular texture with 100 percent passing through a **1/2-inch** sieve, a pH of 3.4 to 4.8, and a soluble-salt content measured by electrical conductivity of **maximum 5** dS/m.

C. Wood Derivatives: Shredded and composted, nitrogen-treated sawdust, ground bark, or wood waste; of uniform texture and free of chips, stones, sticks, soil, or toxic materials.

1. Partially Decomposed Wood Derivatives: In lieu of shredded and composted wood derivatives, mix shredded and partially decomposed wood derivatives with ammonium nitrate at a minimum rate of **0.15 lb/cu. ft.** of loose sawdust or ground bark, or with ammonium sulfate at a minimum rate of **0.25 lb/cu. ft.** of loose sawdust or ground bark.

D. 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.

2.4 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: **1 lb/1000 sq. ft.** of actual nitrogen, 4 percent phosphorous, and 2 percent potassium, by weight.
2. 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: 20 percent nitrogen, 10 percent phosphorous, and 10 percent potassium, by weight.
2. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified testing agency.

D. Chelated Iron: Commercial-grade FeEDDHA for dicots and woody plants, and commercial-grade FeDTPA for ornamental grasses and monocots.

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.

C. Proceed with placement only after unsatisfactory conditions have been corrected.

3.2 PREPARATION OF UNAMENDED, ON-SITE SOIL BEFORE AMENDING

A. Excavation: Excavate soil from designated area(s) to a depth of **6 inches** and 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.

1. Apply, add soil amendments, and mix approximately half the thickness of unamended soil over prepared, loosened subgrade according to "Mixing" Paragraph below. Mix thoroughly into top **4 inches** of subgrade. Spread remainder of planting soil.

C. Mixing: Spread unamended soil to total depth as **indicated on Drawings**, 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.

    a. Mix **lime and sulfur** with dry soil before mixing fertilizer.
    b. Mix fertilizer with planting soil no more than seven days before planting.

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 **6 inches** in loose depth for material compacted by hand-operated tampers.

D. Compaction: Compact each blended lift of planting soil to **75** percent of maximum Standard Proctor density according to ASTM D 698 and tested in-place.

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 **6 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.

1. Apply approximately half the thickness of planting soil over prepared, loosened subgrade. Mix thoroughly into top **4 inches** of subgrade. Spread remainder of planting soil.

C. Application: Spread planting soil to total depth **indicated on Drawings**, 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 **75** percent of maximum Standard Proctor density according to ASTM D 698.

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 BLENDING PLANTING SOIL IN PLACE

A. General: Mix amendments with in-place, unamended soil to produce required planting soil. Do not apply materials or till if existing soil or subgrade is frozen, muddy, or excessively wet.

B. Preparation: Till unamended, existing soil in planting areas to a minimum depth of **8 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: Apply soil amendments and fertilizer, if required, evenly on surface, and thoroughly blend them into full depth of unamended, in-place soil to produce planting soil.

1. Mix **lime and sulfur** with dry soil before mixing fertilizer.
2. Mix fertilizer with planting soil no more than seven days before planting.

D. Compaction: Compact blended planting soil to **75** percent of maximum Standard Proctor density according to ASTM D 698.

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.

3.6 APPLYING COMPOST TO SURFACE OF PLANTING SOIL

A. Application: Apply **compost component of planting-soil mix 6 inches of compost** to surface of in-place planting soil. Do not apply materials or till if existing soil or subgrade is frozen, muddy, or excessively wet.

B. Finish Grading: Grade surface to a smooth, uniform surface plane with loose, uniformly fine texture. Roll and rake, remove ridges, and fill depressions to meet finish grades.

3.7 FIELD QUALITY CONTROL

A. Testing Agency: **Engage** a qualified testing agency to perform tests and inspections. Terra Enviro Consulting, Inc., 208-377-9293 or approved equal.

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 D 698. S pace 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.

3.8 PROTECTION

A. Protection Zone: Identify protection zones according to Section 015639 "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. If planting soil or subgrade is over compacted, disturbed, or contaminated by foreign or deleterious materials or liquids, remove the planting soil and contamination; restore the subgrade as directed by Architect and replace contaminated planting soil with new planting soil.

3.9 CLEANING

A. Protect areas adjacent to planting-soil preparation and placement areas from contamination. Keep adjacent paving and construction clean and work area in an orderly condition.

B. 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 329113

SECTION 329200 - TURF AND GRASSES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Drill seeding
   2. Hydroseeding.
   3. Sodding.
   4. Erosion-control material(s).

B. Related Sections:

   1. Division 31 Section "Site Clearing" for topsoil stripping and stockpiling.
   2. Division 31 Section "Earth Moving" for excavation, filling and backfilling, and rough grading.
   3. Division 32 Section "Planting Irrigation " for turf irrigation.
   4. Division 32 Section "Plants" for border edgings.

C. References:
   1. FS O-F-241 - Fertilizers, Mixed, Commercial.
   2. ASPA (American Sod Producers Association) - Guideline Specifications to Sodding.

1.3 DEFINITIONS

A. Duff Layer: The surface layer of native topsoil that is composed of mostly decayed leaves, twigs, and detritus.

B. Finish Grade: Elevation of finished surface of planting soil.

C. Manufactured Topsoil: Soil produced off-site by homogeneously blending mineral soils or sand with stabilized organic soil amendments to produce topsoil or planting soil.

D. 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.

E. Pests: Living organisms that occur where they are not desired or that cause damage to plants, animals, or people. These include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.

F. Planting Soil: Standardized topsoil; existing, native surface topsoil; existing, in-place surface soil; imported topsoil; or manufactured topsoil that is modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth.

G. Subgrade: Surface or elevation of subsoil remaining after excavation is complete, or top surface of a fill or backfill before planting soil is placed.

H. Subsoil: All soil beneath the topsoil layer of the soil profile and typified by the lack of organic matter and soil organisms.

I. Surface Soil: Soil that is present at the top layer of the existing soil profile at the Project site. In undisturbed areas, the surface soil is typically topsoil, but in disturbed areas such as urban environments, the surface soil can be subsoil.

J. Topsoil: Per specifications section 328500.

K. Weeds: Include Dandelion, Jimsonweed, Quackgrass, Horsetail, Morning Glory, Rush Grass, Mustard, Lambsquarter, Chickweed, Cress, Crabgrass, Canadian Thistle, Nutgrass, Poison Oak, Blackberry, Tansy Ragwort, Bermuda Grass, Johnson Grass, Poison Ivy, Nut Sedge, Nimble Will, Bindweed, Bent Grass, Wild Garlic, Perennial Sorrel, Brome Grass, Black Henbane, Buffalobur, Common Crupina, Dalmatian Toadflax, Diffuse Knapweed, Dyer's Woad, Eurasian Watermilfoil, Field Bindweed, Hoary Cress, joined Goatgrass, Leafy Spurge, Matgrass, Meadow Hawkweed, Meadow Knapweed, Milium, Musk Thistle, Orange Hawkweed, Perennial Pepperweed, Perennial Sowthistle, Poison Hemlock, Puncturevine, Purple Loosestrife, Russian Knapweed, Scotch Broom, Scotch Thistle, Silverleaf Nightshade, Skeletonleaf Bursage, Spotted Knapweed, Syrian Beancaper, Toothed Spurge, Yellow Starthistle, Yellow Toadflax, Russian Knapweed, Jointed Goatgrass, Skeletonleaf Bursage, Hoary cress, Musk thistle, Yellow Starthistle, Hayek, Rush Skeletonweed, Poison Hemlock, Toothed Spurge, Leafy Spurge, Orange hawkweed, Dumort, Black henbane, Dyer's Woad, Perennial pepperweed, Yellow Toadflax, Milium, Eurasian Watermilfoil, Matgrass, Tansy Ragwort

1.4 SUBMITTALS

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

1. Pesticides and Herbicides: Include product label and manufacturer's application instructions specific to this Project.

B. Certification of Grass Seed: From seed vendor for each grass-seed monostand or mixture stating the botanical and common name, percentage by weight of each species and variety, and percentage of purity, germination, and weed seed. Include the year of production and date of packaging.

1. Certification of each seed mixture for turfgrass sod. Include identification of source and name and telephone number of supplier.

C. Submit sod certification for grass species and location of sod source.

D. Qualification Data: For qualified landscape Installer.

E. Product Certificates: For soil amendments and fertilizers, from manufacturer.

F. Material Test Reports: For existing native surface topsoil and imported or manufactured topsoil.

G. Maintenance Instructions: Recommended procedures to be established by Owner for maintenance of turf and meadows during a calendar year. Include cutting method and maximum grass height; types, application frequency, and recommended coverage of fertilizer and herbicide. Submit before expiration of required initial maintenance periods.

H. Seed Tabs: One tag for each seed mix used with date(s) of application.

I. Fertilizer Labels: One label for each mix with date(s) of applications.

J. Hydro-mulch Labels: One label with date(s) of application.

K. Hydro-mulch Tackifier Labels: One label with date(s) of application.

L. Soil Amendment samples.

1.5 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Company specializing in manufacturing products specified in this section, with not less than three (3) years of documented experience.

B. Soil-Testing Laboratory Qualifications: An independent laboratory or university laboratory, recognized by the State Department of Agriculture, with the experience and capability to conduct the testing indicated and that specializes in types of tests to be performed.

C. Soil Analysis: For each unamended soil type, furnish soil analysis and a written report by a qualified soil-testing laboratory stating percentages of organic matter; gradation of sand, silt, and clay content; cation exchange capacity; sodium absorption ratio; deleterious material; pH; and mineral and plant-nutrient content of the soil.
   1. Testing methods and written recommendations shall comply with USDA's Handbook No. 60.
   2. The soil-testing laboratory shall oversee soil sampling, with depth, location, and number of samples to be taken per instructions from Architect. A minimum of two representative samples shall be taken from varied locations for each soil to be used or amended for planting purposes.
   3. Report suitability of tested soil for turf growth.
      a. Based on the test results, state recommendations for soil treatments and soil amendments to be incorporated. State recommendations in weight per 1000 sq. ft. or volume per cu. yd. for nitrogen, phosphorus, and potash nutrients and soil amendments to be added to produce satisfactory planting soil suitable for healthy, viable plants.
      b. Report presence of problem salts, minerals, or heavy metals, including aluminum, arsenic, barium, cadmium, chromium, cobalt, lead, lithium, and vanadium. If such problem materials are present, provide additional recommendations for corrective action.

D. Pre-installation Conference: Conduct conference at Project site prior to any turf installation. Contractor shall schedule conference with the landscape architect.

E. Obtain materials from same source throughout.

F. Contractor shall be responsible to provide proof of material delivery and installation.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Seed and Other Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of conformance with state and federal laws, as applicable. The label shall show the variety of seed, the percentage of germination, purity and weed content.

B. Sod: Harvest, deliver, store, and handle sod according to requirements in "Specifications for Turfgrass Sod Materials" and "Specifications for Turfgrass Sod Transplanting and Installation" in TPI's "Guideline Specifications to Turfgrass Sodding." Deliver sod in time for planting within 24 hours of harvesting. Protect sod from breakage and drying.

C. Bulk Materials:
   1. Do not dump or store bulk materials near drainage facilities, structures, utilities, walkways and pavements, or on existing turf areas or plants.
   2. Provide erosion-control measures to prevent erosion or displacement of bulk materials, discharge of soil-bearing water runoff, and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
   3. Accompany each delivery of bulk fertilizers, lime, and soil amendments with appropriate certificates.

1.7 PROJECT CONDITIONS

A. Planting Restrictions: Coordinate planting periods with initial maintenance periods to provide required maintenance from date of Substantial Completion.

B. Planting Season: Seeding shall be accomplished in the fall prior to September 15th. If this is not accomplished, seeding shall be in the following spring after April 15.

C. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained. Apply products during favorable weather conditions according to manufacturer's written instructions.

1.8 SEQUENCING AND SCHEDULING

A. Coordinate work under provisions of Division 1.

B. Coordinate with installation of underground sprinkler system.

1.9 EXTENDED WARRANTY

A. Provide one-year warranty under provisions of Division 1. Warranty includes coverage for one continuous growing season; replace lawn (seed or sod) that is dead, unhealthy or in an unsightly condition.

1.10 MAINTENANCE SERVICE

A. Initial Turf Maintenance Service: Provide full maintenance by skilled employees of landscape Installer. Maintain as required in Part 3. Begin maintenance immediately after each area is planted and continue until acceptable turf is established but for not less than the following periods:

1. Seeded Turf: 60 days from date of Substantial Completion of entire project.
   a. When initial maintenance period has not elapsed before end of planting season, or if turf is not fully established, continue maintenance during next planting season.
   b. Seeded turf areas will not be accepted as substantial completion until a healthy, full, uniform stand of grass with no bare spots has been obtained.

2. Sodded Turf: 60 days from date of Substantial Completion of entire project.

B. Initial Dryland Grass Maintenance Service: Provide full maintenance by skilled employees of landscape Installer. Maintain as required in Part 3. Begin maintenance immediately after each area is planted and continue until acceptable meadow is established, but for not less than 60 days from date of Substantial Completion.

C. Maintain and establish lawn by watering, fertilizing, weeding, mowing, trimming, replanting, and other operations. Roll, regrade, and replant bare or eroded areas and remulch to produce a uniformly smooth lawn.
   1. In areas where mulch has been disturbed by wind or maintenance operations, add new mulch. Anchor as required to prevent displacement.
   2. Apply herbicides to control weed growth in accordance with manufacturer's instructions. Remedy damage resulting from improper use of herbicides.

D. Watering: Provide and maintain temporary piping, hoses, and lawn-watering equipment to convey water from sources and to keep lawn uniformly moist to a depth of 4 inches.
   1. Schedule watering to prevent wilting, puddling, erosion, and displacement of seed or mulch. Lay out temporary watering system to avoid walking over muddy or newly planted areas.
   2. Water lawn at a minimum rate of 1½ inch per week.

E. Mow lawn as soon as top growth is tall enough to cut. Repeat mowing to maintain specified height without cutting more than 30 percent of grass height. Remove no more than 30 percent of grass-leaf growth in initial or subsequent mowings. Do not delay mowing until grass blades bend over and become matted. Remove excess clippings after mowing. Do not mow when grass is wet. Schedule initial and subsequent mowings to maintain the grass height at 2.5inches

F. Lawn Fertilization: Apply fertilizer at intervals specified.

PART 2 - PRODUCTS

2.1 SEED

A. Grass Seed: Fresh, clean, dry, new-crop seed complying with AOSA's "Journal of Seed Technology; Rules for Testing Seeds" for purity and germination tolerances.

B. Seed Species: State-certified seed of grass species as follows:

C. Seed Species: Seed of grass species as follows, with not less than 95 percent germination, not less than 85 percent pure seed, and not more than 0.5 percent weed seed:
   1. Sun and Partial Shade: NoNet Spreading-type, Rhizomatous Turf Type Tall Fescue from Jacklin Seeds, or approved equal. Contractor shall submit seed mix for review and approval prior to installation.
   2. Seed shall be provided from and mixed by a certified dealer. Seed mixture shall be labeled with manufacturer's guaranteed analysis, germination rate and purity rate.
   3. Apply at manufacturer's recommended application rate.

2.2 TURF GRASS SOD

A. Turfgrass Sod: Certified, complying with "Specifications for Turfgrass Sod Materials" in TPI's "Guideline Specifications to Turfgrass Sodding." Furnish viable sod of uniform density, color, and texture, strongly rooted, and capable of vigorous growth and development when planted.

B. Turfgrass Species: Sod of grass species as follows, with not less than 95 percent germination, not less than 85 percent pure seed, and not more than 0.5 percent weed seed:
   1. Sun and Partial Shade: NoNet Spreading-type, Rhizomatous Turf Type Tall Fescue from Jacklin Seeds, or approved equal. Contractor shall submit seed mix for review and approval prior to installation."

2.3 SOIL AMENDMENTS

A. Compost: (Apply at 3 cu. yds. per 1000 sq. ft.) Well-composted, stable, and weed-free organic matter, pH range of 5.5 to 8; moisture content 35 to 55 percent by weight; 100 percent passing through 3/4-inch sieve; soluble salt content of 5 to 10 decisiemens/m; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings; and as follows:
   1. Organic Matter Content: 50 to 60 percent of dry weight.
   2. Feedstock: Agricultural, food, or industrial residuals; biosolids; yard trimmings; or source-separated or compostable mixed solid waste.

2.4 FERTILIZERS

A. Commercial Slow Release 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 soil-testing laboratory.
   2. Initial Application (two weeks after seeding, assumes fall planting) at 5 lbs/1000 sq. ft:
      a. 16 percent Nitrogen.
      b. 16 percent Phosphorus.
      c. 16 percent Potassium.
      d. Micronutrients
      e. 60 percent slow release nitrogen.
   3. Spring Fertilization: (April 1) at 7 lbs/1000 sq. ft.
      a. 30 percent Nitrogen.
      b. 6 percent Phosphorus.
      c. 12 percent Potassium
      d. 50 percent slow release nitrogen.
   4. Summer Application: (June 1) at 7 lbs/1000 sq. ft.
      a. 30 percent Nitrogen.

b. 6 percent Phosphorus.
c. 12 percent Potassium
d. 50 percent slow release nitrogen.

5. Fall Application: (August 15) at 7 lbs/1000 sq. ft.
   a. 18 percent Nitrogen.
   b. 3 percent Phosphorus.
   c. 18 percent Potassium
   d. 50 percent slow release nitrogen.

2.5 PLANTING SOILS

A. Planting Soil: ASTM D 5268 topsoil, with pH range of 5.5 to 7, a minimum of 4 percent organic material content; free of stones 1 inch or larger in any dimension and other extraneous materials harmful to plant growth. Mix ASTM D 5268 topsoil with the following soil amendments and fertilizers in the following quantities to produce planting soil:
   1. Weight of Compost per 1000 sq. ft.: 3 cu. yds.
   2. Weight of Elemental Sulfur (90% S) per 1000 Sq. Ft.: 2 lbs.
   3. Weight of Commercial Fertilizer per 1000 Sq. Ft.: 5 lbs.
   4. Weight of Muriate of potash (00-00-60) per 1000 Sq. Ft.: 6.5 lbs.
   5. Weight of Monoammonium phosphate (11-52-00) per 1000 Sq. Ft.: 1.2 lbs

B. Planting Soil: Imported topsoil or manufactured topsoil from off-site sources. Obtain topsoil displaced from naturally well-drained construction or mining sites where topsoil occurs at least 4 inches deep; do not obtain from bogs or marshes.

   1. Additional Properties of Imported Topsoil or Manufactured Topsoil: Screened and free of stones 1/2 inch or larger in any dimension; free of roots, plants, sod, clods, clay lumps, pockets of coarse sand, paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, building debris, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, acid, and other extraneous materials harmful to plant growth; free of obnoxious weeds and invasive plants including quackgrass, Johnsongrass, poison ivy, nutsedge, nimblewill, Canada thistle, bindweed, bentgrass, wild garlic, ground ivy, perennial sorrel, and bromegrass; not infested with nematodes, grubs, other pests, pest eggs, or other undesirable organisms and disease-causing plant pathogens; friable and with sufficient structure to give good tilth and aeration. Continuous, air-filled, pore-space content on a volume/volume basis shall be at least 15 percent when moisture is present at field capacity. Soil shall have a field capacity of at least 15 percent on a dry weight basis.

2.6 MULCHES

A. Straw Mulch: Provide air-dry, clean, mildew- and seed-free, salt hay or threshed straw of wheat, rye, oats, or barley.

B. Fiber Mulch: Biodegradable, dyed-wood, cellulose-fiber mulch; nontoxic and free of plant-growth or germination inhibitors; with a maximum moisture content of 15 percent and a pH range of 4.5 to 6.5.

C. Nonasphaltic Tackifier: Colloidal tackifier recommended by fiber-mulch manufacturer for slurry application; nontoxic and free of plant-growth or germination inhibitors.

2.7 PESTICIDES

A. General: Pesticide, registered and approved by 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.

B. Pre-Emergent Herbicide (Selective and Non-Selective): Effective for controlling the germination or growth of weeds within planted areas at the soil level directly below the mulch layer.

C. Post-Emergent Herbicide (Selective and Non-Selective): Effective for controlling weed growth that has already germinated.

D. Weed Abatement: “Round-up” (contact herbicide) by Monsanto, or approved equal.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to be planted for compliance with requirements and other conditions affecting performance.

1. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.
2. Do not mix or place soils and soil amendments in frozen, wet, or muddy conditions.
3. Suspend soil spreading, grading, and tilling operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.
4. Uniformly moisten excessively dry soil that is not workable and which is too dusty.
5. Verify that prepared topsoil is ready to receive the work of this Section.
6. Beginning of installation means acceptance of existing site conditions.
7. All planting areas shall be weed free at the time of seed or sod installation.
8. Soil Tests: Per Landscape Grading specification section 328500. Prior to planting, amendments shall be added to correct for problems as noted by the soils report.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

C. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove the soil and contamination as directed by Landscape Architect and replace with new planting soil.

3.2 WEED ABATEMENT

A. All areas to be planted or hydroseeded shall have weed abatement operations performed on them prior to planting or hydroseeding.

B. Contractor shall spray all exposed weeds with “Round-up” (contact herbicide) or approved equal.

C. Do not water for at least seven (7) days. Remove exposed weeds from the site.

D. Contractor shall operate the automatic irrigation system for a period of fourteen (14) days. At conclusion of this watering period, discontinue watering for three to five (3-5) days.

E. Apply second application of "Round-up" to all exposed weeds. Apply in strict conformance with manufacturer's specifications and instructions. Do not water for at least seven (7) days. Remove weeds from the site.

F. If any evidence of weed germination exists after two (2) applications, Contractor shall be directed to perform a third application.

G. At the time of planting and hydroseeding, all planting areas shall be weed free.

3.3 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities, trees, shrubs, and plantings from damage caused by planting operations.
   1. Protect adjacent and adjoining areas from hydroseeding and hydromulching overspray.
   2. Protect grade stakes set by others until directed to remove them.

B. Install erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

3.4 TURF AREA PREPARATION

A. Limit turf subgrade preparation to areas to be planted.

B. Newly Graded Subgrades: Loosen subgrade to a minimum depth of 4 inches. Remove stones larger than 1 inch in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.
   1. Spread planting soil to a depth of 9 inches in turf areas and 18 inches at shrub bed areas but not less than required to meet finish grades after light rolling and natural settlement. Do not spread if planting soil or subgrade is frozen, muddy, or excessively wet.
      a. Spread planting soil over loosened subgrade.
      b. Reduce elevation of planting soil to allow for soil thickness of sod.

C. Unchanged Subgrades: If turf is to be planted in areas unaltered or undisturbed by excavating, grading, or surface-soil stripping operations, prepare surface soil as follows:
   1. Remove existing grass, vegetation, and turf. Do not mix into surface soil.
   2. Loosen surface soil to a depth of at least 6 inches. Provide weed abatement procedure. Apply soil amendments and fertilizers according to planting soil mix proportions and mix thoroughly into top 6 inches of soil. Till soil to a homogeneous mixture of fine texture.
      a. Apply soil amendments directly to surface soil before loosening.

   3. Remove stones larger than 1 inch in any dimension and sticks, roots, trash, and other extraneous matter.
   4. Legally dispose of waste material, including grass, vegetation, and turf, off Owner's property.

D. Finish Grading: Grade planting areas to a smooth, uniform surface plane with loose, uniformly fine texture. Grade to within plus or minus 1/2 inch of finish elevation. Roll and rake, remove

ridges, and fill depressions to meet finish grades. Limit finish grading to areas that can be planted in the immediate future.

E. Moisten prepared area before planting if soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.

F. Before planting, obtain Landscape Architect's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.

G. Do not sow immediately following rain, or when ground is too dry. Temperature shall be between 55 F and 95 F for a 24 hour period. Wind shall be less than 5 mph.

H. Turf Seed shall be sown at a rate per seed supplier recommendations.

I. Seed shall be hydroseeded or drill seeded at the contractors option. Areas with a 4:1 or greater slope shall be hydroseeded.

3.5 DRILL SEEDING

A. Sow seed with cultipacker ("Brillion" equipment or equal), seeding machine, or approved similar equipment to drill, cover and firm the seed bed in one operation. Evenly distribute seed by sowing equal quantities in two directions at right angles to each other. Apply water with a fine spray immediately after each area has been seeded. Saturate the top 4 inches of soil.

1. Do not use wet seed or seed that is moldy or otherwise damaged.
2. Do not seed against existing trees.
3. Keep soil surface continuously damp.

B. Protect seeded areas with slopes exceeding 1:4 by spreading straw mulch. Spread uniformly at a minimum rate of 2 tons/acre to form a continuous blanket 1 inches in loose thickness over seeded areas. Spread by hand, blower, or other suitable equipment.

1. Anchor straw mulch by crimping into soil with suitable mechanical equipment.

3.6 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 in excess of 4 horizontal to 1 vertical shall b hydroseeded.

1. Mix slurry with nonasphaltic tackifier.
2. Apply slurry uniformly to all areas to be seeded in a one-step process. Apply slurry at a rate so that mulch 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.

3.7 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 subgrade or sod during installation. Tamp and roll lightly to ensure contact with subgrade, 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. Moisten prepared surface immediately prior to laying sod.

2. Lay sod immediately after delivery to site to prevent deterioration.
3. Lay sod across angle (perpendicular) of slopes exceeding 1:3.
4. Anchor sod on slopes exceeding 1:6 with wood pegs spaced as recommended by sod manufacturer but not less than 2 anchors per sod strip to prevent slippage.
5. After sod and soil have dried, roll sodded areas to ensure good bond between sod and soil and to remove minor depressions and irregularities.

C. Saturate sod with fine water spray immediately after 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.

3.8 TURF MAINTENANCE

A. Maintain and establish turf by watering, fertilizing, weeding, mowing, trimming, replanting, and performing other operations as required to establish healthy, viable turf. Roll, regrade, and replant bare or eroded areas and remulch to produce a uniformly smooth turf. Provide materials and installation the same as those used in the original installation.

1. Fill in as necessary soil subsidence that may occur because of settling or other processes. Replace materials and turf damaged or lost in areas of subsidence.
2. In areas where mulch has been disturbed by wind or maintenance operations, add new mulch and anchor as required to prevent displacement.
3. Apply treatments as required to keep turf and soil free of pests and pathogens or disease. Use integrated pest management practices whenever possible to minimize the use of pesticides and reduce hazards.

B. Watering: Install and maintain temporary piping, hoses, and turf-watering equipment to convey water from sources and to keep turf uniformly moist to a depth of 4 inches.

1. Schedule watering to prevent wilting, puddling, erosion, and displacement of seed or mulch. Lay out temporary watering system to avoid walking over muddy or newly planted areas.
2. Water turf with fine spray at a minimum rate of 1 inch per week unless rainfall precipitation is adequate.

C. Mow turf as soon as top growth is tall enough to cut. Repeat mowing to maintain specified height without cutting more than 1/3 of grass height. Remove no more than 1/3 of grass-leaf growth in initial or subsequent mowings. Do not delay mowing until grass blades bend over and become matted. Do not mow when grass is wet. Contractor shall be responsible to maintain, fertilize, and mow all phase one turf areas until 60 days after phase two final acceptance. Schedule initial and subsequent mowings to maintain the following grass height:
1. Mow specified turf areas to a height of 2 inches.

D. Turf Post fertilization: Apply fertilizer after initial mowing and when grass is dry.

1. Apply fertilizer in accordance with manufacturer's instructions.
2. Lightly water to aid the dissipation of fertilizer.
3. Sweep all hard surfaces of fertilizer overthrow.
4. Turf areas seeded months ahead of acceptance of the entire project will be fertilized on an eight to ten week schedule consistent with the seasonal period and application rates specified.

3.9 SATISFACTORY TURF

A. Turf installations shall meet the following criteria as determined by Landscape 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 98 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.
3. All turf areas will be accepted at the same time, including all phased areas.

B. Use specified materials to reestablish turf that does not comply with requirements and continue maintenance until turf is satisfactory.

3.10 PESTICIDE APPLICATION

A. Apply pesticides and other chemical products and biological control agents in accordance with requirements of authorities having jurisdiction and manufacturer's written recommendations. Coordinate applications with Owner's operations and others in proximity to the Work. Notify Owner before each application is performed.

B. Post-Emergent Herbicides (Selective and Non-Selective): Apply only as necessary to treat already-germinated weeds and in accordance with manufacturer's written recommendations.

3.11 CLEANUP AND PROTECTION

A. Promptly remove soil and debris created by turf work from paved areas. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.

B. All scars, ruts or other marks in the ground caused by this work shall be repaired and the ground left in a neat and orderly condition throughout the site. Contractor shall pick up all trash resulting from this work no less frequently than each Friday before leaving the site, once a week, and/or the last working day of each week. All trash shall be removed completely from the site. The Contractor shall leave the site area broom-clean and shall wash down all paved areas within the Contract area, leaving the premises in a clean condition acceptable to the Owner and Construction Manager.

C. Erect temporary fencing or barricades and warning signs to protect newly planted areas from traffic. Maintain fencing and barricades throughout initial maintenance period and remove after plantings are established.

D. Remove nondegradable erosion-control measures after grass establishment period.

END OF SECTION 329200

PAGE INTENTIONALLY BLANK

SECTION 329300 - PLANTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Plants.
2. Planting soils.
3. Tree stabilization.
4. Landscape edgings.

B. Related Sections:
1. Division 31 Section "Site Clearing" for protection of existing trees and plantings, topsoil stripping and stockpiling, and site clearing.
2. Division 31 Section "Earth Moving" for excavation, filling, and rough grading and for subsurface aggregate drainage and drainage backfill materials.
3. Division 32 Section "Turf and Grasses" for turf (lawn) and meadow planting, hydroseeding, and erosion-control materials.

1.3 DEFINITIONS

A. Backfill: The earth used to replace or the act of replacing earth in an excavation.

B. Balled and Bur lapped Stock: Plants dug with firm, natural balls of earth in which they were grown, with ball size not less than diameter and depth recommended by ANSI Z60.1 for type and size of plant required; wrapped with burlap, tied, rigidly supported, and drum laced with twine with the root flare visible at the surface of the ball as recommended by ANSI Z60.1.

C. Balled and Potted Stock: Plants dug with firm, natural balls of earth in which they are grown and placed, unbroken, in a container. Ball size is not less than diameter and depth recommended by ANSI Z60.1 for type and size of plant required.

D. Container-Grown Stock: Healthy, vigorous, well-rooted plants grown in a container, with a well-established root system reaching sides of container and maintaining a firm ball when removed from container. Container shall be rigid enough to hold ball shape and protect root mass during shipping and be sized according to ANSI Z60.1 for type and size of plant required.

E. Duff Layer: The surface layer of native topsoil that is composed of mostly decayed leaves, twigs, and detritus.

F. Fabric Bag-Grown Stock: Healthy, vigorous, well-rooted plants established and grown in-ground in a porous fabric bag with well-established root system reaching sides of fabric bag. Fabric bag size is not less than diameter, depth, and volume required by ANSI Z60.1 for type and size of plant.

G. Finish Grade: Elevation of finished surface of planting soil.

H. Manufactured Topsoil: Soil produced off-site by homogeneously blending mineral soils or sand with stabilized organic soil amendments to produce topsoil or planting soil.

I. 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.

J. Pests: Living organisms that occur where they are not desired, or that cause damage to plants, animals, or people. These include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.

K. Planting Area: Areas to be planted.

L. Planting Soil: Standardized topsoil; existing, native surface topsoil; existing, in-place surface soil; imported topsoil; or manufactured topsoil that is modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth.

M. Plant; Plants; Plant Material: These terms refer to vegetation in general, including trees, shrubs, vines, ground covers, ornamental grasses, bulbs, corms, tubers, or herbaceous vegetation.

N. Root Flare: Also called "trunk flare." The area at the base of the plant's stem or trunk where the stem or trunk broadens to form roots; the area of transition between the root system and the stem or trunk.

O. Stem Girdling Roots: Roots that encircle the stems (trunks) of trees below the soil surface.

P. 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.

Q. Subsoil: All soil beneath the topsoil layer of the soil profile and typified by the lack of organic matter and soil organisms.

R. Surface Soil: Soil that is present at the top layer of the existing soil profile at the Project site. In undisturbed areas, the surface soil is typically topsoil; but in disturbed areas such as urban environments, the surface soil can be subsoil.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated, including soils.

B. Samples for Verification: For each of the following:
   1. Certificates required by law that accompany shipments.

2. Bark Mulch: 1-quart volume of each organic mulch required; in sealed plastic bags labeled with composition of materials by percentage of weight and source of mulch. Each Sample shall be typical of the lot of material to be furnished; provide an accurate representation of color, texture, and organic makeup.
3. Compost Material: One gallon Ziploc bag with sample name, product material, including testing information.
4. Weed Control Barrier: 12 by 12 inches.
5. Edging Materials and Accessories: Manufacturer's standard size, to verify color selected.
6. Root Barrier: Width of panel by 12 inches.

C. Qualification Data: For qualified landscape Installer. Include list of similar projects completed by Installer demonstrating Installer's capabilities and experience. Include project names, addresses, and year completed, and include names and addresses of owners' contact persons.

D. Product Certificates: For each type of manufactured product, from manufacturer, and complying with the following:

1. Manufacturer's certified analysis of standard products.
2. Analysis of other materials by a recognized laboratory made according to methods established by the Association of Official Analytical Chemists, where applicable.

E. Maintenance Instructions: Recommended procedures to be established by Owner for maintenance of plants during a calendar year. Submit before start of required maintenance periods.

F. Warranty: Sample of special warranty.

G. Submit list of plant life sources, size and quality.
1. Substitutions: Submit list of plant life sources, size, quality and plants being recommended for substitution. Substitutions will not be approved unless non-availability can be demonstrated.

H. Project Record Documents:
1. Record plant locations, including substitutions, and quantities.

I. Soil-Testing Laboratory Qualifications: An independent or university laboratory, recognized by the State Department of Agriculture, with the experience and capability to conduct the testing indicated and that specializes in types of tests to be performed.

J. Soil Analysis: For each unamended soil type, furnish soil analysis and a written report by a qualified soil-testing laboratory stating percentages of organic matter; gradation of sand, silt, and clay content; cation exchange capacity; sodium absorption ratio; deleterious material; pH; and mineral and plant-nutrient content of the soil.

1. Testing methods and written recommendations shall comply with USDA's Handbook No. 60.
2. The soil-testing laboratory shall oversee soil sampling; with depth, location, and number of samples to be taken per instructions from Architect. A minimum of three representative samples shall be taken from varied locations for each soil to be used or amended for planting purposes.
3. Report suitability of tested soil for plant growth.

a. Based upon the test results, state recommendations for soil treatments and soil amendments to be incorporated. State recommendations in weight per 1000 sq. ft. or volume per cu. yd. for nitrogen, phosphorus, and potash nutrients and soil amendments to be added to produce satisfactory planting soil suitable for healthy, viable plants.
b. Report presence of problem salts, minerals, or heavy metals, including aluminum, arsenic, barium, cadmium, chromium, cobalt, lead, lithium, and vanadium. If such problem materials are present, provide additional recommendations for corrective action.

K. Provide quality, size, genus, species, and variety of plants indicated, complying with applicable requirements in ANSI Z60.1.

L. Measurements: Measure according to ANSI Z60.1. Do not prune to obtain required sizes.

1. Trees and Shrubs: Measure with branches and trunks or canes in their normal position. Take height measurements from or near the top of the root flare for field-grown stock and container grown stock. Measure main body of tree or shrub for height and spread; do not measure branches or roots tip to tip. Take caliper measurements 6 inches above the root flare for trees up to 4-inch caliper size, and 12 inches above the root flare for larger sizes.
2. Other Plants: Measure with stems, petioles, and foliage in their normal position.

M. Plant Material Observation: Architect may observe plant material either at place of growth or at site before planting for compliance with requirements for genus, species, variety, cultivar, size, and quality. Architect retains right to observe trees and shrubs further for size and condition of balls and root systems, pests, disease symptoms, injuries, and latent defects and to reject unsatisfactory or defective material at any time during progress of work. Remove rejected trees or shrubs immediately from Project site.

1. Notify Landscape Architect of sources of planting materials seven days in advance of delivery to site.

N. Preinstallation Conference: Conduct conference at project site.

O. Tree Pruning/Maintenance: ASNI A300 – American National Standard for Tree Care Operations – Tree, Shrub and Other Wood Plant Maintenance Standard Practices.

P. Tree Pruner Qualifications: Company specializing in pruning trees with proof of Arborist Certification.

1.5 REGULATORY REQUIREMENTS

A. Comply with regulatory agencies for compost material composition.

B. Comply with regulatory agencies for fertilizer and herbicide composition.

C. Plant Materials: Certified by federal department of agriculture; free of disease or hazardous insects.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of conformance with state and federal laws if applicable.

B. Bulk Materials:

1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
2. Provide erosion-control measures to prevent erosion or displacement of bulk materials, discharge of soil-bearing water runoff, and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
3. Accompany each delivery of bulk fertilizers and soil amendments with appropriate certificates.

C. Deliver plants freshly dug.

D. Do not prune trees and shrubs before delivery, except as approved by Landscape Architect. 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.

E. Handle planting stock by root ball.

F. 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. Set balled stock on ground and cover ball with soil, peat moss, sawdust, or other acceptable material.
2. Do not remove container-grown stock from containers before time of planting.
3. Water root systems of plants stored on-site deeply and thoroughly with a fine-mist spray. Water as often as necessary to maintain root systems in a moist, but not overly-wet condition.

G. Deliver fertilizer in waterproof bags showing weight, chemical analysis, and name of manufacturer.

H. Deliver all plant material to the site in their original containers with labels intact and legible at the time of inspection.

I. Remove from the site all plants that are not true to name and all materials that do not comply with the provisions of this section.

1.7 PROJECT CONDITIONS

A. Field Measurements: Verify actual grade elevations, service and utility locations, irrigation system components, and dimensions of plantings and construction contiguous with new plantings by field measurements before proceeding with planting work.

B. Interruption of Existing Services or Utilities: Do not interrupt services or utilities to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary services or utilities according to requirements indicated:

1. Notify Architect no fewer than two days in advance of proposed interruption of each service or utility.
2. Do not proceed with interruption of services or utilities without Architect's written permission.

C. Planting Restrictions: Coordinate planting periods with maintenance periods to provide required maintenance from date of Substantial Completion.

D. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained. Apply products during favorable weather conditions according to manufacturer's written instructions and warranty requirements.

E. Coordination with Turf Areas (Lawns): Plant trees, shrubs, and other plants after finish grades are established and before planting turf areas unless otherwise acceptable to Landscape Architect.

1. When planting trees, shrubs, and other plants after planting turf areas, protect turf areas, and promptly repair damage caused by planting operations.

2. Ensure proper irrigation coverage for plant watering.

1.8 WARRANTY

A. Special Warranty: Warrant the following exterior plants, for the warranty period indicated, against defects including death and unsatisfactory growth, except for defects resulting from lack of adequate maintenance, neglect, or abuse by Owner, or incidents that are beyond Contractor's control.

1. Warranty Period for Trees and Shrubs: One year from date of Substantial Completion.

2. Warranty Period for Ground Cover: Twelve (12) months from date of Substantial CompletionWhen warranties are required, verify with Owner's counsel that special warranties stated in this article are not less than remedies available to Owner under prevailing local laws.

3. Include the following remedial actions as a minimum:

a. Immediately remove dead plants and replace unless required to plant in the succeeding planting season.
b. Replace plants that are more than 25 percent dead or in an unhealthy condition at end of warranty period.

c. A limit of one replacement of each plant will be required except for losses or replacements due to failure to comply with requirements.
d. One (1) year warranty walk-through to review status of plants with Owner and Landscape Architect.

1.9 MAINTENANCE SERVICE

A. Initial Maintenance Service for Trees and Shrubs: Provide maintenance by skilled employees of landscape Installer. Maintain as required in Part 3. Begin maintenance immediately after plants are installed and continue until plantings are acceptably healthy and well established but for not less than maintenance period below.

1. Maintenance Period: One month from date of Substantial Completion.

B. Initial Maintenance Service for Ground Cover and Other Plants: Provide maintenance by skilled employees of landscape Installer. Maintain as required in Part 3. Begin maintenance immediately after plants are installed and continue until plantings are acceptably healthy and well established but for not less than maintenance period below.

1. Maintenance Period: One month from date of Substantial Completion.

C. Removal of tree stakes after one (1) year warranty walk-through is complete.

PART 2 - PRODUCTS

2.1 PLANT MATERIAL

A. General: Furnish nursery-grown plants true to genus, species, variety, cultivar, stem form, shearing, and other features indicated in Plant Schedule or Plant Legend shown 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.

1. Trees with damaged, crooked, or multiple leaders; tight vertical branches where bark is squeezed between two branches or between branch and trunk ("included bark"); crossing trunks; cut-off limbs more than 3/4 inch in diameter; or with stem girdling roots will be rejected.
2. Collected Stock: Do not use plants harvested from the wild, from native stands, from an established landscape planting, or not grown in a nursery unless otherwise indicated.

B. Provide plants of sizes, grades, and ball or container sizes complying with ANSI Z60.1 for types and form of plants required. Plants of a larger size may be used if acceptable to Architect, with a proportionate increase in size of roots or balls.

C. Root-Ball Depth: Furnish trees and shrubs with root balls measured from top of root ball, which shall begin at root flare according to ANSI Z60.1. Root flare shall be visible before planting.

D. Labeling: Label each plant of each variety, size, and caliper with a securely attached, waterproof tag bearing legible designation of common name and full scientific name, including genus and species. Include nomenclature for hybrid, variety, or cultivar, if applicable for the plant as shown on Drawings.

E. If formal arrangements or consecutive order of plants is shown on Drawings, select stock for uniform height and spread, and number the labels to assure symmetry in planting.

2.2 ORGANIC SOIL AMENDMENTS

A. Compost: Well-composted, stable, and weed-free organic matter, pH range of 5.5 to 8; moisture content 35 to 55 percent by weight; 100 percent passing through 3/4-inch sieve; soluble salt content of 5 to 10 decisiemens/m; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings; and as follows:

1. Organic Matter Content: 50 to 60 percent of dry weight.
2. Feedstock: Agricultural, food, or industrial residuals; biosolids; yard trimmings; or source-separated or compostable mixed solid waste.

B. Muck Peat: Partially decomposed moss peat, native peat, or reed-sedge peat, finely divided or of granular texture, with a pH range of 6 to 7.5, and having a water-absorbing capacity of 1100 to 2000 percent.

C. 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. Planting Tablets: Tightly compressed chip type, long-lasting, slow-release, commercial-grade planting fertilizer in tablet form. Tablets shall break down with soil bacteria, converting nutrients into a form that can be absorbed by plant roots.
1. Product: Agriform 20-10-5, or approved equal.
2. Nutrient Composition: 20 percent nitrogen, 10 percent phosphorous, and 5 percent potassium, by weight plus micronutrients.

2.4 PLANTING SOIL MIX

A. Planting Soil Mix: Mix topsoil with the following soil amendments and fertilizers in the following quantities:
1. Ratio of Loose Compost to Topsoil by Volume: 1:5.

B. Additional Amendments:
1. Fertilizer Tablets:
   a. Three (3) tablets for shrubs
   b. Eight (8) tablets for trees.

2.5 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: Crushed Basalt Mulch
2. Size Range: 3 inches maximum, 2 inch minimum.
3. Color: Natural.

2.6 WEED-CONTROL BARRIERS

A. Composite Fabric: Woven, needle-punched polypropylene substrate bonded to a nonwoven polypropylene fabric, 4.8 oz./sq. yd..

2.7 PESTICIDES

A. General: Pesticide registered and approved by 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.

B. Pre-Emergent Herbicide (Selective and Non-Selective): Effective for controlling the germination or growth of weeds within planted areas at the soil level directly below the mulch layer.

2.8 TREE STABILIZATION MATERIALS

A. Stakes and Guys:

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. Flags: Standard surveyor's plastic flagging tape, white, 6 inches long.
3. Proprietary Staking-and-Guying Devices: Proprietary stake and adjustable tie systems to secure each new planting by plant stem; sized as indicated and per manufacturer's written recommendations.

    a. Products: Subject to compliance with requirements, provide the following or approved equal:

        1) Arborbrace; ArborBrace Tree Guying System.

        2) Arbortie by Deeproot, www.deeproot.com .

2.9 MISCELLANEOUS PRODUCTS

A. Antidesiccant: Water-insoluble emulsion, permeable moisture retarder, film forming, for trees and shrubs. Deliver in original, sealed, and fully labeled containers and mix according to manufacturer's written instructions.

B. Planter Filter Fabric: Woven geotextile manufactured for separation applications and made of polypropylene, polyolefin, or polyester fibers or combination of them.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive plants for compliance with requirements and conditions affecting installation and performance.

1. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.
2. Do not mix or place soils and soil amendments in frozen, wet, or muddy conditions.
3. Suspend soil spreading, grading, and tilling operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.
4. Uniformly moisten excessively dry soil that is not workable and which is too dusty.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

C. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove the soil and contamination as directed by Architect and replace with new planting soil.

3.2 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities and turf areas and existing plants from damage caused by planting operations.

B. Install erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

C. Lay out individual tree and shrub locations and areas for multiple plantings. Stake locations, outline areas, adjust locations when requested, and obtain Architect's acceptance of layout before excavating or planting. Make minor adjustments as required.

D. Lay out plants at locations directed by Landscape Architect. Stake locations of individual trees and shrubs and outline areas for multiple plantings.

E. Apply antidesiccant to trees and shrubs using power spray to provide an adequate film over trunks (before wrapping), branches, stems, twigs, and foliage to protect during digging, handling, and transportation.

1. If deciduous trees or shrubs are moved in full leaf, spray with antidesiccant at nursery before moving and again two weeks after planting.

F. Wrap trees and shrubs with burlap fabric over trunks, branches, stems, twigs, and foliage to protect from wind and other damage during digging, handling, and transportation.

3.3 PLANTING AREA ESTABLISHMENT

A. Loosen subgrade of planting areas to a minimum depth of 4 inches. Remove stones larger than 1/2 inches in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.

1. Spread topsoil, apply soil amendments and fertilizer on surface, and thoroughly blend planting soil mix.

2. Spread planting soil to meet finish grades after natural settlement. Do not spread if planting soil or subgrade is frozen, muddy, or excessively wet.

B. Finish Grading: Grade planting areas to a smooth, uniform surface plane with loose, uniformly fine texture. Roll and rake, remove ridges, and fill depressions to meet finish grades.

C. Before planting, obtain Landscape Architect's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.

3.4 EXCAVATION FOR TREES AND SHRUBS

A. Planting Pits and Trenches: Excavate circular planting pits with sides sloping inward at a 45-degree angle. Excavations with vertical sides are not acceptable. 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.

1. Excavate approximately three times as wide as ball diameter for stock.
2. Excavate at least equal width of rootball.
3. Do not excavate deeper than depth of the root ball, measured from the root flare to the bottom of the root ball.
4. If area under the plant was initially dug too deep, add soil to raise it to the correct level and thoroughly tamp the added soil to prevent settling.
5. Maintain required angles of repose of adjacent materials as shown on the Drawings. Do not excavate subgrades of adjacent paving, structures, hardscapes, or other new or existing improvements.
6. Maintain supervision of excavations during working hours.
7. Keep excavations covered or otherwise protected after working hours or when unattended by Installer's personnel.

B. Subsoil and topsoil removed from excavations may be used as planting soil.

C. Obstructions: Notify Landscape Architect if unexpected rock or obstructions detrimental to trees or shrubs are encountered in excavations.

1. Hardpan Layer: Drill 6-inch- diameter holes, 24 inches apart, into free-draining strata or to a depth of 10 feet, whichever is less, and backfill with free-draining material.

D. Drainage: Notify Landscape Architect if subsoil conditions evidence unexpected water seepage or retention in tree or shrub planting pits.

E. Fill excavations with water and allow to percolate away before positioning trees and shrubs.

3.5 TREE, SHRUB, AND VINE PLANTING

A. Before planting, verify that root flare is visible at top of root ball according to ANSI Z60.1. If root flare is not visible, remove soil in a level manner from the root ball to where the top-most root emerges from the trunk. After soil removal to expose the root flare, verify that root ball still meets size requirements.

B. **Remove <u>all</u> burlap and wire baskets from root balls. Remove all nails, ties, and plastic from the trunk and root ball.** Remove pallets, if any, before setting. Do not use planting stock if root ball is cracked or broken before or during planting operation.

C. Remove stem girdling roots and kinked roots. Remove injured roots by cutting cleanly; do not break.

D. Set balled and burlapped stock plumb and in center of planting pit or trench with root flare 1 inch above adjacent finish grades.

1. Use planting 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 planting tablets in each planting pit when pit is approximately one-half filled; in amounts recommended in soil reports from soil-testing laboratory. Place tablets beside the root ball about 1 inch from root tips; do not place tablets in bottom of the hole.
5. Continue backfilling process. Water again after placing and tamping final layer of soil.

E. Set container-grown stock plumb and in center of planting pit or trench with root flare 1 inch above adjacent finish grades.

1. Use planting 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 planting tablets in each planting pit when pit is approximately one-half filled; in amounts recommended in soil reports from soil-testing laboratory. Place tablets beside the root ball about 1 inch from root tips; do not place tablets in bottom of the hole. Place mycorrhizal fungal transplant inoculant in doughnut shape around rootball.
5. Continue backfilling process. Water again after placing and tamping final layer of soil.

F. 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 the root ball on the downhill side will be above the surrounding soil. Apply enough soil to cover the downhill side of the root ball.

3.6 TREE, SHRUB, AND VINE PRUNING

A. Remove only dead, dying, or broken branches. Do not prune for shape.

B. Prune, thin, and shape trees, shrubs, and vines as directed by Landscape Architect.

C. Prune, thin, and shape trees, shrubs, and vines according to standard professional horticultural and arboricultural practices, see ASNI-A300, Paragraph 5.4.1 Young Tree Pruning at Planting. Unless otherwise indicated by Landscape Architect, **do not cut tree leaders**; remove only injured, dying, or dead branches from trees and shrubs; and prune to retain natural character.

D. Do not apply pruning paint to wounds.

3.7 TREE STABILIZATION

A. Install trunk stabilization as follows unless otherwise indicated:

1. Upright Staking and Tying: Stake trees of 2- through 5-inch caliper. Stake trees of less than 2-inch caliper only as required to prevent wind tip out. Use a minimum of two stakes of length required to penetrate at least 18 inches below bottom of backfilled excavation and to extend to the dimension shown on Drawings above grade. Set vertical stakes and space to avoid penetrating root balls or root masses.
2. Use two stakes for trees up to 12 feet high and 3 inches or less in caliper; three stakes for trees less than 14 feet high and up to 4 inches in caliper. Space stakes equally around trees.
3. Support trees with bands of flexible ties at contact points with tree trunk. Allow enough slack to avoid rigid restraint of tree.
4. Support trees with two strands of tie wire, connected to the brass grommets of tree-tie webbing at contact points with tree trunk. Allow enough slack to avoid rigid restraint of tree.

3.8 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. For rooted cutting plants supplied in flats, plant each in a manner that will minimally disturb the root system but to a depth not less than two nodes.

E. Work soil around roots to eliminate air pockets and leave a slight saucer indentation around plants to hold water.

F. Water thoroughly after planting, taking care not to cover plant crowns with wet soil.

G. Protect plants from hot sun and wind; remove protection if plants show evidence of recovery from transplanting shock.

3.9 PLANTING AREA MULCHING

A. Install weed-control barriers before mulching according to manufacturer's written instructions. Completely cover area to be mulched, overlapping edges a minimum of 6 inches and secure seams with galvanized pins.

B. Mulch backfilled surfaces of planting areas and other areas indicated.

1. Trees in Turf Areas: Apply organic mulch ring of 3-inch average thickness, with 36-inch radius around trunks or stems. Do not place mulch within 3 inches of trunks or stems.
2. Organic Mulch in Planting Areas: Apply 3-inch average thickness of organic 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.

3.10 EDGING INSTALLATION

A. Shovel-Cut Edging: Separate mulched areas from turf areas, curbs, and paving with a 45-degree, 4- to 6-inch- deep, shovel-cut edge as shown on Drawings.

3.11 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. Spray or treat as required to keep trees and shrubs free of insects and disease.

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 past management practices whenever possible to minimize the use of pesticides and reduce hazards. Treatments include physical controls such as hosing off foliage, mechanical controls such as traps, and biological control agents.

3.12 PESTICIDE APPLICATION

A. Apply pesticides and other chemical products and biological control agents in accordance with authorities having jurisdiction and manufacturer's written recommendations. Coordinate applications with Owner's operations and others in proximity to the Work. Notify Owner before each application is performed.

B. Pre-Emergent Herbicides (Selective and Non-Selective): Apply to tree, shrub, and ground-cover areas in accordance with manufacturer's written recommendations. Do not apply to seeded areas.

C. Post-Emergent Herbicides (Selective and Non-Selective): Apply only as necessary to treat already-germinated weeds and in accordance with manufacturer's written recommendations.

3.13 CLEANUP AND PROTECTION

A. During planting, keep adjacent paving and construction clean and work area in an orderly condition.

B. 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.

C. After installation and before Substantial Completion, remove nursery tags, nursery stakes, tie tape, labels, wire, burlap, and other debris from plant material, planting areas, and Project site.

3.14 DISPOSAL

A. Remove surplus soil and waste material including excess subsoil, unsuitable soil, trash, and debris and legally dispose of them off Owner's property.

END OF SECTION 329300

PAGE INTENTIONALLY BLANK

SECTION 330130 - ADJUSTMENT OF STRUCTURES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Adjustment of Gate Valves

2. Idaho Standards for Public Works Construction, latest edition.

1.2 RELATED DOCUMENTS

A. American Society of Testing Materials (ASTM)

1.3 SUBMITTALS

A. Product Data: For the following:

1. Castings

B. Shop Drawings: For the following:

1. Gate Valves: Include frames and covers

1.4 PROJECT CONDITIONS

A. Interruption of Existing Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:

1. Notify Engineer and Owner no fewer than two days in advance of proposed interruption of service.
2. Do not proceed with interruption of service without Engineer's written permission.

PART 2 - PRODUCTS

2.1 GENERAL

A. Adjustment Units

1. Concrete
   a. Units shall be a minimum of 2 inches and a maximum of 6 inches thick.

b. Units shall have a minimum compressive strength of 3000 psi and shall be steel reinforced.
c. Units shall be adhered to the structure and casting by using either Portland Cement Concrete or Non-Shrink Hydrated Lime.

PART 3 - EXECUTION

3.1 GENERAL

A. All finish grades of castings and valve boxes shall be 1/4 inches to 3/8 inches below the finish grade of the pavement.

B. All finish grades of castings and valve boxes shall be 6” inches below the finish grade of the gravel.

C. Perform work on adjustments after construction is to a point that the work will not become damaged by other construction activities.

D. Clean all structures after adjustment to remove any sediment or mortar from structure.

E. All manhole and gate valve pick holes must be cleaned and accessible after paving operations.

3.2 ADJUST CASTING

A. Casting adjustments will only be allowed after the first lift of pavement is placed.

B. The raised castings shall not be exposed to traffic for more than 7 days. The raised casting must be ramped with bituminous pavement if traffic is allowed in the same lane as the raised casting. This cost shall be included in the price for adjustment.

C. Clean the top of the structure to allow the concrete mortar to bond.

D. Add or remove adjusting units as needed to achieve finished grade. A minimum of 2 and a maximum of 6 adjusting units will be allowed. A 6-inch adjusting unit is allowed and encouraged when possible.

E. Apply mortar to the top and bottom of the adjusting units a minimum of ¼ inch to a maximum of 1/2 inch thick. Wipe the inner surfaces of the units clean. Seal around and underneath all castings with mortar.

F. All adjustment units exterior shall be wrapped with Geotextile fabric except sanitary sewer, which shall be wrapped with an exterior chimney seal.

G. No shims of any kind will be allowed for adjustment.

H. Clean all excess mortar from the structure.

3.3 ADJUST VALVE BOX

A. The raised valve box shall not be exposed to traffic for more than 7 days. The raised valve box must be ramped with bituminous pavement if traffic is allowed in the same lane as the raised valve box. This cost shall be included in the price for adjustment.

B. Valve boxes shall be adjusted by screwing the top section up or down. The top of the valve box shall be set 1/4 to 3/8 inch below finish grade. Valve box shall have 1 foot of adjustment remaining.

C. Any material deposited in the valve box must be removed.

END OF SECTION 330130

PAGE INTENTIONALLY BLANK

SECTION 330528 - TRENCHING AND BACKFILLING FOR UTILITIES

PART 1: GENERAL

1.01 SUMMARY

A. This work consists of trenching, backfilling, and compacting of underground infrastructure.

1.02 REFERENCES

A. Current Editions of the following Standards and Publications:

1. **I.S.P.W.C. - Idaho Standards for Public Works Construction.**

1.03 SUBMITTALS

A. Gradation of each granular borrow material

B. Compaction test results

1.04 DEFINITIONS

A. Bedding Material: Soil material surrounding the pipe that provide structural support, and secures the pipe true to line and grade.

B. Pipe Foundation: Soil material below the pipe that provides support.

C. Improved Pipe Foundation: Material used when unstable materials are encountered and added pipe support is needed.

D. Pipe Zone: The area of the trench measured from 1 foot above the pipe to the bottom of the excavation.

E. Sand Cushion: Aggregate bedding used around the pipe in the trench.

1.05 WARRANTY

A. Any trench settlements that occur during the warranty period shall be repaired in a manor acceptable to the Owner and at the expense of the Contractor.

PART 2: PRODUCTS

2.01 PIPE BEDDING MATERIALS

A. Bedding material shall be screened pit run or crusher run sand, sandy gravel or fine gravel having a maximum size of ¾" and having a maximum plasticity index of six as determined by AASHTO methods T89 and T90 or by ASTM D4318. Where trench excavation encounters wet or unstable material, pipe bedding must be free draining and non-plastic. Where soft, spongy, or other unsuitable material encountered in the trench bottom, improved pipe foundation shall be used and shall extend from the bottom of the bedding material to the depth necessary to support the pipe.

2.02 IMPROVED PIPE FOUNDATION

A. Conform to **I.S.P.W.C. - Idaho Standards for Public Works Construction, latest edition.**

1. No onsite granular material may be used for improved pipe foundation.

2. Improved pipe foundation shall only be used where directed by the Engineer.

2.03 TRENCH BACKFILL MATERIAL

A. Suitable excavated materials from trench excavation shall be used.

B. Material shall be free from organic materials, frozen clumps, large rocks, concrete and bituminous chunks, rubbish, and other materials deemed unsuitable.

C. Questionable materials shall be reviewed by the Engineer before backfilling shall begin. The Contractor shall proceed at their risk if the Engineer was not consulted.

PART 3: EXECUTION

3.01 EXISTING UTILITIES

A. The Contractor shall locate and protect all utilities that interfere with trench excavation. The Contractor shall be required to remove and restore or protect the utility.

B. The inverts of existing utilities shall be protected during construction. The Contractor is responsible for inspecting and cleaning, if necessary, all lines which have been compromised by construction activities.

C. Backfill and compact around all existing utilities to 100 Percent Standard Proctor Density in lifts not to exceed 6 inches.

D. Report and repair damage to utilities prior to backfill operations.

3.02 TRENCH CONSTRUCTION

A. Construct trench to line and grade shown on the drawings or as directed by the Engineer.

B. Excavate to a depth 6 inches below the bottom of the pipe to allow for bedding materials to be placed.

C. Apply bedding materials in 6-inch lifts and compact to 95 Percent of AASHTO T-99 or as recommend by the pipe manufacturer, whichever is denser.

D. Remove any bedding and backfill that enters the pipe.

E. Check line and grade of pipe for conformance to the drawings. Correct any deficiencies.

F. Where water is encountered in the trench, it shall be removed during pipelaying operations, and the trench so maintained until the ends of the pipe are sealed and provisions are made to prevent floating of the pipe. Trench water shall not be allowed to enter the pipe at any time All cost for

dewatering shall be incidental to the Contract and no additional compensation shall be awarded for dewatering.

3.03 TRENCH BACKFILL

A. Backfill material around all manholes, catch basins, valve boxes, curb boxes, and hydrants shall be compacted with hand operated motorized compactors. The maximum lift thickness shall be 6 inches.

B. All manholes, catch basins, valve boxes, water vaults, and miscellaneous structures shall be backfilled with granular bedding material and shall be compacted with hand operated motorized compactors.

C. Flexible Pipe Materials

1. Granular bedding shall be provided, placed and compacted around the pipe to an elevation 12 inches above the pipe to the full width of the trench. Bedding shall be compacted to 95 Percent of AASHTO T-99.

D. Rigid Pipe Materials

1. In ordinary trench conditions, granular bedding shall be used to the haunch line and compacted to 95 Percent of AASHTO T-99.

E. All trench backfilling operations shall use suitable backfill and shall be compacted to 95 Percent of AASHTO T-99 with ± 3% optimum moisture content except the top 1 foot below the subgrade elevation which shall be compacted to 100 Percent Standard Proctor with ± 3% optimum moisture content.

F. Imported backfill shall be used as directed by the Engineer. The imported backfill shall be mixed with the onsite material to obtain the proper soil compaction. If in the Engineer's opinion the onsite material cannot be compacted to specification, the Engineer shall direct the onsite material to be removed as muck excavation.

3.04 FIELD QUALITY CONTROL

A. Density tests shall be taken as specified in Section 01 40 00 of this Specification. The Engineer may determine that additional tests should be taken and their locations. The Contractor shall assist the Engineer in conducting the tests.

B. Any failing tests shall be excavated and re-compacted until the density requirements are met.

END OF SECTION 330528

PAGE INTENTIONALLY BLANK

SECTION 331100 - SITE WATER LINES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. On and Offsite water main and service including piping, fittings, meter, accessories and bedding to 5' from building.

1.2 REFERENCES

A. ASTM D 1785 - Specification for Poly (Vinyl Chloride) PVC Plastic Pipe, Schedules 40, 80 and 120.
B. ASTM D 2855 - Practice for making Solvent-Cemented Joints with Poly (Vinyl Chloride) (PVC) Pipe and Fittings.
C. AWWA C-900 - PVC Pipe.
D. AWWA C-601 - Standard for Disinfecting Water Mains.
E. AWWA C-500 - Gate Valves.
F. **I.S.P.W.C. - Idaho Standards for Public Works Construction**, latest edition.
G. ASTM A 575 - Specification for Steel Bars, Carbon, Merchant Quality, M-Grades.
H. ASTM A 197 - Specification for Cupola Malleable Iron.
I. NFPA - National Fire Protection Association.

1.3 SUBMITTALS

A. Submit under provisions of Division 1.
B. Shop Drawings: Indicate general installation, components, dimensions, coverage, clearances, and methods of installation.
C. Field Reports: Indicate summary of Hydrostatic Test and Field Acceptance Tests performed in accordance with NFPA 20.
D. Operation and Maintenance Data
    1. Submit under provisions of Division 1.

1.4 QUALITY ASSURANCE

A. Perform work in accordance with the latest edition of the Idaho Rules for Public Drinking Water Systems, **Idaho Standards for Public Works Construction**, and local District Heath Department.
B. Qualifications
    1. Manufacturer: Company specializing in manufacture of the products specified in this Section with minimum five years experience.
    2. Installer: Company specializing in performing the work of this Section with minimum three years experience.
C. Regulatory Requirements
    1. Plumbing Code Compliance: Comply with applicable portions of National Standard Plumbing Code pertaining to selection and installation of potable water system materials and products.
    2. Water Purveyor Compliance: Comply with requirements of Purveyor supplying water to project, obtain required permits and inspections.
    3. Conform to applicable ASTM and AWWA specifications regarding installation of water lines.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect and handle products to site under provisions of Division 1.

1.6 PROJECT/SITE CONDITIONS - not used.
1.7 SEQUENCING AND SCHEDULING - not used.
1.8 EXTENDED WARRANTY - not used.
1.9 MAINTENANCE - not used.

PART 2 – PRODUCTS

2.1 MANUFACTURERS - not used.

2.2 MATERIALS

A. Pipes and Pipe Fittings
1. Provide piping materials and factory-fabricated piping products of sizes, types, pressure ratings, and capacities as indicated. Where not indicated, provide proper selection as determined by Installer to comply with installation requirements. Provide sizes and types matching piping and equipment connections; provide fittings of materials which match pipe materials used in potable water systems. Where more than one type of materials or products are indicated, selection is Installer's option.
2. Piping: Provide pipes of one of the following materials, of weight/class indicated. Provide pipe fittings and accessories of same materials and weight/class as pipes, with joining method as indicated.
a. Class 200 psi Poly Ethylene pipe for 1” service piping.
b. Class 150 Polyvinyl Chloride (PVC) (AWWA C-900) SDR 18. Bell and spigot with rubber sealing ring for pipe 6" to 12” in diameter.
c. Class 52 cement-lined ductile pipe meeting ANSI/AWNA C151 for diameters of 6” to 64”.

B. Valves
1. Gate Valves: Provide as indicated, resilient seated valves, AWWA C509-87, 175 psi working pressure and shall be Clow or Mueller A2360, with 2” square operating nuts with either flanged or mechanical joint. Provide threaded, flanged, hub, or other end configurations to suit size of valve and piping connection. Provide inside screw type for use with curb valve box, iron body, bronze-mounted, non-rising stem.

C. Fire Hydrants
1. Provide 200 psi Mueller Centurion fire hydrants with two coats of red hydrant enamel.
2. Provide Storz coupler on steamer port as manufactured by Red Head Brass or Angus Fire.
3. Per Idaho Standards for Public Works Construction Section 403.

D. Trench Fill Materials
1. Trench backfill: Type A backfill according to Idaho Standards for Public Works Construction Section 306.3.3.

2.3 MANUFACTURED UNITS - not used.
2.4 EQUIPMENT - not used.
2.5 COMPONENTS - not used.

2.6 ACCESSORIES

A. Anchorages: Provide anchorages for tees wyes, crosses, plugs, caps, bends, valves, and hydrants. After installation, apply full coat of asphalt or other acceptable corrosion-retarding material to surfaces of ferrous anchorages.
   1. Rods: Steel, ASTM A 575.
   2. Rod Couplings: Malleable-iron, ASTM A 197.
   3. Thrust Blocks: Concrete, 2,500 psi.

B. Water Meter: Provide water meter and total assembly; read per gallons. Provide meter box, ring and cover. Installation shall conform with the ISPWC

C. No.12 Direct Burial Locator wire with Dri-splice connectors shall be installed with waterlines. Wire shall extend to surface at all valve boxes/meters/fire hydrants and be placed at crown of pipe per **Idaho Standards for Public Works Construction** , latest edition, Section 401.

PART 3 - EXECUTION

3.1 EXAMINATION - not used.
3.2 PREPARATION - not used.

3.3 EXECUTION

A. Install in accordance with the Manufacturer's instructions, only after shop drawings have been approved.
B. Route pipe in straight lines.
C. Install pipe to allow for expansion and contraction without stressing pipe or joints.
D. Install access fitting to permit disinfection of water system.
E. Form and place concrete for thrust blocks at each change of direction of pipe main.
F. Establish elevations of buried piping to ensure not less than 4'-0" of cover.
G. Set valves on solid bearing. Locate valve a minimum of 12" away from hydrant.
H. Center and plumb valve box over valve. Set box cover flush with finished grade.
I. Center and plumb valve box over valve. Set box cover flush with finished grade.
J. Paint hydrant in accordance with **City of Jerome** Fire Department.

3.4 FIELD QUALITY CONTROL

A. Perform field inspection and testing in accordance with **the Idaho Standards for Public Works Construction**, latest edition.
B. Compaction Testing, 1 per 100 lin. ft., 2 per lift.
C. Pressure test entire system in accordance with the **Idaho Standards for Public Works Construction**, latest edition, after backfilling and compacting of the trenches.
D. Test shall be witnessed and approved by the Engineer of Record and the City of Jerome personnel or their representatives.
E. Disinfect water mains in accordance with requirements of AWWA C-601, Section 401 of the **Idaho Standards for Public Works Construction**, latest edition.

3.5 ADJUSTING - not used.
3.6 CLEANING - not used.
3.7 DEMONSTRATION - not used.
3.8 PROTECTION - not used.
3.9 SCHEDULES - not used.

END OF SECTION 331100

PAGE INTENTIONALLY BLANK

SECTION 333100 - SITE SANITARY SEWERAGE SYSTEM

PART 1 – GENERAL

1.1 SECTION INCLUDES
- A. Sanitary sewerage piping, fittings, accessories and bedding.
- B. Connection of building sanitary system to public sanitary sewer system.

1.2 REFERENCES
- A. ASTM D 1557 - Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 10 lb (4.54 Kg) Rammer and 18 inch (457 mm) Drop.
- B. ASTM D 3034 - Specification for Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
- C. ASTM D 1785 - Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80 and 120.
- D. ASTM D 2922 - Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
- E. ASTM D 3017- Test Methods for Water Content of Soil and Rock in Place by Nuclear Methods.
- F. **I.S.P.W.C. – Idaho Standards for Public Works Construction** – current edition.
- G. SD – Standard drawing from **I.S.P.W.C.**
- H. Definitions
  1. Bedding: Fill placed under, beside and directly over pipe, prior to subsequent backfill operations.

1.3 SUBMITTALS
- A. Submit under provisions of Division 1.
- B. Product Data: Provide data indicating pipe, pipe accessories, and fill material.
- C. Project Record Documents
  1. Submit documents under provisions of Division 1.
  2. Record location of pipe runs, connections, cleanouts and invert elevations.
  3. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

1.4 QUALITY ASSURANCE
- A. Regulatory Requirements
  1. Conform to **Idaho Standards for Public Works Construction**, local District Health Department and **City of Jerome** requirements.

1.5 DELIVERY, STORAGE AND HANDLING - not used.

1.6 PROJECT/SITE CONDITIONS
- A. Verify that field measurements and elevations are as indicated.

1.7 SEQUENCING AND SCHEDULING
- A. Coordinate work under provisions of Division 1.
- B. Coordinate the Work with termination of sanitary sewer connection outside building, and trenching.

1.8 EXTENDED WARRANTY - not used.

1.9 MAINTENANCE - not used.

PART 2 – PRODUCTS

2.1 MANUFACTURERS - not used.

2.2 MATERIALS

A. Sewer Pipe

1. Pipe: ASTM D3034, SDR 35, Type PSM, Poly Vinyl Chloride (PVC) material; inside nominal diameter as indicated, bell and spigot style gasket sealed joint end.

B. Sewer Service Connection

1. Service Connection Tee or Wyes Fittings

a. Tees or Wyes: Consistent with main and service lines.

b. Fasteners: All clamps, straps, nuts, bolts and washers to be solid stainless steel.

c. Tee Fittings: Inserta-Tee, Insta-tap, Kor-N-Tee or approved substitution.

2. Service Saddle Connections:

a. Saddles: Romac "CB", Fernco EZ tap, *Saddle by NDS*, or approved substitution.

C. Bedding Materials

1. Aggregate Bedding: Fill Type A as specified in Section 312300.

2. Trench Backfill: Fill from pipe bedding to subgrade per Section 312500.

D. Concrete and Reinforcement

1. Concrete: Portland cement mix, 3,000 psi

a. Cement: ASTM C 150, Type II.

b. Fine Aggregate: ASTM C 33, sand.

E. Per **City of Jerome** requirements.

2.3 MANUFACTURED UNITS - not used.

2.4 EQUIPMENT - not used.

2.5 COMPONENTS

A. Cleanouts

1. General: Provide cast-iron ferrule and countersunk brass cleanout plug, with round cast-iron access frame and heavy duty, secured scoriated cast-iron cover per ISPWC standard drawing (SD-506).

B. Manholes

1. Pre-cast Concrete Manholes: ASTM C 478, pre-cast reinforced concrete, of dimensions with appurtenances indicated on the drawings, with provision for rubber gasket joints manufactured by Amcor or approved equivalent.

a. Base Section: 6-inch minimum thickness for floor slab and 4 inch minimum thickness for walls and base riser section, and having a separate base slab or base section with integral floor.

b. Rise Sections: 4-inch minimum thickness, 48 inch diameter and lengths to provide depth indicated.

c. Top Section: Eccentric cone type, unless concentric cone or flat-slab-top type is indicated. Top of cone to match grade rings.

d. Grade Rings: Provide reinforced concrete rings, of 6 to 21 inches total thickness and match 24-inch diameter frame and cover.

e. Gaskets: ASTM C 433, rubber.

f. Pipe Connectors: ASTM C 923, resilient, of size required, for each pipe connecting to base section.

g. Channel and Bench: Concrete.

2. Manhole Frames and Covers: ASTM A 536, Grade 6-40-18, heavy-duty, ductile iron, 24-inch inside diameter by 7 to 9 inch riser with 4 inch minimum width flange, and 26 inch diameter cover, having small square or short slotted drainage openings.

3. Per **Idaho Standards for Public Works Construction SD-501**.

C. Sewer Grease Trap:

1. Per Mechanical Specifications.

2.6 ACCESSORIES

A. Fittings: Same material as pipe molded or formed to suit pipe size and end design, in required tee, bends, elbows, cleanouts, reducers, traps and other configurations.

B. Pipe Joints: Neoprene ribbed gasket for positive seal.

2.7 MIXES - not used.

2.8 FABRICATION - not used.

2.9 SOURCE QUALITY CONTROL - not used.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that trench cut is ready to receive work and excavations, dimensions, and elevations are as indicated on drawings.

3.2 PREPARATION

A. Hand trim excavations to required elevations. Correct over excavation with Type B aggregate.

B. Remove large stones or other hard matter which could damage pipe or impede consistent backfilling or compaction.

3.3 EXECUTION

A. Bedding

1. Excavate pipe trench in accordance with **Section 312000** for work of this Section. Hand trim excavation for accurate placement of pipe to elevations indicated.
2. Place bedding material in accordance with **Section 312000** at trench bottom, level materials in continuous layer not exceeding 4 inches compacted depth, compact to a minimum of 95 percent.
3. Maintain optimum moisture content of bedding material to attain required compaction density.

B. Pipe

1. Install pipe, fittings, and accessories in accordance with ASTM D 2321, manufacturer's instructions. Seal joints watertight.
2. Pipe installation and backfill shall be consistent with the latest edition of the **I.S.P.W.C**.
3. Lay pipe to slope at gradients noted on drawings; with maximum variation from true slope of 1/16 inch in 10 feet.
4. Install bedding to minimum compacted thickness of 6” above pipe, 4” below pipe and 12” at sides of pipe; compacted to 95 percent.
5. Refer to **Section 312000** for trenching requirements. Do not displace or damage pipe when compacting.
6. Connect to building sanitary sewer outlet and sewage treatment system.
7. See attached drawings.

3.4 FIELD QUALITY CONTROL

A. Field inspection and testing will be performed under provisions of Division 1.

B. Request inspection prior to placing bedding.

C. Compaction testing will be performed in accordance with ASTM D 1557.

D. If tests indicate work does not meet specified requirements, remove work, replace and retest at no cost to owner.

E. Frequency of Tests: 1 per 100 lin. Foot, 2 per lift.

F. Prior to final acceptance, after all utilities are in and prior to paving, an air test shall be conducted. The contractor shall contact the City and the Engineer of Record a minimum of 24 hours prior to testing.

G. All stationing relates to the gravity sewer centerline.

3.5 ADJUSTING - not used.

3.6 CLEANING - not used.

3.7 DEMONSTRATION - not used

3.8 PROTECTION

A. Protect finished installation under provisions of Division 1.

B. Protect pipe and aggregate cover from damage or displacement until backfilling operation is in progress.

3.9 SCHEDULES - not used.

3.10 APPROVAL AND ACCEPTANCE:

A. All Work to within 5' of the structure shall be done in accordance with **the Idaho Standards for Public Works Construction (I.S.P.W.C.)** – latest edition.

B. All work is to be installed and tested per the **Idaho Standards for Public Works Construction** – latest edition.

END OF SECTION 333100

SECTION 334100 - STORM UTILITY DRAINAGE PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. REFERENCES

1. ASTM D 3034 - Specification for Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
2. AASHTO M-252, 3 to 10 inch pipe, Specifications for Corrugated Polyethylene Pipe.
3. AASHTO M-294, 12" to 36" pipe, Specification for Corrugated Polyethylene Pipe.
4. ASTM C 478 - Specification for Pre-cast Reinforced Concrete Manhole Sections.
5. ASTM C 923 - Specification for Resilient Connectors between Reinforced Concrete Manhole Structures, Pipes and Laterals.
6. ASTM C 443 - Specification for Joints for Circular Concrete Sewer and Culvert Pipe, using Rubber Gaskets.
7. ASTM F447 - Elastomeric Seals (Gaskets) for Joining Plastic Pipes.
8. ASTM C 150 - Specification for Portland Cement.
9. ASTM C 33 - Specification for Concrete Aggregates.
10. ASTM A 185 - Specification for Steel Welded Wire Fabric for Concrete Reinforcement.
11. ASTM 615 - Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
12. ASTM A 536 - Specification for Ductile Iron Castings.
13. ASTM D 698 - Test Method for Moisture Density Relations of Soils and Soil-Aggregate Mixtures using 5.5 lb. (2.49 kg.) Rammer and 12 inch Drop.
14. ASTM D 1869 - Specification for Rubber Rings for Asbestos-Cement Pipe.
15. ASTM D 2321 - Practice for Underground Installation of Thermoplastic Pipe for Sewers and other Gravity-Flow Applications.
16. ASTM C 891 - Practice for Installation of Underground Pre-cast Concrete Utility Structures.
17. **I.S.P.W.C. – Idaho Standards for Public Works Construction – current edition.**
18. **City of Jerome** Supplemental Specifications and Details.

B. Section Includes:

1. Pipe and fittings.
2. Nonpressure transition couplings.
3. Cleanouts.
4. Drains.
5. Channel drainage systems.
6. Catch basins.

7. Stormwater inlets.
8. Stormwater detention structures.
9. Pipe outlets.

1.3 DEFINITIONS

A. FRP: Fiberglass-reinforced plastic.

1.4 SUBMITTALS

A. Product Data under provisions of Division 1: For each type of product indicated.

1. Drainage conduits, including rated capacities.
2. Drainage panels, including rated capacities.
3. Geotextile filter fabrics.
4. Shop drawings.
5. Submit manufacturer's installation instructions under provisions of Division 1.
6. Project Record Documents
    a. Submit documents under provisions of Division 1.
    b. Accurately record location of pipe runs, connections, catch basins, cleanouts, and invert elevations each day.
    c. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities each day.

B. Coordination Drawings: Show pipe sizes, locations, and elevations. Show other piping in same trench and clearances from storm drainage system piping. Indicate interface and spatial relationship between manholes, piping, and proximate structures.

C. Product Certificates: For each type of cast-iron soil pipe and fitting, from manufacturer.

D. Field quality-control reports.

1.5 QUALITY ASSURANCE

A. Regulatory Requirements

B. Conform to Idaho Standards for Public Works Construction and the **City of Jerome** Supplemental Specifications and Details for materials and installation of the Work of this Section.
1. Comply with applicable portions of all environmental agency regulations pertaining to storm sewerage systems.
2. Comply with **City of Jerome** Supplemental Specifications and Details for all right-of-way improvements.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Do not store plastic manholes, pipe, and fittings in direct sunlight.

B. Protect pipe, pipe fittings, and seals from dirt and damage.

C. Handle manholes according to manufacturer's written rigging instructions.

D. Handle catch basins and storm water inlets according to manufacturer's written rigging instructions.

1.7 PROJECT CONDITIONS

A. Interruption of Existing Storm Drainage Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:

1. Notify Architect no fewer than two days in advance of proposed interruption of service.
2. Do not proceed with interruption of service without Architect's written permission.

PART 2 - PRODUCTS

2.1 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A 74, Service and Extra-Heavy classes.

B. Gaskets: ASTM C 564, rubber.

C. Calking Materials: ASTM B 29, pure lead and oakum or hemp fiber.

2.2 ABS PIPE AND FITTINGS

A. ABS Sewer Pipe and Fittings: ASTM D 2751, with bell-and-spigot ends for gasketed joints.

1. NPS 3 to NPS 6: SDR 35.
2. NPS 8 to NPS 12: SDR 42.

B. Gaskets: ASTM F 477, elastomeric seals.

2.3 PE PIPE AND FITTINGS

A. Corrugated PE Drainage Pipe and Fittings NPS 3 to NPS 10: AASHTO M 252M, Type S, with smooth waterway for coupling joints.

1. Silttight Couplings: PE sleeve with ASTM D 1056, Type 2, Class A, Grade 2 gasket material that mates with tube and fittings.
2. Soiltight Couplings: AASHTO M 252M, corrugated, matching tube and fittings.

B. Corrugated PE Pipe and Fittings NPS 12 to NPS 60: AASHTO M 294M, Type S, with smooth waterway for coupling joints.

1. Silttight Couplings: PE sleeve with ASTM D 1056, Type 2, Class A, Grade 2 gasket material that mates with pipe and fittings.
2. Soiltight Couplings: AASHTO M 294M, corrugated, matching pipe and fittings.

2.4 PVC PIPE AND FITTINGS

A. PVC Cellular-Core Piping:

1. PVC Cellular-Core Pipe and Fittings: ASTM F 891, Sewer and Drain Series, PS 50 minimum stiffness, PVC cellular-core pipe with plain ends for solvent-cemented joints.
2. Fittings: ASTM D 3034, SDR 35, PVC socket-type fittings.

B. PVC Corrugated Sewer Piping:

1. Pipe: ASTM F 949, PVC, corrugated pipe with bell-and-spigot ends for gasketed joints.
2. Fittings: ASTM F 949, PVC molded or fabricated, socket type.
3. Gaskets: ASTM F 477, elastomeric seals.

2.5 NONPRESSURE TRANSITION COUPLINGS

A. Comply with ASTM C 1173, elastomeric, sleeve-type, reducing or transition coupling, for joining underground nonpressure piping. Include ends of same sizes as piping to be joined, and corrosion-resistant-metal tension band and tightening mechanism on each end.

B. Unshielded, Flexible Couplings:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

    a. Dallas Specialty & Mfg. Co.
    b. Fernco Inc.
    c. Logan Clay Pipe.
    d. Mission Rubber Company; a division of MCP Industries, Inc.
    e. NDS Inc.
    f. Plastic Oddities; a division of Diverse Corporate Technologies, Inc.

3. Description: Elastomeric sleeve with stainless-steel shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.

C. Shielded, Flexible Couplings:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

a. Cascade Waterworks Mfg.
b. Dallas Specialty & Mfg. Co.
c. Mission Rubber Company; a division of MCP Industries, Inc.

3. Description: ASTM C 1460, elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.

2.6 CLEANOUTS

A. Cast-Iron Cleanouts:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

a. Josam Company.
b. MIFAB, Inc.
c. Smith, Jay R. Mfg. Co.
d. Tyler Pipe.
e. Watts Water Technologies, Inc.
f. Zurn Specification Drainage Operation; Zurn Plumbing Products Group.

3. Description: ASME A112.36.2M, round, gray-iron housing with clamping device and round, secured, scoriated, gray-iron cover. Include gray-iron ferrule with inside calk or spigot connection and countersunk, tapered-thread, brass closure plug.
4. Top-Loading Classification(s): Heavy Duty.
5. Sewer Pipe Fitting and Riser to Cleanout: ASTM A 74, Service class, cast-iron soil pipe and fittings.

B. Plastic Cleanouts:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

a. Canplas LLC.
b. IPS Corporation.
c. NDS Inc.
d. Plastic Oddities; a division of Diverse Corporate Technologies, Inc.
e. Sioux Chief Manufacturing Company, Inc.
f. Zurn Light Commercial Products Operation; Zurn Plumbing Products Group.

3. Description: PVC body with PVC threaded plug. Include PVC sewer pipe fitting and riser to cleanout of same material as sewer piping.

2.7 DRAINS

A. Cast-Iron Area Drains:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

    a. Josam Company.
    b. MIFAB, Inc.
    c. Smith, Jay R. Mfg. Co.
    d. Tyler Pipe.
    e. Watts Water Technologies, Inc.
    f. Zurn Specification Drainage Operation; Zurn Plumbing Products Group.

3. Description: ASME A112.6.3 gray-iron round body with anchor flange and round secured grate. Include bottom outlet with inside calk or spigot connection, of sizes indicated.
4. Top-Loading Classification(s): Medium and Heavy Duty.

2.8 CONCRETE

A. General: Cast-in-place concrete according to ACI 318, ACI 350/350R, and the following:

1. Cement: ASTM C 150, Type II.
2. Fine Aggregate: ASTM C 33, sand.
3. Coarse Aggregate: ASTM C 33, crushed gravel.
4. Water: Potable.

B. Portland Cement Design Mix: 4000 psi minimum, with 0.45 maximum water/cementitious materials ratio.

1. Reinforcing Fabric: ASTM A 185/A 185M, steel, welded wire fabric, plain.
2. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (420 MPa) deformed steel.

C. Ballast and Pipe Supports: Portland cement design mix, 3000 psi minimum, with 0.58 maximum water/cementitious materials ratio.

1. Reinforcing Fabric: ASTM A 185/A 185M, steel, welded wire fabric, plain.
2. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (420 MPa) deformed steel.

2.9 CATCH BASINS

A. Standard Precast Concrete Catch Basins:

1. Description: ASTM C 478, precast, reinforced concrete, of depth indicated, with provision for sealant joints.

2. Base Section: 6-inch minimum thickness for floor slab and 4-inch minimum thickness for walls and base riser section, and separate base slab or base section with integral floor.
3. Riser Sections: 4-inch minimum thickness, 48-inch diameter, and lengths to provide depth indicated.
4. Top Section: Eccentric-cone type unless concentric-cone or flat-slab-top type is indicated. Top of cone of size that matches grade rings.
5. Joint Sealant: ASTM C 990, bitumen or butyl rubber.
6. Adjusting Rings: Interlocking rings with level or sloped edge in thickness and shape matching catch basin frame and grate. Include sealant recommended by ring manufacturer.
7. Grade Rings: Include two or three reinforced-concrete rings, of 6- to 9-inch total thickness, that match 24-inch- diameter frame and grate.
8. Pipe Connectors: ASTM C 923, resilient, of size required, for each pipe connecting to base section.

B. Designed Precast Concrete Catch Basins: ASTM C 913, precast, reinforced concrete; designed according to ASTM C 890 for A-16 (ASSHTO HS20-44), heavy-traffic, structural loading; of depth, shape, and dimensions indicated, with provision for joint sealants.

1. Joint Sealants: ASTM C 990, bitumen or butyl rubber.
2. Adjusting Rings: Interlocking rings with level or sloped edge in thickness and shape matching catch basin frame and grate. Include sealant recommended by ring manufacturer.
3. Grade Rings: Include two or three reinforced-concrete rings, of 6- to 9-inch total thickness, that match 24-inch- diameter frame and grate.
4. Pipe Connectors: ASTM C 923, resilient, of size required, for each pipe connecting to base section.

C. Frames and Grates: ASTM A 536, Grade 60-40-18, ductile iron designed for A-16, structural loading. Include flat grate with small square or short-slotted drainage openings.

1. Size: 24 by 24 inches minimum unless otherwise indicated.
2. Grate Free Area: Approximately 50 percent unless otherwise indicated.

D. Frames and Grates: ASTM A 536, Grade 60-40-18, ductile iron designed for A-16, structural loading. Include 24-inch ID by 7- to 9-inch riser with 4-inch minimum width flange, and 26-inch- diameter flat grate with small square or short-slotted drainage openings.

1. Grate Free Area: Approximately 50 percent unless otherwise indicated.

2.10 PIPE OUTLETS

A. Riprap Basins: Broken, irregularly sized and shaped, graded stone according to NSSGA's "Quarried Stone for Erosion and Sediment Control."

1. Average Size: NSSGA No. R-3, screen opening 2 inches.
2. Average Size: NSSGA No. R-4, screen opening 3 inches.
3. Average Size: NSSGA No. R-5, screen opening 5 inches.

B. Filter Stone: According to NSSGA's "Quarried Stone for Erosion and Sediment Control," No. FS-2, No. 4 screen opening, average-size graded stone.

C. Energy Dissipaters: According to NSSGA's "Quarried Stone for Erosion and Sediment Control," No. A-1, 3-ton average weight armor stone, unless otherwise indicated.

2.11 STORMWATER DISPOSAL SYSTEMS

A. Chamber Systems:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

    a. Advanced Drainage Systems.
    b. CULTEC, Inc.
    c. Hancor Inc.
    d. Infiltrator Systems, Inc.
    e. StormTech LLC.
    f. Oldcastle Precast.

3. Storage and Leaching Chambers: Molded PE with perforated sides and open bottom. Include number of chambers, distribution piping, end plates, and other standard components as required for system total capacity.
4. Filtering Material: ASTM D 448, Size No. 24, 3/4- to 2-1/2-inch washed, crushed stone or gravel.
5. Filter Mat: Geotextile woven or spun filter fabric, in one or more layers, for minimum total unit weight of 4 oz./sq. yd..

B. Pipe Systems: Perforated manifold, header, and lateral piping complying with AASHTO M 252M for NPS 10 and smaller, AASHTO M 294M for NPS 12 to NPS 60. Include proprietary fittings, couplings, seals, and filter fabric.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

    a. Advanced Drainage Systems.
    b. Hancor Inc.
    c. NDS.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Excavation, trenching, and backfilling are specified in Division 31 Section "Earth Moving."

3.2 PIPING INSTALLATION

A. General Locations and Arrangements: Drawing plans and details indicate general location and arrangement of underground storm drainage piping. Location and arrangement of piping layout take into account design considerations. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.

B. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements.

C. Install manholes for changes in direction unless fittings are indicated. Use fittings for branch connections unless direct tap into existing sewer is indicated.

D. Install proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.

E. When installing pipe under streets or other obstructions that cannot be disturbed, use pipe-jacking process of microtunneling.

F. Install gravity-flow, nonpressure drainage piping according to the following:

1. Install piping pitched down in direction of flow.
2. Install piping NPS 6 and larger with restrained joints at tee fittings and at changes in direction. Use corrosion-resistant rods, pipe or fitting manufacturer's proprietary restraint system, or cast-in-place concrete supports or anchors.
3. Install piping with 18 inch minimum cover.
4. Install hub-and-spigot, cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook."
5. Install hubless cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook."
6. Install ductile-iron piping and special fittings according to AWWA C600 or AWWA M41.
7. Install corrugated steel piping according to ASTM A 798/A 798M.
8. Install corrugated aluminum piping according to ASTM B 788/B 788M.
9. Install ABS sewer piping according to ASTM D 2321 and ASTM F 1668.
10. Install PE corrugated sewer piping according to ASTM D 2321.
11. Install PVC cellular-core piping according to ASTM D 2321 and ASTM F 1668.
12. Install PVC sewer piping according to ASTM D 2321 and ASTM F 1668.
13. Install PVC profile gravity sewer piping according to ASTM D 2321 and ASTM F 1668.
14. Install PVC water-service piping according to ASTM D 2321 and ASTM F 1668.

15. Install nonreinforced-concrete sewer piping according to ASTM C 1479 and ACPA's "Concrete Pipe Installation Manual."
16. Install reinforced-concrete sewer piping according to ASTM C 1479 and ACPA's "Concrete Pipe Installation Manual."

3.3 PIPE JOINT CONSTRUCTION

A. Join gravity-flow, nonpressure drainage piping according to the following:

1. Join hub-and-spigot, cast-iron soil piping with gasketed joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.
2. Join hub-and-spigot, cast-iron soil piping with calked joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead and oakum calked joints.
3. Join hubless cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-coupling joints.
4. Join ductile-iron culvert piping according to AWWA C600 for push-on joints.
5. Join ductile-iron piping and special fittings according to AWWA C600 or AWWA M41.
6. Join corrugated steel sewer piping according to ASTM A 798/A 798M.
7. Join corrugated aluminum sewer piping according to ASTM B 788/B 788M.
8. Join ABS sewer piping according to ASTM D 2321 and ASTM D 2751 for elastomeric-seal joints.
9. Join corrugated PE piping according to ASTM D 3212 for push-on joints.
10. Join PVC cellular-core piping according to ASTM D 2321 and ASTM F 891 for solvent-cemented joints.
11. Join PVC corrugated sewer piping according to ASTM D 2321 for elastomeric-seal joints.
12. Join PVC sewer piping according to ASTM D 2321 and ASTM D 3034 for elastomeric-seal joints or ASTM D 3034 for elastomeric-gasketed joints.
13. Join PVC profile gravity sewer piping according to ASTM D 2321 for elastomeric-seal joints or ASTM F 794 for gasketed joints.
14. Join nonreinforced-concrete sewer piping according to ASTM C 14 and ACPA's "Concrete Pipe Installation Manual" for rubber-gasketed joints.
15. Join reinforced-concrete sewer piping according to ACPA's "Concrete Pipe Installation Manual" for rubber-gasketed joints.
16. Join dissimilar pipe materials with nonpressure-type flexible couplings.

3.4 CLEANOUT INSTALLATION

A. Install cleanouts and riser extensions from sewer pipes to cleanouts at grade. Use cast-iron soil pipe fittings in sewer pipes at branches for cleanouts and cast-iron soil pipe for riser extensions to cleanouts. Install piping so cleanouts open in direction of flow in sewer pipe.

1. Use Light-Duty, top-loading classification cleanouts in earth or unpaved foot-traffic areas.
2. Use Medium-Duty, top-loading classification cleanouts in paved foot-traffic areas.
3. Use Heavy-Duty, top-loading classification cleanouts in vehicle-traffic service areas.
4. Use Extra-Heavy-Duty, top-loading classification cleanouts in roads.

B. Set cleanout frames and covers in earth in cast-in-place concrete block, 18 by 18 by 12 inches deep. Set with tops 1/2 inch above surrounding earth grade.

C. Set cleanout frames and covers in concrete pavement and roads with tops flush with pavement surface.

3.5 DRAIN INSTALLATION

A. Install type of drains in locations indicated.

1. Use Light-Duty, top-loading classification drains in earth or unpaved foot-traffic areas.
2. Use Medium-Duty, top-loading classification drains in paved foot-traffic areas.
3. Use Heavy-Duty, top-loading classification drains in vehicle-traffic service areas.
4. Use Extra-Heavy-Duty, top-loading classification drains in roads.

B. Embed drains in 4-inch minimum concrete around bottom and sides.

C. Fasten grates to drains if indicated.

D. Set drain frames and covers with tops flush with pavement surface.

E. Assemble trench sections with flanged joints.

F. Embed trench sections in 4-inch minimum concrete around bottom and sides.

3.6 CATCH BASIN INSTALLATION

A. Construct catch basins to sizes and shapes indicated.

B. Set frames and grates to elevations indicated.

3.7 STORMWATER INLET AND OUTLET INSTALLATION

A. Construct inlet head walls, aprons, and sides of reinforced concrete, as indicated.

B. Construct riprap of broken stone, as indicated.

C. Install outlets that spill onto grade, anchored with concrete, where indicated.

D. Install outlets that spill onto grade, with flared end sections that match pipe, where indicated.

E. Construct energy dissipaters at outlets, as indicated.

3.8 CONCRETE PLACEMENT

A. Place cast-in-place concrete according to ACI 318.

3.9 CHANNEL DRAINAGE SYSTEM INSTALLATION

A. Install with top surfaces of components, except piping, flush with finished surface.

B. Assemble channel sections to form slope down toward drain outlets. Use sealants, adhesives, fasteners, and other materials recommended by system manufacturer.

C. Embed channel sections and drainage specialties in 4-inch minimum concrete around bottom and sides.

D. Fasten grates to channel sections if indicated.

E. Assemble channel sections with flanged or interlocking joints.

F. Embed channel sections in 4-inch minimum concrete around bottom and sides.

3.10 STORMWATER DISPOSAL SYSTEM INSTALLATION

A. Chamber Systems: Excavate trenches of width and depth, and install system and backfill according to chamber manufacturer's written instructions. Include storage and leaching chambers, filtering material, and filter mat.

B. Piping Systems: Excavate trenches of width and depth, and install piping system, filter fabric, and backfill, according to piping manufacturer's written instructions.

3.11 CONNECTIONS

A. Connect nonpressure, gravity-flow drainage piping in building's storm building drains specified in Division 22 Section "Facility Storm Drainage Piping."

B. Connect force-main piping to building's storm drainage force mains specified in Division 22 Section "Facility Storm Drainage Piping." Terminate piping where indicated.

C. Make connections to existing piping and underground manholes.

1. Use commercially manufactured wye fittings for piping branch connections. Remove section of existing pipe; install wye fitting into existing piping; and encase entire wye fitting, plus 6-inch overlap, with not less than 6 inches of concrete with 28-day compressive strength of 3000 psi.
2. Make branch connections from side into existing piping, NPS 4 to NPS 20. Remove section of existing pipe, install wye fitting into existing piping, and encase entire wye with not less than 6 inches of concrete with 28-day compressive strength of 3000 psi.
3. Make branch connections from side into existing piping, NPS 21 or larger, or to underground manholes and structures by cutting into existing unit and creating an opening large enough to allow 3 inches of concrete to be packed around entering connection. Cut end of connection pipe passing through pipe or structure wall to conform to shape of and be flush with inside wall unless otherwise indicated. On outside of pipe, manhole, or structure wall, encase entering connection in 6 inches of concrete for minimum length of 12 inches to provide additional support of collar from connection to undisturbed ground.

a. Use concrete that will attain a minimum 28-day compressive strength of 3000 psi unless otherwise indicated.
b. Use epoxy-bonding compound as interface between new and existing concrete and piping materials.

4. Protect existing piping, manholes, and structures to prevent concrete or debris from entering while making tap connections. Remove debris or other extraneous material that may accumulate.

D. Connect to sediment interceptors specified in Division 22 Section "Sanitary Waste Interceptors."

E. Pipe couplings, expansion joints, and deflection fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.

1. Use nonpressure-type flexible couplings where required to join gravity-flow, nonpressure sewer piping unless otherwise indicated.

a. Unshielded flexible couplings for same or minor difference OD pipes.
b. Unshielded, increaser/reducer-pattern, flexible couplings for pipes with different OD.
c. Ring-type flexible couplings for piping of different sizes where annular space between smaller piping's OD and larger piping's ID permits installation.

2. Use pressure-type pipe couplings for force-main joints.

3.12 CLOSING ABANDONED STORM DRAINAGE SYSTEMS

A. Abandoned Piping: Close open ends of abandoned underground piping indicated to remain in place. Include closures strong enough to withstand hydrostatic and earth pressures that may result after ends of abandoned piping have been closed. Use either procedure below:

1. Close open ends of piping with at least 8-inch- thick, brick masonry bulkheads.
2. Close open ends of piping with threaded metal caps, plastic plugs, or other acceptable methods suitable for size and type of material being closed. Do not use wood plugs.

B. Abandoned Manholes and Structures: Excavate around manholes and structures as required and use one procedure below:

1. Remove manhole or structure and close open ends of remaining piping.
2. Remove top of manhole or structure down to at least 36 inches below final grade. Fill to within 12 inches of top with stone, rubble, gravel, or compacted dirt. Fill to top with concrete.

C. Backfill to grade according to Division 31 Section "Earth Moving."

3.13 IDENTIFICATION

A. Materials and their installation are specified in Division 31 Section "Earth Moving." Arrange for installation of green warning tape directly over piping and at outside edge of underground structures.

1. Use warning tape or detectable warning tape over ferrous piping.
2. Use detectable warning tape over nonferrous piping and over edges of underground structures.

3.14 FIELD QUALITY CONTROL

A. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches of backfill is in place, and again at completion of Project.

1. Submit separate reports for each system inspection.
2. Defects requiring correction include the following:

    a. Alignment: Less than full diameter of inside of pipe is visible between structures.
    b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 92.5 percent of piping diameter.
    c. Damage: Crushed, broken, cracked, or otherwise damaged piping.
    d. Infiltration: Water leakage into piping.
    e. Exfiltration: Water leakage from or around piping.

3. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
4. Reinspect and repeat procedure until results are satisfactory.

B. Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects.

1. Do not enclose, cover, or put into service before inspection and approval.
2. Test completed piping systems according to requirements of authorities having jurisdiction.
3. Schedule tests and inspections by authorities having jurisdiction with at least 24 hours' advance notice.
4. Submit separate report for each test.
5. Gravity-Flow Storm Drainage Piping: Test according to requirements of authorities having jurisdiction, UNI-B-6, and the following:

    a. Exception: Piping with soil tight joints unless required by authorities having jurisdiction.
    b. Option: Test plastic piping according to ASTM F 1417.
    c. Option: Test concrete piping according to ASTM C 924.
    d. PVC Piping: Test according to AWWA M23, "Testing and Maintenance" Chapter.

C. Leaks and loss in test pressure constitute defects that must be repaired.

D. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.

3.15 CLEANING

A. Clean interior of piping of dirt and superfluous materials. Flush with potable water.

END OF SECTION 334100

PAGE INTENTIONALLY BLANK

SECTION 334600 - SUBDRAINAGE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. REFERENCES

1. ASTM D 3034 - Specification for Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
2. AASHTO M-252, 3 to 10 inch pipe, Specifications for Corrugated Polyethylene Pipe.
3. AASHTO M-294, 12" to 36" pipe, Specification for Corrugated Polyethylene Pipe.
4. ASTM C 478 - Specification for Pre-cast Reinforced Concrete Manhole Sections.
5. ASTM C 923 - Specification for Resilient Connectors between Reinforced Concrete Manhole Structures, Pipes and Laterals.
6. ASTM C 443 - Specification for Joints for Circular Concrete Sewer and Culvert Pipe, using Rubber Gaskets.
7. ASTM F447 - Elastomeric Seals (Gaskets) for Joining Plastic Pipes.
8. ASTM C 150 - Specification for Portland Cement.
9. ASTM C 33 - Specification for Concrete Aggregates.
10. ASTM A 185 - Specification for Steel Welded Wire Fabric for Concrete Reinforcement.
11. ASTM 615 - Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
12. ASTM A 536 - Specification for Ductile Iron Castings.
13. ASTM D 698 - Test Method for Moisture Density Relations of Soils and Soil-Aggregate Mixtures using 5.5 lb. (2.49 kg.) Rammer and 12 inch Drop.
14. ASTM D 1869 - Specification for Rubber Rings for Asbestos-Cement Pipe.
15. ASTM D 2321 - Practice for Underground Installation of Thermoplastic Pipe for Sewers and other Gravity-Flow Applications.
16. ASTM C 891 - Practice for Installation of Underground Pre-cast Concrete Utility Structures.
17. **I.S.P.W.C. – Idaho Standards for Public Works Construction – current edition.**

B. Section Includes:
1. Geotextile filter fabrics.

1.3 SUBMITTALS

A. Product Data under provisions of Division 1:
1. Geotextile filter fabrics.
2. Submit manufacturer's installation instructions under provisions of Division 1.

3. Project Record Documents
    a. Submit documents under provisions of Division 1.
    b. Accurately record location of pipe runs, connections, catch basins, cleanouts, and invert elevations each day.
    c. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities each day.

1.4 QUALITY ASSURANCE

A. Regulatory Requirements

B. Conform to Idaho Standards for Public Works Construction and the **City of Jerome** codes for materials and installation of the Work of this Section.
    1. Comply with applicable portions of all environmental agency regulations pertaining to storm sewerage systems.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

A. Soil materials are specified in Division 31 Section "Earth Moving."

2.2 GEOTEXTILE FILTER FABRICS

A. Description: Fabric of PP or polyester fibers or combination of both, with flow rate range from 110 to 330 gpm/sq. ft. when tested according to ASTM D 4491.

B. Structure Type: Nonwoven, needle-punched continuous filament.

    1. Survivability: AASHTO M 288 Class 2.
    2. Styles: Flat and sock.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine surfaces and areas for suitable conditions where subdrainage systems are to be installed.

B. If subdrainage is required for landscaping, locate and mark existing utilities, underground structures, and aboveground obstructions before beginning installation and avoid disruption and damage of services.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 EARTHWORK

A. Excavating, trenching, and backfilling are specified in Division 31 Section "Earth Moving."

3.3 LANDSCAPING DRAINAGE INSTALLATION

A. Provide trench width to allow installation of sand trench. Grade bottom of trench excavations to required slope, and compact to firm, solid bed for drainage system.

B. Lay flat-style geotextile filter fabric in trench and overlap trench sides.

C. Place supporting layer of drainage course over compacted subgrade and geotextile filter fabric, to compacted depth of not less than 3 inches.

D. After satisfactory testing, cover sand trench to within 3 inches of finish grade.

E. Wrap top of sand trench with flat-style geotextile filter fabric, overlapping edges at least 4 inches.

F. Fill to Grade: Place satisfactory sand fill material over fiter fabric. Place material in loose-depth layers not exceeding 3 inches. Thoroughly compact each layer. Fill to finish grade.

END OF SECTION 334600

PAGE INTENTIONALLY BLANK