OFFICE OF GROUND WATER AND DRINKING WATER

WASHINGTON, D.C. 20460

SOLICITATION OF PUBLIC COMMENT FOR PROJECT-SPECIFIC BUILD AMERICA, BUY AMERICA NONAVAILABILITY WAIVER PROPOSAL

SUBJECT: UNDER EVALUATION: Project-Specific Nonavailability Waiver of Build America, Buy America (BABA) Act Requirements to the Pittsburgh Water and Sewer Authority, PA, for Multiple Manufactured Products and Construction Materials for the Aspinwall Pump Station, Bruecken Pump Station and Clearwell Emergency Response (ABC) Project

Intro:
This solicitation of public comment by the U.S. Environmental Protection Agency (EPA) is to evaluate a BABA waiver request submitted by an assistance recipient based on nonavailability of multiple product(s) for a single project.

This solicitation of public comment does not represent a final agency decision. The purpose of this proposal is to inquire whether potential domestic products may be available that were not identified by the assistance recipient or through EPA's domestic product research efforts, and whether other factors should be considered in the evaluation of a waiver.

EPA has completed its market research efforts and was unable to identify domestic products meeting the performance-based specifications, in sufficient and reasonably available quantities and of a satisfactory quality. EPA makes every effort to locate domestic products through its waiver process and the public comment period provides a meaningful opportunity to vet the Agency's interim research. In EPA's experience, a viable domestic product is identified through public comment in many cases. Through this public comment period, commenters may provide information that indicates a waiver may not be needed. For example, if a specified item is found to be domestically available, EPA would not issue a final waiver.

Public comments are requested for 15 days (specific dates noted on EPA's website). Please submit comments to BABA-OW@epa.gov. Please include information in the subject of the email identifying it as a public comment on this waiver request, such as "Waiver Comment: Aspinwall Pump Station, Bruecken Pump Station and Clearwell Emergency Response Project" or similar.

Background
The Buy America Preference set forth in section 70914 of the BABA included in the

Infrastructure Investment and Jobs Act (Pub. L. No. 117-58), requires all iron, steel, manufactured products, and construction materials used for infrastructure projects under Federal financial assistance awards be produced in the U.S.

Under section 70914(b), EPA may waive the application of the Buy America Preference, in any case in which it finds that: applying the domestic content procurement preference would be inconsistent with the public interest; types of iron, steel, manufactured products, or construction materials are not produced in the US in sufficient and reasonably available quantities or of a satisfactory quality; or the inclusion of iron, steel, manufactured products, or construction materials produced in the U.S. will increase the cost of the overall project by more than 25 percent. All waivers must have a written explanation for the proposed determination; provide a period of not less than fifteen (15) calendar days for public comment on the proposed waiver; and submit the proposed waiver to the Office of Management and Budget's (OMB) Made in America Office for review to determine if the waiver is consistent with policy.

Summary

Proposed Waiver: The Environmental Protection Agency is soliciting comments regarding whether to issue a project waiver of the manufactured products requirements or construction materials requirements where applicable of section 70914 of the BABA included in the Infrastructure Investment and Jobs Act (Pub. L. No. 117-58), for twenty (20) manufactured products and construction materials used in an infrastructure project funded through the Capitalization Grants for Drinking Water State Revolving Funds. Please refer to the Appendix for a complete list of products for which the waiver is being requested.

Waiver Type: Nonavailability of a domestic product in sufficient and reasonably available quantities or of a satisfactory quality.

Waiver Level and Scope: Project level waiver for multiple products for a single project. No other project will utilize the waiver.

Proposed Waiver Description: Project-specific nonavailability waiver of BABA manufactured products requirements or construction materials requirements where applicable to the Pittsburgh Water and Sewer Authority, for twenty manufactured products and construction materials.

Project Summary: The Pittsburgh Water and Sewer Authority (PWSA) is currently undergoing several design and construction projects related to the replacement of a 40 million gallon clearwell, which is a large storage tank for finished water. This project includes improvements to the Bruecken Pump Station, Aspinwall Pump Station, and an emergency clearwell bypass. The ABC project is the second phase of the City of Pittsburgh's effort to meet their required Consent Decree deadlines with the Pennsylvania Department of Environmental Protection. Each part is necessary leading up to the replacement of the clearwell. This project is completely located within City of Pittsburgh limits.

The Aspinwall Pump Station at the Aspinwall Treatment Plant was built in 1912. Improvements include: the replacement of the existing horizontal split case pumps, motors, switchgear, suction and discharge piping and valves; upgrade electrical power to medium voltage; a new electrical room and creation of office spaces. Activities outside of the pump station include demolition of a garage and fluoride building. Additional improvements include construction of a chemical building housing orthophosphate and hydrofluorosilicic acid, updates to the site utilities, pavement replacement, and stormwater improvements. Exterior improvements to the building include surface cleaning, and roof and window replacement.

Improvements to the Bruecken Pump Station include the demolition of an existing garage, construction of a new facility and associated structures to house pumps (vertical turbine pumps with integral wet well, motors, switchgear), large diameter piping, valves and vault work, electrical equipment, and a chemical building. The existing pump station will remain in place for other PWSA operations. Exterior improvements include replacement of perimeter fencing, re-organization of materials stored on property, utility relocation and stormwater improvements.

The clearwell at the Aspinwall Treatment Plant was built in 1908. Improvements related to the clearwell bypass include: installation of 144-inch and 84-inch diameter steel-coated pipe, vaults, and pile foundations to be in service by the time the clearwell improvements project starts construction.

Length of the waiver: From the effective date of the final waiver until projection completion, which is estimated to be October 1, 2031.

Summary of Items Covered in the Proposed Waiver (including NAICS):
The PWSA is seeking a waiver for the products listed in the appendix of this document.

No domestic products were identified by the assistance recipient, or through EPA's market research completed in May 2025.

Description of Efforts Made to Avoid the Need for a Waiver
Both the PWSA and EPA made every effort to obtain domestically produced manufactured products and construction materials for this project. This is both documented in the waiver request, and in the description of EPA's and Pittsburgh's extensive research efforts listed below.

Prior to submission of the waiver request, the PWSA conducted their own market research. They contacted about eighty (80) individual potential domestic manufacturers for the products which were requested to be waived. Once domestic products which could meet the technical

specifications for the project were not identified, the waiver request was submitted, initiating EPA market research.

EPA conducted initial market research in January 2025. After EPA's research concluded, the assistance recipient identified several other products which they could not find domestic versions. A second round of research was conducted, which concluded in May 2025. The market research process included thorough review of the waiver request submission, examination of domestic manufacturer catalogs and other technical data and marketing materials, personal communication with domestic manufacturers, inquiries of regional project officers, and outreach to contractors and engineers with expertise and familiarity with the project.

During market research, EPA contacted eight (8) manufacturers of pipe penetration sealant. EPA contacted ten (10) manufacturers of buried storm water tanks. EPA contacted ten (10) manufacturers of ladder fall protection. EPA contacted nine (9) manufacturers of door hardware. EPA contacted eight (8) manufacturers of metal edge strips. EPA contacted eleven (11) manufacturers of medium voltage electric motors. EPA contacted ten (10) manufacturers of resilient entrance mats. EPA contacted eleven (11) manufacturers of electric traction elevators. EPA contacted ten (10) manufacturers of quick disconnect fittings. EPA contacted nine (9) manufacturers of three-way mixing control valves. EPA contacted eight (8) manufacturers of uninterruptible power systems. EPA contacted ten (10) manufacturers of magnetic flow meters. EPA contacted ten (10) manufacturers of radar level transmitter equipment. EPA contacted ten (10) manufacturers of induction motors. EPA contacted ten (10) manufacturers of hot water boilers. EPA contacted ten (10) manufacturers of hydronic system pumps. EPA contacted ten (10) manufacturers of differential pressure meters. EPA contacted ten (10) manufacturers of unit heaters. EPA contacted ten (10) manufactures of smoke detectors. EPA contacted nine (9) manufactures of low-voltage electrical cables and equipment. EPA contacted eight (8) manufacturers of medium-voltage electrical cables and equipment. EPA contacted eight (8) manufacturers of lightning protection. EPA contacted eight (8) manufacturers of compression connectors. EPA contacted seven (7) manufacturers of three-phase uninterruptible power supplies. EPA contacted six (6) manufacturers of panelboards. EPA contacted (9) manufacturers of steam pumps. EPA identified these manufacturers in our attempt to find all potential domestic manufacturers of the above-mentioned products.

BABA compliant manufacturers for metal edge strips, hot water boilers, unit heaters, and lightning protection were identified, which are able to meet the project's specifications. As a result of EPA's market research, the PWSA is no longer requesting to waive these items. In addition, the PWSA also removed the door hardware and steam pumps from the waiver request.

Description of Award

Recipient Name and/or Unique Entity Identifier (UEI):
Recipient Name: Pittsburgh Water and Sewer Authority;
Recipient Unique Entity Identifier: S7ZAXKQJ8NJ2
Federal Financial Assistance Identification Number (FAIN): N/A
Federal Financial Assistance Listing Name: 66.468 Drinking Water State Revolving Fund
Federal Financial Assistance Listing Number: 66.468
Federal Financial Assistance Funding amount: $258,611,688
Total Cost of Infrastructure Expenditures: $289,600,000

APPENDIX

Products proposed to be waived (with NAICS and PSC codes) for the for the Aspinwall Pump Station, Bruecken Pump Station and Clearwell Emergency Response Project

Pipe penetration sealant:
- NAICS: 325520
- PSC: 5330

Buried stormwater tanks
- NAICS: 326199
- PSC: 5430

Ladder fall protection
- NAICS: 332999
- PSC: 4240

Induction motors
- NAICS: 335312
- PSC: 6105

Medium voltage motors
- NAICS: 335312
- PSC: 6105

Resilient entrance mats
- NAICS: 326299
- PSC: 7220

Electric traction elevators
- NAICS: 333921
- PSC: 3960

Quick disconnect fittings

- NAICS: 335999
- PSC: 6150

Three-way mixing control valves
- NAICS: 332911
- PSC: 4810

Uninterruptible power system
- NAICS: 335999
- PSC: 6140

Magnetic flow meters
- NAICS: 334513
- PSC: 6680

Radar level Transmitter Equipment
- NAICS: 334513
- PSC: 6680

Hydronic system pumps
- NAICS: 333996
- PSC: 4320

Differential pressure meters
- NAICS: 334513
- PSC: 6685

Automatic Temperature Control System and Smoke Detectors
- NAICS: 334290
- PSC: 6350

Low voltage electrical cables
- NAICS: 335999
- PSC: 6150

Medium voltage electrical cables and equipment
- NAICS: 3335999
- PSC: 6145

Compression connectors
- NAICS: 334417
- PSC: 5935

Three-Phase Uninterruptable Power Supply
- NAICS: 335999
- PSC: 6140

Panelboards
- NAICS: 335313
- PSC: 5998

This waiver request was submitted to the EPA by the state of Pennsylvania and applies only to the project in the subject line. All supporting correspondence and/or documentation from contractors, suppliers or manufacturers included as a part of this waiver request was done so by the recipient to provide an appropriate level of detail and context for the submission. There may be documents with project diagrams, schedules, and supplier correspondence in formats that do not meet the Federal accessibility requirements for publication on the Agency's website. Hence, these exhibits have been omitted from this waiver publication. They are available upon request by emailing BABA-OW@epa.gov.

United States Environmental Protection Agency, Office of Water

Buy America Project Waiver:

Pittsburgh Water and Sewer Authority

Summary

Title of Project: Aspinwall Pump Station, Bruecken Pump Station and Clearwell Emergency Response Project ("Project")

Recipient Agency: Pittsburgh Water and Sewer Authority ("PWSA")

Recipient Address: [redacted]

Proposed Waiver: The U.S. Environmental Protection Agency is proposing a project waiver of the requirements of Section 70914 of the Build America, Buy America ("BABA") Act included in the Infrastructure Investment and Jobs Act ("IIJA") (Pub. L. No. 117-58). Section 70914 requires iron and steel products, manufactured products, and construction materials used in infrastructure projects funded through Pennsylvania Department of Environmental Protection (PADEP) and Pennsylvania Infrastructure Investment Authority's PENNVEST financial authority via Drinking Water State Revolving Fund be produced in the United States ("U.S."). This waiver would permit the use of identified non-domestic iron and steel products, manufactured products, and construction materials, as summarized in Table 1 below, in the construction of the Pittsburgh Water and Sewer Authority's (PWSA) Aspinwall Pump Station, Bruecken Pump Station and Clearwell Emergency Response Project ("Project") funded through PENNVEST Loan Numbers [redacted]

Waiver Type: Nonavailability of domestic product in sufficient and reasonably availability quantities, or of a satisfactory quality.

Waiver Level: Project level waiver for identified products for a specific project.

Length of the Waiver: Until the award's period of performance end date, which is anticipated to be March 2030.

Project Location, Description and Summary: The PWSA, founded in 1984**,** provides water and sewer services to the City of Pittsburgh, Reserve Township and the Boroughs of Millvale, Fox Chapel and Aspinwall. PWSA's drinking water system contains over 950 miles of water mains and supply lines, five (5) reservoirs, and 11 tanks that serve over 300,000 residents.

The Project, located within the City of Pittsburgh limits, includes the construction of improvements to the Bruecken Pump Station (located at the Brilliant Yard site) and Aspinwall Pump Station, as well as the design of a clearwell bypass (both located at the Aspinwall Treatment Plant). This Project is required to be online prior to the replacement of a 40 million-gallon existing clearwell at the Water Treatment Plant (which will be completed under a separate project). The estimated construction cost is approximately $188M. Project elements are described below:

- Bruecken Pump Station improvements include the demolition of existing garage, construction of a new facility and associated structures to house pumping systems (six vertical turbine pumps with integral wet well, motors, switchgear), large diameter piping, valves and vault work,

electrical equipment and a chemical building. The existing pump station will remain in place for other PWSA operations. Exterior improvements include replacement of perimeter fencing, re-organization of materials stored on property, utility relocation and stormwater improvements.

- Aspinwall Pump Station, built in 1912, improvements include replacement of the four (4) existing horizontal split case pumps, motors, switchgear, along with the suction and discharge piping and valves, upgrade electrical power to medium voltage, a new electrical room and conversion of open floor space To two story office space. Activities outside of the APS include demolition of a garage and fluoride building. Additional improvements include construction of a chemical building housing orthophosphate and hydrofluorosilicic acid, updates to the site utilities, pavement replacement, and stormwater improvements.
- Clearwell (constructed in 1908) Bypass, including installation of 144-inch and 84- inch diameter steel-coated pipe, vaults, and pile foundations required to be in service when the clearwell improvements project goes into construction, overflow structure and vaults and connections to existing gatehouses.

PWSA completed 100% design documents on November 15, 2024, and advertised the project for bids on November 18, 2024. Contractor bids are due by February 13, 2025, with Construction expected to start late summer of 2025 and final completion including commissioning and training no later than the September 30, 2030 Consent Decree Deadline. The Project must comply with the PADEP Consent Decree No. 405 M.D. 2024. Table 1 delineates the required milestone compliance dates.

Table 1. Consent Decree Milestone

Task Name	Finish
Consent Decree - Clearwell Bypass (No Connections)	4/14/2028
Consent Decree - Clearwell Bypass (Overflow)	10/15/2029
Consent Decree - Aspinwall Chem Building 2	10/15/2027
Consent Decree - Aspinwall Pumps (2)	10/16/2028
Consent Decree - PROJECT TOTAL	9/30/2030

The Project was initially covered by the *EPA's Public Interest Waiver for Build America, Buy America* requirements for SRF funded projects, as amended (Amended Design Planning Public Interest Waiver of Section 70914(a) of P.L. 117-58, Build America, Buy America Act, 2021 for State Revolving Fund and Water Infrastructure Projects that Initiated Design Planning prior to May 14, 2022 (November 13, 2023)), as it was funded by an Environmental Protection Agency's (EPA) Water Infrastructure Finance and Innovation Act (WIFIA) loan. However, at the 90 percent design stage, PWSA changed the Project's funding source to PENNVEST State Revolving Fund (SRF) funds, which will be using funds from the fiscal year 2024 BIL appropriations. PWSA was notified by PENNVEST, in Fall 2024, that the Project would need to comply with the Build America, Buy America Act requirements.

The project specifications include the EPA's recommended front end specification sections, including federal compliance requirements, to instruct the selected Contractor that the Project must meet BABA requirements. The General Contractor, Sub-contractors, and other constructors, once selected, will be contractually bound to construct the project in accordance with the Build America, Buy America contract language delineated within agreement. and will be required to obtain BABA Certification letters for all included iron and steel products, manufactured products, and construction materials. Project

pricing for early procurement and balance of work procurement was based on the understanding that the project would fall under the EPA's original SRF Design Planning Program BABA Waiver.

In order to meet the tight Consent Decree timelines, the timely completion of this Project is critical. In an effort to mitigate potential delays and contractor claims, PWSA and their Engineering Consultant, [redacted], pre-emptively have taken efforts to specify, identify and confirm availability of BABA compliant construction materials, iron and steel products and manufactured products for the Project, prior to project Advertisement.

Through the Engineer's extensive vendor outreach, several pieces of equipment integral to the facilities were identified as not domestically available in accordance with BABA requirements, or there is no viable alternative that meets Project performance specifications, as summarized in Table 1 below. For example, the electric motors larger than 900hp have an expected 52-week lead time, not including delivery to the pump manufacturer, testing, and shipment to the project site. Other items, such as the storm water tanks, and elevators are custom designs for the project and have long lead times as well. Some of the smaller items on the list do not yet appear to have BABA compliant vendors or suppliers, so were included in the waiver request in order to be pro-active. PWSA is requesting a product specific waiver for these items, because of long lead times associated with their delivery and their impacts to the overall project schedule and ability to meet Consent Decree timelines.

Table 1. Waiver Covered Items

Specification Section	Description
02515	Pipe Penetration Sealant
02810	R-Tank Modular Units (Buried storm water tanks)
04200	Masonry-Joint Reinforcement, Adjustable Masonry Veneer Anchors
05500	Ladder Fall Protection
08710	Door Locksets & Cylinders, Door Hardware, ADA Button and Door Operator
09301	Metal Edge Strips
11060, 11062	Medium Voltage Electric Motors – greater than 900hp
11104	Stop Logs
12481	Resilient Entrance Mats
14216	Electric Traction Elevators
14630	Bridge Crane and Hoists
15095	Quick Disconnect Fittings
15172	Three-way Mixing Control Valve
17110	Uninterruptible Power System (UPS)
17211	Magnetic Flow Meters
17212	Radar Level Transmitter, Transmitter Signal Surge Protectors, Signal Current Isolators

Description of Efforts Made to Avoid the Need for a Waiver: From August 2024 until present, a good faith effort was made by PWSA and its Engineering Consultant [redacted] to specify, and henceforth verify availability of procure iron and steel products, manufactured products, and construction materials that would meet the requirements to be considered a domestically manufactured product under Office of Management Budget M-22-11. contacted vendors to obtain BABA Certification letters for included iron and steel products, manufactured products, and construction materials.

Table 1. Waiver Covered Items	
Specification Section	**Description**
15095	Vacuum Priming Valves
15520	Steam & Condensate Specialties, Steam safety relief valves, Air release valves, Steam safety relief valve drip elbows, Steam sample coolers, Low Pressure Steam Condensate Pumps
15553	Hot Water Boiler
15580	Hydronic System Pumps
15590	Differential Pressure Meter
15620	Hot Water and Steam Unit Heaters, Electric Unit heaters, Corrosion Resistant, Electric Unit Heater, Insulated Flexible Metal Air Duct
15950	Automatic Temperature Control System, Explosion Proof Smoke Detectors, Duct Smoke Detectors
16110	Pre-cast Manholes for electric
16120	Data Communications Cable, Cable Tray Rated Instrument Cable, Power - RHW-2, Control-THWN-2, Power-XHHW-2, Heave Duty Cable CORD, Thermocouple, Extension Cable TCX, ID Tape, Pull Rope
16125	Medium Voltage Cable, Switches - General Indoor, Load Switching Control Relays, Time Switch, Magnetic Lightning Contactor, Magnetic Motor Contactor, Safety Disconnect Switches, Terminal Strips, Thermostat
16446	Lightning Protection
16450	Compression Connectors
16466	Three-Phase UPS
16501	Panelboards for Lighting

[redacted]

[redacted]

Based on in-depth Market Research [redacted] and established design criterion [redacted] several pieces of electrical equipment and process systems integral to the Project were identified as not manufactured in the U.S. and therefore would impact overall project implementation; or equivalent products manufactured in the U.S. do not meet design specifications, which could result in significant project delays – until the manufactured products and equipment are made in the U.S. – or could impact reliability and efficacy of the treatment process if equivalent products manufactured in the U.S. are installed. PWSA, [redacted] or their designee, and the selected Contractor will continue to make a good faith effort to solicit domestic products supported by terms included in requests for proposals, contracts, and nonproprietary communications for purposes of long-term BABA compliance.

Total Project Cost and Federal Financial Assistance: With the total cost of the PWSA's Aspinwall Pump Station, Bruecken Pump Station and Clearwell Emergency Response Project ("Project") estimated at $188 million, the project is a significant portion of PWSA's Capital Improvement Plan and required to move forward due to the Consent Order and Agreement entered September 6, 2019 and renegotiated under a Consent Decree entered September 6, 2024. Due to the impacts to its rate payers, PWSA initiated Pennsylvania's Drinking Water State Revolving Fund (DWSRF) application process for their Water Reliability Plan projects with the submittal of a Pre-Qualification Letter and Project Needs Assessment to the PADEP in June 2022. PENNVEST awarded PWSA the low-interest loan for the Water Reliability Plan projects in July 2022. Subsequently PWSA submitted the Project's the Public Water Supply permit application to the PADEP and received approval in March 2024.

Anticipated Impact if no waiver is issued: If a Buy America Waiver, due to non-availability, is not issued for the above listed products, the Project schedule will be significantly impacted (up to 12 months) due to the non-availability of identified manufactured products, which may cause the project to miss the consent decree milestones as summarized in Table 1 above.

In addition, should the contractor fail to find BABA compliant items for the above listed products, they will likely claim additional costs and delays associated with the procurement. This would also include costs that would be incurred by PWSA for construction inspection and engineering services during construction should the schedule extend, and maintenance costs (and risks of failure) associated with the existing aging equipment at the two pumping station facilities.

Please give this request due consideration.

Sincerely:

Anthony Gallina, PWSA

[redacted]

[redacted]

[redacted]

[redacted]

2.6 ACCESSORIES

A. [redacted]

[redacted]

[redacted]

[redacted]

B. Pipe Penetration (Through Wall/Foundation) Sealant.

[redacted]

2. As approved by Allegheny County Health Department

PART 3 EXECUTION

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

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[redacted]

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[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

2.2 MODULAR STORMWATER STORAGE SYSTEMS

A. Modular Stormwater Storage Systems shall be constructed as indicated on the Drawings. Fittings, installation, and appurtenant materials (geogrids, geosynthetics, etc.) shall be as specified by the manufacturer. Refer to manufacturer specifications for testing requirements. [redacted]

B. The Modular Stormwater Storage Systems must meet the design criteria specified on the Drawings including the required minimum and maximum volumes and minimum and maximum storage elevations. The Modular Storage Systems must be installed within the footprint area outlined on the Drawings unless otherwise approved by the OWNER.

C. The Modular Stormwater Storage Systems shall meet the following minimum characteristics unless otherwise approved by OWNER.

1. Void Ratio of 95%
2. Surface Void Area of 90%
3. Compressive Strength (ASTM D2412/ASTM F2418) of 42 psi
4. Service temperature of -14 degrees to 167 degrees

D. Modular Stormwater Storage Systems shall have the capacity to support a minimum HS-20 loading. Plastic for Modular Stormwater Storage shall adhere to ASTM F2418 and F2787. All joint wrap must be approved by the manufacturer for use.

E. Modular Storage Units shall be clearly labeled with manufacturer and model number to identify each unit for installation.

F. Geogrid installed above modular stormwater storage systems shall be [redacted]

2.3 GEOSYNTHETICS

A. Geosynthetics to be used for the installation of Modular Stormwater Storage systems are specified on the Drawings and in Section 02070 – Geosynthetics.

2.4 STONE BACKILL

A. Section 02060 – Aggregates for Earthwork. AASHTO #57 stone will be used as backfill under and around the Modular Stormwater Storage system as shown on the Drawings. If unsuitable subsoils are discovered during construction requiring that excavation be advanced below the limits shown on the Drawings, it shall be restored at the CONTRACTOR's expense with six inch (6") layers of AASHTO #57 stone to the elevations shown in the Drawings.

PART 3 EXECUTION

3.1 EXCAVATION

5. [redacted]

B. [redacted]

1. [redacted]

C. [redacted]

1. [redacted]

2. [redacted]

3. Ladder Rail Fall Protection System:
   a. System shall consist of a vertical rigid track carrier rail securely and permanently attached to ladder, over which travels a sleeve to which a harness belt can be attached.
   b. Rail:
      1) Notched at six-inch intervals; constructed of stainless steel Type 316.
      2) Provide ladder attachments/rail mounting brackets of same material as rail, and as required by Supplier.

3) Include provisions to secure safety sleeve to carrier rail at top of ladder so that sleeve will not slide down rail when safety belt is unsnapped.
4) Ladders Below Hatches: Rail shall extend from bottom of ladder to top of ladder. Provide telescopic safety post.
5) Ladders Not Below Hatches: Rail shall extend from bottom of ladder to above horizontal landing or roof at top of ladder. Provide removable extension section at top of ladder. Arrange rail to allow climber to stand on landing or roof without unsnapping climber's safety harness.

c. Accessories: furnished by fall prevention system Supplier to Owner:

1) Two safety sleeves compatible for use with rail system. Sleeves shall be cast bronze with five zinc plated steel roller bearings. Sleeves shall travel smoothly on straight or curved rail.
2) Two safety harnesses that attach to sleeve. Harnesses shall be of woven high-strength nylon, with padded straps and forged steel buckles and rings. Harnesses shall distribute impact forces of a fall over climber's thighs, buttocks, chest, and shoulders.
3) Two shock adsorbing lanyards no longer than six-feet, complying with ANSI Z359.1. Lanyards shall be 5/8-inch diameter nylon rope with double locking hooks at each end.

d. Acceptable ladder rail fall protection systems include:

[redacted]

3) Or equal.

D. [redacted]

1. [redacted]

E. [redacted]

1. [redacted]

F. [redacted]

1. [redacted]

2. [redacted]
3. [redacted]
4. [redacted]
5. [redacted]
6. [redacted]

2.2 PERFORMANCE/DESIGN CRITERIA

A. Service Conditions:
1. Temperature: -25-degree C to +40 degree C.
2. Altitude: 0 to 3300 feet above sea level minimum.
3. Derate motors for higher ambient temperature and for higher altitude with motor size based on brake-horsepower.

B. Design Requirements:
1. Operation: Continuous.
2. Compliance: Energy Policy Act of 1992 (EPAct), Final Rule 2014.
3. Tolerance: +/- 10-percent of rated voltage at rated frequency; +/- 5-percent of rated frequency at rated voltage.
4. Standard design: NEMA Design B.

C. Service Factor (percent of additional horsepower):
1. 1.15 for Sine-wave motors.
2. Dual rating: 1.15 Sine-wave and 1.0 Inverter Duty for Inverter Duty motors.

D. Motor Efficiency:
1. NEMA Premium™ efficiency electric motor, single-speed, polyphase, 1-500 horsepower, 3600-rpm 2-pole, 1800-rpm 4-pole, and 1200-rpm 6-pole (1-250 HP), squirrel cage induction motors, NEMA Design B, continuous rated. NEMA Standards Publication MG 1 2011, in Table 12-12.

Table 12-12

Full-Load Efficiencies for 60 HZ Premium Efficiency Electric Motors

Rated 600 Volts or Less (Random Wound)

Open Motors

	2 Pole		4 Pole		6 Pole		8 Pole	
HP	**Nominal Efficiency**	**Minimum Efficiency**	**Nominal Efficiency**	**Minimum Efficiency**	**Nominal Efficiency**	**Minimum Efficiency**	**Nominal Efficiency**	**Minimum Efficiency**
1	77.0	74.0	85.5	82.5	82.5	80.0	75.5	72.0
1.5	84	81.5	86.5	84.0	86.5	84.0	77.0	74.0
2	85.5	82.5	86.5	84.0	87.5	85.5	86.5	84.0
3	85.5	82.5	89.5	87.5	88.5	86.5	87.5	85.5
5	86.5	84.0	89.5	87.5	89.5	87.5	88.5	86.5
7.5	88.5	86.5	91.0	89.5	90.2	88.5	89.5	87.5
10	89.5	87.5	91.7	90.2	91.7	90.2	90.2	88.5

Table 12-12

Full-Load Efficiencies for 60 HZ Premium Efficiency Electric Motors

Rated 600 Volts or Less (Random Wound)

Open Motors

	2 Pole		4 Pole		6 Pole		8 Pole	
HP	**Nominal Efficiency**	**Minimum Efficiency**	**Nominal Efficiency**	**Minimum Efficiency**	**Nominal Efficiency**	**Minimum Efficiency**	**Nominal Efficiency**	**Minimum Efficiency**
15	90.2	88.5	93.0	91.7	91.7	90.2	90.2	88.5
20	91.0	89.5	93.0	91.7	92.4	91.0	91.0	89.5
25	91.7	90.2	93.6	92.4	93.0	91.7	91.0	89.5
30	91.7	90.2	94.1	93.0	93.6	92.4	91.7	90.2
40	92.4	91.0	94.1	93.0	94.1	93.0	91.7	90.2
50	93.0	91.7	91.5	93.6	94.1	93.0	92.4	91.0
60	93.6	92.5	95.0	94.1	94.5	93.6	93.0	91.7
75	93.6	92.4	95.0	94.1	94.5	93.6	94.1	93.0
100	93.6	92.4	95.4	94.5	95.0	94.1	94.1	93.0
125	94.1	93.0	95.4	94.5	95.0	94.1	94.1	93.0
150	94.1	93.0	95.8	95.0	95.4	94.5	94.1	93.0
200	95.0	94.1	95.8	95.0	95.4	94.5	94.1	93.0
250	95.0	94.1	95.8	95.0	95.8	95.0	95.0	94.1
300	95.4	94.5	95.8	95.0				
350	95.4	94.5	95.8	95.0				
400	95.8	95.0	95.8	95.0				
450	96.2	95.4	96.2	95.4				
500	96.2	95.4	96.2	95.4				

Table 12-12

Full-Load Efficiencies for 60 HZ Premium Efficiency Electric Motors

Rated 600 Volts or Less (Random Wound)

Enclosed Motors

	2 Pole		4 Pole		6 Pole		8 Pole	
HP	**Nominal Efficiency**	**Minimum Efficiency**	**Nominal Efficiency**	**Minimum Efficiency**	**Nominal Efficiency**	**Minimum Efficiency**	**Nominal Efficiency**	**Minimum Efficiency**
1	77.0	74.0	85.5	82.5	82.5	80.0	75.5	72.0
1.5	84.0	81.5	86.5	84.0	87.5	85.5	78.5	75.5
2	85.5	82.5	86.5	84.0	88.5	86.5	84.0	81.5
3	86.5	84.0	89.5	87.5	89.5	87.5	85.5	82.5

Table 12-12

Full-Load Efficiencies for 60 HZ Premium Efficiency Electric Motors

Rated 600 Volts or Less (Random Wound)

Enclosed Motors

	2 Pole		4 Pole		6 Pole		8 Pole	
HP	**Nominal Efficiency**	**Minimum Efficiency**	**Nominal Efficiency**	**Minimum Efficiency**	**Nominal Efficiency**	**Minimum Efficiency**	**Nominal Efficiency**	**Minimum Efficiency**
5	88.5	86.5	89.5	87.5	89.5	87.5	86.5	84.0
7.5	89.5	87.5	91.7	90.2	91.0	89.5	86.5	84.0
10	90.2	88.5	91.7	90.2	91.0	89.5	89.5	87.5
15	91.0	89.5	92.4	91.0	91.7	90.2	89.5	87.5
20	91.0	89.5	93.0	91.7	91.7	90.2	90.2	88.5
25	91.7	90.2	93.6	92.4	93.0	91.7	90.2	88.5
30	91.7	90.2	93.6	92.4	93.0	91.7	91.7	90.2
40	92.5	91.0	94.2	93.0	94.1	93.0	91.7	90.2
50	93.0	91.7	94.5	93.6	94.1	93.0	92.4	91.0
60	93.6	92.5	95.0	94.1	94.5	93.6	92.4	91.0
75	93.6	92.4	95.4	94.5	94.5	93.6	93.6	92.4
100	94.1	93.0	95.4	94.5	95.0	94.1	93.6	92.4
125	95.0	94.1	95.4	94.5	95.0	94.1	94.1	93.0
150	95.0	94.1	95.8	95.0	95.8	95.0	94.1	93.0
200	95.4	94.5	96.2	95.4	95.8	95.0	94.5	93.6
250	95.8	95.0	96.2	95.4	95.8	95.0	95.0	94.1
300	95.8	95.0	96.2	95.4				
350	95.8	95.0	96.2	95.4				
400	95.8	95.0	96.2	95.4				
450	95.8	95.0	96.2	95.4				
500	95.8	95.0	96.2	95.4				

2.3 MATERIALS

A. Motor frames:
   1. TEFC motors shall be cast iron.
   2. Aluminum frame motors are not permitted.

B. Stator windings:
   1. Shall be copper with Class F minimum insulation not to exceed Class B temperature rise of 80-degree C at rated load and with Design B torque /current characteristics for all Medium (Integral) motors.

2. Small (fractional) motors shall be supplied with Class F insulation where available.

C. Rotor material shall be aluminum or copper.

D. Fans shall be non-sparking fan blades.

E. Motor leads shall be non-hygroscopic.

2.4 MOTOR TYPES

A. General Requirements for motors 1/2 horsepower through 500 horsepower, unless otherwise shown or specified:
1. Three phase, squirrel cage, with copper windings.
2. Rated for full voltage starting and continuous duty.
3. Rating shall be:
a. 460/ 230 volts, three-phase, 60-Hertz, as shown on the contract drawings.
4. General Purpose Type motors, which may also be called Type 1 per the project equipment specifications shall be:
a. Open Drip Proof Motors, shall be as defined per NEMA MG1, self-cooled by convection air.
b. Weather-Protected Type I Motors (WP-I), shall be as defined per NEMA MG1, similar to ODP construction with addition of screens to prevent entry of rain, snow, and particles, or objects into the motor. Suitable for clean indoor and protected outdoor installations.
c. Weather Protected Type II Motors (WP-II) shall be as defined per NEMA MG1, with maximum protection from entry of airborne particles, moisture and high velocity air. Suitable for unprotected outdoor installations.
5. Severe Duty Type Motors, which may also be called Type 2 per the project equipment specifications, shall be in accordance with IEEE 841.
a. Totally Enclosed Fan-Cooled Motors (TEFC) shall be defined per NEMA MG1.
b. Enclosure: totally enclosed, fan cooled, with external fan blowing air to the motor frame cooling fins for cooling.
c. Applications: severe duty and most outdoor installations.

B. Motors Less Than 1/2 Horsepower:
1. Type shall be:
a. Squirrel cage, capacitor start with Class F insulation and copper windings.
b. Fan motors rated 1/8 horsepower or less: split-phase or shaded-pole type.
2. Rating shall be:
a. 115 Volts, single phase, 60 Hz.
b. 208 Volts, single phase, 60 Hz.
c. 230 Volts, single phase, 60 Hz.

2.5 COMPONENTS

A. Inverter-Fed Polyphase Motors per NEMA MG1 Part 31:

1. Applications: variable torque or constant torque loads, for vertical or horizontal motors with variable frequency drive controllers (VFD).
2. Features shall include:
   a. Insulation design to meet 2000-Volt peak at a minimum of 0.1 micro-second rise time.
   b. Built-in motor winding protection as specified.
   c. Electrically insulated bearings or,
   d. Provide Electro Static Technology's AEGIS Shaft Grounding Ring for Bearing Protection, Inpro/Seal, or equal. The shaft grounding ring shall be solidly bonded per manufacturer's recommendations.

B. Vertical Motors:
1. Features: Inverter duty or non-inverter duty with solid shaft P-base and high thrust bearing compatible with loads imposed by the driven equipment.

C. Thermal Protection:
1. Inverter duty motors:
   a. Motors up to 50 horsepower:
      1) Protection to be NEMA Type 2 bi-metallic thermal switch (Klixon) type.
      2) Motor Nameplate: Marked "OVER TEMP PROT 2" in accordance with NEMA MG 1 12.43.
2. Motors larger than 50 horsepower up to and including 250 horsepower:
   a. Unless another form of thermal protection is specified in the driven equipment specification, provide a NEMA Type 1 temperature sensing device embedded in the motor winding which is sensitive to motor running over temperature.
   b. Sensor: Wired to a temperature relay in a NEMA 4 box located near or on the motor, or to the variable frequency drive controller.
   c. Motor Nameplate: Marked "OVER TEMP PROT 1" in accordance with NEMA MG 1 12.43.
3. Motors larger than 250 horsepower:
   a. Unless another form of thermal protection is specified in the driven equipment specification, provide 100 ohm platinum RTDs, two per phase embedded in each winding phase.
   b. RTDs shall be brought out to a separate control terminal box mounted on the motor.
   c. Motor Nameplate: Marked "OVER TEMP PROT 1" in accordance with NEMA MG 1 12.43.

D. Motor Nameplates:
1. Materials: Engraved or stamped stainless steel.
2. Features shall be as follows:
   a. NEMA Standard MG 1 motor data.
   b. Permanently fastened to the motor frame.
   c. ABMA bearing identification number for motors meeting IEEE 841.
   d. NEMA nominal efficiency for all motors.
   e. NEMA nominal and minimum efficiency for motors meeting IEEE 841.

f. UL frame temperature limit code for explosion proof motors.
g. Over Temperature Protection Type Number.
h. Temperature device rating and alarm and shutdown setpoint.

E. Conduit Boxes:
1. Provide oversized boxes, with split construction with threaded hubs and petroleum-resistant gaskets.
2. Conduit boxes can be rotated in order to permit installation in any of four positions 90 degrees apart.
3. Provide grounding lug located within the conduit box for ground connection.
4. Provide separate conduit boxes for temperature devices.
5. Separate terminal box for any signal leads (RTD, thermistor, vibration transmitter, etc.).

F. Bearings:
1. Provide oil or grease lubricated ball bearings, angle contact roller bearings for axial thrust loads, and cylindrical bearings for radial-only loads.
2. Rated for a minimum L-10 life of 50,000 hours for direct-connected loads.
3. Cartridge type bearings will not be accepted.
4. Fitted with lubricant fill and drain or relief fittings.
5. Belt loads not to exceed forces calculated from NEMA MG 1 Table 14-1 and 14-1A.

G. Bearing lubrication shall be either grease or oil as per the requirements in either 1 or 2:
1. Grease lubricated bearings:
a. Shall be for electric motor use only.
b. Grease shall be capable of higher temperatures associated with electric motors and shall be compatible with Polyurea-based greases.
c. Provide grease fittings, similar to Alemite™ type (or equivalent).
d. Shielded bearings with regreasable provisions are permissible.
2. Provide oil lubricated bearings with externally visible sight glass to view oil level.

H. Lifting Eyes:
1. Provide lifting eyes with a safety factor of 5.
2. Provide one lifting eye for motors more than 50 pounds.
3. Provide two lifting eyes for motors over 150 pounds.

2.6 FINISHES

A. Paint Finish:
1. Provide standard manufacturer paint finish.
2. Provide motors with semi-gloss finish, scratch and heat resistance electric motor paint.

1.4 DESIGN REQUIREMENTS

A. Motors shall be designed, built, and tested in accordance with the latest applicable editions of ANSI/IEEE, NEMA, NFPA, and UL. The classifications, ratings, performance and testing of all motors shall be in accordance with the latest edition of NEMA Publication No. MG 1.

B. Motors shall be of sufficient capacity to operate the driven equipment under all conditions of operation imposed by the driven equipment without loading the motors beyond their rated nameplates current and power.

C. The rating of the motors offered shall in no case be less than the horsepower shown on the Contract Drawings or stated herein. Both the rating and the characteristics of the motor shall be suitable for the successful operation of the driven equipment, under load conditions, within nameplates values of service factor and ambient temperatures.

D. All motors shall be continuous time rated suitable for operation in a 40 degrees C ambient temperature.

E. Motors specified shall meet the requirements of an energy efficient motor as defined by NEMA MG1, energy efficiency requirements. Motors with horsepower or RPMs not listed by NEMA shall conform to comparable standards of construction and materials as those for listed NEMA motors.

F. Motors operated from variable frequency drives shall comply with NEMA MG 1 performance standards for inverter duty motors.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. The equipment covered by this Specification is intended to be standard equipment of proven performance as manufactured by reputable concerns. Equipment shall be designed, constructed and installed in accordance with the best practices of the trade, and shall operate satisfactorily when installed as shown on the Drawings.

B. Electric motors shall be Premium Efficiency motors manufactured by [redacted]

2.2 MATERIALS AND CONSTRUCTION

A. General

1. The motor types specified under this Section shall include three phase, 60 Hertz, alternating current, squirrel cage, 4160V induction motors, horizontal or vertical shaft, enclosure type such as WP-1 as specified in the Division 11 mechanical equipment specifications.

2. Motors shall be designed to meet the application requirements and to have a minimum locked rotor torque of 60% and a minimum breakdown torque of 200% at full voltage. At the specified starting conditions, the motors shall have a minimum of 10% torque margin throughout the driven equipment load curve.
3. Motor rated horsepower shall be sized with a minimum 5% margin on the maximum brake-horsepower for any normal operating condition.
4. Motors for use with variable frequency drives (VFD) shall be inverter duty and shall meet an 80°C temperature rise at 1.0 service factor at maximum rated speed with the VFD waveform. The motor shall be designed to meet the 80°C maximum temperature rise throughout the speed range.

B. Stator Core
1. The stator core shall consist of low loss electrical steel laminations insulated on both sides with separate air vent spacers. The core shall be secured by fingerplates on each end and held in compression by welded cross members or through bolts.
2. The stator core shall be supported by a rigid frame structure. This frame shall transmit to the foundation all static and dynamic forces associated with normal operation and all expected fault conditions.
3. The stator lamination steel shall be 24 gauge with M-19 grade (or better) material which will minimize hysteresis and eddy current losses to yield a maximum core loss of 2.08 watts/lb at 1.5 Telsa. The lamination steel shall also be a C5 core plate capable of burnout temperatures (during rewinding) of 400°C. The core shall be designed to operate with a maximum tooth density of 90,000 lines per square inch at rated voltage.

C. Stator Windings
1. All motors shall be adequately braced to permit across-line full voltage starting. The stator windings and motor leads shall have Class F or H insulation with copper conductors. Class F insulation shall be provided for non-inverter duty motors and Class H insulation shall be provided for inverter duty motors. In either case, temperature rise shall be limited to that for Class B insulation.
2. Motors shall be form wound with mica tape insulation. Slot liners shall be installed prior to coil insertion. The end coil bracing shall be in place prior to the VPI process. The completely wound stator shall be vacuum pressure impregnated to provide a rigid, sealed insulation system capable of passing an immersion test per NEMA MG 1 Part 20.18.
3. Windings shall be epoxy coated. The windings shall be thoroughly treated with approved insulating compound suitable for protection against moisture, salt air and slightly acid or alkaline conditions. The insulation system for enclosed motors shall be upgraded by additional dips and bakes to increase moisture resistance.
4. Motors shall have an inverter grade insulation system designed and built in accordance with NEMA MG1 Part 31.
5. The stator windings and end turn connections shall be fully brazed to withstand full voltage starting regardless of the starting method indicated. The bracing system shall essentially eliminate coil vibration under high current conditions of starting as well as during normal operation. If a tied system is used, it shall be such that no tie depends on the integrity for any other tie within the system.

6. Stator windings shall be connected externally in the motor junction box to accommodate a differential protection scheme as specified herein and indicated on the Drawings.

D. Bearings
1. The motors shall have spherical roller thrust bearings at the non-drive end (top). All anti-friction thrust bearings shall be designed for an L10 life of 100,000 hours (including pump design thrust and rotor weight). For applications with higher thrust loads (which cannot meet the L10 life) plate-type thrust bearings and oil lubricated sleeve guide bearings shall be used. The oil sump shall be designed to maintain a maximum 40°C temperature rise. Motors shall be designed for the necessary up thrust.
2. When required by motor speed and bearing size, provision shall be made for forced lubrication. The oil supply shall be supplied with motor. In addition, oil rings and an adequate oil reservoir in the bearing housings shall be provided to permit orderly shutdown of the motor in the event of failure of the forced feed lubrication system.

E. Enclosures
1. Frame and Construction: The motor frame shall be welded from thick steel members to provide adequate strength and rigidity to meet the vibration levels specified herein. The external side panels of the motor enclosure shall be fabricated from plate steel with a minimum thickness of 1/4". Enclosures manufactured with synthetic materials such as plastic or fiberglass are not acceptable. The bearing bracket shall be secured to the frame with a rabbet fit. There shall be pilot holes for dowel pins in the motor feet. The motor feet shall be tapped for vertical jacking bolts with SAE fine threads (16/inch).
2. Motor enclosures shall conform to the NEMA classifications specified in the Division 11 equipment specifications. Motors shall have a steel or cast iron frame, cast iron end brackets and steel conduit box.
    a. Vertical motors of the open type shall be provided with drip hoods of approved shape and construction. When the drip hood is too heavy to be easily removed, provision shall be made for access for testing.
    b. Open motors shall be provided with corrosion resistant screens over the air openings in accordance with NEMA requirements for guarded machines. All enclosures shall be provided with stainless steel corrosion resistant screens over all openings and reusable washable inlet air filters and differential pressure switches.
3. The internal cooling air of all motors shall circulate from both ends of the motor towards the center of the rotor and stator lamination stacks, then through vents in the rotor and stator laminations (symmetrical cooling) to the exhaust openings or heat exchanger. Under no circumstances shall uni-directional (asymmetrical) cooling airflow be utilized due to the uneven heat distribution caused particularly in the rotor and bearings.
4. All motors shall include corrosion resistant bolts.
5. Drain(s) shall be provided in the lowest location(s), as necessary, to eliminate the accumulation of liquids.

6. There shall be a metal arrow on each end of the motor indicating direction of rotation. The arrows shall be stainless steel and fasten to the motor frame with stainless steel drive pins.
7. There shall be four air gap inspection ports on each end of the motor. Fans and air baffles shall be designed to accommodate air gap measurement.
8. Motors shall be capable of being lifted in one piece and fully assembled when shipped.
9. Motor conduit box shall be split from top to bottom and shall be capable of being rotated to four positions. Motor conduit box shall be in accordance with the following:
    a. The main terminal box shall be made of welded sheet steel, sized for stress cones and have a minimum size of ANSI type II.
    b. The box shall be sized for all components specified such as lightning arresters, surge capacitors, motor differential current transformers, etc. The box shall be completely rotatable 360 degrees in 90 degree increments.
    c. A separate cast aluminum motor mounted terminal box or boxes shall be provided for RTDs, space heaters, bearing relays and any other specified accessories wired to ring tongue/screw type terminal blocks. The box shall be completely rotatable 360 degrees in 90 degree increments.
    d. Conduit box shall be gasketed and shall include rubber-like gaskets between the frame and the conduit box and between the conduit box and its cover.
    e. Conduit boxes or openings in motor housings shall be provided with conduit hub type fittings to permit threaded conduit connections.
    f. Terminal leads shall be flexible and shall be of sufficient length to extend for a distance of not less than ten inches beyond the face of the terminal box. Terminal leads shall be fitted with solderless lugs suitable for attachment to lugs installed on external wiring. Leads shall be sealed with a non-wicking, non-hygroscopic insulating material or an insulating wrap-cap as manufactured by Ideal Industries.
    g. Provisions for terminal box size, length of leads, size of conduit openings and type of terminal lugs shall be complied with irrespective of any other standards or practice.
    h. A motor frame grounding stud shall be provided inside the conduit box. A drilled and tapped hole shall be included.

F. Balancing and Vibration
1. Rotors shall be dynamically balanced with a half key to grade G1 per ISO 1940 to insure low vibration levels. The vibration levels shall be measured on the bearing housing in the X, Y & Z direction at rated speed with the fully assembled machine mounted on a rigid foundation per NEMA MG 1 Part 7.6.2. The vibration spectrum shall be recorded and include frequencies up to 5 times operating speed. The maximum allowable no-load vibration (filtered) shall be 0.08 in/sec.

G. Sound Level
1. The maximum sound power level of all motors and testing requirements to confirm that level shall conform to the requirements of NEMA MG 1 Part 9.

2.3 ACCESSORIES

A. General
1. Motor accessories shall be provided in accordance with the requirements specified herein.
2. Each motor shall be provided with space heaters.
3. Six 100 Ohm platinum, 3-wire, stator RTDs (2 per phase)
4. Two 100 Ohm platinum, 3-wire, bearing RTDs (1 per bearing - upper/lower, inboard/outboard)
5. Motor Vibration Protection
6. Auxiliary terminal boxes for each of the accessories; The motor termination box shall include a hinged door, with left or right-side hinge.
7. Non-drive end bearing insulation.

B. Space Heaters
1. Space heaters for condensation prevention shall be rated 120 volt. Wattage shall be suitable for the particular frame size and type in accordance with the manufacturer's recommendation.
2. Space heater wire leads shall be brought out to an auxiliary conduit box on the motor. Box construction shall match main power conduit box.

C. Winding Thermal Protection
1. Winding thermal protection shall be in accordance with the following:
   a. Resistance temperature detectors shall be 100 ohm platinum, three wire, precision type with calibrated resistance-temperature characteristics. Detectors, two per phase, shall be positioned to detect highest winding temperature and located between coil sides in stator slots. Detector leads shall be wired to a separate NEMA 4X terminal box.

D. Bearing Thermal Protection
1. Bearing temperature detectors RTD type similar to the winding detectors specified above shall be provided on each bearing and the thrust bearing for vertical motors.

E. All six stator winding leads shall be wired to the motor junction box for connection externally to the motor. Stator winding leads shall be provided with two hole pad connectors. Stator winding connections shall be made in the factory and shall comply with IEEE Std 141-1993.

2.4 SPARE PARTS

A. The Contractor shall furnish and deliver to the Engineer/Owner spare parts for the electric motors in accordance with Division 1 - General Requirements.

B. The spare parts shall be listed in an index and packed in containers suitable for long term storage, bearing labels clearly designating the manufacturer's part number with complete information for use and reordering.

C. Spare parts shall be furnished in accordance with the manufacturer's recommendations for the motor size and type. Spare parts shall include at a minimum the following:

1. One complete set of upper and lower bearing liner halves for the drive end (DE) and non-drive end (NDE) bearings for each type and size of motor. Spare bearings shall be furnished for all motor types. When sleeve bearing motors are provided, spare oil rings shall be furnished for those motors.
2. One set of bearing temperature detectors shall be provided (per each set of three, or less) of each type of motor.
3. One complete set of oil ring(s), front and rear inboard and outboard seals.
4. One set of special tools which may be needed.

[redacted]

[redacted]

A. [redacted]

B. [redacted]

C. [redacted]

D. [redacted]

[redacted]

A. [redacted]

1. [redacted]
2. [redacted]
3. [redacted]
4. [redacted]
5. [redacted]
6. [redacted] bearing on a monthly basis. Purged grease shall be inspected for water or rust.

PART 2 - PRODUCTS

[redacted]

2.2 RESILIENT ENTRANCE MATS

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

1. [redacted]

B. Rubber Mats: 3/8-inch- thick mats; with square edges for recessed installations and with solid-sheet (no perforations) style , top profile, and low-rib, narrow-wale corrugated bottom surface.

1. Color: As selected by Architect from full range of industry colors.
2. Mat Size: As indicated .

[redacted]

[redacted]

A. [redacted]

B. [redacted]

[redacted]

A. [redacted]

1. [redacted]

2. [redacted]

PART 2 PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Regulatory Requirements: Comply with ASME A17.1/CSA B44.

B. Accessibility Requirements: Comply with requirements for accessible elevators in the United States Access Board's ADA-ABA Accessibility Guidelines and with ICC A117.1.

2.2 ELEVATORS

A. Elevator System, General: Manufacturer's standard elevator systems. Unless otherwise indicated, manufacturer's standard components shall be used, as included in standard elevator systems and as required for complete system.

B. Elevator Description:
1. Rated Load: 2100 lb
2. Rated Speed: 150 fpm
3. Operation System: Selective-collective automatic operation
4. Auxiliary Operations:
   a. Standby-powered lowering.
   b. service at all floors.
5. Car Enclosures:
   a. Inside Width: Not less than 66 inches from side wall to side wall.

b. Inside Depth: Not less than 66 inches from back wall to front wall (return panels).
c. Inside Height: Not less than 93 inches to underside of ceiling.
d. Front Walls (Return Panels): Satin stainless steel, ASTM A480/A480M, No. 4 finish .
e. Car Fixtures: Satin stainless steel, ASTM A480/A480M, No. 4 finish .
f. Side and Rear Wall Panels: Plas laminate, ASTM A480/A480M, No. 4 finish.
g. Reveals: Black .
h. Door Faces (Interior): Enameled or powder-coated steel .
i. Door Sills: Bronze .
j. Ceiling: Luminous ceiling .
k. Handrails: 1/2 by 2 inches rectangular satin stainless steel, at sides and rear of car.
l. Floor: Manufacturer's standard carpet.
m. Floor recessed and prepared to receive carpet.

6. Hoistway Entrances:
   a. Type: Single-speed side sliding .
   b. Frames: Enameled or powder-coated steel .
   c. Doors and Transoms: Enameled or powder-coated steel .
   d. Sills: Nickel silver.
   e. Sills at Other Floors: Nickel silver.
7. Hall Fixtures: Satin stainless steel, ASTM A480/A480M, No. 4 finish .
8. Additional Requirements:
   a. Provide inspection certificate in each car, mounted under acrylic cover with frame made from satin stainless steel, ASTM A480/A480M, No. 4 finish .
   b. Provide hooks for protective pads in all cars and one complete set(s) of full-height protective pads.

2.3 MACHINE ROOM-LESS ELECTRIC TRACTION ELEVATORS

A. Basis-of-Design Product: Subject to compliance with requirements, provide [redacted]

1. [redacted]
2. [redacted]
3. [redacted]
4. [redacted]

B. Source Limitations: Obtain elevators from single manufacturer.
   1. Major elevator components, including driving machines, controllers, signal fixtures, door operators, car frames, cars, and entrances, shall be manufactured by single manufacturer.

2.4 TRACTION SYSTEMS

A. Elevator Machines: Permanent magnet, variable-voltage, variable-frequency, ac-type hoisting machines and solid-state power converters.
   1. Provide regenerative system.
   2. Limit total harmonic distortion of regenerated power to 5 percent in accordance with IEEE 519.
   3. Provide means for absorbing regenerated power when elevator system is operating on standby power.
   4. Provide line filters or chokes to prevent electrical peaks or spikes from feeding back into building power system.

B. Inserts: Furnish required concrete and masonry inserts and similar anchorage devices for installing guide rails, machinery, and other components of elevator work. Device installation is specified in another Section.

C. Machine Beams: Provide steel framing to support elevator hoisting machine and deflector sheaves from the building structure. Comply with Section 05500 "Metal Fabrications" for materials and fabrication.

D. Car Frame and Platform: Bolted- or welded-steel units.

E. Guides: Roller guides. Provide guides at top and bottom of car and counterweight frames.

2.5 OPERATION SYSTEMS

A. Provide manufacturer's standard microprocessor operation systems as required to provide type of operation indicated.

B. Auxiliary Operations:
   1. Single-Car Standby-Powered Lowering: On activation of standby power, if car is at a floor, it remains at that floor, opens its doors, and shuts down. If car is between floors, it is lowered to the next floor below, opens its doors, and shuts down.
   2. Automatic Dispatching of Loaded Car: When car load exceeds 80 percent of rated capacity, doors begin closing.

2.6 DOOR REOPENING DEVICES

A. Infrared Array: Provide door reopening device with uniform array of 36 or more microprocessor-controlled, infrared light beams projecting across car entrance. Interruption of one or more light beams causes doors to stop and reopen.

2.7 CAR ENCLOSURES

A. Materials and Finishes: Manufacturer's standards, but not less than the following:
   1. Subfloor:

a. Exterior, underlayment grade plywood, not less than 5/8-inch nominal thickness.

2. Floor Finish:
   a. Elevator manufacturer's standard level-loop nylon carpet; color as selected by Architect from full range of industry colors.
3. Plastic-Laminate Wall Panels: Plastic laminate adhesively applied to 1/2-inch fire-retardant-treated particleboard with manufacturer's standard protective edge trim. Panels to have a flame-spread index of 25 75 or less, when tested in accordance with ASTM E84. Plastic-laminate color, texture, and pattern as selected by Architect from plastic-laminate elevator manufacturer's full range.
4. Fabricate car with recesses and cutouts for signal equipment.
5. Fabricate car door frame integrally with front wall of car.
6. Enameled or Powder-Coated Steel Doors: Flush, hollow-metal construction; fabricated from cold-rolled steel sheet. Provide with factory-applied enamel or powder-coat finish; colors as selected by Architect from manufacturer's full range.
7. Sight Guards: Provide sight guards on car doors.
8. Sills: Extruded or machined metal, with grooved surface, 1/4 inch thick.
9. Ceiling: Metallic-finish, plastic-laminate flush panels, with four low-voltage downlights in each panel. Align ceiling panel joints with joints between wall panels.
10. Light Fixture Efficiency: Not less than 35 lumens/W.
11. Ventilation Fan Efficiency: Not less than 3.0 cfm/W.

2.8 HOISTWAY ENTRANCES

A. Hoistway Entrance Assemblies: Manufacturer's standard horizontal-sliding, door-and-frame hoistway entrances complete with track systems, hardware, sills, and accessories. Frame size and profile to accommodate hoistway wall construction.

B. Materials and Fabrication: Manufacturer's standards, but not less than the following:
   1. Enameled or Powder-Coated Steel Frames: Formed from cold- or hot-rolled steel sheet. Provide with factory-applied enamel or powder-coat finish; colors as selected by Architect from manufacturer's full range.
   2. Enameled or Powder-Coated Steel Doors and Transoms: Flush, hollow-metal construction; fabricated from cold-rolled steel sheet. Provide with factory-applied enamel or powder-coat finish; colors as selected by Architect from manufacturer's full range.
   3. Sight Guards: Provide sight guards on doors matching door edges.
   4. Sills: Extruded or machined metal, with grooved surface, 1/4 inch thick.
   5. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C1107/C1107M.

2.9 SIGNAL EQUIPMENT

A. Provide hall-call and car-call buttons that light when activated and remain lit until call has been fulfilled. Provide buttons and lighted elements illuminated with LEDs.

B. Car-Control Stations: Provide manufacturer's standard recessed car-control stations. Mount in return panel adjacent to car door unless otherwise indicated.
   1. Mark buttons and switches for required use or function. Use both tactile symbols and Braille.
   2. Provide "No Smoking" sign matching car-control station, either integral with car-control station or mounted adjacent to it, with text and graphics as required by authorities having jurisdiction.

C. Emergency Communication System: Two-way voice communication system, with visible signal, which dials preprogrammed number of monitoring station and does not require handset use. System is contained in flush-mounted cabinet, with identification, instructions for use, and battery backup power supply.

D. Car Position Indicator: Provide illuminated, digital-type car position indicator, located above car door or above car-control station. Also, provide audible signal to indicate to passengers that car is either stopping at or passing each of the floors served. Include travel direction arrows if not provided in car-control station.

E. Hall Push-Button Stations: Provide one hall push-button station at each landing .
   1. Provide manufacturer's standard wall-mounted units .
   2. Equip units with buttons for calling elevator.

F. Hall Lanterns: Units with illuminated arrows; but provide single arrow at terminal landings. Provide one of the following:
   1. Units mounted in both car door jambs

G. Hall Annunciator: With each hall lantern, provide audible signals indicating car arrival and direction of travel. Signals sound once for up and twice for down.
   1. At manufacturer's option, audible signals may be placed on cars.

H. Emergency Pictorial Signs: Fabricate from materials matching hall push-button stations, with text and graphics as required by authorities having jurisdiction, indicating that in case of fire, elevators are out of service and exits should be used instead. Provide one sign at each hall push-button station unless otherwise indicated.

2.10 FINISH MATERIALS

A. Cold-Rolled Steel Sheet: ASTM A1008/A1008M, commercial steel, Type B, exposed, matte finish.

B. Hot-Rolled Steel Sheet: ASTM A1011/A1011M, commercial steel, Type B, pickled.

C. Stainless Steel Sheet: ASTM A240/A240M, Type 304.

D. Stainless Steel Bars: ASTM A276/A276M, Type 304.

E. Stainless Steel Tubing: ASTM A554, Grade MT 304.

F. Aluminum Extrusions: ASTM B221, Alloy 6063.

G. Nickel Silver Extrusions: ASTM B151/B151M, Alloy UNS No. C74500 or UNS No. C77600.

H. Plastic Laminate: High-pressure type complying with ISO 4586-3, Type HGS for flat applications.

[redacted]

[redacted]

A. [redacted]

B. [redacted]

C. [redacted]

[redacted]

A. [redacted]

B. [redacted]

C. [redacted]

D. [redacted]

E. [redacted]

F. [redacted]

G. [redacted]

6. [redacted]
7. [redacted]

D. [redacted]
1. [redacted]

[redacted]

A. [redacted]
1. [redacted]
2. [redacted]
3. [redacted]
4. [redacted]

B. [redacted]
1. [redacted]
2. [redacted]
3. [redacted]
4. [redacted]
5. [redacted]

c. Or equal.

2.6 QUICK CONNECT FITTINGS

A. Air and water utility station quick connect fittings.
1. Acceptable manufacturers:
a. [redacted]

B. All other quick connect fittings:
1. Type: Coupler type, with cam arms. Capable of connecting to a hose adapter without the use of tools.

2. Size: The same size as the pipeline.
3. Materials: PVDF with Teflon gaskets.
4. Acceptable manufacturers:
   a. [redacted]

2.7 [redacted]

A. [redacted]

B. [redacted]

[redacted]

A. [redacted]
   1. [redacted]
   2. [redacted]

B. [redacted]
   1. [redacted]
   2. [redacted]

C. [redacted]
   1. [redacted]
   2. [redacted]
   3. [redacted]

[redacted]

A. [redacted]
   1. [redacted]
   2. [redacted]
   3. [redacted]

[redacted]

PART 2 PRODUCTS

2.1 ACCEPTABLE PRODUCTS

A. Valves shall be [redacted] modified as necessary to provide the specified features and performance.

B. Control valve operators for HVAC service shall be [redacted]. Operator type and model shall be as required for the control system, modified as necessary to provide the specified features and performance.

2.2 MATERIALS

A. HVAC control valves shall be constructed of the following materials:

Component	**Material**
Body	Bronze, cast iron, brass, or semisteel
Trim, throttling plug	Bronze, brass, or Type 304 stainless steel
Packing	Teflon

B. Materials specified are considered the minimum acceptable for the purposes of durability, strength, and resistance to erosion and corrosion. The Contractor may propose alternative materials for the

purpose of providing greater strength or to meet required stress limitations. However, alternative materials must provide at least the same qualities as those specified for the purpose.

2.3 MANUFACTURER

A. Control valves shall be three-way throttling (modulating) type mixing valves and shall have single-seated valve plugs. Valves 2 inches and smaller shall have NPT threaded connections; valves 2-1/2 inches and larger shall have 125-pound ANSI flanges.

2.4 OPERATORS

A. GENERAL:
1. Operators shall be factory-mounted on the valve and shall be provided as a complete unit with all mounting brackets, linkages, and accessories.
2. Operators shall be sized to meet the operating conditions as specified in paragraph 15172-1.3 and shall be compatible with their associated proportional thermostats.

B. ELECTRIC:
1. Electric valve operators shall operate on 24V AC power and be of the type specially designed for mixing valve control service.
2. Operators shall have solid state control circuitry and drive circuitry.

C. PRODUCT DATA
1. Applicable operation and maintenance information specified in Section 01730 shall be provided in accordance with Section 01330.

[redacted]

END OF SECTION

2.8 POWER SUPPLY AND CONDITIONING EQUIPMENT

A. Except for power supply units which form an integral part of an individual piece of equipment, all power supply and conditioning equipment shall comply with UL 1012 and shall be approved by UL, CSA, or FM for the application.

B. All power supply equipment shall be provided in redundant configurations such that failure of a single unit will not disable all or any part of the instrumentation and communication systems.

C. Direct-Current Power Supplies:
   1. Redundancy step-diode isolation shall be provided for redundant direct current supply units and the power supply negative output terminal shall be grounded. Shall be [redacted]
   2. Nominal 24 VDC instrumentation and control power supply:
      a. Convection-cooled linear type or switching type.
      b. Line regulation: 0.4 percent for line variations from 105 to 132 volts
      c. Load regulation: 0.4 percent for load variations from 0 to full load.
      d. Ripple and noise: Not exceed 100 mV peak-to-peak.
      e. Hold-up time at maximum load: Not less than 16 milliseconds.
      f. Continuous duty from 0 to 50 degrees C at rated load.
      g. Output electronically current limited.
      h. Over-voltage crowbar shutdown.
      i. Output voltage:
         1) Rated 28 VDC
         2) Adjustable plus or minus 5 percent
         3) Set to provide 26.4 volts to the panel direct current bus.
      j. Power Supply: [redacted]
      k. Provide dry contact for power supply failure alarm. Dry contact to be wired as an input to the nearest PLC.

D. Uninterruptible Power System (UPS):
   1. Centralized external UPS
   2. SURGE PROTECTION

E. General: Surge protection shall be provided to protect the electronic instrumentation systems from surges propagating along the signal and power supply lines. The protection systems shall be such that the protection level shall not interfere with normal operation, but shall be lower than the instrument surge withstand level, be maintenance free, and self restoring.
   1. Provide lightning and surge protection devices at all antennas, as well as signal lines, communication networks, and power feeds for all lines that originate or are routed outside a building on any part of the existing or proposed circuits.
   2. Lightning and surge protection devices shall provide full protection from line to line and from line to ground. Units shall be DIN-rail mounted, rated for a minimum of 10kA maximum surge current and voltage suitable for the type of circuit being protected. Reaction time shall be on the order of nanoseconds.

F. Surge protectors shall be listed per UL 1449. Surge protectors shall be removable without changing the impedance of the circuit. Surge protectors product manufacturers shall be:

1. AC power lines shall comply with all requirements of UL 1449 3rd edition with listed devices having a minimum 18kA surge protection and RFI filtering.

a. [redacted]

j. Or equal.

2. For analog signal lines use ANSI/UL497 listed device with minimum 15kA protection SD Series, as manufactured by [redacted]

3. For Ethernet BaseT communications use [redacted]

2.9 [redacted]

A. [redacted]

B. [redacted]

[redacted]

A. [redacted]

1. [redacted]
2. [redacted]
3. [redacted]
4. [redacted]
5. [redacted]
6. [redacted]

2.1 GENERAL AND APPLICATION SPECIFIC INSTRUMENTATION REQUIREMENTS

A. General requirements for instruments are specified within this Section.

B. Application requirements are specified in Section 17200 – Schedules for Instrumentation of Process Systems, and/or on the Drawings.

C. Provide instruments with NSF 61 approvals for drinking water use.

2.2 SYSTEM EQUIPMENT

A. General:
1. In accordance with Section 01330, the General Conditions of the Contract Documents, drawings, information, and technical data for all equipment as, required in Section 17000 and this Section shall be provided. All required product data for this Section shall be included in one complete package.

B. Process switches and devices shall comply with the following requirements:
1. Contact outputs used for alarm actuation shall be normally-closed or normally-opened as required by the process condition to open to initiate the alarm.
2. Contact outputs used to control equipment shall be normally-opened and shall close to start the equipment.
3. Contacts monitored by solid state equipment such as programmable controllers or annunciators shall be hermetically sealed and rated for switching currents from 20 to 100 mA at 24 volts DC.
4. Contacts, monitored by electromagnetic devices such as mechanical relays, shall be rated as NEMA ICS 2, designation B300.
5. Double barriers provided between switch elements and process fluids such that failure of one barrier will not permit process fluids into electrical enclosures.
6. Switch electrical enclosures rated as NEMA 250, Type 4 minimum.
7. Switch range shall be selected so that the specified set point is at least 30 percent but not more than 70 percent of the span, between the upper range limit and the lower range limit.

C. Measuring elements and transmitters shall comply with the following requirements:
1. Measured parameter output indicators complying with paragraph 2.3 shall be provided with any transmitter that does not include an integral indicator. Indicators, whether integral or separate, shall be calibrated in process units, and engraved on the indicator scale plate.
2. The two-wire type transmitters shall have operating power derived from the signal transmission circuit.
3. Transmitters shall meet specified performance requirements with load variations within the range of 0 to 600 ohms with the power supply at a nominal 24 volts DC with the default range of 0 to 100% linearly corresponding to 4 to 20 mAdc.
4. Transmitter output shall increase with increasing measurement.
5. Time constant shall be adjustable from 0.5 to 5.0 seconds for transmitters used for flow, level transmitters used for flow measurement, or pressure measurement.

6. Transmitter output shall be galvanically isolated via electro-mechanical or optical technology.
7. Transmitter enclosures shall be rated NEMA 250, Type 4, unless otherwise specified.
8. Transmitters located outdoors shall be provided with surge protectors:
   a. Signal: Emerson SolaHD STCSS640362, or accepted equal.
   b. AC Power: UL 1449, LED indicator, screw terminal connections, NEMA 4X. [redacted]
9. Four-wire transmitters shall be isolated from the process and power or provided with a loop-powered signal current isolator connected in the output signal circuit.

2.3 PROCESS PARAMETER OUTPUT INDICATOR

A. Provide digital LED or LCD indicators that integral to the instrument housing where available from the manufacturer. Displays shall be scaled in engineering units, over the calibrated range of the instrument. Calibrate the indicator scale in process units.

B. Analog output indicators shall be 2.5-inch milli-ammeter with 90-degree movement enclosed in a NEMA 7/9 rated meter case. Provide indicators with accuracy within two percent of span. Provide a diode to maintain loop continuity for indicator removal.

2.4

A. ELECTROMAGNETIC FLOW METER
1. Instrument Function: Flow Measurement
2. Instrument Description: Magnetic Flow Metering System
3. Device Type on Instrumentation Schedule: FM
4. Signal Input: Process
5. Signal Output: Analog signal as specified in paragraph 2.2 and HART Protocol
6. Flow Tube shall be IP68
7. Process Connection:
   1) Flow tubes shall be flanged, ANSI B16.5, Class 150, raised face.
8. Product Requirements: Magnetic flow meter provided as a system consisting of a flow tube with separate indicating transmitter, unless otherwise scheduled in the Section 17200, complete with interconnecting cables of sufficient length between the flow tube and the transmitter.
9. Indicating transmitter for full-scale flow rates from 1.0 to 30 feet per second. System error shall not exceed the greater of 0.5 percent of flowrate or 0.1 foot per second from 3 to 30 feet per second.
   a. Grounding Rings: Provide up-stream and downstream 316L stainless steel grounding rings shall be fabricated from the same metal as for the electrodes below.
10. Electrodes: Shall have conical shaped probes that are cleaned by the velocity of the flow stream. Probes shall be manufactured of tantalum or platinum-iridium OR Hastealloy unless otherwise specified in Section 17200.
11. Liner: As follows unless otherwise specified in Section 17200.
   1) 6 inches in diameter and smaller shall be PVDFor equivalent liners suitable for potable water application (NSF61 certified).

2) 8 inches in diameter and larger shall have hard rubber liners.

b. Transmitter: Contain electronics associated with the magnetic flow meter system. Enclosure rating NEMA-4X, cast aluminum or metal compartment for power, field connections and calibration adjustments separate from digital circuitry.

1) Means to calibrate the metering system without use of external calibration units. Transmitter self-diagnostics. Traceability certificate of actual flow lab certification provided with each flowtube.

2) Integral 4-digit LCD flow indication calibrated in process units. Data retained in non-volatile memory.

3) Internal circuitry to drive flow signal to zero upon flow meter determined empty pipe condition.

12. Manufacturers:

1) [redacted]

B. VENTURI TUBE

1. Instrument Description: Venturi tube
2. In accordance with Section 17220 Short-Form Venturi and Differential Pressure Transmitter
3. Manufacturer:

1) [redacted]

C. INTRINSIC SAFETY BARRIER

1. Not Applicable

2.5 SIGNAL CURRENT ISOLATOR

A. Isolator shall provide galvanic isolation of milliampere transmission signals from transmitters. Isolator shall be housed in a NEMA 250, Type 4/7 conduit body and derive operating power from the signal input circuit.

B. Input and output signals shall be 4 to 20 milliamperes, and error shall not exceed 0.1 percent of span. Input resistance shall not exceed 550 ohms with an output load of 250 ohms.

C. Isolator shall be [redacted]

2.6 PRODUCT DATA

A. Additional Information: The following product data shall be provided:

1. Flow calculation for each differential-type flow element.
2. Record documentation shall include the data sheets specified in this Section.

B. The following data provided in accordance with Section 01330:
   1. Operating and maintenance information as specified in Section 17000-1.6. Include final reviewed submittal and separate record of all final configuration, jumper, and switch settings for each instrument.
   2. Test results as specified in Section 17030.

[redacted]

[redacted]

A. [redacted]
   1. [redacted]

B. [redacted]
   1. [redacted]
   2. [redacted]
   3. [redacted]
   4. [redacted]
   5. [redacted]

C. [redacted]
   1. [redacted]

PART 2 PRODUCTS

2.1 GENERAL AND APPLICATION SPECIFIC INSTRUMENTATION REQUIREMENTS

A. General requirements for instruments are specified within this Section.

B. Application requirements are specified in Section 17200 and/or on the Drawings.

C. Provide instruments with NSF 61 approvals for drinking water use.

2.2 SYSTEM EQUIPMENT

A. General:
1. In accordance with Section 01330, the General Conditions of the Contract Documents, drawings, information, and technical data for all equipment as, required in Section 17000 and this Section shall be provided. All required product data for this Section shall be included in one complete package.

B. Process switches and devices shall comply with the following requirements:
1. Contact outputs used for alarm actuation shall be normally-closed or normally-opened as required by the process condition to open to initiate the alarm.
2. Contact outputs used to control equipment shall be normally-opened and shall close to start the equipment.
3. Contacts monitored by solid state equipment such as programmable controllers or annunciators shall be hermetically sealed and rated for switching currents from 20 to 100 mA at 24 VDC.
4. Contacts, monitored by electromagnetic devices such as mechanical relays, shall be rated as NEMA ICS 2, designation B300.
5. Double barriers provided between switch elements and process fluids such that failure of one barrier will not permit process fluids into electrical enclosures.
6. Switch electrical enclosures rated as NEMA 250, Type 4, minimum.
7. Switch range shall be selected so that the specified set point is at least 30 percent but not more than 70 percent of the span, between the upper range limit and the lower range limit.

C. Measuring elements and transmitters shall comply with the following requirements:
1. Measured parameter output indicators complying with paragraph 2.2 shall be provided with any transmitter that does not include an integral indicator. Indicators, whether integral or separate, shall be calibrated in process units, and engraved on the indicator scale plate.
2. The two-wire type transmitters shall have operating power derived from the signal transmission circuit.
3. Transmitters shall meet specified performance requirements with load variations within the range of 0 to 600 ohms with the power supply at a nominal 24 VDC with the default range of 0 to 100% linearly corresponding to 4 to 20 mADC.
4. Transmitter output shall increase with increasing measurement.
5. Time constant shall be adjustable from 0.5 to 5.0 seconds for transmitters used for flow, level transmitters used for flow measurement, or pressure measurement.

6. Transmitter output shall be galvanically isolated via electro-mechanical or optical technology.
7. Transmitter enclosures shall be rated NEMA 250, Type 4, unless otherwise specified.
8. Transmitters located outdoors shall be provided with surge protectors:
   a. Signal: [redacted]
   b. AC Power: UL 1449, LED indicator, screw terminal connections, NEMA 4X. [redacted]
9. Four-wire transmitters shall be isolated from the process and power or provided with a loop-powered signal current isolator connected in the output signal circuit.

2.3 PROCESS PARAMETER OUTPUT INDICATOR

A. Provide digital LED or LCD indicators that integral to the instrument housing where available from the manufacturer. Displays shall be scaled in engineering units, over the calibrated range of the instrument. Calibrate the indicator scale in process units.

B. Analog output indicators shall be 2.5-inch milli-ammeter with 90-degree movement enclosed in a NEMA 7/9 rated meter case. Provide indicators with accuracy within two percent of span. Provide a diode to maintain loop continuity for indicator removal.

2.4 [redacted]

A. [redacted]

B. [redacted]

C. [redacted]

D. [redacted]

E. [redacted]

F. [redacted]

G. [redacted]
1. [redacted]
2. [redacted]

H. [redacted]
1. [redacted]
2. [redacted]
3. [redacted]

2.5 RADAR LEVEL TRANSMITTER

A. Instrument Function: Level Measurement.

B. Device Type, per Instrumentation Schedule: LRM

C. Power Supply: 24 VDC, Loop Powered

D. Signal Input: Process

E. Signal Output: 4-20mA, in accordance with paragraph 2.2 of this section.

F. Product Data:
1. Signal type: 80 GHz continuous radar
2. Enclosure: NEMA 4X integral mount.
3. Operator Interface: LCD display, with Bluetooth connectivity for app configuration
4. Measuring range: 0-49 feet.
5. Beam angle: 8°
6. Deviation: ±2 mm.
7. Analog Output: Two-wire 4 – 20 mA/HART
8. Process Temperature Range: -40 to +176°F.
9. Pressure Range: -14.5 to 43.51 psi
10. Sensor: Integrated antenna sized with process connection
11. Process Connection: 1-1/2 inch NPT. Provide companion flanges for each flanged connection, see drawings.
12. Wetted Materials: PVDF encapsulated.
13. Accessories:
    a. Provide mounting hardware and cable length glands.

G. Manufacturers:
1. [redacted]
2. [redacted]
3. [redacted]

H. CONTAINMENT float switch

I. Instrument Function: Level Measurement.

J. Device Type, per Instrumentation Schedule: LWF

K. Power Supply: N/A

L. Signal Input: Process

M. Signal Output: Single pole single throw (SPST)

N. Product Data:

1. Switch shall be mercury-free, encircling a stationary stem and equipped with magnets. As the float rises or lowers along the stem, magnet actuates a hermetically sealed reed switch mounted in the stem.
2. The conductors shall be a minimum size of 22 AWG, Teflon jacketed lead wires. The switch shall be rated at not less than 20 VA. Provide interposing relays in the PLC panel as necessary so as to not exceed power requirements. Bracket mounting. The float shall have PVDF stem and PVDF float.

O. Manufacturers:
1. [redacted]
2. [redacted]
3. [redacted]

2.6 [redacted]

A. [redacted]

B. [redacted]

C. [redacted]

D. [redacted]

E. [redacted]

F. [redacted]
1. [redacted]
2. [redacted]
3. [redacted]
4. [redacted]
5. [redacted]
6. [redacted]
7. [redacted]

G. [redacted]
1. [redacted]
2. [redacted]
3. [redacted]

2.7 [redacted]

A. [redacted]

B. [redacted]

C. [redacted]

D. [redacted]

E. [redacted]

F. [redacted]

1. [redacted]
2. [redacted]
3. [redacted]
4. [redacted]
5. [redacted]
6. [redacted]
7. [redacted]
8. [redacted]
9. [redacted]
10. [redacted]
11. [redacted]
12. [redacted]
13. [redacted]

G. Manufacturers:

1. [redacted]
2. [redacted]
3. [redacted]

2.8 [redacted]

A. [redacted]

2.9 SIGNAL CURRENT ISOLATOR

A. Isolator shall provide galvanic isolation of milliampere transmission signals from transmitters. Isolator shall be housed in a NEMA 250, Type 4/7 conduit body and derive operating power from the signal input circuit.

B. Input and output signals shall be 4 to 20 milliamperes, and error shall not exceed 0.1 percent of span. Input resistance shall not exceed 550 ohms with an output load of 250 ohms.

C. Isolator shall be [redacted]

2.10 PRODUCT DATA

A. Additional Information: The following product data shall be provided:
   1. Record documentation shall include the data sheets specified in this Section.

B. The following data provided in accordance with Section 01330:

1. Operating and maintenance information as specified in Section 17000-1.6. Include final reviewed submittal and separate record of all final configuration, jumper, and switch settings for each instrument.
2. Test results as specified in Section 17030.

[redacted]

[redacted]

A. [redacted]
1. [redacted]

B. [redacted]
1. [redacted]
2. [redacted]
3. [redacted]
4. [redacted]

C. [redacted]
1. [redacted]
2. [redacted]

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. The following candidate manufacturers are capable of producing equipment and/or products that will satisfy the requirements of this section. The manufacturer's standard product may require modification to conform to specified requirements:

1. Pumps
   a. [redacted]

2.2 COMPONENTS

A. General
   1. Select pumps that are bronze-fitted, single-stage, flanged with gage taps, and hydraulically and dynamically balanced for vibrationless operation.
   2. Select pumps capable of being serviced without disconnecting the connecting piping.

B. Components
   1. Pump Casing:
      a. Cast iron
   2. Impeller:
      a. Bronze, enclosed
   3. Shaft:
      a. Carbon steel with bronze sleeve
   4. Bearings:
      a. Sealed for life ball bearings
   5. Motor support:
      a. Cast iron
   6. Seal:
      a. Mechanical seal with ceramic seal seat and carbon seal ring

2.3 SOURCE QUALITY CONTROL

A. Factory tests will not be required. Manufacturers must guarantee performance.

[redacted]

1.3 [redacted]

[redacted]

B. REFERENCES:

1. This section contains references to the following document. It is a part of this section as specified and modified. In case of conflict between the requirements of this section and those of the listed document, the requirements of this section shall prevail.

Reference	Title
ASME	American Society of Mechanical Engineers; Boiler and Pressure Vessel Code Section VIII, 1986 Edition

PART 2 - PRODUCTS

2.1 MATERIALS

Component	Material
Pressure regulator body	Bronze
Pressure regulator seat	Stainless steel
Pressure relief valve	Cast iron
Pressure relief valve trim	Bronze or stainless steel
Air separator	Carbon steel
Chemical feeder	Carbon steel

2.2 [redacted]

[redacted]

inlet, outlet and drain valves, air relief cock, and top access fitting. Feeders shall be designed for manual addition of chemicals to the boiler feedwater and shall be provided with all fittings necessary for bypass type installation.

2.4 FLOW BALANCING VALVES

A. GENERAL:

1. Flow balancing valves shall be circuit balancing valves with provisions for connecting a portable differential pressure meter. Each meter connection shall have positive shutoff valves.

[redacted]

2.5 DIFFERENTIAL PRESSURE METER

A. One [redacted], or equal, differential pressure meter shall be provided. The differential pressure meter shall have a range of 0-60 feet water column, an accuracy of ±3 percent, and a portable carrying case. The differential pressure meter shall be designed for use with the supplied circuit balancing valves and shall be of the same manufacturer. Prove one spare meter to the Owner.

SECTION 15950

AUTOMATIC TEMPERATURE CONTROL SYSTEMS

PART 1 GENERAL

1.1 DESCRIPTION

A. SCOPE:
1. This section specifies the labor, materials and equipment required for the design, fabrication, installation, and testing of the Automatic Temperature Control (ATC) systems.
2. The Contractor is responsible for a fully function temperature controls system.
3. The ATS systems include local control panels with central processing (CPU) hardware, operating and application software, electronic control equipment, sensors, thermostats, conduit and wiring for functional operating automatic temperature control systems.
4. The ATS panel devices shall be as specified in Section 16175 – Electrical Devices. The ATS local control panels shall include data communication network devices and wiring as specified herein.
5. Refer the HVAC controls drawings in the design documentation for additional information.

B. TYPE:
1. The ATC systems shall monitor and electronically control equipment including valve and damper actuators, with digital, analog, and discrete control.

C. UNIT RESPONSIBILITY:
1. The ATC systems specified in this section shall be the product of a single vendor with the assigned unit responsibility for the ATC Systems specified in this section and as specified in paragraph 11000-1.2 C.

1.2 QUALITY ASSURANCE

A. REFERENCES:
1. This section contains references to the following documents. They are a part of this section as specified and modified. In case of a conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.
2. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date,

whether or not the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
NEC	National Electrical Code
UL 864	Building Automation Systems
UL 916	Energy Management Systems

B. RELATED WORK SPECIFIED ELSEWHERE:
1. Work specified in this section shall conform to the general electrical requirements of Division 16.

C. STANDARDS:
1. Electrical work performed in the installation of the ATC systems, as described in this specification, shall be per applicable state and local codes and in conformance with Division 16.

D. QUALIFICATIONS
1. The Contractor shall have a minimum of 10 years' experience installing the ATC system.

1.3 SUBMITTALS

A. The following submittals shall be provided as specified in Section 01330:
1. A copy of this specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements.
2. Check marks (✓) shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation.
3. The Construction Manager shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.
4. Certificate of Unit Responsibility attesting that the Contractor has assigned, and that the manufacturer accepts, unit responsibility in accordance with the requirements of this Section and paragraph 11000-1.2 C. No other submittal material will be reviewed until the certificate has been received and found to be in conformance with these requirements.

5. Block diagrams showing all major components and panels, printers and other processing devices and required cabling between each. Include environmental and space requirements for panels and other major devices.
6. Manufacturer's literature for each type of panel, controller or device shown on the Riser Diagram.
7. Riser Diagram showing, schematically, the entire building system with all major components identified.
8. System points list.
9. Operation and maintenance information specified Section 01730.
10. Provide complete controls diagrams and sequences of operation.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control test reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

B. Software and firmware operational documentation.

1.6 WORK NOT INCLUDED

A. Work not included is as follows:
1. Assembling multiple section dampers with required interconnecting linkages, shafts and brackets and extending the required number of shafts through the ducts for externally-mounted damper motors.
2. PROVISIONS FOR POWER WIRING AS FOLLOWS:
a. Wiring of power feeders through power disconnects, combination motor starters, and variable speed controllers to the electric motors.
b. Wiring of 120 Vac emergency power feeders to automatic temperature control (ATC) panels and to associated local control panels (LCP).
c. Wiring to 120 Vac single-phase motors or 480 Vac three-phase motors.
d. Wiring of remote start/stop pushbuttons, selector switches, manual starters, automatic motor speed control devices.
3. On-Off or other two-position and Hand-Off-Auto or other three-position selector switches; pushbuttons; and motor controllers are specified in Division 16. Devices and device enclosures shall be provided under Division 16 for the location specified.

1.7 SERVICE CONTRACT

A. Provide a proposal for an annual maintenance contract based upon 1 year of service, 5 years of service, and 10 years of service.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. The Engineer believes the following manufacturers of Niagara based controllers with BACnet communications protocol are capable of producing equipment and/or products that will satisfy the requirements of the Section. This statement, however, shall not be construed as an endorsement of a particular manufacturer's products, nor shall it be construed that a named manufacture's standard equipment or products will comply with the requirement of this Section.

B. The candidate manufacturers include:

1. [redacted]

2.2 GENERAL

A. The ATC system shall be composed local control panels, software, wiring, and control devices and sensors. The ATC system shall utilize direct digital control for modulating control of remote devices based upon sensed data.

B. The ATC system local control panel CPU shall include proportional-integral-derivative (PID) control routines with the associated time settings for flexibility in setting control parameters and to provide ease of adjustment from a touch-screen color graphic operator interface unit (OIU).

C. The ATC shall be based upon the NIAGARA framework and unlocked so the Owner may perform maintenance, setpoint adjustment and scheduling adjustment.

D. All licensing shall be included as part of the startup and testing process. The final installation shall include a minimum of 5 years licensing.

E. Building controllers in each building (Areas 10, 11 and 20) shall be able to communicate with one another and shall be able to accommodate off site monitoring by the Owner if desired. Coordinate with the Owner Information Technology personnel to ensure all building locations are integrated with each other.

F. All maintenance by the controls contractor will be done on-site, off-site work will note be allowed.

G. The ATC shall be able to interface with the SCADA system to pass monitoring and alarm points to the SCADA system. Refer to the HVAC controls drawings for additional information.

2.3 ATC HARDWARE

A. GENERAL:
1. Local control panels and associated hardware shall have UL 916 (Energy Management Systems) or UL 864 (Building Automation Systems) approval labels or the approval label of governing agency. Provide overvoltage transient protectors for the system devices and panel electronic devices.

2.4 REMOTE OPERATOR TERMINALS

A. Provide remote operator terminal for Owner interface with the local control panels to display point commands, to perform database entries, to execute software, and to develop custom programs.

B. The ATC shall be accessible from the Owner's LAN, or local workstation via appropriate username and password privileges.

2.5 ATC LOCAL CONTROL PANEL FUNCTIONS

A. DESCRIPTION:
1. ATC Local control panels shall perform temperature control and energy management functions and shall interconnect with other local control panels to form a data communication network.
2. ATC Local control panels shall allow Owner to alter setpoints, change control modes, display point status, and control devices and motors. Local control panels shall execute software programs.
3. ATC local control panels shall diagnose system malfunctions or equipment failures and register alarms and transmit the alarms to the CPU.
4. ATC local control panels requirements:
   a. Power requirements 115 Vac + 10%, 60 Hertz, 1920 watts, 20-ampere power circuit
   b. Operating environment -40o F to 150o F
   c. Contact ratings 4 amperes at 120 Vac
   d. Input/output points Discrete: Form-C contacts
   e. Analog: 4-20 madc

B. DATA ACCESS INTERFACE:
1. The local control panels shall contain RS-232C data connector, RS-485 data connector, and a standard telephone jack for connection to devices including the remote operator's terminal for the following:
   a. View and set day and time.
   b. Modify time-of-day scheduling.
   c. View points and alarms.
   d. Command and modify setpoints.
   e. View totalized point values.
   f. View and set trends.

2.6 ATC SYSTEM SCHEMES

A. TIME-OF-DAY SCHEDULING:
1. Master Scheduling program with thirty-two, eight-day (seven days plus Holiday) for 24 system loads groups that can be assigned:
   a. Control individually configured for day of the week and Holiday
   b. Six time-of-day events including:
      1) equipment start and stop
      2) optimum start and stop
      3) duty cycle start and stop
      4) night purge cycle start.

B. ECONOMIZER CYCLE:
1. Economizer control changes the relative position of outside air and return air dampers based on the measured dry bulb temperature of the outside air stream and the return air stream.
2. Damper control sequenced for fresh air cooling with outside air when the temperature of the outside air is less than the temperature of the return air.
3. Dampers return to the minimum outside air position when the outside air temperature exceeds the return air temperature.

C. ENTHALPY CHANGEOVER:
1. Enthalpy control changes the relative position of outside air, return air, and exhaust air dampers based on the measured enthalpy of the outside air and return air streams.
2. Damper control sequenced to provide fresh air cooling with outside air when the enthalpy of the outside air is less than the enthalpy of the return air.
3. Dampers return to the minimum outside air position when the outside air enthalpy exceeds the return air enthalpy.

D. NIGHT SETBACK:
1. Night setback cycles equipment during facility unoccupied hours to maintain a lower temperature level.

E. TEMPERATURE RESET:
1. Controlled temperatures shall be reset using PID control algorithms.

F.EVENT INITIATED:
1. Equipment shall start or stop based on an event:
   a. temperature
   b. flow
   c. pressure drop

2.7 ATC DATA COMMUNICATION:

A. The local area network (LAN) shall be consistent with the IEEE standards and have a data communication transmission rate of 1 Gbps.

2.6 ATC SYSTEM SCHEMES

A. TIME-OF-DAY SCHEDULING:
1. Master Scheduling program with thirty-two, eight-day (seven days plus Holiday) for 24 system loads groups that can be assigned:
   a. Control individually configured for day of the week and Holiday
   b. Six time-of-day events including:
      1) equipment start and stop
      2) optimum start and stop
      3) duty cycle start and stop
      4) night purge cycle start.

B. ECONOMIZER CYCLE:
1. Economizer control changes the relative position of outside air and return air dampers based on the measured dry bulb temperature of the outside air stream and the return air stream.
2. Damper control sequenced for fresh air cooling with outside air when the temperature of the outside air is less than the temperature of the return air.
3. Dampers return to the minimum outside air position when the outside air temperature exceeds the return air temperature.

C. ENTHALPY CHANGEOVER:
1. Enthalpy control changes the relative position of outside air, return air, and exhaust air dampers based on the measured enthalpy of the outside air and return air streams.
2. Damper control sequenced to provide fresh air cooling with outside air when the enthalpy of the outside air is less than the enthalpy of the return air.
3. Dampers return to the minimum outside air position when the outside air enthalpy exceeds the return air enthalpy.

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2.7 ATC DATA COMMUNICATION:

A. The local area network (LAN) shall be consistent with the IEEE standards and have a data communication transmission rate of 1 Gbps.

2.8 CONTROL DEVICES AND SENSORS

A. [redacted]

C. DUCT SMOKE DETECTORS:

1. Duct smoke detectors shall be UL labeled for their application and shall conform to the requirements of Division 15 and Division 16.
2. Duct Smoke Detectors:
   a. Dual chamber ionization type
   b. Contain no more than 1.0 micro-curie of radioactive material
   c. Detect both visible and invisible products of combustion at a 2% per foot sensitivity
   d. Auxiliary relay with two Form-C dry contacts for control and alarm
   e. [redacted]
3. Explosion Proof Duct Smoke Detectors.
   a. UL labeled for use in a Class I, Division 2, Group D environment.
   b. Photoelectric type operating on 24 Vdc at 10 madc.
   c. Provide two Form-C output contacts
   d. [redacted]

D. [redacted]

SECTION 16120

LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 GENERAL

1.1 SCOPE OF WORK

A. This section specifies stranded copper cables, conductors, and wire rated 600 volts insulation used for power; lighting, analog, digital, or pulse signals and control circuits.

B. This section specifies copper cables and coax cable rated 300 volt insulation used for data communication.

1.2 REFERENCES

A. This section contains references to the following documents. They are a part of this section. In case of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

B. Unless otherwise specified, references to document shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, whether or not the document has been superseded by a version with a later date, discontinued or replaced.

Reference	**Title**
ASTM B3	Soft or Annealed Copper Wire
ASTM B8	Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
ASTM B33	Tinned Soft or Annealed Copper Wire for Electrical Purposes
ICEA S-68-516	Ethylene-Propylene-Rubber-Insulated Wire
NEMA WC7	Cross-Linked-Thermosetting Insulated Wire and Cable for the Transmission and Distribution of Electric Energy
NFPA 70	National Electric Code (NEC)
UL 44	Rubber-Insulated Wires and Cables
UL 83	Thermoplastic-Insulated Wires and Cables

1.3 [redacted]

PART 2 PRODUCTS

2.1 GENERAL

A. Unscheduled Conductors and Cables:
1. Where not specified on the Drawings, conductors and cables shall be sized in accordance with 3.2.

B. Cable Specification Sheets (CABLESPEC):
1. General requirements for conductors and cables specified in this Section are listed on CABLESPEC sheets in paragraph 3.6.

2.2 COLOR CODING

A. Control Conductors:
1. Single-conductor control conductors shall have the following colors for the indicated voltage:

Control Conductor	120V
Power (AC)	Black
Control (AC)	Red
Neutral	White
Ground	Green
Foreign Voltage (DC)	Blue/White
Foreign Voltage (AC)	Yellow

Control Conductor	120V
Power (DC)	Blue
Control (DC)	Violet

B. Power Conductors:
1. Power conductors shall have the following colors for the indicated voltage:

Power Conductor	480V	208/120V
Phase A	Brown	Black
Phase B	Orange	Red
Phase C	Yellow	Blue
Ground	Green	Green
Neutral	Gray	White

C. In general color code all secondary branch circuit and feeder conductors as follows:
1. Two-wire grounded system – 1 black, 1 white (neutral)
2. Three-wire, single-phase, grounded system – 1 black, 1 red, 1 white (neutral)
3. Three-wire, 3-phase, grounded ungrounded, delta system – 1 black, 1 red, 1 blue
4. Four-wire, 3 phase, grounded wye – 1 black, 1 red, 1 blue, 1 white (neutral).
5. Four-wire delta system shall be color coded the same as a grounded wye except high-leg (3 phase) shall be color coded orange and tagged "Hi-Leg".
6. Connect all circuit conductors of the same color to the same ungrounded feeder conductor throughout the installation.
7. Provided any conductor intended solely for equipment grounding purposes green in color. Do not use conductors having white or green covering to indicate other than neutral or grounding. This limitation applies to all power, lighting, and control circuits.

D. Cables may be black with colored 3/4-inch vinyl plastic tape applied at each cable termination and in pull boxes, handholes and manholes. Tape shall be wrapped with 25 percent overlay to provide 3 inches minimum coverage.

E. Signal Conductors:
1. Signal cable conductors shall be color coded black and white for pairs or black, white, and red for triads. Each conductor and each group of conductors shall be numbered.

2.3 POWER AND CONTROL CONDUCTORS AND CABLE, 600 VOLT

A. Single Conductor:
1. Provide stranded conductors for all cable or wires. Provide minimum conductor size of 12 AWG for power and lighting circuits and minimum conductor size of 14 AWG for control circuits.

B. Multiconductor Cable:

1. Provide multiconductor power cable and multiconductor control cable where identified on the drawings. Provide multi-conductor cable designations as per the drawings Provide stranded conductors for all cable or wires.

2.4 SIGNAL CABLES

A. General:
   1. Factory cable between manufactured instrument system components shall be provided in compliance with the instrument manufacturer's recommendations.
   2. Signal cable shall be provided for instrument signal transmission. Single instrument cable (SIC) shall be provided in accordance with the following examples:
      a. CABLESPEC "SIC":
         1) Cable designation:
            a) 1PR#16S shielded twisted pair (STP)
         2) Cable designation:
            a) 1TR#16S triad (STT)

2.5 PORTABLE CORD

A. Portable cord shall be provided in accordance with CABLESPEC "CORD," unless otherwise specified. Cords shall contain an equipment grounding conductor.

2.6 SPLICING AND TERMINATING MATERIALS

A. Connectors shall be tool applied compression type of correct size and UL listed for the specific application. Connectors shall be tin-plated high conductivity copper. Wire nuts for a splice is prohibited.

B. Signal and control conductors shall be connected to terminal blocks and field devices and instruments shall be terminated with conductor terminals as specified in 3.2.

C. Connectors for wire sizes No. 8 AWG and larger shall be compression tool installed one-hole lugs up to size No. 3/0 AWG, and two-hole or four-hole lugs for size No. 4/0 and larger. Mechanical clamp, dimple, screw-type connectors are not acceptable. In-line splices and taps shall be used only by written consent of the Owner/Engineer.

D. Power conductor splices shall be compression type, made with a compression tool die approved for the purpose, as made by [redacted]. Splices shall be covered with electrical products designed for the application, insulated, and covered with a heat-shrinkable sleeve or boot, as specified elsewhere.

E. Motor connection kits shall consist of heat-shrinkable, polymeric insulating material over the connection area and high dielectric strength mastic to seal the ends against ingress of moisture and contamination. Motor connections may use the T[redacted]

F. Motor connection kits shall accommodate a range of cable sizes for both in-line and stub-type configurations. Connection kits shall be independent of cable manufacturer's tolerances. Refer to the electric motor specification Section 11060.

2.7 CORD GRIPS

A. Cord grips shall be provided where indicated on the Drawings to attach flexible cord to equipment enclosures. Cord grips shall consist of a threaded aluminum body and compression nut with a neoprene bushing and stainless steel wire mesh for strain relief. Cord grip shall provide a watertight seal at enclosure interface and sized to accommodate the flexible cord.

2.8 CONDUCTOR NUMBERING

A. Conductor Numbers:
   1. Identify conductors with numbers at both ends. Conductor tag numbers are the equipment number followed by a dash followed by the conductor number specified on the control diagram. Example:
      a. Equipment Tag number = 1900 - L1 where:
      b. 1900 = cable number
      c. L1 = conductor number
   2. Conductors in parallel or in series between equipment have the same conductor number. Neutral conductors have the same conductor number. Wherever possible, the conductor number is the same as the equipment terminal to which it connects.
   3. Where factory-wired equipment has terminal numbers different than the conductor numbers shown on the control diagrams:
      a. Show both on the interconnection diagram
      b. Include a copy of the interconnection diagram inside of the equipment cabinet.

2.9 CONDUCTOR IDENTIFICATION

A. All insulated conductors, control cables (including individual field wired controls) shall be permanently tagged with numbers.

B. The Contractor shall provide complete power and control conductor identification system for all work covered by this contract so that after installation circuits can be easily traced form origin to final destination. Using approved identification system designations, the contractor shall provide and install markers, tags, labels, terminal point numbers, or combination of these, so that all conductors are permanently identified at their origin, at any intermediate terminal board or junction point, and at their final destination.

C. Submit proposed identification system to the Engineer for review. Obtain Engineer's acceptance before detailing the proposed system.

D. For control wiring identification, utilize actual terminal board designations from electrical equipment and instrumentation and control system equipment.

E. All circuits 600 volts and above shall have an identification tag with the following information permanently and legibly stamped on it:
   1. Circuit number and description
   2. Circuit origin and destination
   3. Conductor voltage, circuit voltage, conductor size, type of insulation and sheath.
   4. Date of installation

F. All circuits 600 volts and less shall have an identification tag or band with an identifying number at each end termination and at each splice or pull box or pull point in junction boxes and pull boxes. The identifying number of each wire shall be determined at the point of circuit origin, and shall continue unchanged to the point of circuit termination. In general, the circuit numbering system shall conform to the terminal identification numbers of equipment furnished, such as switchboards, motor control centers, relay panels, control consoles, computers, etc.
   1. Circuit number and description
   2. Circuit origin and destination
   3. Conductor voltage, circuit voltage, conductor size, type of insulation and sheath.
   4. Date of installation

G. Where cables run underground identification of conductors shall be as follows:
   1. Circuit number (if applicable)
   2. Origin and destination
   3. Type of circuit (Branch, Feeder, Control, or Signal)
   4. Voltage or current rating.
   5. Total Length of run (in feet)
   6. Date of Installation

H. Manufacturers
   1. [redacted]

2.10 CONDUCTOR TAGS

A. Conductor tags for conductors No. 12 AWG and below shall be legible permanent heat shrinkable sleeve of white PVC with machine printed black marking. Tags relying on adhesives or taped-on markers are not acceptable.

B. Tags for larger conductors shall be heat shrinkable white polyofin with black marking.

2.11 TERMINAL BLOCKS

A. Identify each power and control conductor at each terminal to which it is connected. Provide identification sleeves for conductors size No. 10 AWG or smaller. Use locking tab type cable markers for conductors No. 8 AWG and larger. Provide white plastic tabs with conductor identification number permanently embossed.

B. Identify conductors in accordance with paragraph 2.8 Conductor Numbers. Adhesive strips are not acceptable.

C. Machine print the letters and numbers that identify each wire on sleeves with permanent black ink with figures 1/8 inch high. Provide yellow or white tubing for sleeves sized to fit the conductor insulation. Shrink the sleeves with hot air after installation to fit the conductor.

D. Unless otherwise specified, terminal blocks shall be panhead strap screw type. Terminals shall be provided with integral marking strips that permanently identify with the connecting wire numbers as shown on the drawings and as described in Specification 16000:
1. Terminal blocks for P-circuits (power 208-600 volts)
   a. Rated not less than the conductor current rating
   b. Rated less than 600 volts AC.
2. Terminal blocks for C-circuits and S-circuits:
   a. Rated not less than 20 amperes
   b. Rated less than 600 volts AC.
3. Terminals shall be tin-plated.
4. Insulating material shall be nylon.

B. [redacted]

9. [redacted]

3.3 SIGNAL CABLE

A. Signal Cable shall be run in a separate conduit from power, control wiring.

B. Provide terminal blocks at instrument cable junctions within dedicated terminal boxes provided by the installer. Signal circuits shall be run without splices between instruments, terminal boxes, or panels.

C. Circuits shall not be made using conductors from different pairs or triads. Triads shall be used wherever 3-wire circuits are required.

D. Shields are not acceptable as a signal path, except for circuits operating at radio frequencies utilizing coaxial cables. Common ground return conductors for two or more circuits are not acceptable.

E. Unless otherwise specified, shields shall be bonded to the signal ground bus at the control panel only and isolated from ground at the field instrument or analyzer and at other locations. Shields or drain wires for spare circuits shall not be grounded at either end of the cable run. Terminals shall be provided for running signal leads and shield drain wires through junction boxes.

F. Spare circuits and the shield drain wire shall be terminated on terminal blocks at both ends of the cable run and be electrically continuous through terminal boxes.

G. Where instrument cable splicing is required, provide an instrument stand with terminal box rated for the area and environment and mounted approximately 3 feet above grade for instrument cable splices with the circuits and individual conductors provided with nameplate as specified in Section 16000.

3.4 PORTABLE CORD

A. Portable power cords feeding permanent equipment, such as pendant cords feeding motors for pumps, cranes, hoists, and portable items shall have a wire mesh cord grip of flexible stainless-steel wire to relieve the tension from the cable termination. Connection of portable cords to permanent wiring shall be accomplished with dedicated boxes and terminals blocks.

3.5 TESTING

A. The Contractor shall test conductors, wire, and cable in accordance with Section 16030.

3.6 CABLE SPECIFICATION SHEETS (CABLESPEC)

A. General:
   1. Conductor, wire, and cable types for different locations, service conditions and raceway systems are specified on individual cable specification sheets. Scheduled and unscheduled conductors, wires, and cables shall be installed in accordance with the CABLESPEC Sheets.

B. CABLESPEC Sheets:
   1. The following CABLESPEC sheets are included in this section:

Type	Volt	Product	Purpose
DC1	600	RS-422: 4-PAIR, 24-AWG UNSHIELDED JACKETED PREMISE WIRE	DATA COMMUNICATION FAST ETHERNET: 100 BASE T CABLE, VIDEO, CCTV
DC2	300	RS-485: 24-AWG, JACKETED PREMISE WIRE	DATA COMMUNICATION REMOTE I/O CABLE
DC4	600	4-PAIR, 24-AWG SHIELDED JACKETED WIRE	DATA COMMUNICATION FAST ETHERNET
SIC	600	P-OS: 1-PR#18 or 16SH or 1-TR#18 or 16SH	CABLE TRAY RATED INSTRUMENT CABLE
RHW-2	600	RUBBER INSULATED OUTDOOR INDUSTRIAL GRADE SINGLE CONDUCTOR	POWER CIRCUITS; SEE 3.11 FOR USE
THWN-2	600	PVC INSULATED WITH NYLON JACKET BUILDING GRADE CONDUCTOR	CONTROL; SEE 3.12 FOR USE
XHHW-2	600	XLP INSULATED INDUSTRIAL GRADE CONDUCTOR	POWER, LIGHTING, & RECEPTACLES; SEE 3.13 FOR USE
CORD	600	HEAVY DUTY CABLE: SJOOW	PORTABLE ITEMS
TCX	300	THERMOCOUPLE EXTENSION CABLE	MATCH THERMOCOUPLE MATERIAL
COAX		RADIO FREQUENCY CO-AXIAL CABLE	DATA COMMUNICATIONS
CAT6	300	4-PAIR, UNSHIELDED TWISTED PAIR CAT 6 CABLE	NETWORK COMMUNICATION <= 10Gbps

3.7 CABLE SPECIFICATION SHEETS (CABLESPEC) – DC1

A. Cable System Identification:
   1. DC1

B. Description:
   1. Premise Cable: IEC Category 5 UTP; NEMA WC-63.1 Category 5e; Fast Ethernet: 100 Base TX; 4 pair, #24 AWG Cable

C. Voltage:
   1. 600 V RMS

D. Conductor Material:
   1. Solid Bare copper

E. Insulation Material:
   1. FRPO - Flame Retardant Polyolefin / FEP-Fluorinated Ethylene Propylene; Color Coded conductor insulation

F. Jacket:
1. LS PVC - Low Smoke Polyvinyl Chloride with ripcord Trade Name Example: Flamarrest Sequential Footage Marking: every two feet Jacket Color:
a. Blue

G. Manufacturer(s):
1. [redacted]

H. Execution:
1. Applications:
a. Gigabit Ethernet Data Communications LAN, CCTV Fixed. Component or Composite Video, Digital Video, RS-422,
2. Installation:
a. Install in accordance with associated equipment manufacturer's instruction.
3. Testing:
a. Test in accordance with paragraph 3.5.

3.8 CABLE SPECIFICATION SHEETS (CABLESPEC) – DC2

A. Cable System Identification:
1. DC2

B. Description:
1. Shielded Data Communication Cable; Remote I/O Cable: RS-485 #22 or #24 AWG Copper.

C. Voltage:
1. 300 V RMS

D. Conductor Material:
1. Tinned copper

E. Insulation:
1. Polyethylene; Trade Name Example: Datalene

F. Jacket:
1. PVC or CPE
2. Color: Chrome

G. Manufacturer(s):
1. [redacted]

H. Execution:
1. Application:
a. DCU or PLC to Remote I/O - Data Communications Cable.
2. Installation:
a. Install in accordance with associated equipment manufacturers instruction.
3. Testing:

a. Test in accordance with paragraph 3.5.

3.9 CABLE SPECIFICATION SHEETS (CABLESPEC) – DC4

A. Cable System Identification:
1. DC4

B. Description:
1. Premise Cable: IEC Category 6 UTP; TIA/EIA-568-B.2 Category 6; Fast Ethernet: 100 Base TX; 4 pair, #24 AWG Cable, Overall Beldfoil + 70% TC Braid Heavy-shielded, 600VAC

C. Voltage:
1. 600 V RMS

D. Conductor Material:
1. Solid Bare copper

E. Insulation Material:
1. FRPO - Flame Retardant Polyolefin / FEP-Fluorinated Ethylene Propylene; Color Coded conductor insulation

F. Jacket:
1. LS PVC - Low Smoke Polyvinyl Chloride with ripcord Trade Name Example: Flamarrest Sequential Footage Marking: every two feet Jacket Color:
a. Blue

G. Manufacturer(s):
1. [redacted]

H. Execution:
1. Applications:
a. Gigabit Ethernet Data Communications LAN for installation within Motor Control Center or other 600VAC areas.
2. Installation:
a. Install in accordance with associated equipment manufacturer's instruction.
3. Testing:
a. Test in accordance with paragraph 3.5.

3.10 CABLE SPECIFICATION SHEETS (CABLESPEC) – SIC

A. Cable System Identification:
1. SIC

B. Description:
1. Single twisted, shielded pair or triad (as required), 16 AWG, instrumentation and signal cable; UL listed; Cable Tray rated

C. Voltage:
1. 600 volts

D. Conductor Material: Bare annealed copper; stranded per ASTM B8

E. Insulation:
1. 15 mil, Polyvinyl Chloride (PVC) with 4 mil nylon, 90 degree C temperature rated; Color Code per ICEA Method-1: Pairs-Black and White with one conductor in each pair printed alpha-numerically for identification

F. Lay:
1. Twisted on a 2-inch lay

G. Shield:
1. 100 percent, 1.35 mil aluminum-Mylar tape with a 7-strand tinned copper drain wire

H. Jacket:
1. 45 mil Polyvinyl Chloride (PVC)

I. Flame Resistance:
1. UL 1277

J. Manufacturer(s):
1. [redacted]

K. Execution:
1. Use:
a. Analog signal cable and RTD device Triad extension cable.
2. Installation:
a. Install in accordance with paragraph 3.3.
3. Testing:
a. Test in accordance with paragraph 3.5.

3.11 CABLE SPECIFICATION SHEETS (CABLESPEC) – RHW-2

A. Cable System Identification:
1. RHW-2

B. Description:
1. Single conductor power; All power conductors #6 AWG and larger including lighting and receptacles, if applicable

C. Voltage:
1. 600 volts

D. Conductor Material:
1. Bare annealed copper; Class-B stranded per ASTM B8

E. Insulation:
1. RHW-2, 90 degree C wet; RHH 90 degree C dry; Composite of ethylene propylene rubber (EPR) per ICEA, UL 44 and NEMA WC-7.

F. Jacket:
1. Chlorosulfonated polyethylene; Trade Name Example: Hypalon

G. Flame Resistance:
1. IEEE 383 & 1202: 70,000 BTU per hour

H. Manufacturer(s):
1. [redacted]

I. Execution:
1. Installation:
a. Install in accordance with paragraph 3.2.
2. Testing:
a. Test in accordance with paragraph 3.5.

3.12 CABLE SPECIFICATION SHEETS (CABLESPEC) – THWN-2

A. Cable System Identification:
1. THWN

B. Description:
1. Single conductor for control circuits.
2. #14 AWG shall be smallest size used and sized for load per NEC.

C. Voltage:
1. 600 volts

D. Conductor Material:
1. Bare annealed copper; stranded per ASTM B8

E. Insulation:
1. THWN/THHN, 90 degree C dry, 75 degree C wet, Polyvinyl Chloride (PVC) per UL 83.

F. Jacket:
1. Nylon

G. Flame Resistance:
1. UL 83

H. Manufacturer(s):
1. [redacted]

I. Execution:
   1. Installation:
      a. Install in accordance with paragraph 3.2.
   2. Testing:
      a. Test in accordance with Section 16030.

3.13 CABLE SPECIFICATION SHEETS (CABLESPEC) – XHHW-2

A. Cable System Identification:
   1. XHHW

B. Description:
   1. Industrial grade single conductor . All power conductors #12 AWG through #8 AWG including lighting and receptacles.
   2. #12 AWG shall be smallest size used.

C. Voltage:
   1. 600 volts

D. Conductor Material:
   1. Bare annealed copper; stranded per ASTM B8

E. Insulation:
   1. NEC Type XHHW-2, 90 degree C dry and C wet;
   2. Cross-Linked Polyethylene (XLP) per ICEA S-66-524 and UL-44;
   3. Color in sizes 14, 12 and 10 AWG: Black, Green, Yellow, White, Orange, Brown, Red, Blue

F. Jacket:
   1. None

G. Flame Resistance:
   1. UL 83

H. Manufacturer(s):
   1. [redacted]

I. Execution:
   1. Installation:
      a. Install in accordance with paragraph 3.2.
   2. Testing:
      a. Test in accordance with Section 16030.

3.14 CABLE SPECIFICATION SHEETS (CABLESPEC) – CORD

A. Cable System Identification:
   1. CORD

B. Description:
1. Industrial Grade Flexible Portable Cord: Synthetic Rubber Insulation with Oil-Resistant Thermoset Jacket construction:
a. Type SOOW for 600 Volt circuits; Type SJOOW for 300 Volt circuits

C. Voltage:
1. 600 V RMS where shown or where unspecified: Type SOOW

D. Conductor Material:
1. Flexible rope stranded annealed copper per ASTM B189 and B33.

E. Insulation:
1. Ethylene propylene (EPR) per ICEA S-68-516 and rated for continuous operation at 90 degrees C.
2. Green used for ground only
3. Color:
a. 2/C Black and White; 3/C Black, White, and Green; 4/C Black, White, Red and Green; 5/C Black, White, Red, Green, and Orange

F. Jacket:
1. Heavy-duty Neoprene per ICEA S-68-516. Color:
a. Yellow

G. Manufacturer(s):
1. [redacted]

H. Execution:
1. Installation:
a. Install in accordance with paragraph 3.2.
2. Testing:
a. Test in accordance with paragraph 3.5.

3.15 CABLE SPECIFICATION SHEETS (CABLESPEC) – TCX

A. Cable System Identification:
1. TCX

B. Description:
1. Thermocouple Cable Extension:
a. Type PLTC cable approved for cable tray installation; Per NEC Article 725.

C. Voltage:
1. 300 volts

D. Conductor Material:
1. Solid alloy, consistent with the type of thermocouple material specified.

E. Insulation:

1. 15 mil, 90 degree C, flame-retardant polyvinylchloride (PVC) with 4 mil nylon cover.

F. Lay:
1. Twisted on 2-inch lay.

G. Shield:
1. 100 percent, 1.35 mil aluminum-Mylar tape.

H. Jacket:
1. 45 mil nylon jacket.

I. [redacted]

J. Execution:
1. Installation:
a. Install in accordance with manufacturer's instructions.
2. Testing:
a. Test in accordance with paragraph 3.5.

3.16 CABLE SPECIFICATION SHEETS (CABLESPEC) – COAX

A. Cable System Identification:
1. COAX

B. Description:
1. Premise Cable: Indoor Riser and Plenum with FRPE Jacket Outdoor /Watertight:
a. Ductbanks Systems with PE Jacket Low Loss Flexible Communication Coaxial Cable

C. Voltage:
1. 300 V; Voltage Withstand: 3000 Volts DC;

D. Conductor Material:
1. Solid 18 AWG;
2. Nominal Impedance: 50-ohm;
3. Nominal Capacitance: 20 Pico-Farad per foot;
4. Bend Radius: 2 inches

E. Insulation Material:
1. Foam Polyethylene (PE) or Tetrafluoroethylene (TFE) UL Flame Test:
a. NFPA-262 NEC Type Specification: CMP

F. Jacket:
1. Polyethylene (PE), Fire Retardant Polyethylene (FRPE) or Fluorinated Ethylene Propylene (FEP)

G. Manufacturer(s):
1. [redacted]

H. Execution:
1. Applications:
a. Giga-Hertz Data Communications, CCTV Fixed.
b. Component or Composite Video, Digital Video
2. Installation:
a. Install in accordance with associated equipment manufacturer's instruction. Provide male, female, TNC Male, UHF Male, straight, bulkhead, right-angle, etc., connectors, fittings, with crimp tools, dies, strip tools, deburr tools and cutting tools as required for the installation.
3. Testing:
a. Test in accordance with paragraph 3.5.

3.17 CABLE SPECIFICATION SHEETS (CABLESPEC) – CAT6

A. Cable System Identification:
1. CAT6

B. Description:
1. IEC Category 6 UTP; TIA/EIA-568-B.2 Category 6
2. NEC CMR (riser) rated
3. UL 444 – Standard for Safety Communications Cables compliant
4. UL1685 flame rating compliant

C. Conductor Material:
1. Solid Bare copper
2. 23AWG

D. Insulation:
1. Material: Polyolefin
2. Color Coded conductor insulation

E. Jacket:
1. LSZH PVC - Low Smoke Zero Halogen Polyvinyl Chloride
2. Sequential Footage Marking: every two feet along jacket
3. Color: Black

F. Manufacturer(s):
1. [redacted]

G. Execution:
1. Applications:

a. Network communications <= 10Gbps

2. Installation:
   a. Install in accordance with associated equipment manufacturer's instruction.
3. Testing:
   a. Test in accordance with paragraph 3.05.

END OF SECTION

5. Provide Testing requirements for cables.

PART 2 PRODUCTS

2.1 CONDUCTORS

A. General requirements for conductors and cables specified in this section are listed on CABLESPEC sheets in paragraph 3.6. The type, size, and number of conductors shall be as specified on the drawings or schedules.

2.2 CABLE TERMINATORS

A. Lug Type:
1. Terminations shall be made with a tin-plated compression type lug and a compression pressure tool and die as approved by the manufacturer of the lug. Tool shall be of the hydraulic pump type or the type that crimps to the required size before releasing.
2. Electrical voltage stresses shall be controlled by high permittivity, high resistivity, heat shrinkable polymeric tubing, seal using heat shrinkable tubing, and heat activated adhesive. Corona extinction level for a completed termination on a cable shall not be less than 1-1/2 times the rated cable phase to ground voltage.
3. Terminations may be made with cold shrinking preformed assemblies.

B. Termination Kits:
1. Capable of terminating single-conductor, polymeric-insulated shielded cables plus a shield ground clamp.
2. Capable of producing a termination with a current rating equal to, or greater than, cable ampacity meeting Class 1 requirements of IEEE 48.
3. Capable of accommodating cable shielding or construction without need for special adapters or accessories.
4. Manufacturers:


C. Load-Break Connectors and Bushings:
1. Load break connectors and bushings shall be rated:
a. 8.3 kV phase to ground
b. 14.4 kV phase to phase across contact
c. 95 kV BIL; 35 kV, 60 Hertz, 1 minute
d. 11 kV corona extinction
e. 200 amp continuous, 300 amperes, 8 hours
f. 15,000 amperes RMS asymmetrical, 12 cycles
g. 10,000 amperes RMS symmetrical, 30 cycles
h. Comply with the requirements of ANSI C119.2
i. Connectors and bushings furnished with installation items.

D. Non-Load-Break Connectors and Bushings:
   1. Non-load-break connectors and bushings shall be rated:
      a. 8.3 kV phase to ground
      b. 14.4 kV phase to phase, 95 kV BIL
      c. 35 kV, 60 Hertz, 1 minute
      d. 11 kV corona extinction
      e. 600 amperes continuous
      f. 900 amperes, 8 hours
      g. 40,000 amperes RMS asymmetrical, 12 cycles
      h. 27,000 amperes RMS symmetrical, 4 seconds
      i. Comply with the requirements of ANSI C119.2
      j. Connectors and bushings furnished with items for a complete installation.

[redacted]

3.6 CABLESPEC SHEETS

A. The following CABLESPEC sheets are included in this section
1. 5EP-S 5KV Single Conductor Cable
2. 15EP-S 15KV Single Conductor Cable

B. CABLE SPECIFICATION SHEET--CABLESPEC:

Cable System Identification:	5EP-S
Description:	Single conductor power cable shielded with Ethylene Propylene Rubber (EPR) insulation with vulcanized chlorosulfonated polyethylene jacket suitable for both wet and dry installations.
Voltage:	5,000 volts
Conductor Material:	Single conductor, uncoated copper; Class B stranded in accordance with ASTM B-496
Strand shield:	Extruded semi-conducting stress relief layer or extruded non-conducting layer.
Insulation:	Ethylene propylene rubber (EPR), Type MV-105, rated continuous 105 degrees C, emergency 140 degrees C, short circuit 250 degrees C, wall thickness shall be 220 mils and rated for 133 percent insulation level.
Insulation screen:	Extruded semi-conducting stress relief layer.
Concentric Neutral:	Bare copper wire.
Shielded:	5 mil bare copper tape helically applied with 10% minimum overlap
Jacket:	Polyvinylchloride (PVC).
Other Features:	High corona resistance, low dielectric constant and power factor, high moisture resistant, resistant to weather and chemicals, high impulse-dc and ac breakdown, outer corrosion protective jacket
Manufacturer(s):	[redacted]

Execution:

Installation:	Install in accordance with paragraph 3.2.
Testing:	Test in accordance with paragraph 3.5 and Section16030

C. CABLE SPECIFICATION SHEET--CABLESPEC:

Cable System Identification:	15EP-S
Description:	Single conductor power cable shielded with Ethylene Propylene Rubber (EPR) insulation with vulcanized chlorosulfonated polyethylene jacket suitable for both wet and dry installations.
Voltage:	15,000 volts
Conductor Material:	Single conductor, uncoated copper; Class B stranded in accordance with ASTM B-496.
Strand shield:	Extruded semi-conducting stress relief layer or Extruded non-conducting layer.
Insulation:	Ethylene propylene rubber (EPR), Type MV-105, rated continuous 105 degrees C, emergency 140 degrees C, short circuit 250 degrees C, wall thickness shall be 220 mils and rated for 133 percent insulation level.
Insulation screen:	Extruded semi-conducting stress relief layer.
Concentric Neutral:	Bare copper wire.
Shielded:	5 mil bare copper tape helically applied with 10% minimum overlap
Jacket:	Polyvinylchloride (PVC).
Other Features:	High corona resistance, low dielectric constant and

power factor, high moisture resistant, resistant to weather and chemicals, high impulse-dc and ac breakdown, outer corrosion protective jacket

Manufacturer(s): [redacted]
or equal.

Execution:

Installation: Install in accordance with paragraph 3.2.

Testing: Test in accordance with paragraph 3.5 and Section 16030.

END OF SECTION

[redacted]

PART 2 PRODUCTS

2.1 GENERAL

A. Wiring devices shall be UL approved for the current and voltage specified and shall comply with NEMA WD-1. Devices shall contain provisions for back wiring and side wiring with captive binding screws.

B. Provide devices colored to conform to manufacturer's or industry standard for special use such as orange for isolated ground receptacles, blue for surge suppression receptacles, and red for emergency power receptacles. Unless shown otherwise on the Drawings or Schedules, normal use devices shall be brown, except those located in finished areas shall be ivory.

2.2 RECEPTACLES AND PLUGS

A. [redacted]

[redacted]

2.3 SWITCHES

A. General Purpose (Indoor, Clean Areas):
   1. General purpose switches shall be quiet AC type, specification grade, back and side wired, and shall be provided in accordance with rated capacities as required or as indicated on Drawings or Schedules. Switches shall match receptacles in color.
   2. Manufactures:

SECTION 16175

ELECTRICAL CONTROLS AND RELAYS

PART 1 GENERAL

1.1 SCOPE OF WORK

A. This section specifies electrical control and monitoring devices:
   1. Control Devices:
      a. Pushbuttons
      b. Selector Switches
      c. Indicating Lights
      d. Control Station Enclosures
      e. Horns
      f. Beacons
   2. Control Relays:
      a. Load-Switching
      b. Logic Level Switching
      c. Timers and Time Switch
      d. Alternators

B. This section specifies power devices:
   1. Magnetic Contactors:
      a. Lighting Contactors
      b. Motor Contactors
   2. Safety Disconnect Switches
   3. Overcurrent Protection: Circuit breakers
   4. Elapsed Time Indicators
   5. Current transformers and transducers
   6. Time Switch
   7. Motor Driven Timers – On Delay and Off Delay
   8. Intrusion Switches and Override Key Switches
   9. Thermostats

C. Request clarification where conflicts occur with this section and other sections in Divisions 11, 15, 16, and 17.

1.2 REFERENCES

A. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

B. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid or on the effective date of the Agreement if there were no Bids.

C. If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued.

D. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
NEMA 250	Enclosures for Electrical Equipment (1000 volts maximum)
NEMA ICS-1	General Standards for Industrial Controls and Systems
NEMA ICS-2	Industrial Control Devices, Controllers, and Assemblies
NEMA KS 1	Enclosed Switches

1.3 SUBMITTALS

A. The following information shall be provided in accordance with Section 01330:
1. A copy of this specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements.
2. Check marks (ü) shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation.
3. The Construction Manager shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications.
4. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.
5. Arrangement, layout, and outline drawings with dimensions and weight, as appropriate.
6. Control schematics and interconnection wiring diagrams depicting internal and external wire and cable terminations. Drawing cross-reference to specification and Contract Document drawings.

B. Nameplate legend with engraving and sizes.
1. Internal layout drawings showing all components.

PART 2 PRODUCTS

2.1 CONTROL DEVICES

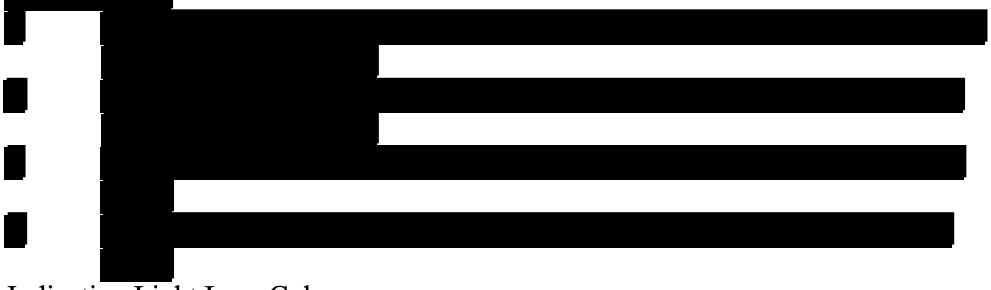
A. Pushbuttons:

1. Pushbuttons shall be flush head, heavy-duty, with NEMA rating to match enclosure type. Operators shall be red for start function, green for stop functions, and black for all other functions. The escutcheon legend shall be as specified on the drawings.
   a. UL Listed.
   b. Dielectric Strength: 1300 Volts for one minute for Logic Reed contacts, 2200 Volts for one minute for other contacts.
   c. 30.5mm mounting hole.
   d. Temperature operating range –10 degree C. to +55 degree C.
   e. Momentary contact type
   f. When switching circuits are monitored by programmable controllers or other solid state circuits, furnish hermetically-sealed, logic-reed type contacts rated not less than 0.15 amperes at 150 Vac and 0.06 amperes at 30 Vdc.
   g. When switching circuits are not monitored by programmable controllers or other solid state circuits, furnish contacts with NEMA Utilization Category rating A600 rated not less than 10 amperes continuous and 6 amperes break at 120 Vac.
2. [redacted]

B. Selector Switches:

1. Selector switches shall be heavy-duty with NEMA rating to match enclosure type. Selector switches shall have maintained position contacts. Switches shall be provided with contact blocks and number of positions as required performing the specified or indicated operations.
2. The escutcheon legend shall be as specified on the drawings. Provide:
   a. UL Listed.
   b. Dielectric Strength: 1300 Volts for one minute for Logic Reed contacts, 2200 Volts for one minute for other contacts.
   c. 30.5mm mounting hole.
   d. Temperature operating range –10 degree C. to +55 degree C.
   e. Standard knob operator (not lever type nor wing lever type)
   f. Number of positions and contact configuration as shown on Drawings.
   g. When switching circuits are monitored by programmable controllers or other solid state circuits, furnish hermetically-sealed, logic-reed type contacts rated not less than 0.15 amperes at 150 Vac and 0.06 amperes at 30 Vdc.
   h. When switching circuits are not monitored by programmable controllers or other solid state circuits, furnish contacts with NEMA Utilization Category rating A600 rated not less than 10 amperes continuous and 6 amperes break at 120 Vac.
3. [redacted]
4. Field instruments and field analyzers specified in Division 17 shall have a lock-out style selector switch for locking on or locking off the 120Vac power source. The selector switch shall use a control station in NEMA-12, 4, 4X, or 7 as required by the area classification. Provide O-Z/Gedney Class 441 with two position key-operated maintained contact switch. Provide surge protection device that matches the enclosure type of the power disconnect type control station, field instrument, or field analyzer: Telematic TP48 transmitter surge protection device, Transtector or equal.

C. Indicating Lights:

1. Red, amber, green, blue, and white indicating lights shall be heavy-duty, push-to-test LED type with NEMA rating to match enclosure type for installation in a 30.5mm hole. Furnish with 28 chip high visibility LED. The escutcheon and lens color shall be as shown on Drawings or scheduled.
2. [redacted]

3. Indicating Light Lens Color:

Lens Color	Typical Function	Example
Red	Danger, running, open	Equipment operating, motor running, valve open, power voltage applied, cycle in automatic
Amber	Fault condition, attention	Equipment failure, status abnormal
Green	Off, closed, ready	End of cycle; unit or head returned; motors stopped; motion stopped; contactors open, valve closed
White or Clear	Normal condition	Normal pressure of air, water, lubrication, control power on, status okay
Blue	Advisory	Control mode not in automatic

D. Control Station Enclosures:
   1. Enclosures locations and ratings:
      a. Classification of areas are specified in Section 16000.

E. Control Power Transformers:
   1. Sized for the panel devices and products.
   2. Dual primary and single secondary fusing.

2.2 CONTROL RELAYS

A. Load-Switching Control Relays:
   1. Control relays used for switching loads such as solenoids, actuators, contactors, motor starter coils, remote interlocking, etc. shall be heavy-duty machine tool type.
   2. Contacts shall be 4-pole and be field interchangeable to either normally-open or normally- closed. Relay shall be capable of accepting a 4-pole adder.
   3. AC relays shall have NEMA A600 contact ratings and electrical clearances for 600 volts. DC relays shall have NEMA P300 contact ratings and electrical clearances for 250 volts.
   4. [redacted]

B. [redacted]

12Vdc, 24Vac, 120Vac, 240Vac inputs as required or indicated or equal.

D. Time Switch

1. Provide an electronic time switch with full-year control in an enclosure. Enclosure ratings are specified in Section 16000. The switch shall incorporate a non-volatile memory that maintains programmed switching times for the life of the time switch and provide a factory installed field replaceable lithium or alkaline battery for time keeping and calendar information for a minimum of 8 years. Furnish with one

single-pole, double-throw output switch rated 20-ampere at 240Vac. Furnish with manual override control.

2. Manufacturer:

a. [redacted]

E. [redacted]

6. [redacted]

F. [redacted]

5. [redacted]

2.3 HORNS AND BEACONS

A. [redacted]

[redacted]

[redacted]

E. Motor Contactors:
   1. Motor contactors shall be designed for continuous operation of induction motors at 600Vac or less at 60-Hertz and shall comply with NEMA ICS 2-210. Unless otherwise specified or indicated, minimum contactor size shall be NEMA Size-1.
   2. Motor contactors shall be supplied with normally open auxiliary contact for use as a hold-in-contact and status contacts with a minimum of two additional Form-C contacts. Provide 120Vac coil voltage and 60-Hertz frequency with the number of poles and auxiliary contacts as indicated.
      a. [redacted]
   3. Provide solid-state overloads relays with one alarm contact. Where specified and shown as E-SSOL, provide the electronic SSOL relay with the following features: Automatic Timing and Controls (ATC) Motor Guardian for alarming and tripping on under-current, over-current, single-phase, ground-fault, motor-jam conditions. Provide ATC current transformers and voltage connections.
      a. [redacted]

2.4 SAFETY DISCONNECT SWITCHES

A. Safety disconnect switches shall be heavy-duty, 30-400-ampere ratings as indicated, fused or non-fused as indicated, stainless steel operator, safety type rated 600 volts AC.

B. Provide fusible disconnect switches with ratings as indicated with built-in fuse pullers. Provide LPS, LPN, or LPJ 200KAIC current limiting fuses as appropriate for the circuit type and the circuit voltage.

C. Provide internal barrier kit for personnel protection from accidental contacts with energized parts.

D. Enclosure locations and ratings/classifications:
   1. Provide as indicated in Section 16000.

E. Provide operating handle capable of being padlocked in the "off" position. The operator shall be a positive, quick-make, quick-break mechanism. Provide bolt-on hubs. Provide door lock.

Provide nameplates with the equipment tag number, equipment description, and power source as indicated on the drawings.

F. Disconnects shall include one auxiliary contact that operates with the power switch blades. The auxiliary contact shall be wired as shown on the drawings for remote status monitoring of the disconnect position where shown or for disconnecting motor space heater where shown.

G. Switches shall be horsepower rated for motors and shall comply with NEMA KS-1. Switches shall be provided with defeatable door interlocks that prevent the door from opening when the operating handle is in the "on" position. Switches shall have line terminal shields.

1. [redacted]

2.5 [redacted]

2.8 TERMINAL STRIPS, BLOCKS, AND DEVICES

A. Terminal Strips, Blocks and associated devices shall be in accordance with Section 16000.

[redacted]

caps so that extension rods of same diameter and length may be added where necessary.

2.3 COMPRESSION CONNECTORS

A. Compression connections shall be irreversible, cast copper as manufactured by [redacted]

2.4 [redacted]

[redacted]

PART 2 - PRODUCTS

2.1 MANUFACTURERS AND MODELS

[redacted]

2.2 RATINGS

A. Rating: 20 kVA.

B. Voltage Supply: 480 volt, 3-phase, 60 Hz.

C. Output Power: 208/120 volt, 3-phase, 60 Hz.

D. Audible Noise: Less than 60 dBA (A weighted) at one meter from all sides in normal mode.

E. Electrostatic Discharge: The UPS shall be able to withstand a minimum 8 KV without damage and without affecting the critical load.

F. Run Time:
1. Full Load: 30 minutes
2. Connected Load to include:
3. Minimum of two breaker cycles for each covered breakers up to 30 minutes.
4. Minimum for all SCADA PLC control panel loads two hours.

2.3 GENERAL

A. The use of a manufacturer's name and model or catalog number is for the purpose of establishing the standard of quality and general configuration desired. "Or-equal" products of other manufacturers will be considered in accordance with the General Requirements.

B. Operating Conditions:
1. Ambient Temperature: 68 to 77 degrees F.
2. Elevation: 1,500 feet.
3. Relative Humidity: 5 to 95 percent, non-condensing.
4. Equipment shall be fully rated without derating for operating conditions.

C. Provide UPS with a microprocessor based monitoring and control system including signal to SCADA as follows:
1. UPS On/Off
2. Alarm/Fault Condition
3. Low DC Voltage (Battery)
4. Normal Power ON
5. UPS In Bypass

2.4 SYSTEM MODES OF OPERATION

A. Normal Mode: During the Normal or Double-conversion Mode the rectifier shall derive power as needed from the commercial AC utility or generator source and supply filtered and regulated DC power to the online inverter. The inverter shall convert the DC power to highly regulated and filtered AC power for the critical loads.

B. Battery Mode: Upon failure of the AC input source, the critical load must continue to be supplied by the inverter without switching. The inverter must obtain its power from the battery. There must be no interruption in power to the critical load upon failure or restoration of the AC input source.

C. Recharge Mode: Upon restoration of the AC input source, the rectifier/battery charger must recharge the battery. The inverter shall, without interruption of power, regulate the power to the critical load.

D. High Efficiency Mode: The static switch will conduct, and the UPS rectifier and inverter will be operated in a "suspended" mode, unless incoming power conditions require conventional double conversion operation, whereby the UPS shall revert to double conversion in less than four (4) milliseconds (ms).

E. Bypass Mode: The static bypass switch must be used for transferring the critical load to the AC utility supply without interruption, and shall be rated for continuous operation. Automatic re-transfer to normal operation must also be accomplished without interruption of power to the critical load. The static bypass switch must be capable of manual operation via the front panel controls.

F. Maintenance Bypass Mode: Matching cabinets in a "slim-line" or standard width design. The maintenance bypass is used for supplying the load directly from the AC utility supply, while the UPS is isolated for maintenance or repair.

2.5 COMPONENTS

A. General: The UPS system shall include a minimum of one step-down transformer, one rectifier, one inverter, one static bypass, one maintenance bypass, one battery system and necessary cables to interface all associated components.

B. Enclosure:
1. Free-standing. Dimension for the overall UPS System enclosure shall not exceed 74 inches H by 66 inches W by 32 inchess D.
2. Enclosure equipped with leveling feet and wheels/casters.
3. Paint and Color: Manufacturer's standard over corrosion inhibiting primer.

C. Transformer Cabinets:
1. Line and match cabinets to provide isolation and voltage conversion for the UPS input and/or output.
   a. Winding Material: Copper.
   b. Frequency: 60 Hz.
   c. Rating: UL 220C/150C rise.

D. Converter (rectifier): Incoming power shall be filtered and converted to DC by a sine-wave rectifier. The rectifier utilizes IGBT technology to correct the input power factor to 0.99 and draws sinusoidal current (with less than 5 percent THD) from the utility. In the event of utility failure, the DC-DC converter shall be supplied power without interruption from the internal or external batteries.
1. Overload Capacity: The converter shall be capable of supplying up to 125 percent of rated load for at least 30 seconds if no bypass is available.

E. Inverter: The inverter utilizes IGBT technology and Digital Signal Processing to convert the DC power from the rectifier or converter to regulated AC power for output to critical loads.
1. Voltage Regulation: The inverter steady state voltage regulation is +/- 1% phase to neutral, 2% phase to phase. Dynamic regulation meets Class 1 performance of IEC62040-3.

2. Frequency Control: The inverter steady state frequency regulation is +/- 0.1 Hz, free running in steady state. UPS is synchronized to the Utility bypass in normal operation.

F. Bypass: Automatic bypass shall provide an alternate path to power in the case of overload, inverter failure or other UPS failure. Maintenance bypass in matching cabinet shall be provided and utilized with the UPS to allow servicing of the UPS.

G. Batteries: Valve Regulated Lead Acid (VRLA), minimum 2-year warranted float service life at 25 degrees C. Eight battery strings (144) blocks) with a recharge time of 10 times the length of the outage 90 percent usable capacity at nominal line. Over-current protection shall protect the batteries from all short circuit fault conditions. Battery operation shall be terminated when the battery voltage drops to the 1.67 VPC set point. If the UPS system's battery bus voltage exceeds the predetermined set point then the UPS will disable the charger and alarm a "check battery" condition.

H. Displays and Controls:
1. Front Panel Display: The UPS shall include a front panel display consisting of a graphical LCD display with backlight, four status LED's, and a six-key keypad.
2. Graphical LCD display: Includes basic language (English and local selectable language), display of unit function and operating parameters. It shall be used to signify the operating state of the UPS, for indicating alarms, for changing operations control parameters and set points.
3. Four status LED's, which indicate:
   a. Alarms, with a red LED.
   b. On Battery, with a yellow LED.
   c. On Bypass, with a yellow LED.
   d. Power On, normal operation, with a green LED.
4. Six-Key Multifunction Keypad: UPS shall have keypad to allow user to adjust UPS parameters, view alarm and inverter logs, change UPS operational modes, and turn the UPS on and off. Keys will be marked as UP, DOWN, LEFT, RIGHT, ESC and ENTER.

I. Power Management Software Package: The UPS shall come standard with power management software that will recognize the UPS with the optional SNMP/Web interface card. The software shall be capable of integrating into industry standard virtualization management software, and performing connected IT load shutdown or migration in case of extended power outages. In addition the manufacture shall offer additional software packages capable of UPS and facility electrical and mechanical system monitoring and management. The UPS's optional communications interface shall provide the following communication capabilities:
1. Monitor and graphically display input and output voltage and other operating characteristics
2. Notify end-users in the event of a power anomaly via network, E-mail or page.
3. Communication Ports:
   a. Communication Card Slots: The UPS shall provide two communication mini-slots in the back of the UPS allowing for additional connectivity

options, including SNMP/Web interface, 4x relay contacts, Modbus and RS-232 capabilities.

b. Serial communications (via RS-232 or USB) with manufacturer's service software package.

J. Power Distribution Module: Provide hand-wired output to panelboard.

K. Alarm Outputs:

1. Provide the following relay dry contact output closures for monitoring purposes:
   a. UPS on, load powered.
   b. UPS in bypass.
   c. Low battery.
   d. Trouble.
   e. Normal operation.

L. Communication: UPS system shall be provided with a network-MS Card, providing communication via Ethernet connection.

2.6 WIRING

A. Wiring practices, materials and coding shall be in accordance with the requirements of the National Electrical Code (NFPA 70).

B. All bolted connections of bus bars, lugs, and cables shall be in accordance with requirements of the National Electrical Code and other applicable standards.

C. All electrical power connections are to be torqued to the required value and marked with a visual indicator.

D. Provision shall be made for power cables to enter or leave from the bottom of the UPS cabinet.

E. Provide hard wired input and output.

2.7 COOLING

A. Cooling of the UPS shall be by forced-air.

B. Replaceable filter on suction side.

C. Redundant fans shall be used. Low velocity fans shall be used to minimize audible noise output.

D. Fan power shall be provided by the UPS output.

E. The thermal design, along with all thermal and ambient sensors, shall be coordinated with the protective devices before excessive component or internal cabinet temperatures are exceeded.

2.8 GROUNDING

A. The AC output neutral shall be electrically isolated from the UPS chassis.

B. The UPS chassis shall have an equipment ground terminal.

C. Provisions for local bonding shall be provided.

2.9 FACTORY TESTING

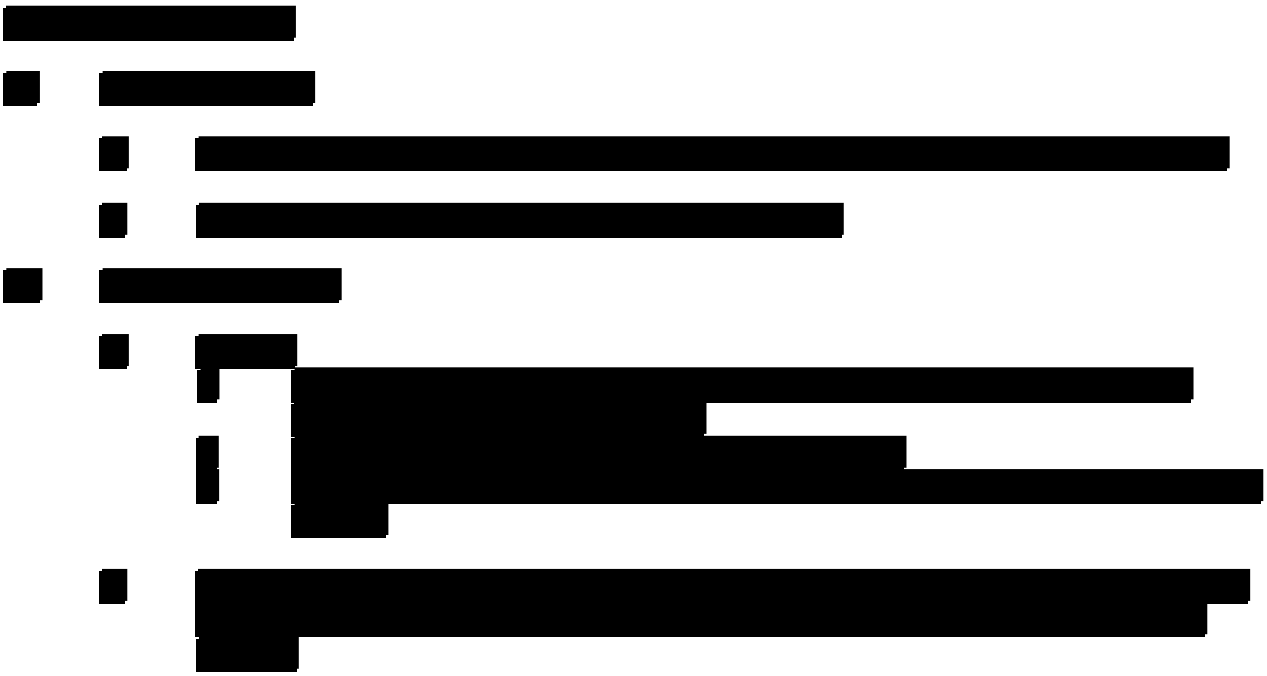
A. The following standard factory tests shall be performed on the equipment provided under this section. All tests shall be in accordance with the latest version of NEMA and UL standards.
   1. Standard Computer-automated UPS system test.
   2. Hipot test.

2.10 REGULATORY REQUIREMENTS

A. The UPS shall be UL labeled.

2.11 DELIVERY, STORAGE AND HANDLING

A. Equipment shall be handled and stored in accordance with manufacturer's instructions. The UPS and accessory cabinets meet structural requirements of ASTM D4169. One copy of these instructions shall be included with the equipment at time of shipment.



PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. The Owner and Construction Manager believe the following candidate manufacturers are capable of producing equipment and/or products that will satisfy the requirements of this Section. This statement, however, shall not be construed as an endorsement of a particular manufacturer's products, nor shall it be construed that named manufacturers' standard equipment or products will comply with the requirements of this Section. Candidate manufacturers include:

1. [redacted]
5. Or equal.

2.2 OUTDOOR PHOTOELECTRIC SWITCHES

A. Solid state, with SPST dry contacts rated for 1440 VA LED lighting, complying with UL 773A.
   1. Light-Level Monitoring Range: 16.14 to 108 lx (1.5 to 10 fc), with adjustable turn-on and turn-off levels.
   2. Time Delay: 15-second minimum.
   3. Surge Protection: Metal-oxide varistor.
   4. Mounting: Twist lock, with base-and-stem mounting or stem-and-swivel mounting accessories as required.

2.3 DAYLIGHT PHOTOELECTRIC SENSORS

A. Solid-state, light-level sensor; wall or ceiling mounted.
   1. Addressable equipped with communication capability to communicate with the Central Lighting Control Panel.
   2. Monitoring Range: 1 to 100 fc, with programmable turn-on and turn-off levels.
   3. Indicators: Power and fault indicators.

2.4 INDOOR OCCUPANCY SENSORS

A. Dual-technology Type, combination PIR and ultrasonic detection, solid-state wall or ceiling mounted.
   1. Addressable equipped with communication capability to communicate with the Central Lighting Control Panel.
   2. Detection Coverage, 180 degrees, minimum 100 ft radius.
   3. Indicators: Power and fault indicators.

2.5 LIGHTING CONTROL SYSTEM – DISTIBUTIVE RELAY TYPE

A. System Description:

1. The lighting control system shall be a network of remote relay modules connected to a digital network via network hubs and controlled through a system server / central station. Lighting control devices connect to the relay modules and communicate via the digital network with the system server. System includes all associated network interfaces and wiring, hubs, relay modules, relays, photocells, switches, dimmers, time clock, and occupancy sensors. System shall utilize distributed relays modules, allowing these relay modules to be located above accessible ceilings in or adjacent to rooms they are controlling.

2. System shall include server / central station with operating software, data network, and BACnet IP communication with other systems as described.

3. System server / central station shall provide programmable operation of lights connected via system relays and controlled with system devices. System software shall provide control of relays and control devices, time and sequence scheduling, timed out and blink light operation and monitoring and reporting of system events and components. Initial programming shall be as shown on plans and schedules.

4. Server / Central Control Station: Lighting control system manufacturer shall be responsible to assure coordination between relay modules, network hubs and control system server/ central station such that system performs as described. Server / central control station shall have a minimum 80 GB hard drive, 8 GB RAM, 3 GHz speed minimum, three Ethernet ports, 1024 x 768 resolution graphic card, and 3 USB 2.0 ports. Server shall be provided with monitor, keyboard and mouse, and plugged into a receptacle connected to an equipment emergency circuit as a minimum.

5. Network Hub: Network Hub shall contain processor and astronomic time clock for control and monitoring of lighting. Network Hub shall be fed from an equipment emergency circuit at a minimum.

6. Relay Modules: Mounted in NEMA enclosure with physically separate 120/277V wiring compartment from low voltage control wiring. Provide low voltage digital communication to control devices as shown on drawings and schedules. Supplemental power packs shall be provided as required for multiple control devices. This equipment shall be identified in shop drawing submission. Dimmable relay modules shall be provided where indicated. Relay modules shall contain up to 4 relays. Relay modules shall be labeled with room number that relays control lighting within.

7. Single-Pole Relays: Mechanically held unless otherwise indicated; split-coil, momentary-pulsed type, rated 20 A, 125V AC for tungsten filaments and 20 A, 277V AC for electronic ballasts, 50,000 cycles at rated capacity.

8. Control Devices: All occupancy sensors (Ultrasonic, IR and Dual Technology type), photocells, switches and timers shall be provided with system and designed to operate on system network. Supplemental power packs shall be provided as required for multiple control devices. This equipment shall be identified in shop drawing submission.

2.6 LIGHTING CONTROL SYSTEM – DIGITAL ADDRESSABLE LIGHTING INTERFACE (DALI)

A. System Description:

1. The lighting control system shall consist of digital lighting control network connecting DALI compliant digital addressable ballasts, control modules and lighting control devices directly with a system server / central control station. Individually addressable electronic ballasts, control modules, and control devices are operated from signals received through DALI-compliant bus from variety of DALI compliant digital controllers and interfaces and programmed through the system server / central control station. System includes all associated network bus and wiring, DALI controllers and interfaces, panels, photocells, switches, dimmers, time clock, and occupancy sensors. System shall utilize DALI compliant ballast and dimming modules provided with light fixtures.

2. System shall include server / central station with DALI operating software, data network, and BACnet IP communication with other systems as described.

3. System server / central station shall provide programmable operation of lights connected via system bus and controlled with system devices. System software shall provide control of DALI ballast, control modules and control devices, time and sequence scheduling, timed out and blink light operation and monitoring and reporting of system events and components. Initial programming shall be as shown on plans and schedules.

4. Server / Central Control Station: Lighting control system manufacturer shall be responsible to assure coordination between relay modules, network hubs and control system server/ central station such that system performs as described. Server / central control station shall have a minimum 80 GB hard drive, 8 GB RAM, 3 GHz speed minimum, three Ethernet ports, 1024 x 768 resolution graphic card, and 3 USB 2.0 ports. Server shall be provided with monitor, keyboard and mouse, and plugged into a receptacle connected to an equipment emergency circuit as a minimum.

5. Control Devices: All occupancy sensors (Ultrasonic, IR and Dual Technology type), photocells, switches and timers shall be provided with system and be DALI compliant. Devices shall be designed to operate on system network. Supplemental DALI compliant signal repeaters and controllers shall be provided as required. This equipment shall be identified in shop drawing submission.

[redacted]