CONTRACT DOCUMENTS

AND

SPECIFICATIONS

FOR

PROJECT NO. WPC 23-1
FY'23 WATER POLLUTION CONTROL
CAPITAL EQUIPMENT REPLACEMENTS

ATTENDANCE AT PRE-BID CONFERENCE IS MANDATORY

PREPARED BY:
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CLAYTON EDWARDS, P.E., DIRECTOR
WATER AND SEWER DEPARTMENT

Account Numbers: 7503382-544003, 7503392-544003, and 7503395-544003

Water and Sewer Department
175 E. 2nd Street, Suite 1400
Tulsa, Oklahoma 74103
(918) 596-9845

TECHNICAL SPECIFICATIONS

PROJECT SPECIFICATIONS

FOR

TULSA METROPOLITAN UTILITY AUTHORITY

PROJECT NO. WPC 23-1

FY'23 WATER POLLUTION CONTROL CAPITAL EQUIPMENT REPLACEMENTS
TULSA, OKLAHOMA

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INTRODUCTION:

200.1 Project work shall include all equipment, labor, materials, hardware, cable, terminations, and incidentals necessary to remove existing equipment that is to be replaced, install the new equipment, and place the new equipment in fully operational, functional, and warrantable service. All equipment to be supplied shall be brand new current year model and not used, remanufactured, or discontinued items.

200.2 The Authority's contact people are:

Water Pollution Control:	Matt Vaughan – Section Manager 175 E. 2nd Street, Suite 1400 Tulsa, OK 74103 918-596-9845 mvaughan@cityoftulsa.org
Northside Wastewater Plant Lower Bird Creek WWTP Port South Lift Station	Colin Wilmering – Northside WWTP and Lower Bird Creek WWTP Superintendent 5628 N 105th East Avenue Tulsa, OK 74117 918-591-4578
Southside Wastewater Plant Southeast Basin Lift Station	Josh Fisher – Southside WWTP Superintendent 5300 S. Elwood Avenue Tulsa, OK 74107 918-591-4450

201 QUALIFICATION REQUIREMENTS

201.1 Only contractors holding a valid pre-qualification certificate from the Tulsa Metropolitan Utility Authority in Classification A or D, General Utility Constructions, are eligible to bid on this project. No additional qualification information is required to be submitted.

201.2 Only contractors that attend the mandatory pre-bid meeting will be allowed to bid on this project.

202 SUMMARY OF BID ITEMS

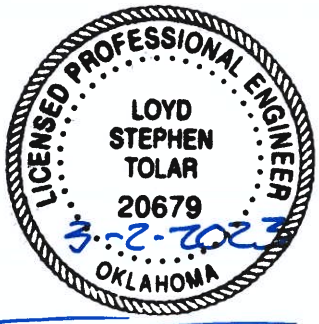
The Basis of Award shall be determined by the Total Base Bid plus Additive Alternates No. 1-4. Any proposal submitted incomplete shall be considered non-responsive.

BID ITEM	SPEC NO.	DESCRIPTION
1	203.998	Mobilization
2	203.100	All materials, labor, equipment, and supervision required for the Aeration Basin Gallery #2 (North) Waste Activated Sludge (WAS) 6" Flow Meter and Piping Improvements at the NSWWTP per these specifications.
3	203.800	All materials, labor, equipment, and supervision required for the Headworks Thickener Facility Lighting Improvements at the NSWWTP per these specifications.
4	203.820	All materials, labor, equipment, and supervision required for the Digester #1 and #2 Building Make Up Air Unit Replacement at the NSWWTP per these specifications.
5	203.200	All materials, labor, equipment, and supervision required for the Lift Station Basement Floor Drainage Improvements at the Interceptor Lift Station per these specifications.
6	203.640	All materials, labor, equipment, and supervision required for the Waste Activated Sludge (WAS) Storage Blowers Replacement and Piping Improvements at the SSWWTP per these specifications.
7	203.700	All materials, labor, equipment, and supervision required for the Rotary Drum Thickeners (RDT) Rehabilitation at the SSWWTP per these specifications.
8	203.720	All materials, labor, equipment, and supervision required for the Replacement of the Sodium Hypochlorite RAS Chemical Metering Pumps at the SSWWTP per these specifications.
9	203.740	All materials, labor, equipment, and supervision required for the Replacement of the Sodium Bisulfite Chemical Metering Pumps at the SSWWTP per these specifications.
10	203.760	All materials, labor, equipment, and supervision required for the 30" Flow Meters Replacement at the Main Lift Station SSWWTP per these specifications.
11	203.780	All materials, labor, equipment, and supervision required for the Surface Aerator Bearing Plates Rehabilitation at the LBCWWTP per these specifications.
12	203.880	All materials, labor, equipment, and supervision required for the Surface Aerator Variable Frequency Drive (VFD) Improvements at the LBC WWTP per these specifications.
13	203.999	Mechanical, Electrical, Plumbing and Unforeseen Circumstances Allowance for various mechanical, electrical, plumbing, and unforeseen work not shown on the construction drawings or specified in the contract documents.
ADDITIVE ALTERNATE NO. 1		
14	203.300	All materials, labor, equipment, and supervision required for the Contact Basin Level Instrument and Sampling System Improvements at the NSWWTP per these specifications.
ADDITIVE ALTERNATE NO. 2		
15	203.400	All materials, labor, equipment, and supervision required for the Disinfection and Dechlorination Buildings Shower/Eyewash Stations and Water Heaters Replacement at the NSWWTP per these specifications.

ADDITIVE ALTERNATE NO. 3		
16	203.765	All materials, labor, equipment, and supervision required for the 24" Flow Meter Replacement at the Cherry Creek Lift Station per these specifications.
ADDITIVE ALTERNATE NO. 4		
17	203.850	All materials, labor, equipment, and supervision required for the Rotary Drum Thickeners (RDT) Variable Frequency Drive (VFD) Replacements at the SSWWTP per these specifications.

END OF SECTION

TMUA PROJECT NO. WPC 23-1
FY'23 WATER POLLUTION CONTROL CAPITAL EQUIPMENT REPLACEMENTS
SPECIFICATION CERTIFICATION SHEET



Stephen Tolar, P.E., S.E.
OK 20679
Holloway, Updike and Bellen, Inc.
C.A. No. 219
Expires June 30, 2023

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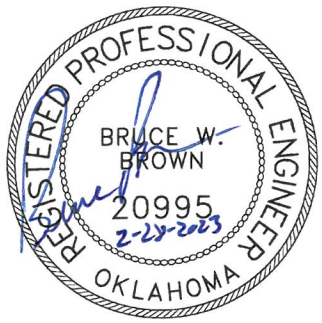
TMUA PROJECT NO. WPC 23-1
FY'23 WATER POLLUTION CONTROL CAPITAL EQUIPMENT REPLACEMENTS
SPECIFICATION CERTIFICATION SHEET

203.800 Electrical – General Provisions **203.801 Raceways, Boxes, Fittings and Supports** **203.802 Wires and Cables (600 Volt Maximum)** **203.803 Miscellaneous Equipment**	 **Bruce Brown, P.E.** **OK 20995** **Brown Engineers of Arkansas, LLC.** **C.A. No. 4933** **Expires June 30, 2024**

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203.100 All materials, labor, equipment, and supervision required for installing new Magnetic Flow Meters for wastewater service per these specifications.

203.100.1 The work consists of demolishing existing meters and installing new magnetic flow meters in accordance with the following schedule:

LOCATION	QUANTITY	SIZE
Northside WWTP Was Gallery 1&2	1	6"
Southside WWTP Main Lift Station	4	30"
Cherry Creek lift Station	1	24"

203.100.2 The project includes the correct and complete installation of new components specified herein in conformance with the manufacturer's instructions and recommendations for installation, subsequent testing of the new units and ensuring all components are in proper operation.

203.100.3 Contractor shall sequence work so that meters are replaced one at a time while maintaining operation of adjacent units.

203.100.4 Contractor shall be knowledgeable about and shall field verify all elevations and dimensions of existing structures, piping, conduit, valves and equipment that in any way, directly or indirectly, relates to the removal of existing equipment and/or installation of new equipment. Work shall be based on field measurements. The Authority will make information on file that pertains to the existing equipment available for review.

203.100.5 Project work shall include all materials, equipment, labor, and supervision, necessary to complete the project as specified herein including, but not limited to, any and all crane work, rigging, delivery and complete installation of components to fully operational and warrantable condition.

203.100.6 All work requiring flow stoppage or equipment removed from service must be scheduled 48 hours in advance with Plant Superintendent. Contractor shall have valves, temporary pumps and any other necessary materials and equipment at the installation site prior to flow stoppage. It is the contractor's responsibility to prepare the impacted system and any related systems for disassembly. This includes closing of upstream/downstream valves and pumping down any reservoirs as necessary.

203.100.7 Summary: Electromagnetic flow meters shall utilize bipolar pulse DC coil excitation to measure voltage induced by the flow of conductive liquid through a magnetic flux. The voltage shall be linearly proportional to flow velocity from 0.033 to 33 feet per second.

203.100.8 Submittals: Furnish complete Product Data, Shop Drawings, Test Reports, Operating Manuals, Record Drawings, Manufacturer's certifications, Manufacturer's Field Reports.

203.100.9 Delivery, Storage and Handling:

203.100.9.1 Store all instruments in a dedicated structure with space conditioning to meet the recommended storage requirements provided by the manufacturer.

203.100.9.2 Any instruments that are not stored in strict conformance with the manufacturer's recommendation shall be replaced.

203.100.10 Warranty: The meter shall have standard one year warranty from startup date.

203.100.11 Products

203.100.11.1 Manufacturer: Endress+Hauser Promag 400 W Series, or equal.

203.100.11.2 Manufacturer Units

203.100.11.2.1 The flow meter shall be a flanged sensor which complies with AWWA C751 and a remote transmitter with interconnecting cables up to 650 feet in length. Contractor to field confirm actual cable lengths required prior to submittal.

- The flow metering system shall be microprocessor-based and possess a non-volatile memory to store the sensor calibration and transmitter setup information. The electronics shall be interchangeable for meters sizes 1"- 90".
- The sensor shall be the proper size to measure the design flow rate of the piping and measure bi-directional flow as a standard.
- The sensor shall consist of a stainless steel flow tube with AWWA C207 carbon steel flanges. The flanges shall be Class 150 for 24" and smaller, and AWWA Class D for 28" and larger.
    - Sensors from 1"-12" shall have fixed (welded) or rotating lap joint flanges.
    - Sensors from 14"-120" shall have the flanges welded to the sensor body.
- The sensor liner and electrode material shall be chosen to be compatible with the process fluid.
- The sensor tube shall be lined with hard rubber in accordance with NSF-61.
- The sensor shall house two measuring electrodes, a grounding electrode, and one for physical empty pipe detection. The electrodes shall be bullet-nosed shaped and made of 316L SS.
- Meters shall have an unrestricted mounting magnetic flowmeter sensor for applications without the typical inlet/outlet straight pipe run requirements. The full bore magnetic flowmeter in sizes 1"-120" shall maintain zero pressure loss while achieving 0.5% of rate accuracy even when mounted directly before or after a piping elbow, T-fitting or insertion device. This flow tube shall have four measuring electrodes (sizes 1-2.5") and six

measuring electrodes (sizes 3"-120") plus a grounding electrode and an empty pipe electrode.

- The external sensor housing shall enclose the coil assemblies and internal wiring. The materials shall be designed and constructed to prevent moisture ingress and promote corrosion resistance.
- The electrode circuit shall have a minimum impedance of 10^{12} ohms to overcome moderate coating buildup.
    - The sensor shall be rated for NEMA 6P/IP68 service and shall allow for permanent immersion in water depths up to 10 feet.
- The transmitter shall be remotely mounted, and custom length cables shall be attached at the factory.
- The flow sensor shall be painted and certified according to ISO-12944 corrosion class. Third party modification or sensor preparations will not be accepted without type test documentation to support the exposure conditions, depth and duration of resistance.

203.100.11.2.2 The transmitter shall be a three-stage microprocessor controller mounted integrally or remotely as specified in the instrument schedule. The transmitter shall incorporate a universal 100-240 VAC/18-30 VDC power supply. The transmitter housing will carry a NEMA 4X rating and shall be constructed to prevent moisture ingress, promote corrosion resistance, and be impervious to saline environments.

- The transmitter shall allow local programming that can be operated through the enclosure window without opening the electrical enclosure.
- The transmitter display shall indicate simultaneous flow rate and total flow with 3 totalizers (forward, reverse, and net total) and user-selectable engineering units, readout of diagnostic error messages, and support 12 standard languages.
- The transmitter shall safeguard against entering of invalid data for the particular meter size and all programming parameters shall be access-code protected with a minimum requirement of dual passwords according to data sensitivity.
- The transmitter output shall be 4-20mA HART®, 0-20mA, pulse/frequency/ switch.
- The transmitter output(s) shall be integral to the magnetic flowmeter transmitter electronics and using an external third-party signal converter is unacceptable.
- There shall be no limitation of transmitter operational capability or diagnostic dependency between integral and compact mounting orientation.
- The transmitter output selected must be supported by add-on instructions (AOI), Level 3 add-on profiles (AOP), device drivers (DD), general station description (GSD) files, instructions and pre-engineered code.
- The transmitter shall support commissioning options via a service interface or device driver less operation via an internal web server accessible through a transmitter accessible RJ-45 Ethernet port or a WLAN (Wireless Local Area Network) connection as specified.
- The transmitter shall retain all setup parameters and accumulated measurements internally in non-volatile memory in the event of power failure. The memory unit shall be

transferrable from a damaged unit or used for a duplicate device with no loss of device parameters or data stored.

- The transmitter shall be protected against voltage spikes from the power source with internal transient protection. Power consumption shall be no more than 16 VA, independent of meter size.
- Device failure modes, self-monitoring characteristics and remedy diagnosis shall follow NAMUR standards NE 43 and NE 107.
- The transmitter shall provide access to service and monitoring parameters designed to identify transient or permanent process influences.
- The transmitter and sensor shall include a method to verify flow meter performance to the original manufacturer specifications.
    - The system shall be traceable to factory calibration using a third party, attested onboard system pursuant to ISO standards.
    - The verification technique shall not require external handhelds, interfaces, special tooling or electrical access for a verification to be performed.
    - The transmitter shall store up to eight verifications in the microprocessor.
    - A verification of the system shall be possible at any time, locally or remotely, on demand and under process conditions.
    - The verification report shall be compliant to common quality systems such as ISO 9000 7.6.a to prove reliability of the meter specified accuracy

203.100.12 Accessories

203.100.12.1 Stainless steel tag – labeled to match the contract documents.

203.100.12.2 Provide grounding rings, as per manufacture's recommendations.

203.100.13 Source Quality Control & Calibration

203.100.13.1 Magnetic flow meters shall be factory calibrated on an ISO-17025 accredited test stand per "General Requirements for the Competence of Testing and Calibration Laboratories" with certified accuracy traceable to NIST.

203.100.13.2 Evidence of accreditation shall originate from a national verification agency such as A2LA.

203.100.13.3 Each meter shall ship with a certificate of a 2-point calibration report exceeding stated standard accuracy of 0.5% of rate.

203.100.13.4 A real-time computer-generated printout of the actual calibration data points shall indicate apparent and actual flows. The flow calibration data shall be confirmed by the manufacturer and shipped with the meters to the project site.

203.100.13.5 The manufacturer shall provide complete documentation covering the traceability of all calibration instruments.

203.100.13.6 The manufacturer shall provide ISA data sheet ISA-TR20.00.01 as latest revision of form

20F2321. The manufacturer shall complete the form with all known data and model codes and dash out the inapplicable fields. Incomplete data sheets submitted will result in a rejected submittal.

203.100.14 Safety

203.100.14.1 All electrical equipment shall meet the requirements of ANSI/NFPA 70, National Electric Code latest edition.

203.100.14.2 All devices shall be certified for use in hazardous areas: Class 1, Div. 2, Groups B/C; temperature rating T3 (200 deg. C)

203.100.14.3 All devices shall be suitable for use as non-incendive devices when used with appropriate non-incendive associated equipment. Devices with intrinsically safe ratings will normally be acceptable with vendor's approval.

203.100.14.4 Electrical equipment housing shall conform to NEMA 4X classification.

203.100.14.5 Non-intrinsically safe electrical equipment shall be approved by a Nationally Recognized Testing Laboratory (NRTL) such as FM, UL, CSA, etc. for the specified electrical area classification.

203.100.14.6 Electrical equipment specified as intrinsically safe shall qualify as "simple apparatus" or NTRL approved intrinsically safe equipment per ANSI/ISA-RP12.6 "Installation of Intrinsically Safe Systems for Hazardous (Classified) Locations," latest edition.

203.100.15 TAGGING: New equipment shall be tagged from the manufacturer with a permanent and visible tag showing the new equipment number using the City of Tulsa Equipment ID numbering system. Refer to Specification Section 204.3.6 for requirements.

203.100.16 TESTING: All associated new equipment and/or appurtenances shall be installed in strict conformance with the manufacturer's recommendations, which are to be submitted with the shop drawings. After completion of the installation, the equipment shall be tested by the Contractor under actual operating conditions to achieve the flow specified. The test shall be conducted under the supervision of the manufacturer's technical representative and in the presence of the owner's representative. Three (3) copies of test results shall be submitted to the Engineer. The equipment manufacturer shall furnish the services of a factory field representative to inspect the installation, testing and start up the equipment.

203.100.17 OPERATION AND MAINTENANCE: The manufacturer shall provide information to the Owner's representative regarding the operation and maintenance of the equipment.

203.100.18 PRODUCT DELIVERY AND STORAGE: All equipment and components shall be delivered in

ample time so as not to delay the Work. Store materials to permit easy access for inspection and identification. Keep steel members off the ground, using pallets, platforms, and other supports. Protect steel members and packaged materials from corrosion and deterioration by keeping in covered storage and off of the ground.

END OF SECTION

203.640 All materials, labor, equipment, and supervision required for installing three (3) new rotary-lobe, positive displacement blower packages for Unthickened WAS Storage at the Southside WWTP per these specifications.

203.640.1 The work consists of demolishing three (3) existing blower systems and installing three new rotary-lobe positive displacement blower systems and associated piping, fittings, valves, bases, rails, supports, and electrical improvements at the Southside WWTP. The project includes the correct and complete installation of new components specified herein in conformance with the manufacturer's instructions and recommendations for installation, subsequent testing of the new units and ensuring all components are in proper operation.

203.640.2 Contractor shall sequence work so that blower units are replaced one at a time while maintaining aeration to the Unthickened WAS Storage Basins. Coordinate work with blower discharge piping replacement. System outages of up to 12 hours are allowed when coordinated at least 48 hours in advance with WWTP Staff.

203.640.3 Contractor shall provide and install blower systems that match the existing unit configuration to greatest extent possible. New equipment should generally match existing inlet and outlet locations and be sized to maintain existing clearances for operation and maintenance access. Provide dimensional drawings of blower systems by submittal and do not initiate any other related work until submittal is approved.

203.640.4 Blower systems and associated piping improvements are identified as S010-VRS1-BL01-03 on Drawings 203.640.A - J.

203.640.5 Contractor shall be knowledgeable about and shall field verify all elevations and dimensions of existing structures, piping, conduit, valves and equipment that in any way, directly or indirectly, relates to the removal of existing equipment and/or installation of new equipment. Work shall be based on field measurements. The Authority will make information on file that pertains to the existing equipment available for review.

203.640.6 Project work shall include all materials, equipment, labor, and supervision, necessary to complete the project as specified herein including, but not limited to, any and all crane work, rigging, delivery and complete installation of components to fully operational and warrantable condition.

203.640.7 All work requiring flow stoppage or equipment removed from service must be scheduled 48 hours in advance with Plant Superintendent. Contractor shall have valves, temporary pumps and any other necessary materials and equipment at the installation site prior to flow stoppage. It is the contractor's responsibility to prepare the impacted system and any related systems for disassembly. This includes closing of upstream/downstream valves and pumping down any

reservoirs as necessary.

203.640.8 The contractor shall install rotary-lobe positive-displacement blower system(s) built by a qualified manufacturer. All components shall be furnished by a single manufacturer who shall be responsible for the performance and compatibility of the system.

203.640.9 SUBMITTALS

- The submittals shall consist of a bill of material listing all components the blower system manufacturer will deliver; component Manufacturer's catalog cut sheets listing materials of construction, performance curves/charts, standards of design, warranty statement; prime/paint coating system plus the following information:

203.640.10 BLOWER

- BHP at: normal system operating conditions
- Discharge temperature at ambient temperature and normal system operating conditions.
- L10 bearing life calculations for each bearing.

203.640.11 MOTOR

- 1/2, 3/4, full load efficiencies and power factors
- L10 bearing life calculations for each bearing.

203.640.12 SILENCERS

- An attenuation performance curve for each type of silencer.

203.640.13 PRESSURE RELIEF VALVE

203.640.13.1 Set Pressure

- Shop drawings of assembled system stating what items will be shipped to the job site assembled and those shipped loose for field assembly.
- V-belt drive calculations.
- A list of all exceptions and an explanation of each non-compliance with the specifications.

203.640.14 QUALITY ASSURANCE

- The blower system(s) will be built by a blower system supplier who has units at 50 or more wastewater treatment plants, the same size or larger than those specified below, that have been in successful operation for fifteen or more years.
- All components shall be furnished by a single supplier who shall be responsible for the performance and compatibility of the system.

- The blower system manufacturer shall be an authorized warranty service center for the bare blower provided.

- Blowers, motors, and all primary components shall be manufactured in the United States with replacements and parts available from multiple sources within the United States.

203.640.15 STORAGE & HANDLING

- Care must be taken during unloading and handling of equipment to ensure against undue strain to the blower and motor. DO NOT use lifting straps or chains under the blower or motor. Lift from under the main frame, base or use base mounted lifting lugs (if provided).

- In storage blowers must be kept clean, free of moisture and rotated a minimum of 20 revolutions each week to maintain warranty. For storage in excess of four months, or in a damp or corrosive environment see the manufacturer's operation and maintenance manual.

203.640.16 CONDITIONS OF SERVICE

APPLICATION:	Coarse Bubble Aeration
NUMBER OF BLOWERS:	3
SITE ELEVATION, FASL:	629
DESIGN INLET TEMPERATURE, ºF:	100
DESIGN RELATIVE HUMIDITY, %:	85
SCFM ± 4 %:	500
ICFM ± 4 %:	583
DIFFERENTIAL PRESSURE, PSIG:	6.55
MAX BHP REQUIRED:	21.8
RPM LIMIT AT ABOVE SCFM:	1835
MOTOR SIZE, HP:	30
SOUND LIMIT REQ. @ 1 METER IN FREE FIELD, dBA:	88

203.640.17 Manufacturer will provide a warranty stating that the blower system is warranted to be in accordance with the product specifications mutually agreed upon and to be free from defects in workmanship and materials. The blower system manufacturer's product warranty will extend to all products supplied by the blower system manufacturer whether or not manufactured by the blower system manufacturer. This warranty shall terminate at twelve (12) months in service with the original user.

203.640.18 PRODUCTS

203.640.18.1 MANUFACTURERS

- The blower system(s) shall be manufactured by Universal Blower Pac, Inc., Noblesville, Indiana, or equal.

203.640.18.2 CONSTRUCTION

203.640.18.3 BLOWER

IMPELLERS:	Involute design; cast or ductile iron; static and dynamically balanced; operate without rubbing, liquid seals or lubrication.
SHAFTS:	One piece steel that pass through the impellers or cast integrally with the impellers.
TIMING GEARS:	Spur or helical tooth; alloy steel; held by taper pins, wedge rings, or bolted to timing hubs spline mounted to the shafts.
LUBRICATION:	Gear end oil splash, other end grease or oil splash. Blower shall be equipped with projecting glass viewports with brass bodies for easy oil level indication from multiple angles.
SEALS:	Labyrinth or lip on each bearing with air vents between seals and impeller chamber.

203.640.18.4 MOTOR

DESIGN:	B, squirrel-cage, induction per NEMA MG1 & IEEE standards
HP:	Nameplate greater than the brake horsepower at 10% above the relief valve set pressure as described in 1.03 D 2.
RPM:	1800
TYPE:	TEFC
POWER:	460 Volt, 3 phase, 60 Hertz
INSULATION:	Class F with class B rise
SERVICE FACTOR:	1.15 at power voltage and site elevation listed above
EFFICIENCY:	"premium efficient" per latest edition of NEMA MG1

203.640.18.5 V-BELT

- High-capacity type, oil and heat resistant, static-dissipating drive belts selected to have a 1.4 or higher service factor above the required blower brake horsepower. Sheaves shall mount to the blower and motor shafts with QD type bushings. A jack-shaft or drive coupling shall be used if recommended by the system manufacturer.

203.640.18.6 DRIVE GUARD

- Top, sides and bottom made of 14 gauge sheet steel with expanded metal front and back. Designed to allow ample ventilation for the drive, have an easy access cover and conform to applicable safety codes.

203.640.18.7 BASE

- A steel angle or channel skeleton-frame base, elevated on legs, with continuous welded joints shall be supplied. Bare base weight shall equal 50% or more of the blower's weight, but not less than 100 pounds. The inlet filter, inlet silencer, blower, motor, drive, drive guard, discharge silencer, valves, interconnecting piping, supports and all other accessories shall be shipped assembled on the base to the extent allowable by trucking.
-
- Refer to Construction Drawings for existing base configuration and available space. Match existing configuration to extent possible.

203.640.19 ACCESSORIES

203.640.19.1 INLET FILTER

- Each blower shall have a filter with a paper media that removes 99.5% of 2 micron particles. The maximum pressure drop across the clean element and housing shall be less than 2-inches of water column.

- Filter shall be shipped installed on the inlet silencer and positioned for outdoor service. Filter shall be Universal Silencer CCF or equal.

203.640.19.2 SILENCERS

- Silencers 3" and smaller shall be of the premium, straight-through absorptive type. Larger silencers shall be of the multiple-chamber design. Silencers will have acoustically packed nozzle next to blowers operating above transition speed. Silencers with threaded connections shall have ports on each end and those with flanged connections will have ports on the side and end. Multi-chamber silencer attenuation performance shall be at least 18 dB at 63 hertz, 23 dB at 125 hertz, 27 dB at 250 hertz and 31 dB at 500 hertz.

- Each blower shall have an inlet silencer with an air velocity of 4000 to 5700 feet per minute. Silencer shall be Progentex, Inc. series DS, RSI, DRSI, Universal Silencer, Inc. series U5, URB, RIS, Burgess Manning series CA, BMAI, BMSI Stoddard series L/C21, D13/L41, L61/63 or equal. Combination type inlet filter/silencers shall not be permitted.

- Each blower shall have a discharge silencer. Based on inlet CFM air velocity shall be 5500 to 7000 feet per minute. Silencer shall be Progentex, Inc. series DS, RS, DRS, Universal Silencer, Inc. series U5, URB, SD, Burgess Manning series CA, BMA, BMSS, Stoddard series L/C21, D13, D32/33 or equal. Combination type discharge silencer/base frames shall not be permitted.

203.640.19.3 FLEXIBLE JOINT

- Each blower shall have an inlet and discharge flexible joint that matches the blower ports' size and type of connection. The joint's elastomer must be rated higher than the maximum expected service temperature and pressure.

- Each blower shall have an external discharge flexible joint that matches the blower discharge silencer size. The joint's elastomer must be rated higher than the maximum expected service temperature and pressure. The flexible joint shall ship installed on the system.

203.640.20 VALVES

203.640.20.1 PRESSURE RELIEF VALVE

- Each blower shall be protected by a stacked weight type pressure relief valve preset to start opening at half a PSIG above the PSIG listed in the "service" section, be full open at not more than 10% above the set pressure, and rated for the SCFM and PSIG listed in the "service" section.

203.640.20.2 CHECK VALVE

- Each blower shall have a discharge check valve with wafer connection, cast-iron body, cast-iron split discs and seal rated above the maximum anticipated discharge temperature. Valve shall be shipped installed on the system.

203.640.21 INSTRUMENTS

203.640.21.1 FILTER RESTRICTION GAUGE

- Each inlet filter shall have a filter restriction gauge that progressively measures vacuum in the filter element. Provide a visual indicator, with a manual reset and a electronic sensor, conduit and wiring to local control panel.

203.640.21.2 PRESSURE GAUGE

- Each blower shall have a 2 1/2" diameter, stainless steel case, brass bourdon tube, liquid filled, 1/4 NPT connection pressure gauge with a 0-15 PSIG scale on systems operating up to 10 PSIG and 0-30 PSIG for higher pressures. Gauge shall have a 1/4" brass snubber and isolation valve. Gauge shall be Winters 800 or equal.

203.640.21.3 THERMOMETER / TEMPERATURE SWITCH

- Each blower shall have a high discharge air temperature switch and thermometer. The thermometer shall have an easy to read 3-1/4" dual scale dial thermometer and a 3A 250VAC / 2A 250VDC SPDT relay in a 304 stainless steel housing. Color coordinated pointers display the current process temperature and set point. A front adjustment knob controls the set pointer. The internal mechanical switch movement prevents the set point pointer from sticking to the process indicating pointer. Brass wetted internal materials have 3 percent accuracy. The thermometer shall have a 10.5' stainless steel capillary with ½" NPT process connection. The electrical connections shall be finger-safe screw terminals. A u-clamp mounting bracket shall be included for mounting to the acoustical enclosure surface.

203.640.21.4 PRESSURE SWITCH

- Each blower shall have a high discharge pressure switch.

203.640.21.5 REPLACEMENT PARTS

- Each blower shall be furnished with the following spare parts:
  - One spare filter element
  - One set of spare V-belts
  - Lubricants for 6 months

203.640.22 COATINGS

- All equipment shall be cleaned to SSPC-SP 3 and receive a 2-3 mil DFT shop coat of phenolic alkyd, zinc-chromate, red iron oxide, rust inhibitive universal primer. The blower systems shall then receive a finish coat of Coronado Alkyd Enamel, 139 series, 50% gloss, high temperature paint. The coat shall be 2-3 mil DFT.

203.640.23 ELECTRICAL

- Install a new wall mounted NEMA 4X 316SS combination starter/disconnect for each blower system. Match existing location and reuse existing conduit and wire to extent possible. Install new conduit and wire as required back to first point of termination.

203.640.24 CONTROLS AND INTEGRATION

- Install one (1) new NEMA 4X 316SS Local Control Panel for the 3 blower system. Match existing features and layout. Match existing location and reuse existing conduit and wire to extent possible. Install new conduit and wire as required back to first point of termination.

  Provide the following control features:
  - Control Power On
  - Blower 1 High Discharge Pressure
  - Blower 1 High Discharge Air Temperature
  - Blower 1 High Differential Pressure Across Filter
  - Blower 2 High Discharge Pressure
  - Blower 2 High Discharge Air Temperature
  - Blower 2 High Differential Pressure Across Filter
  - Blower 3 High Discharge Pressure
  - Blower 3 High Discharge Air Temperature
  - Blower 3 High Differential Pressure Across Filter
  - Alarm Reset

  Provide Integration services as required to restore existing SCADA functions on the HMI. Current functions include:

  - General Alarm for system
  - Run Status for each blower

203.640.25 EXECUTION

203.640.25.1 ERECTION/INSTALLATION APPLICATION

- Blowers are recommended to be installed on a non-moving foundation with the industry standard depth of twice the blower gear diameter or a pad 2 times the total mass of all rotating components, whichever depth is greater.
    - If these recommendations cannot be accommodated, the following points must be followed to ensure an adequate installation:
        - The blower pad must be located on the equivalent of compacted soil substructure, which will allow the pad to remain flat, rigid, and free of resonant frequencies within the operating range of the equipment.
        - The blower must be anchored using bolts intended specifically for dynamic loading.
        - The area between the base and pad must be filled with 1" minimum non-shrink grout.
        - The unit must be installed and leveled per the manufacturer's instructions supplied in the O&M manual.

203.640.25.2 TAGGING: New equipment shall be tagged from the manufacturer with a permanent and visible tag showing the new equipment number using the City of Tulsa Equipment ID numbering system. Refer to Specification Section 204.3.6 for requirements.

203.640.23.2 TESTING: The blower system and all associated new equipment and/or appurtenances shall be installed in strict conformance with the manufacturer's recommendations, which are to be submitted with the shop drawings. After completion of the installation, the equipment shall be tested by the Contractor under actual operating conditions to achieve the flow specified. The test shall be conducted under the supervision of the manufacturer's technical representative and in the presence of the owner's representative. Three (3) copies of test results shall be submitted to the Engineer. The equipment manufacturer shall furnish the services of a factory field representative to inspect the installation, testing and start up the equipment.

203.640.25.3 OPERATION AND MAINTENANCE: The manufacturer shall provide information to the Owner's representative regarding the operation and maintenance of the equipment.

203.640.25.4 PRODUCT DELIVERY AND STORAGE: All equipment and components shall be delivered in ample time so as not to delay the Work. Store materials to permit easy access for inspection and identification. Keep steel members off the ground, using pallets, platforms, and other supports. Protect steel members and packaged materials from corrosion and deterioration by keeping in covered storage and off of the ground.

END OF SECTION

PART 1 GENERAL

1.01 SCOPE OF WORK

A. Furnish all labor, materials and equipment required and install complete and make operational, electrical system as shown on the Drawings and as specified herein.

B. The work shall include the following:

1. Provide conduit, wire and field connections for all motors, motor controllers, control devices, control panels and electrical equipment furnished under Divisions 1, 11, 13 and 15.

2. Provide conduit, wiring and terminations for variable frequency drives, reactors, harmonic filters, transformers and power factor correction capacitors furnished and mounted under other related Divisions.

C. Each bidder or their authorized representatives shall, before preparing their proposal, visit all areas of the existing buildings and structures in which work under this sub-bid is to be performed and inspect carefully the present installation. The submission of the proposal by this bidder shall be considered evidence that their representative has visited the buildings and structures and noted the locations and conditions under which the work will be performed and that he/she takes full responsibility for a complete knowledge of all factors governing his/her work.

1.02 SUBMITTALS

A. As a minimum all equipment specified in each Section of Division 16 shall be submitted at one time. As an example all lighting fixtures shall be submitted together, all motor control centers shall be submitted together, etc. Submittals that do not comply will be returned disapproved.

B. Mark submittals to clearly identify proposed equipment including accessories, options, and features and to exclude parts not applicable to the project. When manufacturer's cut sheets apply to a product series rather than a specific product, the data specifically applicable to the project shall be highlighted or clearly indicated by other means. Each submittal piece of literature and each submittal drawing shall clearly reference the Project Specification and/or Contract Drawing that the submittal is to cover. General catalogs will not be accepted as cut sheets to fulfill submittal requirements.

C. Check shop drawings for accuracy prior to submittal. Shop drawings shall be stamped with the date checked and a statement indicating that the shop drawings conform to this Section and the Drawings. This statement shall also list all exceptions to this Section and the Drawings. Mark submittals to identify proposed equipment including accessories, options and features being proposed for approval and exclude parts not to be used. Shop drawings not so checked and noted shall be returned marked NOT APPROVED.

D. The Engineer's check shall be for conformance with the design concept of the project and compliance with this Section and the Drawings. Errors and omissions on approved shop

drawings shall not relieve the Contractor from the responsibility of providing materials and workmanship required by this Section and the Drawings.

E. All dimensions shall be field verified at the job site and coordinated with the work of all other trades.

F. Material shall not be ordered or shipped until the shop drawings have been approved. No material shall be ordered or shop work started if shop drawings are marked "APPROVED AS NOTED - CONFIRM," "APPROVED AS NOTED - RESUBMIT" or "NOT APPROVED."

G. Operation and Maintenance Data

1. Submit operations and maintenance data for equipment furnished under this Division, in accordance with Section 01730. The manuals shall be prepared specifically for this installation and shall include catalog data sheets, drawings, equipment lists, descriptions, parts lists including replacement part numbers, to instruct operating and maintenance personnel unfamiliar with such equipment.

2. Manuals shall include the following as a minimum:

a. A complete "As-Built" set of approved shop drawings.

b. A complete list of the equipment supplied, including serial numbers, ranges and pertinent data.

c. Detailed service, maintenance and operation instructions for each item supplied.

H. Exceptions for Submittals

1. Exceptions to the Specifications or Drawings shall be clearly defined by the Electrical Subcontractor in a separate section of each submittal package. The submittal shall contain the reason for the exception, the exact nature of the exception and the proposed substitution so that a proper evaluation may be made by the Engineer. The acceptability of any device or methodology submitted as an "or equal" or "exception" to the Specifications shall be at the sole discretion of the Engineer.

I. Submittals will be returned to the Contractor under one of the following codes.

Code 1 -"APPROVED" is assigned when there are no notations or comments on the submittal. When returned under this code the Contractor may release the equipment and/or material for manufacture.

Code 2 -"APPROVED AS NOTED" - This code is assigned when a confirmation of the notations and comments IS NOT required by the Contractor. The Contractor may release the equipment or material for manufacture; however, all notations and comments must be incorporated into the final product.

Code 3 -"APPROVED AS NOTED/CONFIRM" - This combination of codes is assigned when a confirmation of the notations and comments IS required by the Contractor. The Contractor

may, at his own risk, release the equipment or material for manufacture; however, all notations and comments must be incorporated into the final product. This confirmation shall specifically address each omission and nonconforming item that was noted. Confirmation is to be received by the Engineer within 10 calendar days of the date of the Engineer's transmittal requiring the confirmation.

Code 4 -"APPROVED AS NOTED/RESUBMIT" - This combination of codes is assigned when notations and comments are extensive enough to require a resubmittal of the package. This resubmittal is to address all comments, omissions and non-conforming items that were noted. Resubmittal is to be received by the Engineer within 15 calendar days of the date of the Engineer's transmittal requiring the resubmittal.

Code 5 -"NOT APPROVED" is assigned when the submittal does not meet the intent of the Contract Documents. The Contractor must resubmit the entire package revised to bring the submittal into conformance. It may be necessary to resubmit using a different manufacturer/vendor to meet the Contract Documents.

Code 6 -"COMMENTS ATTACHED" is assigned where there are comments attached to the returned submittal which provide additional data to aid the Contractor.

Code 7 -"RECEIPT ACKNOWLEDGED" - This code is assigned to acknowledge receipt of a submittal that is not subject to the Engineer's review and approval; and, is being filed for informational purposes only. This code is generally used in acknowledging receipt of *means and methods of construction* work plan, field conformance test reports, and Health and Safety plans.

Codes 1 through 5 designate the status of the reviewed submittal with Code 6 showing there has been an attachment of additional data.

1.03 REFERENCE STANDARDS

A. Electric equipment, materials and installation shall comply with the National Electrical Code (NEC).

B. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.04 PRIORITY OF THE CONTRACT DOCUMENTS

A. If, during the performance of the work, the Contractor finds a conflict, error or discrepancy between or among one or more of the Sections or between or among one or more Sections and the Drawings, furnish the higher performance requirements. The higher performance requirement shall be considered the equipment, material, device or installation method which represents the most stringent option, the highest quality or the largest quantity.

B. In all cases, figured dimensions shall govern over scaled dimensions, but work not dimensioned shall be as directed by the Engineer and work not particularly shown, identified, sized, or located shall be the same as similar work that is shown or specified.

C. Detailed Drawings shall govern over general drawings, larger scale Drawings take precedence over smaller scale Drawings, Change Order Drawings shall govern over Contract Drawings and Contract Drawings shall govern over Shop Drawings.

D. If the issue of priority is due to a conflict or discrepancy between the provisions of the Contract Documents and any referenced standard, or code of any technical society, organization or association, the provisions of the Contract Documents will take precedence if they are more stringent or presumptively cause a higher level of performance. If there is any conflict or discrepancy between standard specifications, or codes of any technical society, organization or association, or between Laws and Regulations, the higher performance requirement shall be binding on the Contractor, unless otherwise directed by the Engineer.

E. In accordance with the intent of the Contract Documents, the Contractor accepts the fact that compliance with the priority order specified shall not justify an increase in Contract Price or an extension in Contract Time nor limit in any way, the Contractor's responsibility to comply with all Laws and Regulations at all times

1.05 ENCLOSURE TYPES

A. Unless otherwise required, electrical enclosures shall be NEMA Types as follows:

1. NEMA 4 in outdoor locations, rooms below grade including basements and buried vaults and "WET" locations shown on the Drawings.

2. NEMA 4X in "CORROSIVE" locations shown on the Drawings.

1.06 CODES, INSPECTION AND FEES

A. Equipment, materials and installation shall comply with the requirements of the local authority having jurisdiction.

B. Obtain all necessary permits and pay all fees required for permits and inspections.

1.07 INTERPRETATION OF DRAWINGS

A. Unless specifically stated to the contrary, the Drawings do not show exact locations of conduit runs. Coordinate the conduit installation with other trades and the actual supplied equipment.

B. Install each 3 phase circuit in a separate conduit unless otherwise shown on the Drawings.

C. Conduit shown exposed shall be installed exposed; conduit shown concealed shall be installed concealed. Unless otherwise indicated install branch circuit conduits exposed in process/ industrial type spaces and concealed in finished spaces.

D. Where circuits are shown as "home-runs" all necessary fittings and boxes shall be provided for a complete raceway installation. Where home-runs indicate conduit is to be installed concealed or exposed the entire branch circuit shall be installed in the same manner.

E. Verify the exact locations and mounting heights of lighting fixtures, switches and receptacles prior to installation.

F. Except where dimensions are shown, the locations of equipment, fixtures, outlets and similar devices shown on the Drawings are approximate only. Exact locations shall be determined by the Contractor and approved by the Engineer during construction. Obtain information relevant to the placing of electrical work and in case of any interference with other work, proceed as directed by the Engineer and furnish all labor and materials necessary to complete the work in an approved manner.

G. Circuit layouts are not intended to show the number of fittings, or other installation details. Furnish all labor and materials to install and place in satisfactory operation all power, lighting and other electrical systems shown.

H. Redesign of electrical or mechanical work, which is required due to the Contractor's use of an alternate item, arrangement of equipment and/or layout other than specified herein, shall be done by the Contractor at his/her own expense. Redesign and detailed plans shall be submitted to the Engineer for approval. No additional compensation will be provided for changes in the work, either his/her own or others, caused by such redesign.

I. Raceways and conductors for low voltage (120 Volts) thermostats controlling HVAC unit heaters, exhaust fans and similar equipment are not shown on the Drawings. Provide raceways and conductors between the thermostats, the HVAC equipment and the motor starters for a complete and operating system. Raceways shall be installed concealed in all finished space and may be installed concealed or exposed in process spaces. Refer to the HVAC drawings for the locations of the thermostats.

1.08 SIZE OF EQUIPMENT

A. Investigate each space in the structure through which electrical equipment furnished under Division 16 must pass to reach its final location. Coordinate shipping splits with the manufacturer to permit safe handling and passage through restricted areas in the structure.

B. The equipment shall be kept upright at all times during storage and handling. When equipment must be tilted for passage through restricted areas, brace the equipment to ensure that the tilting does not impair the functional integrity of the equipment.

1.09 RECORD DRAWINGS

A. As the work progresses, legibly record all field changes on a set of Project Contract Drawings, hereinafter called the "Record Drawings."

1.10 MATERIALS AND EQUIPMENT

A. Materials and equipment furnished under this contract shall be new.

B. Material and equipment of the same type shall be the product of one manufacturer and shall be UL listed.

1.11 EQUIPMENT IDENTIFICATION

A. Identify equipment, disconnect switches, separately mounted motor starters, control stations, etc. furnished under Division 16 with the name of the equipment it serves. Motor control centers, control panels, panelboards, switchboards, switchgear, junction or terminal boxes, transfer switches, etc, shall have nameplate designations as shown on the Drawings.

B. Nameplates shall be engraved, laminated plastic, not less than 1/16-in thick by 3/4-in by 2-1/2-in with 3/16-in high white letters on a black background.

C. Nameplates shall be screw mounted to NEMA 1 enclosures. Nameplates shall be bonded to all other enclosure types using an epoxy or similar permanent waterproof adhesive. Two sided foam adhesive tape is not acceptable. Where the equipment size does not have space for mounting a nameplate the nameplate shall be permanently fastened to the adjacent mounting surface.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 SLEEVES AND FORMS FOR OPENINGS

A. Provide and place all sleeves for conduits penetrating floors, walls, partitions, etc. Locate all slots for electrical work and form before concrete is poured.

B. Exact locations are required for stubbing-up and terminating concealed conduit. Obtain shop drawings and templates from equipment vendors or other subcontractors and locate the concealed conduit before the floor slab is poured.

C. Where setting drawings are not available in time to avoid delay in scheduled floor slab pours, the Engineer may allow the installations of such conduit to be exposed. Requests for this deviation must be submitted in writing. No additional compensation for such change will be allowed.

3.02 CUTTING AND PATCHING

A. Cutting and patching shall be done in a thoroughly workmanlike manner and be in compliance with modifications and repair to concrete as specified. Saw cut concrete and masonry prior to breaking out sections.

3.03 INSTALLATION

A. Work not installed according to the Drawings and Specification shall be subject to change as directed by the Engineer at Contractor's expense.

B. Electrical equipment shall be protected against mechanical and water damage. Store all electrical equipment in dry permanent shelters. Do not install electrical equipment in place until structures are weather-tight.

C. Damaged equipment shall be replaced or repaired by the equipment manufacturer, at the Engineer's discretion and at the Contractor's expense.

D. Repaint any damage to factory applied paint finish using touch-up paint furnished by the equipment manufacturer.

3.04 WORK SUPERVISION

A. The Contractor shall designate in writing the qualified electrical supervisor who shall provide supervision to all electrical work on this project. The minimum qualifications for the electrical supervisor shall be a unlimited electrical journeyman as defined by the Oklahoma Construction Industries Board. The supervisor or his appointed alternate possessing at least a journeyman electrician license shall be on site whenever electrical work is being performed. The qualifications of the electrical supervisor shall be subject to approval of the Owner and the Engineer.

END OF SECTION

PART 1 GENERAL

1.01 SCOPE OF WORK

A. Furnish and install complete raceway systems as shown on the Drawings and as specified herein.

B. Home runs indicated are to assist the contractor in identifying raceways to be installed concealed or exposed. Raceways identified to be installed exposed on the Drawings shall be run near the ceilings or along the walls of the areas through which they pass and shall be routed to avoid conflicts with HVAC ducts, cranes and hoists, lighting fixtures, doors and hatches. Raceways indicated to be run concealed shall be run in the center of concrete floor slabs, in partitions, or above hung ceilings, as required.

PART 2 PRODUCTS

2.01 RACEWAYS AND FITTINGS

A. Aluminum Conduit and Fittings

1. Rigid Aluminum conduit, couplings, factory elbows and fittings shall be 6063 alloy and shall comply with ANSI C80.5.

2. Acceptable manufacturers:

   a. New Jersey Aluminum Corp.

   b. AFC Co.

   c. VAW of America, Inc.

   d. Or Equal.

B. Steel Conduit and Fittings

1. Rigid metal conduit (GRS), couplings, factory elbows and fittings shall be heavy wall steel tubing with a hot-dipped galvanized finish inside and out after threading and shall comply with ANSI C 80.1 and UL/6.

2. Intermediate metal conduit (IMC), couplings, factory elbows and fittings shall be medium wall steel tubing with a hot-dipped galvanized finish inside and out after threading and shall comply with UL/1242.

3. Electrical metallic tubing (EMT), factory elbows and fittings shall be thin wall steel tubing with an electrically galvanized finish after fabrication and comply with ANSI C80.3 and UL/797.

4. Acceptable manufacturers:

    a. Allied Tube & Conduit Corp.

    b. LTV Steel Tubular Products Corp.

    c. Triangular PWC Inc.

    d. Or equal.

5. Rigid metal and intermediate metal conduit fittings shall be of the threaded type, and shall be steel or malleable iron, with a hot-dipped galvanized finish. Threadless fittings and split couplings are not allowed except in specific applications as approved by the Engineer.

6. Electrical metallic tubing fittings shall be of the rain tight, concrete tight, compression type with malleable iron or pressure cast steel body, steel hex type compression nut and electrically galvanized finish.

7. Acceptable manufacturers:

    a. Appleton Electric Co.

    b. O-Z Gedney Co.

    c. RACO Inc.

    d. Gould/Efcor

    e. Steel City

    f. Or equal

C. PVC Coated Rigid Steel Conduit and Fittings

1. PVC coated rigid steel conduit shall be heavy wall steel tubing with a hot-dipped galvanized finish inside and out after threading with a minimum 0.040-in thick, polyvinyl chloride coating permanently bonded to it and an internal chemically cured urethane or enamel coating. The rigid steel conduit shall comply with ANSI C80.1 and UL/6 prior to coating.

2. PVC coated couplings, factory elbows and fitting shall be furnished with a PVC coating bonded to steel the same thickness as used on the PVC coated conduit. The ends of all couplings, fittings, etc. shall have a minimum of one pipe diameter in length of PVC overlap.

3. Acceptable manufacturers:

    a. "OCAL" as manufactured by Thomas & Betts

b. "Plasti-Bond Red" as manufactured by Robroy Industries

c. Triangle PWC Inc

d. Or equal

D. Non Metallic Conduit and Fittings

1. PVC conduit shall be rigid polyvinyl chloride schedule 40. Rigid PVC conduit up to trade sizes 3-1/2-in shall comply with NEMA TC-2 and UL/651 and shall be sunlight resistant, rated for use with 90 degree C conductors in exposed, direct burial or concrete encased applications. Underground utility duct, 4-in trade size and above, shall be polyvinyl chloride (PVC).

2. Connectors, couplings, fittings and ancillary materials shall be supplied by the conduit manufacturer. Connectors, fittings and ancillary materials shall be rated for the environment for which they are installed.

3. Acceptable manufacturers:

a. Carlon Corp.

b. Certained Corp.

c. Conux Pipe Systems, Inc.

d. Or equal.

E. Liquid-tight Flexible Metal Conduit, Couplings and Fittings

1. Liquid-tight flexible metal conduit shall be square locked, galvanized steel flexible conduit with a moisture proof, flame resistant, polyvinyl chloride jacket, for use with rigid metal conduit systems. Sealtite, Type UA, manufactured by the Anaconda Metal Hose Div.; Anaconda American Brass Co.; American Flexible Conduit Co., Inc.; Universal Metal Hose Co. or equal.

2. Liquid-tight conduit fittings shall be hot-dipped mechanically galvanized, positive grounding, screw in type. Provide external bonding lugs on sizes 1-1/4-in and larger. Box connectors shall have insulated throats as manufactured by the Thomas & Betts Co.; Crouse-Hinds Co. or equal.

3. Acceptable Manufacturers:

a. American Flexible Conduit Co.

b. Anaconda Metal Hose/ANAMET Inc.

c. Electri-flex Co.

d. Thomas & Betts

e. O-Z Gedney

f. Or equal

2.02 BOXES AND FITTINGS

A. Dry and Damp Location Boxes and Fittings

1. Outlet boxes shall be zinc-galvanized, extra depth, pressed steel with knockouts and of size and type suitable for the intended application.

2. Boxes that are less than 100 cubic inches in size used for junction or pull boxes shall be zinc galvanized pressed steel not less than 14 USS gauge with appropriate blank covers, minimum size 4-11/16-in square by 2-1/8-in deep.

3. Boxes that are 100 cubic inches and larger shall be constructed of hop dip galvanized sheet steel without knockouts. Covers shall be secured with round head brass machine screws. All joints shall be welded and ground smooth.

4. Terminal cabinets shall be NEMA 12 sheet steel unless otherwise shown on the Drawings. Boxes shall be painted and have continuously welded seams. Welds shall be ground smooth and galvanized. Box bodies shall be flanged and shall not have holes or knockouts. Box bodies shall not be less than 14 gauge metal and covers shall not be less than 12 gauge metal. Terminal boxes shall be furnished with latching hinged doors, terminal mounting straps and brackets. Terminal blocks shall be rated not less than 20A, 600V.

5. Acceptable Manufacturers:

a. Appleton

b. Raco

c. Steel City

d. Hoffman

e. Electromate Division of Robroy Ind.

f. Wiegmann

B. Wet Location Boxes and Fittings

1. NEMA 4 terminal boxes, junction boxes, pull boxes, etc, shall be sheet Type 316 stainless steel unless otherwise shown on the Drawings. Boxes shall have continuously welded seams and mounting feet. Welds shall be ground smooth. Boxes shall be flanged and shall not have holes or knockouts. Box bodies shall not be less than 14 gauge metal and covers shall not be less than 12 gauge metal. Covers shall be gasketed and fastened with stainless steel clamps. Terminal boxes shall be furnished with hinged doors, terminal mounting straps and brackets. Terminal blocks shall be NEMA type, not less than 20 Amps, 600 Volt.

2. Cast or malleable iron device boxes shall be Type FD. Boxes and fittings shall have cadmium-zinc finish with cast covers and stainless steel screws.

3. Cast aluminum device boxes shall be Type FD. Boxes and fittings shall be copper free aluminum with cast aluminum covers and stainless steel screws

4. Acceptable Manufacturers:

   a. Appleton

   b. Crouse-Hinds

   c. Steel City

   d. Hoffman

   e. Electromate - Division of Robroy Ind.

   f. Or equal

C. Hazardous (Classified) Location Boxes

1. Explosion-proof boxes shall be designed for Class 1, Group D, Division 1 hazardous locations, and shall also have O-ring seals to meet NEMA 4 requirements. Boxes and covers shall be aluminum, with stainless steel hinges and stainless steel bolts; Type EJB-N4 as manufactured by the Crouse-Hinds Co.; Appleton Electric Co.; Adalet-PLM or equal.

2.03 HARDWARE

A. Conduit Mounting Equipment

1. Stainless steel channel with stainless steel hardware shall be used in ALL indoor areas and in outdoor locations.

2. Furnish any and all necessary supports, brackets, conduit sleeves, racks and bracing as required. All boxes and hardware shall be stainless steel.

B. Conduit Supports

1. Trapezes

   a. In dry indoor areas, beams, channels, struts, hangers, bracing, rods, beam clamps, accessories and components shall be stainless steel.

   b. Stainless steel beams, channels, struts or fiberglass beams, channels, struts with stainless steel hangers, bracing, rods, beam clamps, accessories and components shall be used in all areas.

2. Conduit Racks

a. In dry indoor areas, conduit racks, accessories and components shall be stainless steel.

b. Stainless steel conduit racks with stainless, accessories and components shall be shall be used in all areas.

PART 3 EXECUTION

3.01 RACEWAY APPLICATIONS

A. Refer to Table 16110-1 for specific raceway application requirements.

B. All conduit of a given type shall be the product of one manufacturer.

3.02 BOX APPLICATIONS

A. Terminal boxes, junction boxes and pull boxes shall have NEMA ratings suitable for the location in which they are installed.

B. All conduit bodies and pulling outlets shall comply with NEC wire bending space requirements. Mogul type fittings shall be used for sizes 2-1/2-in and larger.

TABLE 16110-1 ***Raceway Application Guidelines***	
Location/Circuit Type	***Raceway Type***
All locations ▪ Class 2 and 3 signal wiring and 4-20 mA instrumentation cables, non-fiber (copper) data highway.	▪ Exposed – Rigid Aluminum conduit. ▪ Underground - PVC duct (as specified) in concrete duct bank.
Clean, dry non-finished areas - electrical rooms, generator rooms, mechanical rooms, shops, dry storage, etc.	▪ Exposed – Rigid Aluminum conduit.
Process areas - non-corrosive, non-hazardous locations designated as DAMP or WET on the Drawings.	▪ Exposed – Rigid Aluminum conduit.
Hazardous areas - all locations - Class 1, Division 1 and 2.	▪ Exposed – Rigid Aluminum conduit, where allowed by code, otherwise Galvanised rigid conduit (GRS)
Outdoor areas - all locations.	▪ Exposed – Rigid Aluminum conduit.

3.03 FITTINGS APPLICATIONS

A. Combination expansion-deflection fittings shall be used where exposed conduits cross structure expansion joints or in straight runs where expansion is anticipated. Combination expansion-deflection fittings shall be installed where embedded conduits cross structural expansion joints. Refer to Structural Drawings for expansion joint locations. Provide bonding jumpers around fittings.

B. All underground conduit penetrations at walls or other structures shall be sealed watertight. Conduit wall seals and sleeves shall be used in accordance with the manufacturer's installation instructions and the details shown on the Drawings.

C. Conduit sealing bushings shall be used to seal conduit ends exposed to the weather and at other locations shown on the Drawings.

D. **Gas Containment Area Sealing**

1. Internally and externally seal each conduit entering or leaving any area containing noxious gases to prevent contamination into clean areas via the conduit system. Areas requiring this protection are rooms where chlorine, ammonia and ozone are stored, generated or handled. Caulking material for conduit internal use shall be synthetic elastomer type, 3M, Series CP25 or equal. External sealing shall be in accordance with the typical details shown on the Drawings.

E. Insulated throat grounding bushings shall be used where specified herein and where conduits stub up into electrical equipment such as MCC's, switchgear, etc.

3.04 INSTALLATION

A. No conduit smaller than 3/4-in electrical trade size shall be used, nor shall any have more than the equivalent of three 90 degree bends in any one run. Pull boxes shall be provided as required by the NEC after every 270 degrees of bends and for straight run not to exceed 200 feet or as directed.

B. All conduit which may under any circumstance contain liquids such as water, condensation, liquid chemicals, etc, shall be arranged to drain away from the equipment served. If conduit drainage is not possible, conduit seals shall be used to plug the conduits. The ends of all conduits shall be temporarily plugged to exclude dust, moisture and debris from entering during construction.

C. Conduit ends exposed to the weather shall be sealed with conduit sealing bushings.

D. Conduits noted as spare shall be capped or plugged at both ends with easily removable fittings.

E. Conduit terminating in NEMA 3R, 4, 4X enclosures shall be terminated with Myers type conduit hubs.

F. Conduit terminating in pressed steel boxes shall have double locknuts and insulated bushings.

G. Conduits containing equipment grounding conductors and terminating in sheet steel boxes shall have insulated throat grounding bushings.

H. Conduits shall be installed using threaded fittings except for PVC or EMT.

I. The use of running threads is prohibited. Where such threads are necessary, a 3-piece union shall be used.

J. All conduits entering or leaving a motor control center, switchboard or other multiple compartment enclosure shall be stubbed up into the bottom horizontal wireway or other

manufacturer's designated area, directly below the vertical section in which the conductors are to be terminated. The 3-in extension of conduit above the floor slab or concrete equipment pad may be reduced to a dimension that suits the equipment manufacturer's installation requirements if the 3-in stub-up interferes with the equipment being provided.

K. Rigid galvanized steel conduits buried in earth shall be completely painted with bitumastic.

L. Rigid galvanized steel conduits which have been field cut and threaded shall be painted with cold galvanizing compounds.

M. PVC coated rigid galvanized steel conduit shall be used for elbows at risers at the utility pole for electrical and telephone service conduits. Rigid galvanized steel conduit shall be used at utility pole for electrical and telephone service and fire alarm conduits to a height of 10-ft above finished grade. Furnish and install weather heads at service pole riser if required by utility company.

N. Liquid-tight flexible metal conduit shall be used for all motor terminations, the primary and secondary of transformers, generator terminations and other equipment where vibration is present or may require removal. Non-metallic flexible conduit can be used with rigid PVC conduit systems.

O. Flexible couplings shall be used in hazardous locations for all motor terminations and other equipment where vibration is present.

P. PVC coated rigid steel conduit shall be used as a transition section where concrete embedded conduit stubs out of floor slabs or through below grade walls or where conduit installed under building slabs on grade stub out of floors. The PVC coated rigid steel conduit shall extend a minimum of 3-in into and out of the floor slab, concrete pad, or wall to allow for proper threading of the conduit.

Q. Expansion fittings shall be used on exposed runs of PVC conduit where required for thermal expansion. Installation and number of fittings shall be as recommended by manufacturer.

R. Conduit supports, other than for underground raceways, shall be spaced at intervals not exceeding the distance required by the NEC to obtain rigid construction.

S. Single conduits shall be supported by means of one-hole pipe clamps in combination with one-screw back plates, to raise conduits from the surface. Multiple runs of conduits shall be supported on fabricated channel trapeze type racks with steel horizontal members and threaded hanger rods. The rods shall be not less than 3/8-in diameter. Surface mounted panel boxes, junction boxes, conduit, etc, shall be supported by spacers to provide a minimum of 1/2-in clearance between wall and equipment.

T. Conduit Supports (Other than Underground Raceways)

1. Trapezes

a. Conduit support trapezes shall be vertically supported every 10-ft or less, as required to obtain rigid conduit construction.

b. Lateral seismic restraints (Sway Bracing) shall be spaced 30-ft or less.

c. Horizontal seismic restraints shall be spaced at 40-ft or less. There shall be at least one horizontal restraint per horizontal run.

d. Attachment to structural steel shall be by beam clamps or welded beam attachment. C-clamps will not be allowed for vertical hangers. Side beam clamps with beam hooks shall be used for seismic restraint only.

e. Attachment to concrete shall be cast-in-place inserts, cast-in place welded plates with welded studs or stainless steel adhesive anchors.

2. Flush Mounted Supports

a. Support shall be spaced 10-ft or less, as required to obtain rigid conduit construction.

b. Attachment to concrete shall be with cast-in-place inserts, cast-in place welded plates with welded studs or stainless adhesive anchors.

3. Conduit Racks

a. Support shall be spaced 10-ft or less, as required to obtain rigid conduit construction.

b. Horizontal seismic restraints shall be spaced at 30-ft or less, with welded studs or stainless adhesive anchors.

4. Conduit Hangers

a. Conduit hangers shall be vertical supported 10-ft or less, as required to obtain rigid conduit construction.

b. Lateral seismic restraints (Sway Bracing) shall be spaced 20-ft or less.

c. Horizontal seismic restraints shall be spaced at 30-ft or less. There shall be at least one horizontal restraint per horizontal run.

d. Attachment to structural steel shall be by beam clamps or welded beam attachment. C-clamps will not be allowed for vertical hangers. Side beam clamps with beam hooks shall be used for seismic restraint only.

e. Attachment to concrete shall be cast-in-place inserts, cast-in place welded plates with welded studs or stainless steel adhesive anchors.

5. All reinforcing bars shall be located by the Electrical Subcontractor with the use of a rebar locator prior to installing adhesive capsule type anchors. Mark the location of all reinforcing bars in an area bounded by a line drawn at least 18-in from the edge of the support bearing/weld plates on all four sides of the bearing/weld plates prior to fabricating and installing bearing/weld plates.

6. Where interference occurs, adjust anchor locations to clear reinforcing bars and alter support configuration at no additional cost to the Authority.

U. Miscellaneous steel for the support of fixtures, boxes, transformers, starters, contactors, panels and conduit shall be furnished and installed. Channel supports shall be ground smooth and fitted with plastic end caps.

V. Steel channels, flat iron and channel iron shall be furnished and installed for the support of all electrical equipment and devices, where required, including all anchors, inserts, bolts, nuts, washers, etc, for a rigid installation. Channel supports shall be ground smooth and fitted with plastic end caps.

W. 3/16-in polypropylene pull lines shall be installed in all new conduits noted as spares or designated for future equipment. Conduit noted as spare shall be capped or plugged at both ends with easily removable fittings

X. Where no type or size is indicated for junction boxes, pull boxes or terminal cabinets, they shall be sized in accordance with the requirements of NEC Article 314. Enclosure type and material shall be as specified herein.

Y. Pull or junction boxes shall be furnished and installed where shown on the Drawings, in every 200 feet of straight conduit runs or in runs where more than the equivalent of four 90 degree bends occur or at any point necessary for wire pulling and splicing. Splices shall not be made in pulling elbows.

END OF SECTION

PART 1 GENERAL

1.01. SCOPE OF WORK

A. Furnish, install and test all wire, cable and appurtenances as shown on the Drawings and as specified herein.

1.02. DELIVERY, STORAGE AND HANDLING

A. Carefully handle all conductors to avoid kinks and damage to insulation.

PART 2 PRODUCTS

2.01. GENERAL

A. Wires and cables shall be of annealed, 98 percent conductivity, soft drawn copper.

B. All conductors shall be stranded, except that lighting and receptacle wiring may be solid.

C. Except for control, signal and instrumentation circuits, wire smaller than No. 12 AWG shall not be used.

D. Wire shall have 600 Volt insulation except where indicated otherwise.

2.02. BUILDING WIRE

A. Wire for lighting, receptacles and other circuits not exceeding 150 Volts to ground shall be NEC type THHN/THWNas manufactured by General Cable.; American Insulated Wire Corp.; Southwire Co.;or equal.

B. Wire for circuits over 150 Volts to ground within buildings and structures shall be NEC type THHN/THWN as manufactured by General Cable.; American Insulated Wire Corp.; Southwire Co.; or equal.

C. Wire for circuits over 150 Volts to ground used underground or for service entrance shall be NEC type THHN/THWN as manufactured by General Cable.; American Insulated Wire Corp.; Southwire Co.; or equal.

D. Bare copper ground wire shall be stranded, annealed copper wire ASTM-B3 alloy coated soft copper electrical wire ASTM B189.

E. Equipment grounding conductors shall be NEC Type THW green and sized in accordance with NEC Table 250-122. Ground grid conductors shall be insulated unless shown otherwise on the Drawings.

2.03. CONTROL, STATUS AND ALARM WIRE

A. Wire shall be No.14 AWG NEC type THHN/THWN stranded as manufactured by The Okonite

Co.; General Cable.; American Insulated Wire Corp.; Southwire Co.; or equal.

2.04. INSTRUMENTATION WIRE

A. Wire for process instrumentation signals (i.e. 1-5 VDC, 4-20 mADC), R.T.D., potentiometer and similar signals shall be:

1. Single pair cable:

a. Conductors: 2 No. 16 stranded and twisted on 2-in lay

b. Insulation: XLP with 600 Volt, 105 degrees C rating

c. Shield: 100% Aluminum/polyester foil with drain wire

d. Jacket: PVC with UL Subject 13, UL 1581 and manufacturers' identification

e. Max overall diameter: 0.262-in

f. Miscellaneous: UL Listed as Instrument Tray Cable for use in accordance with Article 727 and Article 725 of the NEC.

g. Manufacturers: Belden; Manhattan; General Cable; The Okanite Co.;or equal

2. Area Network (LAN) Ethernet cable shall be designed for use with a high-speed (100 Mbps/Gbps) Ethernet communications network. The twisted pair cable shall have nominal impedance of 100 ohms at 1 Mhz and a maximum attenuation of 10 dB per 1000 feet at 1 Mhz. The twisted pair cable shall be plenum rated and shall have a minimum of four 24 AWG solid copper conductor pairs. All RJ-45 terminations on the twisted pair cable shall be done as specified by the manufacturer. Terminations shall provide strain relief on the cable jacket. Strain relief on the wire and /or wire insulation shall not be acceptable. Cable and connections shall meet or exceed Category 5 ratings and upon completion of the network installation, the system shall be tested to Category 5 standards. Category 5 cable shall be as manufactured by Belden; Phoenix; Digital; Seicor, or equal.

2.05. SPLICES (POWER CONDUCTORS)

A. Unless otherwise indicated on the Drawings, splices shall not be made in the cables without prior written approval of the Engineer. Where splicing is approved by the Engineer, splicing materials for all 600 Volt splices shall be made with long barrel, tin plated copper compression (hydraulically pressed) connectors and insulated with heavy wall heat shrinkable tubing. The conductivity of all completed connections shall be not less than that of the uncut conductor. The insulation resistance of all completed connections of insulated conductors shall be not less than that of the uncut conductor.

B. Wire lugs shall be tin plated copper, long barrel compression type (hydraulically pressed) for wire sizes No. 8 AWG and larger. Lugs for No. 10 AWG and smaller wire shall be locking spade type with insulated sleeve. Lugs shall be as manufactured by the Thomas and Betts Co.; Burndy; Amp; or equal.

C. Compression type connectors shall be insulated with a heat shrink boot or outer covering and epoxy filling. Splice kits shall be as manufactured by Raychem (Tyco); Ideal Industries; 3M Co. or equal.

D. Solderless pressure connectors shall be self-contained, waterproof and corrosion-proof units incorporating prefilled silicone grease to block out moisture and air. Connectors shall be sized according to manufacturer's recommendations. The connectors shall be UL listed and CSA approved, as manufactured by King Innovation; Ideal Industries, Inc., or equal.

2.06. MOTOR CONNECTIONS

A. Motor connections shall be ring type mechanical compression terminations installed on the branch circuit wires and the motor leads and secured with bolt, nut and springwasher. Connections shall be insulated with a Raychem Type RVC, roll-on stub insulator; Thomas & Betts, Shrink-Kon MSCV20; or equal. For wire sizes N0. 8 and larger, long barrel, tin plated copper compression (hydraulically pressed) type connections Burndy Co., or equal) shall be installed on the branch circuit wires and the motor leads. Connections shall be insulated with heavy duty heat shrinkable material (Raychem Corp., or equal.

2.07. TERMINATION AND SPLICES (CONTROL, STATUS AND ALARM CONDUCTORS)

A. Termination connectors shall be of the locking fork-end (upturned leg ends) type as manufactured by Ideal Industries; 3M Co.; Panduit Corp. or equal.

B. Insulated compression type connectors shall be of the expanded vinyl insulated parallel or pigtail type as manufactured by Ideal Industries; 3M Co.; Panduit Corp. or equal.

C. Solderless pressure connectors shall be self-contained, waterproof and corrosion-proof units incorporating prefilled silicone grease to block out moisture and air. Connectors shall be sized according to manufacturer's recommendations. The connectors shall be UL listed and CSA approved, as manufactured by King Innovation; Ideal Industries, Inc or equal.

2.08. TERMINATIONS (INSTRUMENTATION CABLES)

A. Termination connectors shall be of the locking fork-end (upturned leg ends) type as manufactured by Ideal Industries; 3M Co.; Panduit Corp. or equal.

2.09. WIRE AND CABLE MARKERS

A. Wire and cable markers shall be "Omni-Grip" as manufactured by the W.H. Brady Co.; Thomas & Betts Co., SMS; 3M Co., STD-TAG; or equal.

B. Wire and cables with diameters exceeding the capacity of the "Omni-Grip" shall be marked with pre-printed, self-adhesive vinyl tapes as manufactured by the W.H. Brady Co.; Panduit Corp.; 3M Co.; or equal.

PART 3 EXECUTION

3.01. INSTALLATION

A. Uniquely identify all wires, cables and each conductor of multi-conductor cables (except lighting and receptacle wiring) at each end and in all manholes, hand holes and pull boxes with wire and cable markers.

B. Use lubrications to facilitate wire pulling. Lubricants shall be UL approved for use with the insulation specified.

C. Provide multi-conductor control and signal cables within the underground system. Cables shall be installed continuous from building to building without splices. Individual control conductors and twisted shielded pairs signal cables will not be allowed in underground systems.

D. The crimping tools used in securing the conductor in the compression type connectors or terminal lugs shall be those made for that purpose and for the conductor sizes involved. The crimping tool shall be the ratchet type which prevents the tool from opening until the crimp action is completed. Such tools shall be a product of the connector manufacturer.

E. Install an equipment grounding conductor in all raceways.

F. Seal openings in slabs and walls through which wires and cables pass.

G. Pull cables from the direction that requires the least tension. Use a feed-in tube and sheave designed for cable installation. Use sheaves with radii that exceed the cable manufacturer's recommended minimum bending radius. Use a dynamometer and constant velocity power puller. Velocity should not be less than 15-ft./min. or more than 50-ft./min. Do not exceed the cable manufacturer's maximum recommended tension.

H. If cable can not be terminated immediately after installation, install heat shrinkable end caps.

I. Fireproof exposed cables in manholes, vaults, pullboxes, switchgear and other areas not protected by conduit where medium voltage cables are present. Use fire-proofing tape and glass tape in accordance with the manufacturer's instructions. Fire-proofing tape shall be installed with one half-lapped layer of Scotch Brand 77 Electric Arc and Fireproofing Tape (3M Corp., or equal). Tape shall be secured with a two-layer band of Scotch Brand 69 Glass Electrical Tape (3M Corp., or equal) over the last wrap.

3.02. WIRE COLOR CODE

A. All wire shall be color coded or coded using electrical tape in sizes where colored insulation is not available. Where tape is used as the identification system, it shall be applied in all junction boxes, manholes and other accessible intermediate locations as well as at each termination.

B. The following coding shall be used:

System	Wire	Color
240/120 Volts	Neutral	White
Single-Phase, 3 Wire	Line 1	Black
	Line 2	Red
208Y/120, Volts	Neutral	White
3 Phase, 4 Wire	Phase A	Black

	Phase B	Red
	Phase C	Blue
240/120 Volts	Neutral	White
3 Phase, 4 Wire	Phase A	Black
delta, center tap	Phase B (High)	Orange
ground on phase	Phase C	Blue
coil A-C		
480Y/277 Volts	Neutral	White
3 Phase, 4 Wire	Phase A	Brown
	Phase B	Orange
	Phase C	Yellow

C. Neutral or ground wires that terminate in a Panelboard and require color tape shall have the color tape extend at least 6-in from the termination point.

3.03. TERMINATIONS AND SPLICES

A. Power conductors: Unless otherwise indicated on the Drawings, no splices may be made in the cables without prior written approval of the Engineer. Where splicing is approved, terminations shall be die type or set screw type pressure connectors as specified. Splices (where allowed) shall be die type compression connector and waterproof with heat shrink boot or epoxy filling for copper conductors # 4 AWG and larger. Splices shall be solderless pressure connectors with insulating covers for copper conductors # 6 AWG and smaller. Aluminum conductors (where specified) shall employ terminations and splices specifically designed for aluminum conductors.

B. Control Conductors: Termination on saddle-type terminals shall be wired directly with a maximum of two conductors. Termination on screw type terminals shall be made with a maximum of two spade connectors. Splices (where allowed) shall be made with insulated compression type connectors.

C. Instrumentation Signal Conductors (including graphic panel, alarm, low and high level signals): terminations same as for control conductors. Splices allowed at instrumentation terminal boxes only.

D. Except where permitted by the Engineer no splices will be allowed in manholes, handholes or other below grade located boxes.

E. Splices shall not be made in push button control stations, control devices (i.e., pressure switches, flow switches, etc), conduit bodies, etc.

3.04. INSTRUMENTATION CABLES

A. Instrumentation cables shall be installed in rigid steel raceways as specified. All circuits shall be installed as twisted pairs or triads. In no case shall a circuit be made up using conductors from different pairs or triads. Triads shall be used wherever three wire circuits are required.

B. Terminal blocks shall be provided at all instrument cable junction and all circuits shall be

identified at such junctions.

C. Shielded instrumentation wire, coaxial, data highway, I/O and fiber optic cables shall be run without splices between instruments, terminal boxes, or panels.

D. Ground shielding on instrumentation wires at one end only as recommended by the instrument manufacturer and isolated at all other locations. Terminal blocks shall be provided for inter-connecting shield drain wires at all junction boxes. Where individual circuit shielding is required, each shield circuit shall be provided with its own block.

E. Install shielded instrumentation wire in conduit and pull boxes that contain only shielded instrumentation wire. Instrumentation cables shall be separated from all other (i.e. power, control, etc.) cables in manholes by enclosing them within rigid steel raceways and boxes.

F. Shielded cable terminations at each end shall be provided with heat shrinkable tubing placed over the exposed shield and conductors. The tubing shall extend 1-in minimum over the jacket end and extend 0.5-in minimum from the jacket end over the exposed conductors.

3.05. FIELD TESTING

A. Test all 600 Volt wire insulation with a megohm meter after installation and prior to termination. Make tests at not less than 1000 Volts DC. Test duration shall be one minute. Submit a written test report of the results to the Engineer. Notify the Engineer in writing 48 hours prior to testing.

B. Field testing and commissioning shall be done in accordance with the latest revision of the "Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems" published by the International Electrical Testing Association (NETA Standard ATS-1999)unless otherwise modified by this Section. Minimum wire insulation resistance shall not be less than 250 Megohms.

END OF SECTION

PART 1 GENERAL

1.01 SCOPE OF WORK

A. Furnish and install all miscellaneous equipment as shown on the Drawings and as specified herein.

1.02 EQUIPMENT LIST

A. This Section provides the requirements for miscellaneous equipment typically employed in a facility, however, not all components specified in this Section are necessarily utilized on this project.

PART 2 PRODUCTS

2.01. MATERIALS

A. Disconnect Switches

1. Disconnect switches shall be heavy-duty, quick-make, quick-break, visible blades, 600 Volt, 3 Pole with full cover interlock, interlock defeat and flange mounted operating handle. All current carrying parts shall be copper

2. NEMA 4 enclosures shall be stainless steel.

3. NEMA 4X enclosures shall be stainless steel.

4. Switches shall be as manufactured by the Square D Co.; General Electric; Cutler-Hammer, or equal.

B. Equipment Identification Nameplates

1. All field mounted electrical equipment such as disconnects, push button stations, etc, shall be provided with a weather resistant engraved laminoid equipment identification nameplate screwed or bolted adjacent to the device. Nameplate shall identify the mechanical equipment controlled exactly as shown on the electrical singleline drawings (i.e, P-95 Cooling Water Pump No. 1).

PART 3 EXECUTION

3.01. INSTALLATION

A. A. Mounting Stands

1. Field mounted disconnects, pushbutton control stations, alarm panels, enclosed starters and circuit breakers, transformers, automatic transfer switches, wireways, contactors, terminal boxes, junction and pull boxes shall be mounted on galvanized or stainless steel stands as specified. Where clearance requirements for stands may not be maintained, the Engineer may direct electric control equipment to be wall-mounted adjacent to the driven

equipment, but in no case shall the distance from the drive motor to the control station exceed 3-ft, all at no additional cost to the Owner.

2. Channel supports shall be ground smooth and fitted with plastic end caps.

B. All panelboards located in pedestal cabinets or outdoors and panelboards that have branch circuits feeding exterior to the building shall be equipped with lightning arresters and surge capacitors.

3.02. FIELD TESTING

A. Before supplying power to the alarm panels, the following tests shall be done: Verify that all wiring connection interfaces that are required are present. Check for secure connections. Using a continuity device, verify that all discrete inputs and output to and from the control panel are wired in correct polarity and are operating in the correct state of operation (normally open or closed state). Check for any direct short circuits across all voltage supply sources. As each of the above tests are performed, the Electrical Contractor shall highlight and initial each circuit that is tested. This set of prints shall be signed and left inside the enclosure.

B. Check mechanical interlocks for intended operation. Make any adjustments required.

C. In the event of an equipment fault in the panel, notify the Engineer immediately. After the cause of the fault has been identified and corrected, a joint inspection of the equipment shall be conducted by the Contractor and Engineer. Repair or replace the equipment as directed by the Engineer prior to placing the equipment back into service at no additional cost to the Owner.

END OF SECTION

203.998 Mobilization Bid Item – A mobilization bid item is included to help cover initial costs of bonds, insurance, permits, submittal preparation and other incidental costs.

203.998.1 Payment shall be made for a Mobilization Bid Item which is intended to cover the costs of bonds, insurance, permits, submittal preparation and other incidental costs. Payment of the Mobilization Bid Item may be requested in full on the first payment application. The Mobilization Bid Item shall not exceed five percent (**5%**) of the **sum of all Base Bid Items excluding the Mobilization Bid Item**. Add Alternate Items are not part of the Base Bid Items.

END OF SECTION

203.999 Mechanical, Electrical, Plumbing, and Unforeseen Circumstances Allowance – The allowance amount is shown on the bid proposal for various mechanical, electrical, plumbing, or unforeseen circumstances work not shown on the Construction Drawings or specified in the Contract Documents.

203.999.1 The allowance shall be used for cost of materials, labor, installation, and overhead and profit for additional MEP/Unforeseen Circumstances work that is not shown on the Construction Drawings or specified in the Contract Documents.

203.999.2 The allowance shall be used only at the discretion of the City of Tulsa. Any allowance balance remaining at the completion of the contract will be credited back to the City of Tulsa on the final Application for Payment submitted by the contractor.

203.999.3 The contractor shall provide to the City of Tulsa representative a written request for the use of any of the allowance with a schedule of values and all associated backup information.

203.999.4 The contractor shall proceed with work included in the allowance only after receiving a written order from the City of Tulsa representative authorizing such work. Proceeding with work expected to be covered in the allowance without a written order from the City of Tulsa representative will be at the contractor's risk. Contractor may not be paid for unapproved work/materials at the discretion of the City of Tulsa representative.

203.999.5 Any additional costs for bonds and insurance shall not be included in any MEP allowance because this cost is already included in the contract.

END OF SECTION

204 ANCILLARY EQUIPMENT & WORK

The cost of items in this Section and other Sections of these specifications shall be equitably included in the appropriate Bid items.

204.1 Prior to disposal of any material or equipment that is City of Tulsa property and removed as part of the contract work, Contractor shall contact the appropriate **WWTP Plant Superintendent** and explicitly offer to the Authority first right to claim and retain such materials or equipment as City of Tulsa property. Contractor shall be responsible for the disposal of all such equipment and materials not claimed by the Authority. Items identified for salvage shall be removed carefully, protected, palletized and delivered to the Northside or Southside Maintenance Department. A copy of the Contractor's transmittal shall be provided to the Engineer after delivery.

204.2 Contractor shall field verify all elevations and dimensions of existing piping, valves, and equipment to be demolished. Contractor work shall be based on field measurements and shall include field adjustments and additions for the proper installation of equipment. The contractor shall take note of all objects in the vicinity of equipment being installed to ensure that there are no issues with interference. It is the responsibility of the contractor to make modifications necessary to adjacent objects such as pipe supports and similar to install the new equipment unless such objects are not reasonably visible during the site visit. It is the responsibility of the contractor to review all field conditions and take necessary field measurements prior to ordering equipment. The City of Tulsa will make available the information it has pertaining to the existing equipment.

204.3 General Equipment Requirements:

204.3.1 Approved Equal Equipment: The manufacturers and models specified in the equipment specifications are considered pre-approved. The winning contractor may, at their discretion, submit for approval equipment that has not been approved prior to the bid opening. When doing this, the contractor should be aware that the submitted equipment must not only meet the performance requirements stated in the equipment specifications, but it also must meet or exceed the manufacturing, material, and quality specifications of the pre-approved equipment even though those specifications are not expressly listed in the section. The Engineer will review any non pre-approved equipment through the submittal process and compare it with the pre-approved equipment to determine that the equipment is or is not equal. Contractor should be

prepared to supply technical data, material information, standards conformance information, and other related information as requested by the Engineer. If the requested information is not supplied, the equipment will be deemed to be not equal. Approval of non pre-approved equipment will be at the sole discretion of the Engineer.

204.3.2 Equipment Demolition: All equipment shall be demolished in accordance with each bid item section. No existing equipment is to be abandoned in place unless specifically noted otherwise. All equipment being removed during demolition shall either be set aside for determination of surplus value or disposed of by the contractor per each bid item specification. If after removing the old equipment and installing the new equipment there are unused items still in place, it shall be the responsibility of the contractor to remove these items in a manner that will not affect adjacent equipment or systems. All removed electrical and fluid components shall be properly capped off at the point of removal. Removal shall be performed in a manner that will allow re-installation/replacement of the removed items at a later date if necessary.

204.3.3 Gauges: Each pump shall be provided with a combination pressure/vacuum gauge in the suction piping and a pressure gauge in the discharge piping. Gauges shall conform to ANSI/ASME B40.1 and shall be indicating dial type, with C-type phosphor bronze Bourdon tube and stainless steel rotary geared movement, or direct drive type with stainless steel helical-wound capillary tube pressure sensing element. The gauge shall have a phenolic open front turret case, and adjustable pointer, a stainless steel or phenolic ring, and an acrylic or shatterproof glass window. The dial shall be 4 ½ inches in diameter, with white background and black markings. Pointer travel shall span not less than 200 degrees or more than 270 degrees. All gauges shall be Accuracy Grade A or better. Pressure gauges shall read in pounds per square inch. Compound gauges shall read in inches of mercury vacuum and pounds per square inch. The range of each gauge shall be per pump manufacturer's recommendation.

All gauges shall be installed with a diaphragm seal, brass flushing port and brass isolation valve of appropriate size.

204.3.4 Mechanical Seals and Seal Water:

204.3.4.1 All pumps shall be equipped with cartridge mounted double mechanical seals recommended by the pump manufacturer and compatible with Pump Seal Water Support Systems (PSWSS) installed at each pump. Refer to Construction Drawings and pump specifications for additional requirements.

204.3.4.2 The new seal water conditioning station (SWCS) and PSWSS may contain components that were not originally part of an existing seal water system. It is the responsibility of the contractor to supply and install all necessary electrical components including wiring, conduit, connectors, contactors, etc.… for a complete installation of the new seal water system. It may also be necessary to integrate the new seal water system components into the existing equipment control system. The contractor shall be responsible for all labor and materials required to integrate new components into the existing control system. All electrical work on the seal water station shall conform to the General Electrical Requirements herein. Contractor shall demolish and remove all existing seal water components not reused in construction.

204.3.4.3 Seal water piping and accessories shall not utilize rigid PVC piping. Seal water lines connected directly to the mechanical seals shall be PEX. All other piping in the seal water station shall be of a non-corrosive metal material such as stainless steel, or painted copper. Valves and other components shall be bronze unless otherwise required.

204.3.4.4 Some existing pumps do not have mechanical seals. Contractor shall determine from field investigations the location of seal water for those pumps. It is the responsibility of the contractor to supply and install all seal water piping, electrical work and materials, and control work and materials required to add a seal water station where one was not used for existing equipment. Locations are to be approved by the engineer.

204.3.4.5 If a new pump is installed that does not require seal water and there are existing seal water lines at the pump location, it is the responsibility of the contractor to remove existing water lines. Lines shall be removed as far up stream as possible to a point that will not interfere with water supply to other equipment. No existing lines shall be abandoned in place.

204.3.5 Valves:

204.3.5.1 All valve parts and surfaces shall be of corrosion resistant materials or have a factory applied epoxy coating sufficient to prevent corrosion in a wastewater environment. See painting/coating section for coating thickness requirements.

204.3.5.2 Plug Valves and Check Valves: Plug valves and check valves shall be of the same size, style and construction as the units being replaced. It is the responsibility of the contractor to review the existing valves and provide correct similar units. Acceptable manufacturers are Pratt, DeZurik, Clow, Val-Matic, or an approved equal.

204.3.5.3 Butterfly Valves: Butterfly valves shall be of the same size, style, and construction as the units being replaced. It is the responsibility of the contractor to review the existing valves and provide correct similar units. Acceptable manufactures are DeZurik, Clow, Val-Matic, or an approved equal.

204.3.5.4 Gate Valves: Gate valves shall be of the same size, style and construction as the units being replaced. It is the responsibility of the contractor to review the existing valves and provide correct similar units. Acceptable manufacturers are Wey, DeZurik, or approved equal.

204.3.5.5 Plug and butterfly valves supplied with hand wheel operators that are installed more than 6'-0" above floor level shall be supplied with chain wheels and chains to allow for valve operation from the floor.

204.3.5.6 Valves and operators shall be selected by the contractor such that when installed in close proximity to one another

the operators will be a sufficient distance apart to allow for uninhibited use by personnel.

204.3.5.7 All Valve placement and orientation shall be installed per Manufacture's recommendations. Systems operation and valve orientation layout (drawing) shall be included in the submittals for review with valve submittal(s).

204.3.6 Equipment Tagging: New equipment shall be tagged, according to the requirements listed below and City standards, with a permanent and visible tag showing the new equipment number and naming using the City of Tulsa Equipment ID numbering system. All tags should be visible to anyone without the need to remove covers or otherwise "hunt" for the tag. See individual equipment sections for Equipment ID numbers for each item. Tags shall conform to the following specifications.

204.3.6.1 Requirements:

- Any equipment valued over $1,000

- All Valves greater than 6"

- All valves great than 2" buried. Concrete collar tags for valves require a 316 stainless steel tag at each installed location. See valve box concrete collar detail for additional required details.

- All relief and motorized valves that are smaller than 6"

- Any equipment that requires preventive maintenance

- Any equipment that is critical to the process of the plant

- Any equipment that is considered a Safety item

- Emergency Eyewash/Showers

- All Fire Extinguishers

- All Ladders

- Hoists

- All Detectors

- Overhead Doors

- Fire Alarms/Sprinklers

- Emergency Lights

- All electrically powered devices require three (3ea) tags at minimum - one at unit, one on the disconnect and on panel/switch/MMC bucket.

- All equipment with assigned Equipment number

- All mechanical, heating, ventilation and cooling system equipment. Each unit and item of maintenance location shall be tagged individually, along with each component within the system in other areas of the building/facility. Custom engrave (bi-laminated) plastic sleeved tags with equipment numbers, naming and direction arrows for each piping, refrigerant lines, condensate, drain lines and system lines shall receive a label every 6 LF at min which can be readable from below or system access point.

204.3.6.2 Equipment ID tagging shall meet the following requirements:

PRODUCTS

Equipment ID Number and Name Tagging Plates

All equipment tagged on the drawings, except for buried submerged equipment shall be provided with an Equipment ID Number Plate bearing the equipment tag number and equipment name. Each equipment ID Plates shall be rectangular 3.5"x .75" and 1/16" thick laminated blue phenolic plastic engraving stock that is U/V stable. Lettering shall be 1 line of text, centered, and white capitalized block letters .25" high and engraved to a depth of 0.08mm.

Equipment ID Number Plates must follow the Equipment ID numbering and naming scheme. Each equipment or systems should also include an additional tag noting the general name of the equipment or system adjacent to the equipment ID numbering tag (i.e., "Final Clarifier #3", VFD for Pump #2, etc.).

Equipment ID Number Plates shall be attached with permanent adhesive or stainless fasteners.

Additional Number Plates shall be provided for ancillary devices associated with each piece of new tagged equipment.

Additional tags shall be provided for all electrical disconnects, variable frequency drives, switching and Motor Control Centers whether new or existing.

VALVE, BUTTERFLY AND GATE EQUIPMENT ID NUMBER AND NAME TAGGING PLATES

Equipment ID Number and Name Plates

Additional details for all valves and gates, except buried or submerged valves, that have been assigned an Equipment ID number on the Drawings or in the valve or gate schedule, shall be provided with a permanent number plate. Equipment ID Number Plates shall be round 1.5" and 1/16" thick laminated blue phenolic plastic engraving stock that is U/V stable. Lettering shall be in 3 sections, centered, and white capitalized block letters 3/16" high and engraved to a depth of 0.08mm.

Example: 1st line XXXX-

2nd line XXXX-

3rd line XXXXX

Equipment ID Number Plates must follow the Equipment ID numbering and naming scheme. Reference the project equipment warranty log for additional information.

Equipment ID Number Plates shall be attached with permanent stainless cable ties or stainless fasteners. Plated or coated fasteners will not be permitted.

See contract drawings for buried valves concrete collar details and special custom stainless steel tagging requirements. All buried valves 2" and greater require a tagging with system name and equipment number.

204.3.7 Equipment Coatings: All equipment shall be supplied with a factory applied coating sufficient to withstand a wastewater environment. Factory applied coating shall be in accordance with the painting/coating section.

204.3.8 Equipment Installation: All anchor bolt connections shall include the use of a washer, lock washer, and nut (without nylon or similar insert).

204.3.8.1 Installation of all equipment and related items shall be performed as directed in the manufacturer's installation instructions.

204.3.8.2 No cutting, drilling or welding of new equipment or part thereof as delivered from the manufacturer for the purpose of adapting or modifying said unit to facilitate its installation will be permitted without written prior approval by the authority.

204.3.8.3 The Contractor shall be responsible for any and all concrete modifications that may be required to install the new equipment. This shall include modifications or replacement of equipment pads and supports. All modifications shall be designed and constructed to conform to the recommendations of *ACI 302.1R-04 Guide for Concrete Floor and Slab Construction* and *ACI 301-10 Standard Specifications for Structural Concrete*. All concrete modifications and repairs shall be coated per the painting/coating section herein.

204.3.9 Equipment Start Up and performance:

204.3.9.1 All new equipment installed by the contractor must be started up and be in operational service for 48 hours with no performance issues prior to demolishing and installing like, adjacent equipment in the same system. If the new equipment exhibits any performance issues, the contractor shall repair the equipment/installation as required and begin a new 48 hour observation period.

END OF SECTION

204.4 General Electrical Requirements

204.4.1 Electric Code Compliance: All electrical work shall be performed in compliance with current electrical code.

204.4.2 Electrical Disconnects: All equipment installed or worked on with an electrical portion in the scope of work shall have a new local disconnect switch installed. All local disconnect switches shall be of stainless steel construction meeting NEMA 4X standards. In the event a Class 1, Division 1 rating is required for explosion proof service, the disconnect shall meet all required ratings for Class 1, Division 1 service. Control panels that incorporate an integral disconnect will not be required to have an external disconnect.

204.4.3 Electric Motors: All electric motors shall be premium efficiency, suitable for operating the intended equipment per the equipment manufacturer's recommendations.

204.4.4 Electrical Wiring & Related Items: Contractor shall use caution to avoid damage to existing power cables. These cables shall be reused in new equipment installation provided their reuse meets current code requirements. Contractor shall be responsible for any damage to existing electrical equipment or power cables. The contractor shall be responsible for removing the existing control system and replacing it with the new control system. No unused remnants of the existing control system shall be abandoned in place.

204.4.5 Identification: Conduits in manholes, hand-holes, building entrance pull boxes, junction boxes and equipment shall be provided with identification tags. Identification tags shall be 19 gage stainless steel with ½ inch stamped letters and numbers as indicated on the drawings. Identification tags shall be attached to conduits with nylon tie wraps and shall be positioned to be readily visible.

204.4.6 Rigid Steel Conduit shall be heavy wall, plated/hot-dip galvanized, shall conform to ANSI C80.1, and shall be manufactured in accordance with UL 6. Not applicable to this contract unless specifically noted otherwise.

204.4.7 Liquid tight Flexible Metal Conduit shall be hot-dip galvanized steel, shall be covered with a moisture proof polyvinyl chloride jacket, and shall be UL labeled. For interior applications only.

204.4.8 Rigid Nonmetallic (PVC) Conduit - PVC conduit shall be heavy wall, Schedule 40, UL labeled for aboveground and underground uses, and shall conform to NEMA TC-2 and UL651. Not acceptable and not applicable to this contract.

204.4.9 Aluminum Rigid Conduit system:

204.4.9.1 The conduit shall be rigid aluminum, threaded, T-1 temper as part of electrical of an all-aluminum conduit system with couplings, bends and fittings as required. Any fasteners and other hardware shall be 316 stainless steel as required and applicable. In the event a Class 1, Division 1 rating is required for explosion proof service, the conduit system shall meet all required ratings for Class 1, Division 1 service. Provide in all interior and exterior installation locations.

204.4.9.2 The conduit system shall be UL 6A and ANSI C80 5 rated for application.

204.4.9.3 Provide "seal-off" corrosion protection at all and panels, device outlets and equipment as recommended by conduit Manufacture.

204.4.9.4 Acceptable manufactures are Wheatland Tube, Republic Conduit, and American Conduit by Sapa or equal.

204.4.9.5 Unless a Manufacture requirements, code or other governing requirement specifically require something other than aluminum conduits, all conduits and accessories shall be aluminum

204.4.10 Conductors. All conductors in power, control and instrumentation circuits shall be identified and color coded as described herein.

204.4.10.1 Conductor Identification Number. Except for lighting and receptacle circuits, each individual conductor in power, control and instrumentation circuits shall be provided with wire identification markers at the point of termination.

204.4.10.2 The wire numbers shall be of the heat-shrinkable tube type, with custom typed identification numbers.

204.4.10.3 The wire numbers shall be as indicated on the equipment manufacturer's drawings.

204.4.10.4 The wire markers shall be positioned to be readily visible for inspection.

204.4.11 Conductor Color Coding. Power conductors shall be color coded as indicated below. For conductors 6 AWG and smaller, the color coding shall be insulation finish color. For sizes larger than 6 AWG, the color coding may be by marking

tape. The equipment grounding conductor shall be green or green with one or more yellow stripes if the conductor is insulated.

204.4.11.1 The following color coding system shall be used for Power conductors:

204.4.11.1.1 120/240V, single-phase – black, red and white

204.4.11.1.2 120/208V, three-phase – black, red, blue and white

204.4.11.1.3 120/240V, three-phase – black, orange, blue and white

204.4.11.1.4 277/480V, three-phase – brown, orange, yellow and gray

204.4.11.1.5 Where 120/240 and 120/208 volt system share the same conduit or enclosure, the neutral for either the 120/240 volt system or the 208 volt system shall be white with a permanent identifiable violet stripe.

204.4.11.2 Control and instrumentation circuit conductors shall be color coded as indicated below:

204.4.11.2.1 Multiconductor Control Cable: 600 Volt Multiconductor 14 AWG Control Cable

204.4.11.2.2 REFERENCE: UL 83, UL 1277, ICEA S-73-532, ICEA S-58-679.

204.4.11.2.3 CONDUCTOR: 14 AWG, 7 OR 19 strands, concentric-lay, uncoated copper. Maximum operating temperature 90°C dry, 75°C wet.

204.4.11.2.4 INSULATION: Polyvinyl chloride, not less than 15 mils average thickness;13 mils minimum thickness, UL 83 Type THHN and THWN.

204.4.11.2.5 SHIELD: None.

204.4.11.2.6 JACKET: Conductor: Nylon, 4 mils minimum thickness, UL 83.

204.4.11.2.7 Cable assembly: Black, flame-retardant polyvinyl, UL 1277, applied over tape-wrapped cable core.

204.4.11.2.8 COLOR INDENTIFICATION: ICEA S-58-679, Method1, Table 2 or ICEA S-58-679, Method 3, Table 2. White or green conductors shall not be provided. A durable marking shall be provided on the surface of the cable at intervals not exceeding 24 inches. Marking shall include manufacturer's name, Type THWN or THHN, conductor size, number of conductors, and voltage class.

204.4.12 Signal Control Cable:

204.4.12.1 REFERENCE: UL 62, UL 1277.

204.4.12.2 CONDUCTOR: 16 AWG,7-strand, concentric-lay, uncoated copper. Maximum operating temperature 90°C dry, 75°C wet.

204.4.12.3 INSULATION: Polyvinyl Chloride, not less than 15 mils average thickness: 13 mils minimum thickness, UL 62, Type TFN.

204.4.12.4 LAY: Twisted pair with 1-1/2 inch to 2-1/2 inch lay.

204.4.12.5 SHIELD: Cable assembly, combination aluminum-polyester tape and 7-strand, 20 AWG minimum size, tinned copper drain wire, shield applied to achieve 100 percent cover over insulation conductors.

204.4.12.6 JACKET: Conductor. Nylon, 4 mils minimum thickness, UL 62.

204.4.12.7 Cable assembly: Black, flame-retardant polyvinyl chloride, UL 1277, applied over tape-wrapped cable core.

204.4.12.8 CONDUCTOR IDENTIFICATION: One conductor black, one conductor white.

204.4.13 Single Conductors: 600 Volt, Single Conductor Power Cable

204.4.13.1 REFERENCE: UL 83, ICEA S-95-658 (NEMA WC 70).

204.4.13.2 CONDUCTOR: Stranded, uncoated copper. Maximum operating temperature 90°C dry, 75°C wet.

204.4.13.3 INSULATION: Polyvinyl, UL 83, type THHN and THWN, ICEA S-95-658.

204.4.13.4 SHIELD: None

204.4.13.5 JACKET: Conductor. Nylon, 4 mils minimum thickness, UL 83.

204.4.14 Pump Control Panels (Cabinets) – Unless otherwise noted, Contractor shall provide each unit with the following system components to conform to the following specifications:

204.4.14.1 Input Disconnect: Furnish an input circuit breaker with an interrupting rating of 65,000 rms symmetrical amperes.

204.4.14.2 Control Devices: Include door mounted control and monitoring devices for each sump pump as follows:

A. "Manual-OFF-Auto" control selection

B. Power disconnect

C. Elapsed time meter; shall be non-resettable, rollover at 9999 hours showing resolution of 0.1 hours

D. Phase loss monitor

E. Indicator lamps for Power On, Run, Phase Loss and Overload.

204.4.14.3 NEMA contactors size 1 or larger rated to handle the connected load.

204.4.14.4 Refer to Drawings for control panel schematics for additional requirements.

204.4.14.4 Coil Voltage: 120-volts, 60-hertz.

204.4.15 Variable Frequency Drives (VFD):

204.4.15.1 Enclosures: New VFD units shall be supplied with and installed in a new enclosure. All component enclosures shall be NEMA 12 compliant, and shall fit in the location of replaced equipment.

204.4.15.2 System Features: Contractor shall provide each unit with the following system components to conform to the following specifications:

204.4.15.3 Input Disconnect: Furnish an input circuit breaker with an interrupting rating of 65,000 rms symmetrical amperes

204.4.15.4 The VFD units must comply with all requirements of the existing pumps. The new VFD units shall be 18 pulse "clean power", low harmonic in compliance with IEEE 519 guidelines for harmonic mitigation and have a continuous output current of approximately 30% more than the motor full load nameplate current.

204.4.15.5 New VFD units shall be installed with no cutting, drilling or welding of the new equipment or part thereof as delivered from the manufacturer, for the purpose of adapting or modifying said unit to facilitate its installation, will be permitted without written prior approval by the Authority.

204.4.15.6 Control Devices: Include door mounted control and monitoring devices for each drive as follows:

Start push button

Stop push button

"Local-OFF-Remote" control selection

Maintained Emergency shutdown button – Palm press and red in color

Speed selection – Door mounted potentiometer operating single turn 0% - 100%

Frequency meter with hertz and 0-100 scales

Output ammeter

Elapsed time meter shall be non-resettable, rollover at 9999 hours showing resolution of 0.1 hours

Diagnostic package with fault indication and reset push button

Indicator lamps for the ON, OFF, Auto, Vibration and FAULT unit status conditions

Vibration sensors shall be installed and operated such that when a vibration alarm is triggered, the VFD/Pump shuts down automatically

Vibration sensors shall have the operating capacity of sending a 4-20 mA signal to an analog PLC input and a dry set of contacts for the relay logic

204.4.15.7 PLC Control Features: Furnish a control system for each drive to allow the following Auto/PLC functions:

Remote, isolated 4-20 mA speed control input

Isolated 4-20 mA speed output

PLC Remote Run command

Alarm outputs

ON/OFF status output

Additional features and controls specified with the drive equipment

Local/Auto status output

204.4.15.8 New and replacement VFDs shall be installed such that all 4-20mA features are available. If a VFD being replaced is not currently configured to communicate with the SCADA system, the replacement unit shall communicate with the SCADA system in the same manner of a new VFD installation. On new VFD installations, all 4-20mA communication features shall be installed in the VFD for future connection to the SCADA system. All function and options which are included in the

new VFD shall be integrated fully into the City's SCADA system, including SCADA screen(s).

204.4.15.9 General Purpose Contactors: Provide general purpose contactors in accordance with NEMA ICS 2 meeting the following:

Coil Voltage: 120-volts, 60-hertz

Poles: Provide three-pole contactors, unless otherwise indicated.

204.4.15.10 Electrical Wiring: Contractor shall be responsible for verifying or replacing all wiring from existing breakers and/or disconnects to the new equipment including replacing breakers as required. All wiring and electrical construction shall meet current electrical code.

204.4.15.11 Complete O&M Manuals and operating parameters shall be supplied on CD.

204.4.15.12 Electrical Wiring & Related Items:

204.4.15.13 All wire to wire connections shall be made using insulated mechanical connectors. All shielded cable shall use heat shrink to cover cable outer cover and shield for termination. No wire nuts or butt splices are to be used unless previous authorization is given by the engineer. Insulated mechanical connectors shall be manufactured by Penn-Union, Galvan Industries, Polaris Electrical Connectors, or an approved equal manufacturer.

204.4.1514 Power and control wiring will follow the NFPA 79 Chapter 13 standard.

204.4.15.15 Control wiring labeling shall follow NFPA 79 Chapter 13 standard. Control wiring identification tags shall be a thermal transfer print. A Brady TLS2200 or equivalent.

END OF SECTION

204.5 Painting/Coating

204.5.1 Surface Preparation and Shop Prime Painting: All equipment and disturbed surfaces shall be cleaned and shop primed per equipment manufacturer's recommendation as part of the work. Equipment nameplates and similar information tags shall be masked off for removal after finish coat applications. All surface preparation for applying a specified coating system shall be done in accordance with the appropriate "Application Bulletin" from the manufacture for the specific product specified. Equipment vendors/manufactures shall be consulted concerning the required final coating system to ensure that it will be compatible with the primer coat applied at the factory, in the event that the shop applied primer coat is not removed prior to the coating installation.

In coordination with the painting system submittals, the Contractor shall coordinate and provide an independent testing service or Manufacture's Representative to conduct an overcoat analysis testing report and topcoat compatibility testing prior to finalizing product selection and submission. The written report shall be included in the submittal process for all unique areas of new work and would include sufficient number of testing locations for inspection certification of all areas of the contract new work.

Provide minimum SP-10 Near white blasting unless Manufacture requirements are more stringent in all areas submerged or exposed to raw sewage, grit structures, sewage flow structures, classification spaces (as shown on plan sheets) and sewage process equipment (high corrosive areas).

New and rehabilitation work should include, but not limited to field inspection/investigations/testing, storage, preparations, proper procedures, access coordination, a "complete scope application" and any required details for a finish product.

204.5.2 Final Coat: Unless otherwise specified, all new equipment shall be shop or field painted with a final coat, provided all shop painted finish surfaces shall receive matching field touch-up painting as final treatment, all with a finish coat per the equipment manufacturer's recommendation. All disturbed surfaces shall be field painted after equipment installation with a finish coat per the equipment manufacturer's recommendation.

204.5.2.1 Disturbed surfaces will be defined as including piping between suction and discharge valves on pump assembly replacements and pipe to either side of valves on individual valve replacements. All other disturbed surfaces will be defined as existing materials adjacent to new equipment.

204.5.3 Coating Systems

204.5.3.1 The Coating System for painting structural steel, piping, valves, etc. not exposed to sunlight shall be Sherwin-Williams Coating System Identification A-1, Alkyd 2-coat system. This system has a primer "KemKromik, Univ. Primer" and a finish coat "Industrial Urethane, Alkyd Enamel" or an approved equal. Contractor shall submit supplier information for approval prior to painting.

204.5.3.2 The Coating System for painting structural steel, piping, valves, etc. non-immersed, mildly corrosive, wet environments and not exposed to sunlight shall be Sherwin-Williams Coating System Identification E-1, Polyamide Epoxy system. This system has a primer "Macropoxy 646" and a finish coat "Macropoxy 646" or an approved equal. Contractor shall submit supplier information for approval prior to painting.

204.5.3.3 The Coating System for painting metal surface for exterior weathering exposure in a corrosive environment shall be Sherwin-Williams Coating System Identification EU-2,Urethane Finish, Corrosive Areas 3-coat system or equal. This system has a primer "CorothaneGalvapac", second coat "Macropoxy 646" and a finish coat "Hi-solids Polyurethane" or an approved equal. Contractor shall submit supplier information for approval prior to painting.

204.5.3.4 Coating System for painting metal surface for full or partial immersion service shall be Sherwin-Williams Coating System Identification E-3, Amine Epoxy Glass Flake Reinforcement or equal. This is a two-coat system using Sher-Glass Epoxy FF. The first coat shall have a red oxide color with a minimum dry film

thickness of 10-15 mils. The second coat shall have a haze gray color. Total dry film thickness shall be a minimum 20-25 mils. Application and total dry film thicknesses shall be installed per Manufacture's recommendations.

204.5.3.5 Paint color code shall adhere strictly to DEQ code requirements. Paint Color Schedule (<u>All colors and codes are Sherwin Williams. A crossover for Tnemec and Carboline is available on request</u>.):

a.	Potable	WaterFlyway SW6794
b.	Plant Effluent Water (PEW)	Pantone 522, DEQ
c.	Chilled Water	French Roast SW6069 w/ Heartthrob SW6866 bands
d.	Heating Water Supply	Gray Screen SW7071 w/ White bands
e.	Heating Water Return	Gray Screen SW7071 w/ Black bands
f.	Compressed Air	Supreme Green W6442
g.	Instrument Air	Supreme Green SW6442
h.	Blower Air	Supreme Green SW6442
i.	Natural Gas	Heartthrob SW6866
j.	Sludge Return	Bagel SW6114
k.	Sludge Waste	Sensational Sand SW6094
l.	Digested Sludge	French Roast SW6069
m.	Sludge Sample	Web Gray SW7075 w/ Hearththrob SW6866 bands
n.	Drain/Sump	Web Gray SW7075
o.	Raw Sewage	Software SW7074

204.5.3.6. If the equipment or piping being painted does not fall under any of these categories, the contractor shall make the best color match to the materials being replaced and adjacent like materials after submittal of color selection for acceptance.

204.5.3.7. PEW System specific requirements: All PEW System piping, valves, supports, operators, couplings and miscellaneous shall be color coded and marked as follows.

a. Color Coding: Topcoat shall be Purple (Pantone 522) per the Oklahoma Department of Environmental Quality (DEQ) Title 252, Chapter 656, Section 252:656-27-4. In addition, piping shall have orange bands that are six (6) inches wide and spaced along the pipe at five (5) foot intervals.

b. Lettering: The following language: "CAUTION: RECLAIMED WATER-DO NOT DRINK." shall be provided on the pipe near the equipment served, adjacent to valves, at each branch or tee, and at least every 50 feet in straight runs of pipe and be per Department of Environmental Quality (DEQ) Title 252, Chapter 656, Section 252:656-27-4. Lettering shall be painted or stenciled on piping or shall be applied as snap-on markers. Snap-on markers shall be plastic sleeves, Brady "Bradysnap-On B-915" or Seton "Setmark" Lettering shall be white. Reference Table 1 for lettering size requirements.

c. Flow Arrows: PEW System piping shall not have flow arrows.

204.5.3.8 After painting, any labeling or tags covered by the paint shall be re-applied, updated or uncovered such that all labels are readable and clearly identifies the system. In the event of new piping or equipment replacing piping or equipment with labeling, the new equipment shall be labeled to match the existing. Marking and signage shall be applied once area painting is complete as part of the schedule of value item.

204.5.3.9 Equipment supplied from the manufacturer with an epoxy coating or manufactured from a corrosion resistant material (stainless steel, etc…) shall not be painted/coated after installation.

204.5.3.10 Factory applied epoxy coating systems shall be in the following thicknesses unless noted otherwise per Manufacturer's recommendations:

a.	Primer Coat	*3.0 to 5.0 mils
b.	Finish Coat	*4.0 to 6.0 mils

*Note – Per Manufacturers Recommendations.

204.6 Concrete Coating

204.6.1 Materials: Concrete coating shall be Sikagard 62, Raven 405, Sauereisen SewerGard No. 210, or an approved equal to protect concrete and concrete repairs from H_2S and other corrosive elements found in wastewater process facilities. Epoxy coating to be applied according to the manufacturer's installation instructions and shall extend beyond repair areas by a minimum of 6". All concrete coating products shall be handled and stored in the manner set forth in the manufacturer's installation instructions.

The Contractor shall coordinate and provide an independent testing service or Manufacture's Representative to conduct an overcoat analysis testing report and top coat compatibility testing prior to finalizing product selection and submission. The written report shall be included in the submittal process for areas of new work and would include sufficient number of testing locations for inspection certification of all areas of the contract new work.

204.6.2 Surface Preparation: Concrete surfaces to receive coating shall be inspected prior to surface preparation to determine the condition of the surfaces specified to receive the coating product(s) and the appropriate method or combination of methods to be used for surface preparation to meet the requirements of the coating system(s) to be applied per manufacturer's instructions. The Contactor shall bid the specified product(s) and, if a compatibility issue is found. The Manufacture will provide additional recommendations for the application and environment during the submittal process. Special attention during the Mandatory prebid meeting shall be taken by the Contractor and their subcontractors to inspect and observe the existing concrete corrosion resistant coating, if any.

204.6.2.1 Oils, grease, incompatible existing coatings, waxes, form release, curing compounds, efflorescence, sealers, salts, or other contaminants which may affect the performance and adhesion of the coating to the substrate shall be removed per ASTM D-4258.

204.6.2.2 Incidental to this contract, every effort shall be made to minimize voids or holidays, providing a uniform coating thickeness and coating thin areas by this contract to comply with Manufacturers recommended requirements. Concrete fins, protrusions, burrs, sharp edges, surface debris, existing coating(s) and concrete spatter shall be corrected by grinding or scraping on both new and existing concrete surfaces. Contract document plan sheets indicate areas of new concrete and existing concrete coating application areas.

204.6.2.3 Unless otherwise submitted and approved by the Engineer, surfaces to receive coating shall be abrasive blasted per ASTM D-4259 to remove laitance and weak concrete to expose subsurface voids, open honeycomb and air pockets. Concrete substrate shall receive a surface profile matching or exceeding the Manufacturer requirements. Prior to blasting, existing concrete as indicated on the contract plans sheets may require physical abrasive tool or bush hammer preparations over the entire surfaces to provide and prove the stable substrate as part of the new work. After blasting, surfaces shall be cleaned of all loose blast grit, dust and other debris by sweeping, vacuuming, air blasting and washing as necessary.

A fully prepared surface meeting the Manufacturers requirements shall be provided, including but not limited to surface preparations, mechanical rubbing/surfacing or grouted surface ("surfacer/primer") to comply with the Manufacturer substrate is incidental to the new coating system scope. A mortar slurry fully rubbed surface or concrete repairs of the wall is not allowed unless specifically recommended by the Manufacturer and approved by the Engineer as part of the new work. Surfacer or grouting for the Manufacturer's requirements may include bug holes, chipped small voids, light honeycomb, cleaning edges, form "fins" or other small imperfections in concrete surfaces as required for the new coating system

installation. Additionally, preparations may also include preparations of the existing coating systems for the new system. For structural concrete repairs, see plan sheet details and applicable bid items.

204.6.2.4 Surface preparation method(s) used shall be performed in a manner that provides a uniform, sound clean neutralized surface suitable for the specified coating product(s).

204.6.2.5 Infiltration shall be stopped by using a material which is compatible with the repair products and is suitable for top coating with the coating product(s). The Contactor shall bid the specified product(s) and, if a compatibility issue is found. The Manufacture will provide additional recommendations for the application and environment during the submittal process.

204.6.2.6 Where defective concrete is encountered requiring repair at the direction of the Engineer refer to Specification Section 204.7 Concrete Rehabilitation for requirements. Concrete rehabilitation areas are defined by the direction of the Engineer for building back of the concrete to an original finished surface if required, a new finished surface if required or areas defined as concrete rehabilitation as shown on the plan sheets and/or by specific bid item for such concrete or structural repairs. **All other surface preparations required for coatings are incidental to the new coating system.**

204.6.3 Application of coating products: Application procedures shall conform to the recommendations of the coating product(s) manufacturer, including environmental controls, product handling, mixing, application equipment and methods.

204.6.3.1 Prepared surfaces shall be primed by application of the waterborne epoxy primer described herein at an application rate of 200 square feet per gallon (8 mils wet film thickness). The primer shall be allowed to dry to a tack free state. The solvent-free epoxy topcoat described herein shall then be spray applied to a minimum wet film thickness of 80-100 mils.

204.6.3.2 No more than 12 hours shall be permitted to pass between each application of the waterborne epoxy, the solvent-free epoxy primer and the epoxy topcoat. Subsequent top coating or additional coats of the coating product(s) shall occur within the products recoat window as adjusted for temperature extremes. Additional surface preparation procedures will be required if this recoat window is exceeded.

204.6.3.3 Coating product(s) shall interface with adjoining construction materials throughout the structure to effectively seal and protect concrete substrates from infiltration and attack by corrosive elements. Procedures and materials necessary to affect this interface shall be as recommended by the coating product(s) manufacturer.

204.6.4 Submittals: The Contractor shall submit the following to the Engineer, in accordance with this Specification:

- Product data sheets and installation procedures for proposed concrete repair mortar(s).

- Detailed design notes, calculations and Shop Drawings for any temporary works, including formwork and falsework.

204.7 Concrete Rehabilitation

204.7.1 Description: The Work shall consist of:

- Removing the deteriorated concrete as shown and described on the Drawings and in this Specification, including saw cutting the perimeter of the repair area.
- Preparing the surface of the concrete for the repair, including abrasive cleaning, cleaning of existing reinforcement, and applying bonding agent to prepared reinforcement and concrete surface bonding agent as required by Manufacturers systems. Minimum exposed reinforcement rehabilitation would include sand blasted SSPC-SP 5 white metal blast cleaning and

coated with (green) epoxy reinforcement repair coating system unless specifically required otherwise.

- Supplying materials and the mixing and placing of concrete repair mortar or concrete as shown and described on the Drawings and in this Specification including vibrating, finishing and curing.
- Supplying, fabricating, constructing, maintaining and removing temporary works, including falsework and formwork.

204.7.2 Submittals: The Contractor shall submit the following to the Engineer, in accordance with this Specification:

- Product data sheets and installation procedures for proposed concrete repair mortar(s).

- Detailed design notes, calculations and Shop Drawings for any temporary works, including formwork and falsework.

204.7.3 Materials: The Contractor shall supply all materials necessary for the repair and restoration of deteriorated concrete areas as follows:

204.7.3.1 Acceptable Manufacturers:

a. Sika MonoTop 611, as manufactured by Sika Corporation, Lyndhurst, New Jersey, and Quadex QM-1s Restore, as manufactured by Quadex, North Little Rock Arkansas, are considered to conform to the requirements of this specification and has performed satisfactorily for patching or overlaying for a minimum of three years.

   Sauereisen and other Manufacturers may require specific sub-straight and patching requirements specific system(s) pending submittal approval process.

b. Substitutions: The use of other than the specified product will be considered providing the contractor requests its use in writing to the Engineer. This request shall be accompanied by:

- A certificate of compliance from an approved independent testing laboratory that the proposed substitute product meets or exceeds the specified performance criteria, tested in accordance with the specified test standards; and
- Documented proof that the proposed substitute product has a three year proven record of performance of patching or overlaying, confirmed by actual field tests and five successful installations that the Engineer can investigate.

Certification from the manufacturer demonstrating compliance with the ISO 9000 quality standard in the development, manufacture, and sale of the product.

204.7.3.2 Performance Criteria Typical Technical Data

a. Typical Properties of the mixed polymer-modified portland cement mortar:
   - Working Time: approximately 30 minutes
   - Finishing Time: 30-60 minutes
   - Color: concrete gray

b. Typical Properties of the cured polymer-modified portland cement mortar:
   - Compressive Strength (ASTM C-109)
     - 1 day: 3,000 psi
     - 7 day: 5,500 psi
     - 28 day: 6,500 psi
   - Splitting Tensile Strength (ASTM C-496) at 28 days: 500 psi
   - Flexural Strength (Modulus of Rupture) (ASTM C-78) at 28 days: 720 psi
   - Bond Strength (ASTM C-882 Modified) at 28 days: 2200 psi
   - Chloride ion permeability (AASHTO T-277): < 600 coulombs
   - The silica fume, polymer-modified portland cement mortar shall not produce a vapor barrier.

204.7.3.3 Materials

a. Silica-fume, Polymer-modified portland cement mortar:

- The mortar shall be a silica fume-enhanced, polymer-modified composition containing a blend of selected cements, plasticizing/water-reducing admixtures and shrinkage compensating agents.
- The material shall be non-combustible, either before or after cure.
- The silica fume, polymer-modified portland cement mortar shall be supplied in a factory proportioned unit.
- The silica fume, polymer-modified portland cement mortar must be placeable from 3 inches in depth and extendable in greater depths.

b. To prepare the silica fume, polymer-modified portland cement concrete (for pumping): the factory proportioned unit maybe extended with 34-36 lbs. of a minus 1⁄4 in. clean, well-graded, saturated surface dry aggregate, having low absorption and high density. Aggregate shall conform to ASTM C-33.

c. Materials for forming, as required for the designated work, shall be approved by the Engineer.

204.7.4 Construction Methods

204.7.4.1 Surface Preparation Prior to any concrete repairs, the Contractor shall remove all dust, dirt, water and debris from the surface of the concrete in a manner that will not result in the material being deposited into the channel or onto the underlying ground surface below. The Contractor shall supply and erect appropriate protection barriers/shrouding or other approved means as required on the bridge deck or piers so as to completely contain all loose or flying debris from the surface removal preparations. The means of containment shall be subject to the approval of the Engineer. No

debris shall fall into the channel or onto any underlying roadway or ground surfaces.

204.7.4.2 Concrete Removal All areas of unsound concrete to be repaired will be marked by the Engineer once the Contractor has cleaned the existing surface as per Section 204.6.2 of this Specification. The Contractor shall saw cut the outer perimeter of the repair areas 1" deep or as directed by the Engineer. Feathered edges will not be acceptable. The Contractor shall take care to ensure that the existing reinforcing steel or prestressing strands (if applicable) are not damaged during saw cutting. Any damage caused by the Contractor to any portion of the structure not intended for repair shall be repaired by the Contractor, at the Contractor's expense, to the satisfaction of the Engineer. The Contractor shall remove all areas of unsound concrete by chipping or other approved methods. Only chipping hammers of the 20 lb class or less shall be used, and operated at an angle of 45 degrees or less from the horizontal. The Contractor shall exercise caution and take care not to damage any existing reinforcing steel intended to remain in place.

204.7.4.3 Types of Repairs Concrete repairs will be classified as follows:

a. Type A Partial Depth Concrete Repair – A Type A repair is defined as removal of unsound concrete to a depth not greater than the top of the existing reinforcing steel. The Contractor shall remove all unsound concrete from the areas as determined by the Engineer until a sound concrete substrate is exposed.

b. Type B Partial Depth Concrete Repair – A Type B repair shall be defined as removal of unsound concrete to a depth a minimum of 1" beyond the existing outer mat of reinforcing steel. For substructure, girder or mass concrete repairs the maximum depth shall be 2" beyond the existing outer mat of reinforcing steel or as directed by the Engineer. For slab repairs the maximum depth shall be mid depth of the slab.

204.7.4.4 The Contractor shall supply and place additional reinforcing steel as directed by the Engineer when the existing reinforcing steel has a section loss of 25% or greater. The reinforcing steel shall be of the same type and size as the existing, and spliced with a minimum lap length of 30 bar diameters. Exposed reinforcing steel shall be sandblasted clean and maintained to a near white condition. The Contractor shall roughen all areas of the existing sound concrete substrate to a ¼" amplitude using methods acceptable to the Engineer. All resulting material and by-products from demolition operations shall be collected, loaded, hauled, and disposed of by the Contractor at an approved waste disposal facility. Costs for reinforcing steel shall be considered incidental and included in other portions of the work.

204.7.4.5 Surface Preparation Immediately prior to placing the repair mortar or concrete, the Contractor shall thoroughly clean the existing concrete surfaces and formed repair areas, and apply a low resistivity bonding agent or cement slurry as recommended by the repair mortar manufacturer or as directed by the Engineer.

204.7.4.6 Repair Mortar Placement and Finishing The concrete repair mortar shall be handled, stored, mixed and applied in accordance with the manufacturer's instructions. Immediately prior to placing the repair mortar, the Contractor shall thoroughly clean the existing concrete surfaces and formed repair areas, and apply a low resistivity bonding agent or cement slurry as recommended by the repair mortar manufacturer or as directed by the Engineer. The Contractor shall place the repair mortar such that the existing profile and cross section are restored to their original dimensions. Any deviations of ¼" or greater from the repaired areas to the existing surface shall be repaired by the Contractor at his expense to the satisfaction of the Engineer. If the existing or repair concrete surface is damaged in any way by construction operations, or if the concrete repair shows signs of distress or scaling prior to final acceptance, it shall be repaired or replaced by the Contractor at his own expense. The Contractor shall finish the repair surface in accordance with the concrete coating manufacturer's requirements.

204.7.4.7 Curing shall be in accordance with the manufacturer's instructions or as otherwise directed by the Engineer.

204.7.5 Quality Management

204.7.5.1 General Concrete repair mortar that is not stored, handled, prepared, placed, or cured in accordance with the manufacturer's instructions will be rejected by the Engineer and his/her decision shall be considered final. The Engineer reserves the right to require immediate removal of any concrete from rejected batches that may have already been placed in the structure. Quality assurance testing will be carried out by the Engineer and all associated costs will be paid for by the Owner. There shall be no charge to the Owner for materials taken by the Engineer for testing purposes.

204.7.6 Method of Measurement

204.7.6.1 Concrete Repairs Concrete repairs will be measured on a surface area basis. The area to be paid for will be the total number of square feet of concrete repaired in accordance with this specification as computed from measurements made by the Engineer.

204.7.7 Basis of Payment

2.4.7.7.1 Type A Partial Depth Concrete Repair – Type A Partial depth concrete repairs will be paid for at the Contract Unit Price per square foot for "Type A Partial Depth Concrete Repair", measured as specified herein, which price will be payment in full for performing all operations herein described and all other items incidental to the Work.

204.7.7.2 Type B Partial Depth Concrete Repair – Type B Partial depth concrete repairs will be paid for at the Contract Unit Price per square foot for "Type B Partial Depth Concrete Repair", measured as specified herein, which price will be payment in full for performing all operations herein described and all other items incidental to the Work.

END OF SECTION

PART 1 - GENERAL

1.1 STANDARDS

A. Concrete work shall conform to all requirements of ACI 301-89 "Specifications for Structural Concrete for Buildings", ACI 350 "Code Requirements for Environmental Engineering Concrete Structures", ACI 318-89 "Building Code Requirements for Reinforced Concrete" except as modified herein.

B. All referenced standards shall be the latest editions.

1.2 SCOPE

A. Work consists of furnishing all plant, labor, materials, equipment and appliances, and performing all operations in connection with installation of the concrete work, complete, in strict accordance with the Specifications and Drawings.

1.3 INSPECTION

A. Embedded items must be inspected and tests for concrete and other materials shall have been completed and approved by the Engineer before concrete is placed.

1.4 SLAB ON EARTH

A. Before proceeding to construct concrete slabs on earth, all pipes under concrete floor on earth shall have received the required tests. All backfill and fill material under slabs on grade shall be compacted in 6" layers to 95% maximum density as measured by AASHTO T99 test method. Unsuitable material encountered in subgrade shall be removed and replaced with material approved by the Engineer. Subgrade shall be brought to true, even plane and compacted to solid bearing. Gravel drainage fill shall be placed and compacted where shown on Drawings.

PART 2 - MATERIALS

2.1 All concrete materials shall conform to the latest revised ASTM Designations listed below and shall be subject to the approval of the Engineer:

A. Coarse Aggregate shall be crushed stone conforming to ASTM C-33 with a maximum size of 1".

B. Fine Aggregate shall conform to ASTM C-33 and shall be washed river sand composed of clean, uncoated grains of strong materials.

C. Cement shall be Portland cement conforming to ASTM Specification C-150, Type V. Only one brand of cement shall be used for exposed concrete.

D. Water: Clean, fresh and free from oil, acids, alkali, vegetable, sewage, organic or other deleterious matter.

E. Air-Entraining Admixtures shall conform to ASTM C-260.

G. Premolded Expansion Joint Filler Strips shall be non-extruding type conforming to the current AASHTO Designation M213.

H. Non-Shrink Grout shall be Pre-mixed "Embeco" as manufactured by Master Builder's, "Ferrolith G" as manufactured by Sonneborn-Contech, or approved equal. Type as recommended by the manufacturer for the particular applications.

I. Liquid Curing Compound/Sealer shall be "MC 429" as manufactured by Master Builder's, "Kure-N-Seal" as manufactured by Sonneborn-Contech, "Thompson's Water Seal" as manufactured by E. A. Thompson, Inc. or approved equal.

J. Granular Drainage Fill: Required under all interior building concrete slabs on grade and where noted on the drawings. It shall be either:

1. Clean, washed gravel with particle sizes grading from maximum of 1" down to not more than 5% passing a No. 4 sieve.

2. Clean, washed coarse sand with particular sizes ranging from pea gravel down to largest grains permitted in concrete sand.

K. Joint Waterproofing for existing structures or as required on the plans shall be Ironite (Metallic) Waterproofing as manufactured by the Ironite Company of Chicago, Illinois or approved equal.

L. Vapor Barrier required under all interior concrete slabs on grade and where noted in drawings shall be polyethylene sheet, 6 mil thickness conforming to ASTM E-154.

M. Liquid Chemical Hardener shall be the magnesium fluosilicate and zinc fluosilicate type "Lapidolith" as manufactured by Sonneborn-Contech, Inc., "Symons Quad Cure" as manufactured by Symons Corp., "Hornolith" as manufactured by W. R. Grace & Co., or approved equal.

N. Cementitious Waterproofing and Finish Compound shall be "Thoroseal Plaster Mix" with "Acryl 60" as manufactured by Standard Dry Wall Products or equal.

2.2 QUALITY AND CONTROL

A. Design

Concrete shall be composed of Portland cement, fine aggregate, coarse aggregate and water. All concrete shall be designed by an independent testing laboratory, approved by the Engineer, in accordance with the A.C.I. Standard "Recommended Practice for Selecting Proportions for Concrete" (ACI 211) to produce the strength for each class of concrete specified, and with slumps and maximum sizes of coarse aggregate in accordance with the requirements outlined below. The concrete shall be so designed that the concrete materials will not segregate and excessive bleeding will not occur. Submit laboratory trial mix designs and test results for each class of concrete to be used to the Engineer for approval before any concrete is placed. Any costs of the testing laboratory for designing concrete mixes shall be borne by the Contractor. Concrete strengths shall be as follows:

Class A Concrete - 4000 psi minimum @ 28 days (Air entrained) - six (6) sacks cement minimum

Class B Concrete - 3000 psi @ 28 days - five (5) sacks cement minimum

Class C Concrete - 2000 psi @ 28 days

Class D Concrete - 3000 psi @ 28 days (3/8" Max. Aggregate Size "Pea Gravel")

MAXIMUM SLUMPS FOR VARIOUS
TYPES OF CONSTRUCTION

Types of Construction	Hand Placed Maximum	High Frequency Vibrator Used - Maximum
Reinforced Foundation, Footings and Base Slabs of Tanks	5"	3"
Slabs, Beams and Reinforced Walls	6"	5"
Building Columns	6"	5"
Pavements, curb and sidewalks	3"	3"

The slump shall not exceed the maximum specified above for the type of construction for which it is to be used. The 28 day compressive strength determined in accordance with current ASTM Specifications C-39 and C-31 and with specimens cured in accordance with C-31 shall not be less than that shown above for the specified class of concrete. No water will be added after the amount specified by the mix design.

B. Production of Concrete

All ready-mix concrete shall be batched, mixed and transported in accordance with "Specifications for Ready-Mixed Concrete (ASTM C-94)". Plant equipment and facilities shall conform to the "Check List for Certification of Ready-Mixed Concrete Production Facilities" of the National Ready-Mixed Concrete Association. Site mixed concrete shall conform to the requirements of "Specifications for Structural Concrete" (ACI 301). The Contractor may elect to use either ready-mixed or site mixed concrete for this project provided he informs the Engineer of his choice.

C. Laboratory Testing

The Owner shall engage an independent testing laboratory to conduct concrete tests. Contractor will be responsible for sampling concrete for test cylinders, recording, and delivering them to the laboratory, providing all materials required, and for making all slump tests in the field directed by the Engineer. All costs in connection with work performed by the laboratory will be paid by the Owner. The Contractor shall be responsible for the costs of work performed by the laboratory required for redesign of concrete proportions and additional testing of in place concrete when cylinders indicate

low strength concrete has occurred.

At least one test shall be made on fresh concrete for each one hundred (100) cu. yds. of each class of concrete (or fraction thereof) placed on any one day and in any event, not less than one test for each class of concrete each day it is used. Testing shall be done in accordance with the following ASTM Specifications, latest edition:

C172- Standard Method of Sampling Fresh Concrete

C31 - Standard Method of Making and Curing Concrete Compression and Flexure Test Specimens in the Field

C39 - Standard Method of Test of Compressive Strength of Molded Concrete Cylinders

C143- Standard Method of Slump Test for Consistency of Portland Cement Concrete

Before any concrete is poured, the Contractor shall construct a storage box in accordance with ASTM Specification C31. Each set of tests shall consist of one slump test and four compression test cylinders. All cylinders shall be kept in the storage box for the first 24 hours. The four cylinders shall be laboratory cured and tested for adequacy of the design for strength of the concrete in accordance with ASTM Specification C31. One cylinder shall be tested at 7 days and two at 28 days.

The fourth cylinder will be retained for subsequent testing if required by the Engineer.

D. Failure of Concrete to Meet Strength Requirements: The concrete shall be considered acceptable if, for any one class of concrete, the average of all tests of any five consecutive sets is equal to or greater than the specified strength, provided that no more than one test in ten falls between 90% and 100% of the specified strength. The only cylinders to be used for determination of concrete acceptability will be those laboratory cured and tested at 28 days. When it appears the tests of laboratory-cured cylinders will fail to meet these requirements, the Engineer may require changes in the proportions of concrete for the remainder of the work in order to meet the strength requirements. In addition, the Engineer may also require additional curing on portions of the concrete already poured.

The Engineer may also require tests in accordance with Methods of Securing, Preparing

and Testing Specimen from Hardened Concrete for Compressive and Flexural Strengths (ASTM Specifications C42) when the concrete cylinder tests fail to meet strength requirements. In the event there still is question as to the quality of the concrete in the structure, the Engineer may require load tests for that portion where the questionable concrete has been placed. Such load tests will be made as outlined in American Concrete Institute Building Code, (ACI 318), and shall be at the expense of the Contractor. In-place testing shall be at the expense of the Contractor.

E. Removal of Under Strength Concrete: If the above tests indicate that a particular batch of previously placed concrete is under strength, the Engineer may direct that the under strength batch be removed and replaced. The removal of the under strength concrete shall also include the removal of concrete that has obtained the required strength if the Engineer deems this necessary to obtain structural or visible continuity when the concrete is replaced.

The removal, and replacement of any under strength concrete, shall be made at no additional cost to the Owner. This shall include any new formwork required or any reinforcing steel that may be required. The Owner shall not be charged any additional costs for any extra work that is required because of the failure of any concrete to meet the minimum test requirements.

F. Concrete Strengths: The various strengths of concrete shall be installed as follows:

1. Class A, 4000 psi, Air-Entrained shall be used for all liquid containing and non-liquid containing structures, (footings, driveways, slabs, walls, columns and roofs.)

2. Class B, 3000 psi shall be used for sidewalks, curbs and thrust blocking.

3. Class C, 2000 psi shall be used for all non-structural fill concrete, mud slabs, over excavation concrete and other selective backfill conditions as approved by the Engineer.

4. Class D, 3000 psi pea gravel concrete (maximum aggregate size of 3/8") shall be used for all masonry fill, masonry columns cells, and masonry bond beams.

PART 3 - INSTALLATION

3.1 PREPARATION BEFORE PLACING

A. Water shall be removed from excavations before concrete is deposited. Hardened concrete, wood chips, shavings, and other debris shall be removed from interior of forms and inner surfaces of mixing and conveying equipment. Wood forms shall be oiled or, except in freezing weather, wetted with water in advance of pouring. Reinforcement shall be secured in position, inspected and approved by the Engineer before starting pouring of concrete.

3.2 CONVEYING

A. Concrete shall be conveyed from mixer to forms as rapidly as practicable and by methods, which will prevent segregation or loss of ingredients. It shall be deposited as nearly as practicable in its final position. Chutes used shall be such that concrete slides in them and does not flow. Chutes, if permitted, shall have a slope of less than 1 on 2. Where a vertical drop greater than five (5) feet is necessary, placement shall be through elephant trunks or similar devices to prevent segregation. Ready-mixed concrete shall be delivered with a load ticket showing mix proportions and the time mixing began for each load. The load ticket shall be furnished to the Engineer.

3.3 PLACING

A. Concrete shall be placed before initial set has occurred and in no event after it has contained its water content for more than 30 minutes for site mixed concrete or 1 hour for ready-mixed concrete. Unless otherwise specified, all concrete shall be placed upon clean, damp surfaces free from running water, or upon properly consolidated fills, but never upon soft mud or dry, porous earth. Deposit concrete continuously or in layers of such thickness that no concrete will be placed on concrete which has hardened sufficiently to cause the formation of seams or planes of weakness within the section.

B. If a section cannot be placed continuously, provide construction joints as herein specified. The concrete shall be compacted and worked in an approved manner into all corners and angles of the forms and around reinforcement and embedded fixtures as to prevent segregation of the coarse aggregate. Construction of forms for the lifts of vertical walls shall be such as to make all parts of the walls easily accessible for the placement, spading, and consolidation of the concrete as specified herein.

C. No "finished water" shall be surface applied during finishing efforts.

D. Curing methods shall be submitted to the Engineer and applied per manufacture's recommendations.

3.4 VIBRATION

A. All concrete shall be placed with the aid of mechanical vibration equipment as approved by the Engineer. Vibration shall be transmitted directly to the concrete; in no case shall it be transmitted through forms. The duration of vibration at any location in the forms shall be held to the minimum necessary to produce thorough compaction. Vibrations shall be supplemented by forking or spading by hand, and adjacent to the forms on exposed faces in order to secure smooth, dense and even surfaces, with particular care being taken to prevent coarse aggregate from becoming set too near any surfaces that are to receive rubbed finish.

3.5 CONSTRUCTION JOINTS

A. Construction joints shall be formed as indicated on the drawings or as approved or directed by the Engineer. Contractor shall submit a joint location plan for each structure to the Engineer for approval 28 days prior to commencing concrete operations on that structure. Where indicated or required, dowel rods shall be used. All concrete at the joints shall have been in place not less than 12 hours, and longer if so directed by the Engineer, before concrete resting thereon is placed. Before placing is resumed, or commenced, excess water and laitance shall be removed, and concrete shall be cut away, where necessary, to insure a strong dense concrete at the joint. In order to secure adequate bond, the surface of concrete already in place shall be cleaned, roughened, and then spread with a one-half (½) inch layer of mortar of the same cement-sand ratio as is used in the concrete, immediately before the new concrete is deposited. The unit of operation is not to exceed 40 feet in any horizontal direction, unless otherwise required by the Drawings. Construction joints, if required, shall be located near the mid-point spans for slabs, beams or girders. Joints in columns or piers shall be made at the underside of the deepest beam or girder at least five (5) hours before any overhead work is placed thereon. Joints not shown or specified shall be so located as to least impair strength and appearance of work. Vertical joints in wall footings shall be reduced to a minimum. Placement of concrete shall be at such a rate that surfaces of concrete not

carried to joint levels will not have attained initial set before additional concrete is placed thereon.

B. Girders, beams and slabs shall be placed in one operation. To ensure a level straight joint in exposed vertical surfaces, a strip of dressed lumber may be tacked to the inside of the forms at the construction joint. The concrete shall be poured to a point one (1) inch above the underside of the strip. The strip shall be removed one (1) hour after concrete has been placed and any irregularities in the joint line leveled off with a wood float and all laitance removed. Waterstops shall be installed in all construction joints below grade or in liquid containing structures as noted on the Plans. Install as per SECTION 3.3, CONSTRUCTION JOINTS, EXPANSION JOINTS, & WATERSTOPS.

3.6 PATCHING

A. Any concrete which is not formed as shown on the Plans, or for any reason is out of alignment or level or shows a defective surface shall be considered as not conforming with the intent of these Specifications and shall be removed from job by Contractor at his expense, unless the Engineer grants permission to patch defective area, which shall be done in accordance with the following procedure. Permission to patch any such area shall not be considered a waiver of the Engineer's right to require complete removal of defective work if patching does not, in his opinion, satisfactorily restore quality and appearance of surface. Suitable non-shrink, latex or epoxy mortar shall be used for patching and repairing defective surface if permitted by the Engineer.

B. After removing forms, all concrete surfaces shall be inspected and any poor joints, voids, stone pockets, all tie holes, or other defective areas shall be patched, if permitted by the Engineer. Where necessary, defective areas shall be chipped away to a depth of not less than one (1) inch with edges perpendicular to the surface. Area to be patched and a space at least six (6) inches wide entirely surrounding it shall be wetted to prevent absorption of water from the patching mortar. A grout of equal parts Portland cement and sand, with sufficient water to produce a brushing consistency, shall then be well brushed into the surface followed immediately by the patching mortar. The patch shall be made of the same material and of approximately the same proportions and shall not be richer than 1 part cement to 3 parts sand. White Portland cement shall be substituted for a part of the gray Portland cement to match color of the surrounding concrete. The proportion of white and gray cements shall be determined by making a trail patch. The amount of mixing water shall be as little as consistent with the requirements of handling and placing.

The mortar shall be retempered without the addition of water by allowing it to stand for a period of one (1) hour during which time it shall be mixed occasionally with a trowel to prevent setting.

C. The mortar shall be thoroughly compacted into place and screened off so as to leave patch slightly higher than surrounding surface. It shall then be left undisturbed for a period of 1 to 2 hours to permit initial shrinkage before being finally finished. The patch shall be finished in such a manner as to match the adjoining surface. On surfaces where unlined forms have been used, the final finish shall be obtained by striking off the surface with a straightedge spanning the patch and held parallel to the direction of the form marks.

D. Tie holes left by withdrawal of rods or the holes left by removal of ends of ties shall be filled solid with non-shrink grout after first being thoroughly wetted within 7 days of placement and prior to any area backfill.

3.7 SLAB FINISHES

A. Exterior Concrete Walks:

After thoroughly consolidating the concrete the top surface shall be struck off with a straight edge and tamped or vibrated sufficiently to bring mortar to the surface. Finish with a wood float to a smooth, even surface and lightly broomed to provide "slip resistant" surface. Edges shall be rounded with a 1/4" radius.

B. Interior slabs to receive grout fill or mortar setting bed shall be finished by tamping concrete with special tools to force coarse aggregate below the surface, and screened with straightedges to bring surface to finish plane with a tolerance not exceeding 1/8" in 2 feet. Surface shall be left roughened sufficiently to produce good bond with topping material. Use stiff brushes, brooms or rakes as necessary to provide 1/8 inch deep grooves at maximum of ½ inch on center.

C. Top and bottom slabs of all structures and water carrying conduits except as noted otherwise on the Plans shall be finished as follows: The top of the slab shall be screened to grade and cross section; lightly tamped as required to bring up a good bed of mortar for finishing and re-screened as necessary. The surface shall then be finished with a wood float and leveling darby. No further finish will be required on top slabs of structures

or conduits, which are to be buried. In the case of all exposed top slabs of structures and conduits, they shall be given a final wood float and a lightly broomed, slip resistant finish to a uniform surface, which conforms with accuracy to required shape, slope and grade. Slabs shall be edged as appropriate. No liquid hardener is to be applied to these surfaces.

D. Interior floor slabs that are not to receive any finish floor covering shall be "slip resistant finish" as follows: The top surface shall be steel troweled and have a final finish applied by brushing lightly with a soft bristle brush to form a slightly roughened surface.

E. Liquid Hardener shall be applied to the floors where scheduled to be exposed concrete. Concrete surfaces to be treated must be thoroughly set and dry, clean and free of dust. Three applications of the liquid hardener are required, using one gallon per 100 square feet for the complete treatment. Apply hardener strictly according to the manufacturer's printed instructions. Liquid floor hardener is not required when a minimum of two (2) coats of Thompson's Waterseal or equal has been used as a curing and/or separating compound. Submit material and method to be used for Engineer's approval.

3.8 FINISH OTHER THAN SLABS

A. All top surfaces, other than slabs, not covered by forms, and which are not to be covered by additional concrete or fill shall receive a wood float finish without additional mortar. Care shall be taken that no excess water is present when the finish is made. Other surfaces shall be brought to finished elevations and left true and regular. All exposed top surface interior concrete shall be grouted smooth and given a cement wash of one part light colored Portland cement and two parts fine aggregate mixed with water to consistency of thick paint. Grout shall be cork or wood floated to fill all pits, air bubbles, and surface holes. Excess grout shall be scraped off with a trowel and rubbed with burlap to remove any visible grout film. Surface shall be kept damp during setting period. The finish for any area shall be completed in the same day and the limits of a finished area shall be made at natural breaks in finished surface. Painting of exposed-to-view concrete surfaces is specified under SECTION 9.1 - PAINTING of these Specifications.

B. Rubbed Finish:

Unless otherwise indicated, all faces (except top surfaces of slabs) exposed to view, such as walls, grade beams, columns, beams, walls of water carrying conduits to a point 1'-0"

below normal water level, canopy soffits and fascias, etc. shall be finished as follows:

Forms shall be removed, as specified in SECTION - CONCRETE FORMWORK, and all fins removed, off-sets leveled, damaged places and depressions resulting from the removal of metal ties or other causes shall be carefully pointed with a mortar of sand and cement in the proportion which has been employed for the particular class of concrete treated. The surface film of all such pointed places shall be carefully removed before setting occurs. After the point has set sufficiently to permit it, all exposed surfaces shall be dampened and rubbed with a No. 16 Carborundum stone, to a smooth even plane. Final rubbing shall be done with a No. 30 Carborundum stone, or an abrasive of equal quality, to obtain an entire surface of a smooth texture and uniformity in color. Mortar or grout worked up during rubbing shall be promptly removed by sacking with burlap or other suitable means so that no visible grout film or paste will remain. A cement wash or plaster coat shall not be used. All surfaces shall be finished uniformly smooth and washed clean. The rubbed finish for any area shall be completed in the same day and the limits of a finished area shall be made at natural breaks in the finished surface. If the Contractor does not provide suitable surface finish using Carborundum stones specified above, the Engineer, without additional cost to the Owner, may require the use of a power operated grinding machine or other methods to produce the desired finish.

C. Cementitious Waterproofing and Finish:

As an option to the rubbed finish, as specified herein, all faces (except top surfaces of slab) exposed to view, such as walls, grade beams, columns, beams, canopy soffits and facias, etc., shall be finished using "Thoroseal" coating or approved equal as described in the following paragraphs.

1. General

Forms shall be removed, as specified in SECTION 3.4 - CONCRETE FORMWORK, and all fins removed, off-sets leveled, damaged places and depressions resulting from the removal of metal ties or other causes shall be carefully pointed with a mortar of sand and cement in proportion which has been employed for the particular class of concrete treated. The surface film of all such pointed places shall be carefully removed before setting occurs. After the point has set sufficiently to permit it, all exposed surfaces shall receive the following treatment.

2. Mixing

Thoroseal plaster mix shall be prepared using a solution composed of not less than one part Acryl 60 (approximately two quarts Acryl 60 per bag) and three parts of clean, potable water (for ceilings, use 1 part Acryl 60 to 2-1/2 parts of the water). This solution shall then be added to the Thoroseal plaster mix slowly in sufficient quantity so that the mixture is the consistency of a heavy batter suitable for application by method specified. Color to be selected by the Owner.

3. Application

At Contractor's option, one of the following methods of application shall be selected:

a. Sprayed-on finish should be applied with plaster-type spray gun, not high pressure paint type. Spray on evenly distributed coat of Thoroseal plaster mix. To spot-fill deep holes, float or brush first coat before starting second spray application.

Thoroseal plaster mix shall be applied on average surfaces in two coats at the rate of 5 to 6 lbs. per square yard for concrete walls, 6 to 9 lbs. per square yard for masonry walls; but sufficient material shall be applied to fill all holes and voids.

b. Trowel and float finish - Apply light trowel coat of Thoroseal plaster mix over entire surface to be treated. The workman shall make sure the material is firmly pressed into all voids and leveled. Allow this coat to cure thoroughly before applying the regular trowel application. When surface is set so it will not roll or lift, float uniformly using a sponge float.

Thoroseal plaster mix shall be applied on average surfaces at the rate of 4 to 6 lbs. per square yard for concrete walls, 6 to 9 lbs. for masonry walls. If concrete is rough or untrue, 6 to 9 lbs. per square yard may be required, but sufficient material shall be applied to fill and seal all pores and voids. This application will be approximately 1/8" thick. Leveling uneven surfaces will require more material per square yard.

To prevent shadowing of struck or deep masonry joints, or areas of unequal absorption (like some form marks), after key coat has cured for 5 days, apply a light trowel coat of Thoroseal plaster mix with Acryl 60 in the mixing water over the entire surface to be treated. Allow this coat to set thoroughly before applying the regular trowel application as outlined above.

Do not apply when temperatures are 40ºF or due to fall below 40ºF within 24 hours or to frozen or frost-filled surfaces.

3.9 CURING

A. General - Immediately following placing, all Class A and Class B concrete shall be protected from premature drying, hot and cold temperatures, rain, flowing water and mechanical injury. Maintain above 50ºF and in moist condition for at least seven (7) days after placing for normal concrete and three (3) days for high early strength concrete. Comply with "Recommended Practice for Curing Concrete" ACI 308, unless otherwise indicated. Curing compound of satisfactory composition and characteristics may be used except on surfaces to which new concrete is to be bonded or surfaces scheduled to be painted or to receive other coating and provided such compound does not stain or discolor any surface which will be exposed. Cure formed concrete surfaces, including undersides of beams, supported slabs and other similar surfaces by moist curing with forms in place for full curing period or until forms are removed. If forms are removed, continue curing by methods specified above, as applicable.

B. Cold Weather Procedures - Protect concrete work from physical damage or reduced strength, which could be caused by frost, freezing actions, or low temperatures, in compliance with ACI 306, "Cold Weather Concreting", and as herein specified.

1. When air temperature has fallen to or is expected to fall below 40ºF, uniformly heat water and aggregates before mixing as required to obtain a concrete mixture temperature of not less than 55ºF, and not more than 80ºF at point of placement.

2. Do not use frozen materials or materials containing ice, frost or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.

3. Do not use calcium chloride, salt and other materials containing antifreeze agents or chemical accelerators, unless otherwise accepted in mix designs.

4. Contractor shall obtain and keep on the Project site a copy of the current edition of ACI 306, "Recommended Practice for Cold Weather Concreting", for reference during all concrete operations in cold weather.

C. Hot Weather Procedures:

When hot weather conditions exist that would seriously impair the quality and strength of concrete, place concrete in compliance with ACI 305, "Hot Weather Concreting", and as herein specified.

1. Cool ingredients before mixing to maintain concrete temperature at time of placement below 90ºF. Mixing water may be chilled, or chopped ice may be used to control the concrete temperature provided the water equivalent of the ice is calculated to the total amount of mixing.

2. Cover reinforcing steel with water-soaked burlap if it becomes too hot, so that the steel temperature will not exceed the ambient air temperature immediately before embedment in concrete.

3. Wet forms thoroughly before placing concrete.

4. Do not use retarding admixtures unless otherwise accepted in mix designs.

5. Contractor shall obtain and keep on the project site a copy of ACI 305R, "Hot Weather Concreting" for reference during all concreting operations in hot weather.

D. Protection from the Sun:

All concrete shall be adequately protected from injurious action of sun in a manner satisfactory to the Engineer.

E. Temperature Control:

During and at the conclusion of the specified curing period, means shall be provided to ensure that the temperature of the air immediately adjacent to the concrete does not fall more than 3ºF in any 1 hour nor more than 30ºF in any 24 hours.

3.10 NON-SHRINKING GROUT

A. Where non-shrinking grout is called for on the Plan, it shall be mixed in strict accordance with the manufacturer's directions. It shall be of a type as recommended by the manufacturer for the particular application.

END OF SECTION

PART 1 – GENERAL

1.1 SCOPE

A. The extent of concrete reinforcement is shown on the drawings and in schedules.

B. The work includes fabrication and placement of reinforcement for cast-in-place concrete, including bars, welded wire fabric, ties and supports.

1.2 QUALITY ASSURANCE

A. Codes and Standards:

Comply with requirements of the latest edition of the following codes and standards, except as herein modified:

American Welding Society (AWS), AWS D1.4 "Recommended Practices for Welding Reinforcing Steel, Metal Inserts and Connections in Reinforced Concrete Construction".

Concrete Reinforcing Steel Institute (CRSI), "Manual of Standard Practice". (Current Ed.)

American Concrete Institute (ACI), ACI 318 "Building Code Requirements for Reinforced Concrete".

American Concrete Institute (ACI), ACI 350 "Code Requirements for Environmental Engineering Concrete Structures

B. Submittals:

Mill Certificates; Concrete Reinforcement: Submit steel producer's certificates of mill analysis, tensile and bend tests for reinforcing steel.

Shop Drawings: Reinforcing number, sizes, spacing dimensions, configurations, locations, mark numbers, lap splice lengths, concrete cover and reinforcing supports. Sufficient reinforcing details to permit installation of reinforcing without reference to contract drawings.

1.3 DELIVERY, HANDLING AND STORAGE

A. Deliver reinforcement to the project site bundled, tagged and marked. Use metal tags indicating bar size, lengths, and other information corresponding to markings shown on placement diagrams.

B. Store concrete reinforcement materials at the site to prevent damage and accumulation of dirt or excessive rust.

1.4 MATERIALS

A. Steel reinforcement shall conform to the "Specification for Deformed Billet Steel Bars for Concrete Reinforcement," ASTM A615, Grade 60.

B. Wire fabric reinforcement shall conform to the current "Specifications for Welded Steel Wire Fabric for Concrete Reinforcement," ASTM A-185, or "Specifications for Welded Deformed Steel Wire Fabric for Concrete Reinforcement," ASTM A-497.

C. Supports for Reinforcement shall be bolsters, chairs, spacers and other devices for spacing, supporting and fastening reinforcement in place. Use only wire bar type supports complying with CRSI recommendations, unless otherwise indicated. Do not use wood, brick, and other unacceptable materials.

1.5 SPLICES

A. No splices of bars, except when shown on the Plans, will be permitted without the approval of the Engineer. Minimum lap splice shall be 48 bar diameters unless specifically detailed or noted otherwise on drawings. Splices in adjacent bars shall be staggered a minimum distance equal to the lap splice length. Bars shall be rigidly clamped or wired at all splices in a manner approved by the Engineer. Welding may not be used except with the specific approval of the Engineer. Welding, when approved, shall conform to the AWS D1.4. Welded wire fabric shall be lap spliced a minimum of 2 inches plus the wire spacing at edge laps and end laps.

1.6 DETAILING & FABRICATION

A. Furnish Shop Detail and Field Placing Drawings for all reinforcing steel for approval of the Engineer. Shop Drawings shall include reinforcing, placing plans and details indicating size, location, arrangement, splice locations, bending diagrams, placing sequence, etc. Placing Drawings shall be in sufficient detail to allow field personnel to accurately place reinforcing. Shop and Placing Drawings shall be prepared in accordance with "Manual of Standard Practice for Detailing Reinforced Concrete Structures" ACI 315, current edition. Photographic copies of engineering drawings shall not be used as placing drawings.

B. Reinforcement bars shall be bent cold to the shapes indicated on the Plans. Fabrication tolerances, fabrication, and detailing of steel reinforcement shall conform to the "Manual of Standard Practice for Detailing Reinforced Concrete Structures" (ACI-315).

C. Steel reinforcement shall be of the type and size, cut to lengths and bent to shapes as indicated on the Plans. Unless otherwise indicated, hooks, lap splices, embedment lengths, and other details of reinforcement shall be provided as set forth in the ACI Building Code (ACI 318) to develop the full tensile strength of the bar.

1.7 PLACING REINFORCEMENT

A. All reinforcement at the time concrete is placed shall be free from mud, oil, paint, excessive rust and excessive mill scale or any other coating that would destroy or reduce its bond with the concrete.

B. All reinforcement shall be secured in place true to lines and grades indicated by use of metal or concrete supports, spacers, or ties as approved by the Engineer. The bars and mesh shall be tightly secured against displacement by ties of annealed wire, or suitable clips at intersections. Wall reinforcement shall be supported and held securely against displacement in its proper position clear of the forms as indicated on the Plans. Placing tolerance shall conform to ACI 318.

C. Nails shall not be driven into the wall forms to support reinforcement nor shall any other device used for this purpose come in contact with the form on the liquid side of any liquid containing structure. Metal devices used to provide the required clear distances from reinforcing steel to liquid side of concrete surfaces shall be galvanized, or shall be as approved by the Engineer.

D. The main reinforcement of slabs in contact with the ground shall be supported in its proper position, as indicated on the Plans, by means of precast cement mortar blocks, of approved dimensions, resting on the slabs' subbase. Such precast blocks shall be made of mortar composed of 1 part cement to 2 parts sand and shall have a loop of No. 16 black annealed wire cast into each block. The length of the wire loop shall be sufficient to allow the block to be tied to the reinforcement. Blocks shall be spaced at the intervals required to maintain the reinforcement in its required position in the slab during the placing of the concrete. The slab reinforcement shall not be used to support planking or runways used in placing concrete.

E. Bending of bars embedded in hardened concrete will not be permitted except when specifically approved by the Engineer for the field condition encountered. Field cutting of bars will only be permitted when specifically approved by the Engineer.

F. In the case of exposed finish surfaces of floor slabs, galleries, deck slabs, and beams, metal chairs, spacers and other metal accessories necessary to provide the required clear distances and proper alignment and spacing between bars shall be galvanized or shall have plastic protective covering over portions in contact with forms.

1.8 CONCRETE PROTECTION FOR REINFORCEMENT

A. Steel reinforcement shall be placed and held in position so that the concrete cover, as measured from the surface of the bar shall be the following, except as otherwise shown, on the drawings:

1. Slabs:

1½ inches, in general, top and bottom.
1½ inches at surfaces troweled as floor finish, walkway, or driveway.
2 inches on bottom for slabs over water and where exposed to the weather.

2. Footings:

2 inches at top of footings.
3 inches at bottom, sides, and end of footings.

3. Walls:

   2 inches on surfaces against earth.
   1½ inches on interior surfaces.
   2 inches on interior surfaces contacting water.

4. Beams and Girders in Contact with Water:

   2 inch minimum to stirrup steel.
   2½ inch minimum to main longitudinal steel.

5. Columns:

   2 inches, in general, to main vertical reinforcement.
   2½ inches, to main reinforcement on surfaces in contact with water.

6. Beams and Girders: General:

   1½ inch minimum to stirrup steel.
   2 inches minimum to longitudinal steel.

END OF SECTION

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Construction joints, expansion joints, and the placing of waterstops where such are indicated on the plans.

B. Construction joints shall be of the type indicated on the drawings and shall be located as shown on the plans unless otherwise approved by the Engineer. Contractor shall submit a joint location plan as specified in 204.8 CAST IN PLACE CONCRETE.

1.2 WATERSTOPS

A. Waterstops shall be installed in construction joints as required by the Plans. All waterstops shall be continuous throughout their length.

B. The waterstops shall be heavy duty polyvinyl waterstop conforming to Corps of Engineers Specification CRD-C-572, latest edition, as manufactured by Serviced Products Division of W.R. Grace and Company: Vinylstops by Sonneborn- Contech; Sealtight Duo-PVC Waterstops by W. R. Meadows, Inc.; Vinylex Corporation; "labyrinth" waterstop, Type B-2 as manufactured by Water Seals, Inc.; or an approved equal of the same type and material and approximately equal in dimensions and weight but not necessarily of exactly the same shape. Waterstops shall be of the size and type designated on the Plans.

C. "Rib Type" waterstops shall be of ribbed construction with a center bulb, 5" wide, capable of resisting a maximum pressure load of 65 feet of water.

D. All waterstops shall be installed so that one-half its width will be embedded on one side of the joint and one-half on the other. The Contractor shall employ a method of holding the waterstop in position for the first pour that is satisfactory to the Engineer. The method selected must ensure that the waterstop will be held securely in true vertical or horizontal position and in straight alignment in the joint.

E. Care shall be exercised to ensure that the waterstop is completely encompassed in good mortar.

F. Preformed Plastic Waterstops:

Preformed Plastic Waterstop, when approved by the Engineer, shall meet or exceed all requirements of Federal Specifications SS-S-00210, "Sealing Compound, Preformed Plastic for Expansion Joints", Type I or Type II. Such plastic waterstop shall be equal to SYNKO-FLEX as manufactured by Synko-Flex Products Company, Houston, Texas, or "CenSeal GS-231" by Concrete Sealants, Inc., New Carlisle, Ohio and shall meet the following requirements:

The plastic waterstop shall be produced from blends of refined hydrocarbon resins and plasticizing compounds reinforced with inert mineral filler, and shall contain no solvents, irritating fumes or obnoxious odors. The plastic waterstop shall not depend on oxidizing, evaporating or chemical action for its adhesive or cohesive strength. It shall be supplied in extruded form of suitable cross-section and of a size to seal the joint areas of concrete sections. The plastic waterstop shall be protected by a suitable removable two-piece wrapper. The two-piece wrapper shall be so designed that one-half may be removed longitudinally without disturbing the other half, to facilitate application of the sealing compound.

1.3 JOINTS IN WATERSTOPS

A. All waterstops shall be continuous and so joined at all points of contact in the same plane, or at intersections with waterstops in different planes, as to form a complete barrier to the passage of water through any construction or contraction joint.

B. Joints in the waterstops, whether made for the purpose of continuity in a straight strip or for the purpose of securing a watertight junction between strips in different planes, shall be made by heat welding as hereinafter specified.

C. Joints in PVC waterstops shall be made by heating the two surfaces to be jointed until the material has softened to the point where it is just short of being fluid and then bringing the two softened surfaces together with a slight rubbing motion followed by firmly pressing them together so that a solid and tight bond is made.

D. The joints in strips of waterstop made in the above manner shall be such that the entire cross section of the joint shall be dense, homogeneous and free of all porosity. All finished joints shall have a tensile strength of not less than 75 percent of the material of the strip as extruded.

E. The heating of the surfaces to be joined shall be done by means of an electric splicing iron designed for the specified purpose and controlled by means of a voltage regulator.

F. In use, the heat of the hot plate shall be so regulated as to prevent too rapid melting and accompanying charring of the waterstop material.

G. The use of makeshift hot plates will not be permitted nor will other means of heating the strips to be joined be allowed except in a case of emergency, as determined by the Engineer.

H. The Contractor shall provide such jigs as will assist in making the joints in a proper and workmanlike manner and in holding the strips so that the alignment of jointed strips is correct and angles are true to those required.

I. Prior to embedment all joints in the waterstop strips will be inspected by the Engineer and any found defective shall be remedied without delay.

1.4 PROTECTION OF WATERSTOP BETWEEN POURS

A. The Contractor shall take such steps as are necessary to protect exposed waterstops in the interim period between concrete pours. This would include damage from construction equipment, tools and concrete "slobbers". In the event the waterstop receives small amounts of construction debris and/or concrete "slobbers" while concrete is "green", the Contractor shall fully clean waterstop directly following the stripping of formwork and prior to the placement of future reinforcement.

1.5 EXPANSION JOINTS

A. Expansion joints of the size and type shown on the plans, or specified herein, shall be placed in concrete pavement or structure as shown on the plans.

1. Materials:

a. Preformed Asphalt Fiber Joint Material

Asphalt fiber sheet filler shall consist of preformed strips of inert material impregnated with asphalt. It shall be of the thickness shown on the Plans or indicated in these Specifications.

The sheet filler shall conform to the requirements of AASHTO Specification M-213 with the following additional provisions.

The sheet filler shall be of such character that it will not be deformed by ordinary handling during hot weather nor become hard and brittle in cold weather. It shall be of a tough, resilient, durable material not affected by weathering.

b. Hot Poured Rubberized Tar Joint Sealer

Hot poured rubberized mastic joint sealer shall consist of a mixture of durable, elastic rubber, coal tar pitch and other materials which will form a resilient and adhesive compound capable of effectively sealing concrete joint surfaces against repeated expansion and contraction. The material shall be installed in accordance with the manufacturer's directions. Hot poured tar sealer shall be used for pavement and sidewalk expansion joints.

B. Joint Surface Preparation:

1. Clean joint surfaces immediately before installation of sealant or caulking compound. Remove dirt, insecure coatings, moisture and other substances which would interfere with bond of sealant or caulking compound.

2. For all sealants, do not proceed with installation of sealant over joint surfaces which have been painted, lacquered, waterproofed or treated with water repellent

or other treatment or coating unless a laboratory test for durability (adhesion), in compliance with Paragraph 4.3.9 of FS TT-S-00227, has successfully demonstrated that sealant bond is not impaired by coating or treatment. If laboratory test has not been performed, or shows bond interference, remove coating or treatment from joint surfaces before installing sealant.

3. Etch concrete and masonry joint surfaces to remove excess alkalinity, unless sealant manufacturer's printed instructions indicate that alkalinity does not interfere with sealant bond and performance. Etch with 5% solution of muriatic acid; neutralize with diluted ammonia solution, rinse thoroughly with water and allow to dry before sealant installation.

C. Installation:

1. Comply with sealant manufacturer's printed instructions except where more stringent requirements are shown or specified and except where manufacturer's technical representative directs otherwise.

2. Prime or seal joint surfaces where shown or recommended by sealant manufacturer. Do not allow primer/sealer to spill or migrate onto adjoining surfaces.

3. Employ only proven installation techniques, which will ensure that sealants will be deposited in uniform, continuous ribbons without gaps or air pockets, with complete "wetting" of joint bond surfaces equally on opposite sides. Except as otherwise indicated, fill sealant rabbet to a slightly concave surface, slightly below adjoining surfaces. Where horizontal joints are between a horizontal surface and a vertical surface, fill joint to form a slight cove, so that joint will not trap moisture and dirt.

4. Install sealants to depths as shown or, if not shown, as recommended by sealant manufacturer but within the following general limitations, measured at center (thin) section of bead.

5. For sidewalks, pavements and similar joints sealed with elastomeric sealants and

subject to traffic and other abrasion and indentation exposures, fill joints to a depth equal to 75% of joint width, and neither more than 5/8" deep nor less than 3/8" deep.

6. For normal moving joints sealed with elastomeric sealants, but not subject to traffic, fill joints to a depth equal to 50% of joint width, but neither more than ½" deep nor less than 1/4" deep.

7. Do not allow sealants or compounds to overflow or spill onto adjoining surfaces, or to migrate into voids of adjoining surfaces. Use masking tape or other precautionary devices to prevent staining of adjoining surfaces, by either primer/sealer or the sealant.

8. Remove excess and spillage of compounds promptly as the work progresses. Clean adjoining surfaces by whatever means may be necessary to eliminate evidence of spillage, without damage to adjoining surfaces or finishes.

9. Placement of expansion joint material shall fully cover joint area(s) between concrete placements. No gaps or joint material opens which permit fresh concrete to flow to existing concrete surface will be allowed.

D. Cure and Protection

1. Cure sealants in compliance with manufacturer's instructions and recommendations, to obtain high early bond strength, internal cohesive strength and surface durability. Do not cure in a manner which would significantly alter material's modules of elasticity or other characteristics.

2. Installer shall advise Contractor of procedures required for curing and protection of sealants during construction period, so that they will be without deterioration or damage (other than normal wear and weathering) at time of Owner's acceptance.

END OF SECTION

PART 1 - GENERAL

1.1 SCOPE

A. Work in this section includes all labor, plant and material necessary to furnish and install all concrete formwork required by the project. Concrete formwork shall conform to all requirements of current editions of ACI 301 "Specifications for Structural Concrete for Buildings" and ACI 318 "Building Code Requirements for Reinforced Concrete" and ACI 347 "Recommended Practice for Concrete Formwork" and ACI 350 "Code Requirements for Environmental Engineering Structures" except as modified herein.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Forms shall be of wood, metal, highly water resistant plywood, or other material approved by the Engineer. Forms for sections greater than 18" thick shall be of wood. Form surfaces shall be smooth and free from irregularities, dents, sags, or holes when used for permanently exposed surfaces. Bolts and rods used for internal ties shall be so arranged that, when the forms are removed, all metal will not be less than two (2) inches from any concrete surface. Wire ties will not be permitted where concrete surface will be exposed to weathering, and discoloration would be objectionable. Exposed concrete shall have approved form liners of Masonite or plywood, or shall be constructed of smooth surfaced plywood.

B. Corner forms forming 3/4 inch chamfers or as otherwise specified on plans, shall be used on all outside corners that are to be exposed in the finished structure. Chamfer forms shall be of molded plastic or polyvinyl chloride chamfer strips. Use one style of form throughout the project. The type to be used shall be submitted to the Engineer for approval.

C. Rustication and Score Line Strips shall be a non-absorbent material such as extruded polyvinyl chloride, plastic, fiberglass or metal or they may be milled from a good quality lumber and well sealed to prevent moisture absorption, wood strips may not have protruding splinters which may become embedded in the concrete. Sealing wood shall be accomplished by emersion or brushing on two coats of form coating.

D. Form Ties for concrete shall have an approved waterstop barrier to prevent seepage of moisture along the ties. The ends of the metal after breaking off shall be minimum of 2 inches from the finished wall face. Submit samples to the Engineer for review. All temporary tie components of tie system shall be removed from placement once placement is completed and prior to backfilling. Non-shrink grout shall be placed at all voids created by ties.

E. Form Coatings: Provide commercial formulation form-coating compounds that will not bond with, stain, nor adversely affect concrete surfaces, and will not impair subsequent treatment of concrete surfaces requiring bond or adhesion, nor impede the wetting of surfaces to be cured with water or curing compounds.

F. Cylindrical Columns and Supports: Form round-section members with paper or fiber tubes, constructed of laminated plies using water-resistant type adhesive with wax-impregnated exterior for weather and moisture protection. Provide units with sufficient wall thickness to resist loads imposed by wet concrete without deformation.

G. Inserts: Provide metal inserts, anchor bolts and other embedded items for anchorage of materials or equipment to concrete construction, not supplied by other trades and as required for the work.

H. Provide sheet metal reglets formed of the same type and gauge as the flashing metal to be built into the reglets, unless otherwise indicated. Where resilient or elastomeric sheet flashing or bituminous membranes are terminated in reglets, provide reglets of not less than 26 gauge galvanized sheet steel. Fill reglet or cover face opening to prevent intrusion of concrete or debris.

I. Side forms of footings may be omitted and concrete placed directly against excavation only when requested by Contractor and accepted by Engineer. When forms are omitted, provide additional concrete required beyond the minimum design profiles and dimensions of the footings as indicated to provide minimum concrete coverage for reinforcement. Contractor shall maintain the earth form to proper alignment with no sloughing of material into the minimum design profile shown on the drawings.

J. Dovetail Anchor Slots at surfaces to receive masonry veneer to be Heckman #100 or equal.

K. Formwork used for exposed finished concrete surface placements shall be in like new condition and designed to provide flat and true surfaces.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Design and engineering of formwork, shoring and reshoring as well as its construction is the responsibility of the contractor. Design formwork for loads, lateral pressures and allowable stresses outlined in ACI 347R and for design considerations, wind loads, allowable stresses and other applicable requirements of the controlling local Building Code. Where conflicts occur between these two standards, the more stringent requirements shall govern.

B. Forms shall be built true to line and grade, and be mortartight and sufficiently rigid to prevent displacement or sagging between supports. All formwork and shoring shall be designed for the construction loads to be placed on them, and the design and construction of said forms shall be in accordance with ACI Standard "Recommended Practice for Concrete Formwork" (ACI 347). The structural adequacy of the formwork shall rest with the Contractor. All forms shall be so constructed that they can be removed without hammering or prying against the concrete.

C. Before concrete placement check the lines and levels of erected formwork. Make corrections and adjustments to ensure proper size and location of concrete members and stability of forming systems.

D. During concrete placement check formwork and related supports to ensure that forms are not displaced and that completed work will be within specified tolerances.

E. Provide temporary openings in wall forms, columns forms and at other locations necessary to permit inspection and clean-out.

3.2 EMBEDDED ITEMS

A. Before placing concrete, care shall be taken to determine that any embedded metal or wood parts are firmly and securely fastened in their correct location as indicated. Use setting drawings, diagrams, instruction and directions provided by suppliers of items

attached thereto. They shall be thoroughly clean and free from coating, rust, scale, oil, or any foreign matter. Embedding of wood in concrete shall be avoided whenever possible, metal being used instead. If wood is allowed, it shall be thoroughly wetted before concrete is placed.

B. All aluminum embedded items shall be coated with epoxy paint where in contact with concrete.

3.3 FORM REMOVAL

A. Forms shall not be removed without approval of the Engineer. Forms shall not be removed before the minimum times given below, or longer if job control tests indicate the concrete has not attained strength specified below, except when specifically authorized by the Engineer.

Beams and Slabs	14 days or proof of strength requirements met.
Walls up to 12" Thick and Vertical Surfaces	1 day if minimum daily temperature is above 50°F, 3 days otherwise
Columns	5 days or proof of strength requirements met.
Walls greater than 12" Thick	3 days if minimum daily temperature is above 50°F with proof of strength requirements met, 7 days otherwise.

B. In general, forms or shores for supported slabs and beams shall not be removed until the concrete, so supported, has acquired 70% of its design strength; except where loads other than the dead weight of the concrete are added, the shores shall not be removed until 24 hours after the concrete has obtained 90% of its design strength. Forms shall be removed immediately after expiration of the lapsed times specified above or sooner, if required by the Engineer, where concrete is to receive a rubbed finish.

END OF SECTION

I. CARPENTRY

A. SUMMARY

This Section includes the following:

Framing with dimension lumber.

Wood grounds, nailers, and blocking.

Wood furring.

Sheathing.

Underlayment.

B. SUBMITTALS

1. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.

    a. Product data for the following products:

    Underlayment.

    Insulating sheathing.

    Air infiltration barrier.

    Metal framing anchors

    Construction adhesives.

    b. Material certificates for dimensional lumber specified to comply with minimum allowable unit stresses. Indicate species and grade selected for each use as well as design values approved by the Board of Review of American Lumber Standards Committee.

    c. Wood treatment data as follows including chemical treatment manufacturer's instructions for handling, storing, installation, and finishing of treated material:

    For each type of preservative treated wood product include certification by treating plant stating type of preservative solution and pressure process used, net amount of preservative retained, and compliance with applicable standards.

    For water-borne treated products include statement that moisture content of treated materials was reduced to levels indicated prior to shipment to product site.

    Warranty of chemical treatment manufacturer for each type of treatment.

C. QUALITY ASSURANCE

1. Single-Source Responsibility for Engineered Wood Products: Obtain each type of engineered wood products from one source from a single manufacturer.

D. DELIVERY, STORAGE AND HANDLING

1. Delivery and Storage: Keep materials under cover and dry. Protect against exposure to weather and contact with damp or wet surfaces. Stack lumber as well as plywood and other panels; provide for air circulation within and around stacks and under temporary coverings including polyethylene and similar materials.

   For lumber and plywood pressure treated with waterborne chemicals, place spacers between each bundle to provide air circulation.

E. LUMBER, GENERAL

1. Lumber Standards: Furnish lumber manufacture red to comply with PS 20 "American Softwood Lumber Standard" and with applicable grading rules of inspection agencies certified by American Lumber Standards Committee's (ALSC) Board of Review.

   Inspection Agencies: Inspection agencies and the abbreviations used to referenced them with lumber grades and species include the following:

   SPIB – Southern Pine Inspection Bureau.
   WCLIB – West Coast Lumber Inspection Bureau.
   WWPA – Western Wood Products Association.

   Grade Stamps: Provide lumber with each piece factory-marked with grade stamp of inspection agency evidencing compliance with grading rule requirements and identifying grading agency, grade, species, moisture content and at time of surfacing, and mill.

2. Nominal sizes are indicated, except as shown by detail dimensions. Provide actual sizes as required by PS 20, for moisture content specified for each use.

   Provide dressed lumber, S4S, unless otherwise indicated.

Provide lumber with 15 percent maximum moisture content at a time of dressing and shipment for sizes 2 inches or less in nominal thickness, unless otherwise indicated.

F. DIMENSION LUMBER

1. For light framing provide "Stud," "No. 2," lumber for stud framing (2 to 4 inches thick, 2 to 4 inches wide, 10 feet and shorter) and "Study" or "No. 2" grade for the light framing (2 to 4 inches thick, 2 to 6 inches wide), any species. Number #3 lumber is not acceptable for use as installed work in this project.

2. For structural framing (2 to 4 inches thick, 5 inches and wider), shall be No. 1 or No. 2 grade Southern Pine graded under SPIB rules. Structural framing shall be used for the bearing walls supporting the roof trusses.

G. MISCELLANEOUS LUMBER

Provide lumber for support or attachment of other construction including rooftop equipment curbs and support bases, cant strips, bucks, nailers, blocking, furring, grounds, stripping, and similar members. Fabricate miscellaneous lumber from dimension lumber of seizes indicated and into shapes shown.

Moisture content to be 19 percent maximum for lumber items not specified to receive wood preservative treatment and grade to be; "Standard" grade light-framing-size lumber of any species or board-size lumber as required. "No. 2 Common" grade boards per WCLIB or WWPA rules or "No. 2 Boards" per SPIB rules.

H. CONSTRUCTION PANELS, GENERAL

Construction Panel Standards: Comply with PS 1 "U.S. Product Standard for Construction and Industrial Plywood" for plywood construction panels and, for products not manufactured under PS 1 provisions, with APA PRP-108. Trademark: Furnish construction panels that are each factory-marked with APA trademark evidencing compliance with grade requirements.

I. CONCEALED PERFORMANCE-RATED CONSTRUCTION PANELS

Where construction panels are indicated for the following concealed types of applications, provide APA Performance-Rated Panels complying with the requirements designated under each application for grade designation, span rating, exposure durability classification, edge detail (where applicable), and thickness.

1. Wall Sheathing: APA RATED SHEATHING, Exterior Grade, thickness noted on drawings.

2. Roof Sheathing: APA RATED SHEATHING, Exterior Grade of thickness shown on drawings.

3. Plywood Backing Panels: For mounting electrical or telephone equipment, provide fire-retardant-treated plywood panels with grade designation, APA C-D PLUGGED EXPOSURE 1, in thickness indicated, or, if not otherwise indicated, not less than 15/32 inch.

J. FASTENERS

General: Provide fasteners of size and type indicated that comply with requirements specified in this article for material and manufacture.

Where rough carpentry is exposed to weather, in ground contact. Or in area of high relative humidity, provide fasteners with a hot-dip zinc coating per ASTM A 153 or of AISI Type 304 stainless steel.

Nails, Wire, Brads, and Staples: FS FF-N-105.

Power Driven Fasteners: National Evaluation Report NER-272.

Wood Screws: ANSI B18.61.

Lag Bolts: ANSI B18.2.1.

Bolts: Steel Bolts complying with ASTM A 307, Grade A; with ASTM A 563 hex nuts and where indicated, flat washers.

K. METAL FRAMING ANCHORS

General: Provide metal framing anchors of type, size, metal, and finish indicated that comply with requirements specified including the following:

Current Evaluation/Research Reports: Provide products for which model code evaluation/research reports exist that are acceptable to authorities having jurisdiction and that evidence compliance of metal framing anchors for application indicated with the building code in effect for this Project.

Allowable Design Loads: Provide products for which manufacturer publishes allowable design loads that are determined from empirical data or by rational engineering analysis and that are demonstrated by comprehensive testing performed by a qualified independent testing laboratory.

Galvanized Steel Sheet: Steel sheet zinc-coated by hot-dip process on continuous lines prior to fabrication to comply with ASTM A 525 for Coating Designation G60 and with ASTM A 446, Grade (structural quality); ASTM A 526 (commercial quality); or ASTM A 527 (lock-forming quality); as standard with manufacturer for type of anchor indicated.

L. PRESERVATIVE WOOD TREATMENT BY PRESSURE PRODUCTS

General: Where lumber or plywood is indicated as preservative-treated wood or is specified herein to be treated, comply with applicable requirements of AWPA Standards C2 (Lumber) and C9 (Plywood). Mark each treated item with the AWPB or SPIB Quality Mark Requirements.

Pressure-treat above-ground items with water-borne preservatives to a minimum retention of 0.25 pcf. For interior uses, after treatment, kiln-dry lumber and plywood to a maximum moisture content, respectively, of 19 percent and 15 percent. Treat indicated items and the following:

Wood cants, nailers, curbs, equipment support bases, blocking, stripping, and similar members in connection with roofing, flashing, vapor barriers, and waterproofing.

Wood sills, sleepers, blocking, furring, stripping, and similar concealed members in contact with masonry or concrete.

Wood framing members less than 18 inches above grade.

Wood floor plates installed over concrete slabs directly in contact with earth.

If cut after treatment, coat cut surfaces to comply with AWPA M4. Inspect each piece of lumber or plywood after drying and discard damaged or defective pieces.

M. INSTALLATION, GENERAL

Discard units of material with defects that impair quality of rough carpentry construction and that are too small to use in fabricating rough carpentry with minimum joints or optimum joint arrangement.

Set rough carpentry to required levels and lines, with members plumb and true to line and cut and fitted.

Fit rough carpentry to other construction; scribe and cope as required for accurate fit. Correlate location of furring, nailers, blocking, grounds, and similar supports to allow attachment of other construction.

Securely attach rough carpentry to substrate by anchoring and fastening as indicated.

Countersink nail heads on exposed carpentry work and fill holes.

Use common wire nails, unless otherwise indicated. Use finishing nails for finish work. Select fasteners of size that will not penetrate member where opposite site will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting of wood; predrill as required.

N. WOOD GROUNDS, NAILERS, BLOCKING, AND SLEEPERS

Install wood grounds, nailers, blocking, and sleepers where shown and where required for screeding or attachment of other work Form to shapes as shown and cut as required for true line and level of work to be attached. Coordinate location with other work involved.

Attach substrates as required to support applied loading. Countersink bolts and nuts flush with surfaces, unless otherwise indicated. Build into masonry during installation of masonry work. Where possible, anchor to formwork before concrete placement.

O. WOOD FRAMING, GENERAL

Framing Standard: Comply with N.F.P.A. "Manual for Wood Frame Construction," unless otherwise indicated.

Install framing members of size and spacing indicated.
Anchor and nail as shown, and to comply with the following:

National Evaluation Report No. NER-272 for pneumatic or mechanical driven staples, P-Nails, and allied fasteners.

Publish requirements of manufacturer of metal framing anchors.

"Recommended Nailing Schedule" of referenced framing standard and with N.F.P.A. "National Design Specification for Wood Construction."

"Table 2304.9.1 – Fastening Schedule," of the International Building Code.

Do not splice structural members between supports.

Firestop concealed spaces of wood framed walls and partitions at each floor level and at the ceiling line of the top story. Where firestops are not automatically provided by the framing system used, use closely fitted wood blocks of nominal 2-inch-thick lumber of the same width as framing members.

P. TERMITE CONTROL

New construction will require the foundation to be pre-treated for termites. If a soil treatment is used, it must be done after compaction. Disturbed areas must be re-treated. Forms and traps must be plastic or metal. A vapor barrier must be installed. Applications must be made within one foot of the foundation under adjoining slabs.

A licensed pest control contractor will be required to provide preventive treatment for termites. Preventative treatment must be provided by a registered pesticide approved by the local building officials. A certificate of pre-treatment will be presented to the Owner as part of the close-out documentation.

II. CAULKING

A. SCOPE

The work covered by this section includes the furnishing of all labor, materials and equipment for all caulking of doors, and for all joint sealants where required. All materials shall be brought on the job in labeled original containers and shall show quality, kind and manufacturer's name.

B. SUBMITTALS

Within sixty (60) days after award of Contract, and before any material are delivered to the job site, submit to the Engineer a complete list of all materials proposed to be furnished and installed under this portion of the work, making the submittal in accordance with the provisions of the General Conditions of these Specifications.

C. MATERIALS

Caulking Compound shall be an elastic waterproof acrylic latex caulking compound. Caulking compound shall be "Sonolac" as manufactured by Sonneborn Building Products Division, Contech, Inc., Minneapolis, Minnesota; "AC-20 Acrylic Latex" by Pecora Corp., Harleysville, Pennsylvania, or approved equal.

Color shall match adjacent work. Deliver caulking compound in manufacturer's original sealed containers.

Sealant: Polysulfide base sealant based on liquid polysulfide polymer manufactured by Thiokol Chemical Corporation, bearing Thiokol Chemical Corporation's "Tested and Approved Seal". Sealant shall be delivered to the job site in sealed containers, each bearing a "Tested and Approved" seal, manufacturer's name, and product designation. Sealant shall be two (2) part polysulfide base sealant conforming to Thiokol's Building Trade Performance Specification as follows:

- Class A (self-leveling) for joints in horizontal surfaces.
- Class B (non-sag) for joints in vertical surfaces.

Type I (Hardness: 20 35 Shore A) for caulking, glazing and sealing vertical surfaces and non traffic bearing horizontal surfaces.

Type II (Hardness: 35 45 Shore A) for caulking and sealing horizontal surfaces subject to foot and light vehicular traffic, or abrasion.

Thiokol shall be "Synthacaulk GC-5" by Pecora Corp., Harleysville, Pennsylvania; "Sonolastic Two Part" by Sonneborn Building Products Division, Contech, Inc., or approved equal. Color shall match the adjacent materials as closely as possible. Colors shall be selected by the Engineer. Where stock colors are not acceptable, special colors shall be prepared and furnished, as approved by the Engineer. Submit cured samples for Engineer's color selection.

Joint Filler: Back-up material for caulking and sealant shall be compressible in nature and shall have a proven record of compatibility with the sealant used. Glassyard, PVC, Butyl or neoprene rod is acceptable -- expanded polyethylene foam, polyurethane foam, and similar gas-expanded foams are not acceptable.

D. INSTALLATION

Location: Polysulfide sealant shall be used for caulking all exterior joints of any type and elsewhere as indicated. Elastic caulking may be used for interior joints not requiring polysulfied sealant. Set all exterior thresholds in caulking. Caulk all joints in masonry walls; between masonry and concrete intersections; around all windows, door frames, louvers, pipes and other penetrations through walls, floors, and ceilings; joints in metal panels, fascias, etc., and all other joints required for a weathertight and/or neat workmanlike installation.

Application: Thoroughly clean all surfaces to be caulked so they will be clean, free from loose dirt, grease, etc., and dry. Surfaces that are to be caulked with polysulfide sealant must first be cleaned with Methyl-Ethyl- Keytone in strict accordance with manufacturer's directions. Install joint filler back-up material to provide proper caulking depth to width ratio according to sealant manufacturer's recommendations. Apply caulking with a gun with proper size nozzle. Use sufficient pressure to fill all voids and joints solidly. Remove excess caulking and leave surfaces neat, even, smooth, and clean; free of sags, blisters and irregularities. Application shall be according to manufacturer's directions and at least three (3) weeks ahead of painting.

E. CLEAN-UP

Upon completion of the work, all caulking and sealing compounds shall be removed from surrounding areas and all joints checked for watertightness and touched up as required. It shall be the Contractor's responsibility to provide a weathertight building.

END OF SECTION

205 SUBMITTALS

All submittals shall be accompanied by a transmittal letter and/or cover letter that includes the project name, bid item information/number and submittal number, the contract specification number under which the equipment is being supplied, the Equipment ID number of the equipment being referenced, and the submittal revision number as appropriate.

205.1 Contractor shall submit, for each bid item, the manufacturer's instructions and recommendations for installation, for subsequent testing of the units, and for ensuring they are in proper operation. These instructions shall be part of these specifications and binding on the contractor.

205.2 Contractor shall include, for each bid item, a work plan acceptable to the Engineer describing the duration and sequence of work. Plan shall be approved prior to commencement of work. All work requiring flow stoppage or removing equipment from service must be scheduled 48 hours in advance with Plant Superintendent. When flow stoppage is required for equipment installation, contractor shall have all necessary materials at the installation site prior to any flow stoppage, and shall proceed with installation of equipment to minimize downtime.

205.3 Contractor shall, within 15 days of issuance of Work Order, submit four (4) copies of the following items for review and approval - one (1) copy to be returned to Contractor following review, two (3) copies to be retained by Authority. At the Authority's sole opinion, electronic submittals may be selected:

205.3.1 Product Data and Information: Submit catalog data including rating and descriptive literature of all components and systems for approval by Authority. This shall include items required by 204.

205.3.2 Itemized list with manufacturer's part numbers, part descriptions and a schedule of values (unit prices) for the equipment and materials proposed for each location. The SOV shall be approved by the authority and will be used as the basis of periodical pay applications by the Contractor.

205.3.3 Shop Drawings: Submit the following shop drawings for approval by Authority:

205.3.3.1 Bill of materials including manufacturers' name and catalog number

205.3.3.2 Outline drawing showing dimensions, arrangement, and

identification of components and nameplate schedule for all units

205.3.3.3 Individual schematic control diagrams for each unit.

205.3.3.4 Submittals should clearly identify items intended to be incorporated into the project. Mark or circle items clearly. Line through items or sizes that do not apply. Clearly identify where and what portion of the project the items are intended for use. Minimize "bundling" and separate important long lead time items out to coordinate and facilitate a review. Electrical and controls shall be submittal separately from related equipment.

205.3.4 Manufacturer's start up, certifications and training requirements:

Manufacture's certification that the equipment is suitable and will perform within specification and manufacturer's design operating parameters for the locations and conditions herein specified. Manufacture's services shall also include site visits by the Manufacture's *Technical Representative's* prior to construction, during installation and for start-up, as necessary for an inspection, detailed start up report and Manufacture's certification of proper installation. Submit the Manufactures start-up report(s) and certification(s) of proper installation when they become available to the Engineer and during the week the equipment being put into service. Included final copies of the Manufacture's Start-up Certificates in the final O&Ms. Start-up report/Manufacture's Certification should include pertinent start up details, inspection certifications, equipment description, location, project information, complete initial set points, initial operational readings, equipment numbers and date and other pertinent system information for future operations and maintenance.

Training shall also be provided for the equipment and systems installed. Submit a draft training agenda, draft handouts, power point/video and a Manufacture's Technical Representative's resume for acceptance prior to scheduling the start-up and training. Provide two separate training days, as coordinated with the Plant to accommodate both day and night shifts. The duration of the training should be a minimum of 4 hours per training day of classroom and field training or more, if recommended by

the Manufacturer. A professional video services shall also be provided to cover both complete class room and field training sessions. Deliverables are to Include; the full training video on DVD with the final O&Ms to the City. Provide additional standard Manufacturer's videos if available on the same DVD in the final O&M.

205.3.5 Safety Plan: This submittal will be checked for general conformance with Section 211 Safety requirements and applicable OSHA and local regulations. Notwithstanding, it is the Contractors responsibility to ensure that the plan is comprehensive and in full conformance with all applicable OSHA, federal, state and local regulations.

205.3.6 Work Plan: Submit for approval by Authority, the work plan clearly showing the work task sequencing plan and time requirements, including downtime durations. Draft work plans shall be submitted at least a month before any shut down or equipment being removed from service and provide opportunity for applicable coordination of the work. A time extension for additional contract time will not be granted for work not sufficiently planned and coordinated with the City and facility operations. This shall include items required by 204.

205.3.7 Submit for approval by Authority, plans and specifications for any concrete pad, support, piping, or other construction modifications from original installation.

205.3.8 Warranty Equipment Log: Submit a preliminary draft within 60 calendar days from the issuing of the Notice to Proceed. The blank template form will be provided by the Authority and is available upon request. A Warranty Equipment Log draft spreadsheet shall be built and completed by the Contractor with project equipment information and equipment numbers for review of the Authority. From that point on, the log will be updated each month by the Contractor and be a handout in the Monthly Meetings. Upon project completion, the spread sheet (Warranty Log) shall be completed with all required information such as equipment name, equipment tag name, equipment numbers, start-up dates, training dates, O&M dates and other relevant information and transmitted to the Owner for their future use in maintaining the equipment. *The warranty log will be used as the tool to establish and agree on the equipment warranty period start date(s).*

205.3.9 Schedule of values: Submit for approval by the Authority prior to and for the pay application process a proposal bid item based schedule of values with appropriate breakdowns. Contractor will be required to make appropriate and sufficient breakdown based on bid items, areas of work, scope, Subcontractor efforts and such relevant information that the pay application process can be reviewed more easily, as directed by the Authority.

205.4 Operations and Maintenance Manual Submittals and deliverables:

205.4.1 Contractor shall furnish to the Engineer one soft searchable PDF of a preliminary Operation and Maintenance Manual complete for each piece of equipment, item and associated control systems furnished and installed for review, similar to and following 250 Submittals requirements above. Preliminary Operation and Maintenance manual submittals much be a completed draft searchable and tabbed version.

205.4.2 Contractor shall furnish and transmit to the Authority **Two (2) bound hard copies of all final O & M manuals, four (4) USB flash drive/memory cards to the City with the final O&M manuals along with final completed submittals and transmit a final electronically of the final O&Ms by email link to the City/Engineer.** An O&M package is required for each equipment at each City facility of the project (even if the same equipment is being installed at different plants or facility's). The USB flash drive/memory card shall be formatted in matching O&Ms; searchable pdf, tabbed sections and shall include matching all printed material included in the hard copies. A separate pdf folder shall be created for each **Equipment** numbered piece of equipment, within which all files pertaining to that piece of equipment shall be located.

205.4.3 The following Contractor's pay application percentages apply to the project, which include completed documentation work and deliverables as applicable to each individual equipment on the Contractor's pay application schedule of value items (bid items) and as approved by the Engineer:

1) Any equipment payment item reaching 80% complete shall include: preliminary O&M manual submittal to the Engineer for approval with all the specified materials and contents per section 4.1, including the equipment summary sheet completed to extent possible. Submitted and approved preliminary O&Ms processed.

2) Any equipment payment item reaching 90% complete shall include: Equipment or system in functional service and Owner training completed.

3) Any equipment payment item reaching 100% complete shall include: Equipment fully in service, substantially completed, work scope completed completely and all SCADA - control functions working correctly and properly for an uninterrupted period of two weeks. Within 30 days after the Engineer's approval and Equipment being put in service, Contractor shall furnish to the Engineer the remaining four (4) hard copies of the final operations and maintenance manual and the three searchable tabbed PDF copies on CD/jump drives. Contractor shall submit any missing material for the manual prior to requesting certification of substantial completion on equipment with and requiring O&Ms, training and start-up. The last 10% of payment shall be for those items completed prior to applying for full payment of that item (100% payment).

205.4.4 Format and Contents: Each O & M manual shall include the following:

205.4.4.1 O&M Cover sheet. A standard Manufactures cover sheet may be used (as PDF), but it will need to be updated to include all of the following detail added to the cover sheet(s). See sample sheet included below.

a) Project Name

b) City project number and Contractor's contract number

c) Bid item number and specification number

d) Facility location

e) Equipment name

f) City's equipment number

g) Manufacture's name

h) Date of document (or installation)

{MANUFACTURER INFORMATION (Logo, etc.)}

{Name} OPERATION AND MAINTENANCE MANUAL

{Description of what is Included in O&M Manual}

To:
Project Contractor Name
Address
City, State Zip
Phone Number

Project Name and Location
PO#: (if applicable)

Manufacture Project Number (if applicable)

Submittal for fulfillment of specification section:
{Specification Section and Short Description}

Equipment List (if applicable)

Application	Type	Number	Equipment Tag #

Represented Locally By:
Supplier Name
Address
City, State Zip
Phone Number

Prepared By:
Manufacturer
Address
City, State Zip
Phone Number

Date

205.4.4.2 One copy of a completed **EQUIPMENT NAMEPLATE AND SUMMARY DATA** form as the first page with the O&M. And directly behind that sheet a single sheet with generic site plan showing where the equipment was installed, with call outs to the site name, building/facility name and relative installation location information.

205.4.4.3 One copy of the equipment Start-Up report, Inspection form and Manufacture's certification of proper installation as applicable. Report should be and include information from startup and being put into service by the Manufacturer's Technical Representative. Documents should also include all initial set points, settings and data that is adjustable for future reference.

205.4.4.4 Index for pages, sections or tags as required.

205.4.4.5 One copy of the manufacturer's operating and maintenance instructions. Operating instructions include equipment start-up, normal operation, shutdown, emergency operation and troubleshooting. Maintenance instructions include equipment installation, calibration and adjustment, preventive and repair maintenance, troubleshooting, parts list and recommended spare parts.

205.4.4.6 List of electrical relay settings and control and alarm contact settings or any other initial set points or operational levels/elevations. Provide plan sheet(s) as applicable.

205.4.4.7 Electrical interconnection wiring diagram for equipment furnished including all control and lighting systems

205.4.4.8 Record drawings showing as-built schematic control diagrams for each unit and one-line diagrams.

205.4.4.9 Cross-references where required between the appropriate sections of the Contractor's O&M manual and the manufacturers' manuals.

205.4.4.10 The Contractor shall provide all required warranty paperwork completed and filled in by the Contractor for the City's use. The completed warranty paperwork shall be specifically transmitted to the Plant Superintendent at time of start-up equipment being put into service and a separate copy be provided within the Final O&Ms also transmitted to the City. The warranty document shall specifically name the City/Authority.

205.5. Equipment Nameplate Information – Contractor shall, upon startup of each piece of equipment, complete the form, titled **EQUIPMENT NAMEPLATE AND SUMMARY DATA**, found at the end of this section, and shall include the completed form in the front of that equipment's respective O & M manual. The form shall be included with each O & M manual copy submitted. Equipment ID nameplate requirements are found in specification section 204.3.6 of these specifications. Equipment tagging shall be installed prior to start up, training and equipment substantial completion.

205.6 Submittals shall be sent to the following address:

Holloway, Updike and Bellen, Inc.

2001 N Willow Ave.

Broken Arrow, OK 74012

(918) 251-0717

EQUIPMENT NAMEPLATE AND SUMMARY DATA

Equipment Name/Facility Location: _____

Equipment Number: _____

Description (Include size): _____

Project #: _____

Spec. #: _____

Vendor: _____

Manufacturer: _____

Model #: _____

***Item or Drawing #** _____

***Serial #**: _____

Purchase Price: $_____

Date Placed in Service (for 1-yr Warranty): _____

Manufacturer's Warranty Period and End Date: _____

Parts / Associated Details: _____

_____

_____

Maintenance Schedule

(May be an attached sheet from O&M Manual; do not use "See O&M Manual")

- ✓ Initial: _____
- ✓ Weekly: _____
- ✓ Monthly: _____
- ✓ Semi-Annual: _____
- ✓ Annual: _____

Applicable Motor Information: N.A. (Circle if not applicable)

Vendor: _____

Manufacturer: _____

Model #: _____

Item #: _____

Serial #: _____

Frame: _____ Insul. Class: _____

Volts/Hz/Amps: _____

HP / RPM / SF: _____

Manufacturer's Warranty Period and End Date: _____

*__Item or Drawing #__ may not be unique. For example, it may be the same for a group of same size valves or gates, each one having this same number that is unique to the group. The __Serial #__ should be listed only when unique to this individual piece of equipment, otherwise it is N.A.

206 MONTHLY PROGRESS REPORTS AND PROGRESS MEETINGS

206.1 The Contractor shall submit monthly written project progress reports detailing the project's progress to date, problems encountered or anticipated which impact project schedule, and plans for the next two weeks' work.

206.2 Project progress reports shall be due as agreed upon during pre-work meeting.

206.3 Monthly progress meetings shall be scheduled on a weekday mutually agreeable to the Authority and the Contractor and shall be specified at the pre-work conference. The Contractor shall run the Monthly Meetings for the duration of the project and provide a meeting agenda including work completed, work planned, project, updated project schedule and other pertinent project status information.

206.4 The contractor shall submit a work progress and planned completion schedule for each bid item at the monthly progress meeting. The pre-work conference will constitute the first monthly progress meeting.

206.5 The Contractor shall maintain, update and submit an Equipment Log at each monthly meeting that lists each piece of equipment by Equipment ID number and lists Startup Date, Warranty Start Date and O&M Manual Submittal Date, among other project details. The spread sheet document shall be a shared document and submitted to the City at the end of the project for City's future use. A sample Equipment log is available upon request.

207 SECURITY

207.1 Each project site where work is to be performed under this Contract is a secured site. The Contractor shall be responsible for security as described in this section.

207.2 Site Access: The Contractor shall respect all existing security measures at each project site, and shall implement the following measures to apply to all work performed under this Contract. Coordination for Plant access and City of Tulsa security pass access will be required.

207.2.1 Work at both Northside and Southside shall be restricted to the hours defined by TMUA GC-19 unless otherwise authorized by the Plant Superintendent.

207.3 Common Requirements

207.3.1 Identification Badges: An Identification Badge, issued by the City of Tulsa Security Office, is required for the following people:

· The driver of each vehicle that will be entering the facility multiple times or on a regular basis.

· Sub-contractors and foremen that will be supervising other workers.

The Identification Badge also functions as an Access Card to allow access through the front gate of the facility. One year is the maximum time that an Access Card is active.

207.3.2 Contractor will coordinate with the Engineer to request Identification Badges. Application for an Identification Badge will require a background investigation. Each person that is applying for an Identification Badge will need to complete the following two (2) forms:

· City of Tulsa Access Card / Identification Card Request Form

· City of Tulsa Security, Background and Prescreen Investigation Form

A current soft copy of the forms can be obtained from the Engineer.

207.3.3 The Contractor will send the completed forms as required. Approved individuals will coordinate with the City of Tulsa Security Office to complete the process and obtain their Identification Badge.

207.3.4 The Contractor will coordinate with the Engineer to request reactivation of Access Cards. Reactivation may require re-application and additional background investigation.

207.4 Contractor shall maintain a log book listing as a minimum the names of all persons admitted to each secured site by the Contractor, the purpose of the site visit, the dates and times of arrival at the site, entry to the secured site, and departure from the site.

207.5 Contractor and Authority acknowledge that Contractor shall not solely be responsible for all secured access to the site, that City personnel will have access and will be performing their regular duties pertaining to the operation and maintenance of the site facilities, and that security at the site shall require the cooperation of all persons authorized to access the site for the performance of their work. To the extent the Contractor is responsible for and has control of secured access, Contractor shall restrict site access to only persons essential to the performance or inspection of the work being performed under this Contract.

207.6 Contractor shall provide Engineer twenty-four (24) hours advance notification of any delivery of equipment or materials to the site, and shall make arrangements with Engineer to provide for inspection of such delivery.

207.7 Any observation by the Contractor of activity at or associated with the project site that Contractor observes and considers to be unusual or suspicious in nature, or that Contractor believes poses a threat to the integrity or welfare of the project site or associated facilities, shall be duly noted at the time of the observation in the log book identified in item B above. Any such observation shall be immediately reported to the Engineer.

207.8 No statement pertaining to security in these Specifications shall constitute a contract between Contractor and Authority for the performance of security services.

208 SAFETY

208.1 Contractor shall be responsible for performing all work under this contract in a safe manner and in compliance with all applicable local, state, and federal safety and health regulations. All of the following requirements shall apply:

208.2 Contractor shall submit a site safety plan prior to start of work. Contractor's attention is directed to safety regulations applicable to the work under this contract, which include but are not limited to the following:

208.2.1 OSHA Standards 29CFR1910.147, the control of hazardous energy (Lockout/Tagout)

208.2.2 Fire Prevention and Protection: The Contractor shall take all necessary measures to prevent fire, and shall provide satisfactory firefighting means at the location of work.

208.2.3 Condition of Equipment and Materials: All equipment, tools, and appliances, and materials used in connection with the project shall be handled and operated only when they are in safe operating condition and in accordance with a standard safety procedure.

208.2.4 Confined Space Entry: Contractor shall determine if any work areas in this contract are considered permit spaces for entry, as defined in OSHA regulations, and shall perform all work so determined in accordance with all applicable state and federal labor, safety, and health regulations. The Contractor shall transmit with each pay application all the months copies of the Contractors confined space permits to the City and at the end of

the project with final pay application submittal a complete package of a copy of all the project's Contactor confined space permits.

208.2.5 Combustible - Explosive Atmospheres: Contractor shall determine if any work areas in this contract are considered combustible and explosive spaces for entry, as defined in OSHA regulations, and shall perform all work and employ equipment in accordance with all applicable state and federal labor, safety, and health regulations.

209 PROTECTION OF PROPERTY

209.1 The protection of City, State and Government equipment, fences, gates, signs, and other City property is of prime importance, and if damaged, destroyed or removed, they shall be repaired, replaced, or paid for by the Contractor. Disturbance to this property must first be approved by the agency which controls it.

209.2 No valve or other control on any utility main or building service line shall be operated for any purpose by the Contractor.

209.3 At places where the Contractor's operations are adjacent to, or crossing, the plane of railway, telegraph, telephone, electric, and gas lines, or water lines, sanitary sewers, and storm sewers, damage to which might result in expense, loss or inconvenience, work shall not be commenced until all arrangements necessary for the protection thereof have been made. Contractor shall notify the Notification Center of Oklahoma One-Call System, Inc., of any excavation or demolition prior to the commencement of such work. Notification shall be made no sooner than then (10) days nor later than forty-eight (48) hours prior to start of work, excluding Saturdays, Sundays, and legal holidays.

209.4 The Authority has attempted to locate all storm sewers, culverts, buried telephone or electrical conduits, sanitary sewers, water mains, and gas mains that might interfere with the construction of this project. The Contractor shall cooperate with the owners of any underground or overhead utility lines in their removal and rearrangement operations in order that these operations may progress in a reasonable manner and duplication or rearrangement work may be reduced to a minimum, and that services rendered by those parties will not be unnecessarily interrupted.

209.5 It shall be the responsibility of the contractor to follow all rules and regulations set forth by the Oklahoma Department of Environmental Quality with regards to storm water runoff associated with construction activities involving the disturbance of

land. The contractor shall review the regulations and determine if a DEQ storm water discharge permit is required. If a permit is required, it is the responsibility of the contractor to apply for and obtain the permit prior to disturbance of soil. If a permit is not required, the contractor shall still take all necessary action to comply with DEQ rules.

209.6 In the event the contractor in any way fails to comply with the requirement of protecting, repairing, and restoring of any utility or utility service, the Engineer may, upon forty-eight (48) hours' notice, proceed to protect, repair, rebuild or otherwise restore such utility or utility service as may be deemed necessary, and the cost thereof will be deducted from any money due or which may become due the contractor pursuant to the terms of his contract.

210 PROTECTION OF MATERIALS

210.1 All materials and equipment delivered to the work site shall be adequately housed and protected against damage or deterioration as required by the equipment manufacturer. The Contractor shall keep his storage yard(s) in good order, arrange his materials neatly, and protect them from damage.

211 REFERENCES TO OTHER SPECIFICATIONS

211.1 Where a referenced American Society for Testing Materials (ASTM), National Electric Code (NEC), National Electrical Manufacturers Association (NEMA), American National Standards Institute (ANSI), Institute of Electrical and Electronics Engineers (IEEE), or other agency designated specification is specified for a material, component, or device, that designated specification shall be the current revision, either tentative or adopted. If a referenced specification is in disagreement with these specifications, the Tulsa Metropolitan Utility Authority specifications shall govern.

212 CLEAN-UP

212.1 Immediately upon completion of the work at each site in the contract, the Contractor shall remove all excess materials, equipment, tools, and debris, and restore the site to a condition and in a manner satisfactory to the Engineer.

213 PLACING WORK IN SERVICE

213.1 If desired by the Authority, portions of the work may be returned to service when completed, and the Contractor shall give prior access to the work for this purpose, but such use and operation shall not constitute an acceptance of the work. Any

such return to service shall comply with Section GC-38 of the General Conditions of these Contract Documents and Specifications.

213.2 Warranty: All equipment and work shall have a one (1) year factory warranty from date of acceptance, which shall include all materials and labor unless more stringently specifically note elsewhere otherwise.

214 PAYMENT

214.1 Contractor shall submit a schedule of values for all major items of work as a basis for each partial payment. Payments will be made in accordance with section GC-29 of the General Conditions of these Contract Documents and Specifications. Contractor shall submit the SOV in sufficient time prior to the first pay application for the Engineer's review. Contractor should anticipate a typical submittal review durations for the projects SOV review.

214.2 Contractor's attention is directed to the Sales Tax Exemption Document in these Contract Documents and Specifications. Contractor shall have the option of instructing vendors to directly bill the Authority for materials the Contractor purchases while performing work under the terms of this Contract.

END OF SECTION


CITY OF
Tulsa
A New Kind of Energy