

SECTION 11000EQUIPMENT - GENERALPART 1 - GENERAL1.1 DESCRIPTION

- A. Work Included: Furnish, install and test all equipment specified in this Contract and as shown on the Drawings.
- B. Related Work Specified Elsewhere (When Applicable):
 - 1. Submittals are specified in Section 01340.
 - 2. Equipment Startup, Certification and Operator Training are specified in Section 01800.
 - 3. Site work is specified in Division 2.
 - 4. Concrete and grout are specified in Division 3.
 - 5. Metals are specified in Division 5.
 - 6. Field painting is specified in Section 09900.
 - 7. Surface Preparation and Shop Coatings are specified in Section 09905.
 - 8. Controls and Instrumentation are specified in Division 13.
 - 9. Pipe, plumbing, and mechanical work are specified in Division 15.
 - 10. Electrical work and components, and variable frequency drives, are specified in Division 16.

1.2 QUALITY ASSURANCE

- A. Provide only equipment of proven reliability manufactured by reputable manufacturers.
- B. Acceptable manufacturers are listed in each equipment item section in this Division. Substitute or "or-equal" equipment will be allowed only when indicated.
- C. Certificates, patents, licenses or other required legalities, when applicable, are specified in each Section of this Division.
- D. Manufacturer's names listed in "Acceptable Manufacturers" section of each specification are intended to indicate the type and quality of materials desired. Where the words "or equivalent" are indicated other manufacturers of equal quality, that comply fully with the specifications, are allowed. Where the words "or equivalent" are not included, the Contractor must provide equipment in compliance with the specifications that is manufactured from the listed manufacturers.
- E. The Specifications and Drawings direct attention to certain required features of the equipment but do not purport to cover all details entering into its design and construction. Nevertheless, the Contractor shall furnish the equipment complete in all details and ready for operation for the intended purpose.
- F. These Specifications are intended to provide standard equipment of a recognized manufacturer meeting all the requirements of the Specifications. Due to differences in such prefabricated equipment of various manufacturers, the Contractor shall submit complete shop drawings, cuts, specifications, etc. to the Engineer to review for compliance with the Contract Documents prior to ordering any equipment. If the equipment differs materially from the dimensions given on the Drawings, the

Contractor shall submit complete drawings showing elevations, dimensions etc. for the installation. If Engineer's acceptance is obtained for alternate equipment, the Contractor shall make any needed changes in the structures, piping or electrical systems necessary to accommodate the equipment at no additional cost to the Owner.

G. Workmanship shall be first class in all respects.

1.3 SUBMITTALS

- A. Provide shop drawings and samples as specified in the General Conditions and Section 01340 of the Construction Contract. Equipment Systems Manufacturers shall integrate all required shop drawings into a common package.
- B. Catalog Data: Submit manufacturer's literature and illustrations for all equipment to be installed, including dimensions, construction details, shop painting details, and materials by generic name.
- C. Installation Instructions: Submit complete sets of manufacturer's instructions for each equipment item, including equipment storage requirements.
- D. Complete Operation and Maintenance Manuals in compliance with Specification Section 01340. Otherwise provide complete operating manuals and the following maintenance data:
 - 1. Maintenance instructions.
 - 2. Parts list.
 - 3. List of special tools (where applicable).
- E. Certificates: Submit manufacturer's certification that equipment, accessories and shop painting meet or exceed the Specification requirements. Submit equipment performance testing results as required by these specifications. Should the proposed equipment not comply with all the specification requirements, all deviations from the specification requirements shall be listed.
- F. Submit all requirements for interface with controls and/or equipment furnished in Divisions 13 and 16. Submit wiring diagrams as required to accurately depict all such interface requirements to ensure proper operations of each system or item of equipment.
- G. Submittals are further specified in this Division.
- H. Guarantees/Warranties as specified below.
- I. Attention is directed to the fact that the Drawings are based upon a particular piece of equipment.
 - 1. If the equipment to be provided requires an arrangement differing from that indicated on the Drawings, the Contractor shall prepare and submit for review, detailed mechanical drawings showing all necessary changes. Such changes shall be at no additional cost to the Owner.
- J. Contractor shall provide a letter, from each individual equipment manufacturer certifying that the equipment manufacturer or supplier has:
 - 1. Reviewed the Construction Documents, the intended installation by the Contractor, and the intended functional and operational conditions;
 - 2. Determined all conditions to be acceptable; and
 - 3. Found no conditions which would cause the warranty to be void; or the equipment to function improperly, or not meet the performance requirements.

4. The submittals will not be reviewed without the inclusion of these noted certifications.
- K. Provide certified bearing life calculations on all equipment bearings.

1.4 SEISMIC CONTROL

- A. Submit complete seismic restraint calculations and details stamped by a registered Professional Engineer registered in the State of Maine with at least five years of experience in the analysis and design of equipment support and anchorage for chemical feed tanks. Calculations shall include anchor bolt type, embedment, concrete compressive strength, and minimum spacing between anchors and minimum distances of anchors from concrete edges. Submit seismic calculations for anchoring all concrete equipment pads not shown on the Drawings.
- B. Seismic analysis and design shall be in accordance with the International Building Code, 2000. Calculate the seismic force (F_p) using equations and coefficients for the Seismic Hazard Exposure or Use Group II and Seismic Hazard Performance or Design Category D.
- C. The analysis and design shall be based on actual equipment data (dimensions, weight, center of gravity) obtained from submittals reviewed with no exceptions taken by the Engineer or the manufacturers.
- D. The seismic restraint design shall clearly indicate the attachment points to the building structure and all design forces (in X, Y, and Z direction) at the attachment points. The seismic restraint engineer shall coordinate all attachments with the building's structural engineer of record, who shall verify the attachment methods and the ability of the building structure to accept the loads imposed.

1.5 GUARANTEE/WARRANTIES

- A. The Contractor shall obtain a warranty from the manufacturer in the name of the Owner. Submit the equipment manufacturer's warranty to the Engineer for review.
- B. Equipment that is supplied by a system supplier and is intended to function as a complete and integrated system shall be warranted by the system supplier as set forth in this specification section.
- C. The manufacturer's warranty must guarantee the equipment to be free of defects for a period of one year from the date of substantial completion as defined in the General Conditions, unless otherwise stated in the equipment item specification section.
- D. All required warranties which run longer than the Contractor's one year warranty period shall be issued to the Owner after the Contractor's one year warranty period has expired. The Contractor will be required to handle warranty problems during the one year warranty period following substantial completion.
- E. Any part of mechanical equipment that shows undue or excessive wear, or that fails due to normal operational conditions within the first year of operation after the date of Substantial Completion, shall be considered as evidence of defective material or defective workmanship, and it shall be replaced with equipment or parts to meet the specified requirements at no cost to the Owner.

1.6 DELIVERY, STORAGE AND HANDLING

- A. Coat all machined surfaces subject to corrosion with an easily removable rust preventive compound prior to shipment.
- B. Ship fabricated assemblies in the largest sections permitted by carrier regulations, properly labeled for field erection.
- C. Deliver equipment in manufacturer's original, unopened and undamaged packages, unless mounted on equipment assembly.
- D. Contractor shall store and maintain all equipment in strict accordance with the manufacturer's written short term and long term storage requirements.
- E. Store in a manner to protect items with epoxy shop coatings from exposure to UV light which can cause chalking of the epoxy. Length of acceptable exposure prior to providing UV protective measures shall be in accordance with coating manufacturer's recommendations. This includes protection from UV light after installation while awaiting covering or filling of tanks, or prior to field painting for items scheduled to be topcoated
- F. Should damage occur, immediately make all repairs and replacements necessary to the satisfaction of the Engineer at no cost to the Owner.

PART 2 - PRODUCTS

2.1 GENERAL DESIGN OF EQUIPMENT

- A. All parts and components of mechanical equipment shall be designed for satisfactory service under continuous duty without undue wear under the specified operating conditions, for a period of not less than one year.
- B. All parts of mechanical equipment shall be amply proportioned for all stresses which may occur during operations, and for any additional stresses which may occur during fabrication and erection. Iron castings shall be tough, close-grained gray iron casting, Class 30, in accordance with ASTM A48, latest revision. Structural steel shall conform to ASTM A36.
- C. Mechanical equipment, including drives and electrical motors, unless otherwise noted, shall be supplied and installed in accordance with the Williams-Steiger Occupational Safety and Health Act of 1970 and subsequent amendments. The Contractor's attention is drawn to the requirements for equipment guards. The noise level of equipment, drives and motors, unless otherwise noted, shall not exceed 90 dBA measured 3 feet from the unit under free field conditions.
- D. All equipment and machinery furnished under this Contract shall be the latest improved design suitable for the service specified. All equipment and machinery shall be designed and constructed to operate efficiently, continuously and quietly under the specified requirements with a minimum of maintenance, renewals and repairs. The design and construction of all equipment and machinery shall be such as to permit operation with minimum wear, vibration and noise when properly installed.
- E. Ample room for erecting, repairing, inspecting and adjusting of all equipment and machinery shall be provided. The design, construction and installation of all

equipment and machinery shall conform to and comply with the latest safety codes and regulations.

- F. All equipment of identical size, type and service shall be the product of the same manufacturer.
- G. All equipment selected shall suit the general arrangement of the space in which it is to be installed.
- H. Unless otherwise specified, electrical SCR controller units shall be furnished with the driven equipment, mounted and factory aligned, where applicable. Wiring of motors and controls shall be in accordance with the requirements of Division 16 and other applicable portions of the Specifications. Electrical variable frequency drives shall be furnished and installed by the electrical contractor, unless otherwise noted as specified in Division 16.
- I. Suitable provisions shall be made for easy access for service and replacement parts.

2.2 BOLTS, ANCHOR BOLTS AND NUTS

- A. All necessary bolts, anchor bolts, nuts, washers, lock washers or locking nuts, plates and bolt sleeves shall be furnished by the Contractor in accordance herewith. Anchor bolts shall have suitable washers, lock washers and, where so required, their nuts shall be hexagonal.
- B. All anchor bolts, nuts, washers, lock washers, plates, and bolt sleeves shall be galvanized unless otherwise indicated or specified.
- C. Expansion bolts shall have malleable iron and lead composition elements of the required number of units and size.
- D. Unless otherwise specified, stud, tap, and machine bolts shall be of the best-quality refined bar iron. Hexagonal nuts of the same quality of metal as the bolts shall be used. All threads shall be clean cut and shall conform to AN Standard B 1.1-1974 for Unified Inch Screw Threads (UN and UNR Thread Form).
- E. Bolts, anchor bolts, nuts, washers, and lock washers specified to be galvanized, shall be zinc coated, after being threaded, by the hot-dip process in conformity with the ASTM Standard Specification for Zinc (Hot-Galvanized) Coatings on Products Fabricated from rolled, Pressed, and Forged Steel Shapes, Plates, Bars, and Strip, Designation A123, latest revision or the ASTM Standard Specifications for Zinc Coating (Hot Dip) on Iron and Steel Hardware, Designation A153, latest revision as is appropriate.
- F. Bolts, anchor bolts, nuts, washers, and lock washers specified to be stainless steel shall be Type 316 stainless steel.
- G. Anchor bolts and expansion bolts shall be set accurately. If anchor bolts are set before the concrete has been placed, they shall be carefully held in suitable templates of acceptable design. Where indicated on the Drawings, specified, or required, anchor bolts shall be provided with square plates at least 4 in. by 4 in. by 3/8 in. or shall have square heads and washers and be set in the concrete forms with suitable pipe sleeves, or both. If anchor or expansion bolts are set after the concrete has been placed, all necessary drilling and grouting or caulking shall be done by the Contractor and care shall be taken not to damage the structure or finish by cracking, chipping, spalling, or otherwise during the drilling and caulking.

- H. All bolts shall be suitable size for the intended purpose, with direct input from the equipment or product manufacturer. In no case shall anchor bolt size be less than 3/8" diameter.
- I. Stainless steel hardware is required in all submerged applications, and all corrosive atmospheres, including but not limited to the chemical rooms, chlorine contact tanks, etc.

2.3 FOUNDATIONS, INSTALLATION AND GROUTING

- A. The Contractor shall furnish the necessary materials and construct suitable concrete foundations for all equipment installed by him, even though such foundations may not be indicated on the Drawings. The tops of foundations shall be at such elevations as will permit grouting as specified below.
- B. All such equipment shall be installed by skilled mechanics and in accordance with the instructions of the manufacturer.
- C. In setting pumps, motors, and other items of equipment customarily grouted, the Contractor shall make an allowance of at least 1 in. for grout under the equipment bases. Shims used to level and adjust the bases shall be steel. Shims may be left embedded in the grout, in which case they shall be installed neatly and so as to be as inconspicuous as possible in the completed work. Unless otherwise permitted, all grout shall be a suitable non-shrink grout.
- D. Grout shall be mixed and placed in accordance with the recommendations of the manufacturer. Where practicable, the grout shall be placed through the grout holes in the base and worked outward and under the edges of the base and across the rough top of the concrete foundation to a peripheral form so constructed as to provide a suitable chamfer around the top edge of the finished foundation.
- E. Where such procedure is impracticable, the method of placing grout shall be as permitted by the Engineer. After the grout has hardened sufficiently, all forms, hoppers, and excess grout shall be removed, and all exposed grout surfaces shall be patched in an approved manner, if necessary. All foundation and grout exposed surfaces shall be given a burlap-rubbed finish, and painted with at least two coats of the epoxy based paint specified for concrete.
- F. If threaded rod with lower support nuts are used to secure the equipment in place temporarily during concrete equipment pad placement, the support nuts shall be removed prior to grouting so that the threaded rod anchor bolts are not supporting the equipment and the top nuts can be tightened to secure the equipment directly to the large bedding surface provided by the non-shrink grout and concrete equipment pad. Equipment foundations shall be designed to absorb equipment vibration and transmit forces to building structure or ground.

2.4 ELECTRIC MOTORS

- A. Unless otherwise specified or permitted by the Engineer, all electric motors furnished and installed by the Contractor shall conform to the requirements hereinafter set forth.
 - 1. Ratings of Motors

- a. Every motor shall be of sufficient capacity to operate the driven equipment under all load and operating conditions without exceeding its rated nameplate current or power or its specified temperature limit.
 - b. When the horsepower rating is specified for a motor, the motor furnished shall meet the requirements of the output specified. When the horsepower rating is not specified, the motor shall have sufficient capacity to operate the driven equipment as given in the Detailed Specifications.
 - c. All electric motors shall have either UL or FM approval ratings.
 - d. Motor shall have a service factor of 1.15, unless otherwise specified. Motors intended for use on a variable frequency drive shall have a service factor of 1.15 while on inverter duty.
2. Type of Motors
- a. All motors shall be NEMA Design B, and shall have starting characteristics and ruggedness as may be necessary under the actual conditions of operation and, unless otherwise specified, shall be suitable for full-voltage starting.
 - b. Motors shall be manufactured by General Electric Co., Reliance, Toshiba, Siemens, or be an equivalent product, that meets all the requirements herein.
 - c. All motors shall have Class F insulation with temperature rise in accordance with NEMA Standards for Motors and Generators and based on a maximum ambient temperature of 40 deg. C.
 - d. Explosion-proof motors shall comply with all requirements of Class I, Division 1, Group D, hazardous locations as defined by the National Electrical Code and with all other safety codes pertaining thereto. Explosion proof motors shall be rated explosion proof for continuous in air duty.
 - e. All motors shall be premium efficiency type. The nominal and/or minimum guaranteed efficiency shall be printed on the motor nameplate. The efficiency values shall conform to Energy Policy Act of 1992, unless exempted, and shall be as indicated in the following table:

Nominal Full Load Motor Efficiencies						
HP	Open Motors			Enclosed Motors		
	2 Pole	4 pole	6 Pole	2 Pole	4 pole	6 Pole
1.0		82.5	80.0	75.5	82.5	80.0
1.5	82.5	84.0	84.0	82.5	84.0	85.5
2.0	84.0	84.0	85.5	84.0	84.0	86.5
3.0	84.0	86.5	86.5	85.5	87.5	87.5
5.0	85.5	87.5	87.5	87.5	87.5	87.5
7.5	87.5	88.5	88.5	88.5	89.5	89.5
10.0	88.5	89.5	90.2	89.5	89.5	89.5

3. General Design of Motors
- a. Motors shall comply with the latest NEMA Standards for Motors and Generators, unless otherwise specified.

- b. Motor windings shall be braced to withstand successfully the stresses resulting from the method of starting. The windings shall be treated thoroughly with acceptable insulating compound suitable for protection against moisture and slightly acid or alkaline conditions.
 - c. Bearings shall be of the self-lubricating type, designed to ensure proper alignment of rotor and shaft and to prevent leakage of lubricant.
 - d. Bearings for open motors shall be of the sleeve or ball type, as specified under the respective items of mechanical equipment. Bearings for totally enclosed and explosion-proof motors shall be of the ball type.
 - e. Vertical motors shall be provided with thrust bearings adequate for all thrusts to which they can be subjected in operation.
 - f. Vertical motors of the open type shall be provided with drip hoods of acceptable shape and construction. When the drip hood is too heavy to be easily removed, provision shall be made for access for testing.
4. Synchronous Motors
- a. Synchronous motors shall comply in all respects with the latest NEMA Standards for Motors and Generators, and AN Standard C50 for Rotating Electrical Machinery.
 - b. Synchronous motors shall be designed for operation of the motor-driven equipment under the conditions specified in the Detail Specifications.
 - c. The temperature rise (based on a cooling temperature not exceeding 40 deg. C. and an altitude not exceeding 3,300 ft.) in the various parts of the motors, when operating continuously at rated voltage, frequency, and power factor, shall conform to the applicable requirements of the above-mentioned NEMA Standards.
 - d. Synchronous motors shall be manufactured by General Electric Co., or be an equivalent product.
5. Single-Phase Motors with Auxiliary Devices
- a. Single-phase motors requiring switching devices and auxiliary starting resistors, capacitors, or reactors shall be furnished as combination units with such auxiliaries either incorporated within the motor housings or housed in suitable enclosures mounted upon the motor frames. Each combination unit shall be mounted upon a single base and shall be provided with a single conduit box.
6. Motor Terminal Boxes and Leads
- a. Motors shall be furnished with oversize conduit terminal boxes to provide for making and housing the connections and with flexible leads of sufficient length to extend for a distance of not less than 4 inches beyond the face of the box. The size of cable terminals and conduit terminal box holes shall be as permitted by the Engineer. An acceptable type of solderless lug shall be furnished. Totally enclosed and explosion-proof motors shall have cast-iron terminal boxes.

2.5 DRIVE COUPLINGS

- A. Couplings shall be all metal, flexible, designed for both angular and parallel misalignment, provided with a guard, and provided with a means for lubrication.
- B. Close-coupled connections shall have machined shouldered joints for motor and pump motor support.
- C. Acceptable Manufacturers:
 - 1. H.S. Watson, Co. Toledo, Ohio
 - a) Watson-Spicer Shafts
 - 2. Mechanics Universal Joint Division of Borg-Warner Corporation., Rockford, Illinois
 - a) Flexible Shafts
 - 3. Or equivalent

2.6 BELT DRIVES

- A. V-belt drives shall be provided with front removable guards (refer to Section 2.11), not requiring disturbing of the sheaves.
- B. Capable of upsize and downsize sheaving.
- C. Design shall be based upon minimum 1.5 service factor, unless specified elsewhere.

2.7 SCR CONTROLLERS

- A. Each SCR controller shall be a completely solid state assembly consisting of an electronic switching amplifier, silicon controlled full wave rectifier and associated circuitry.
- B. Bridge and gate trigger circuitry shall employ printed circuit boards.
- C. Any required power transformers shall be supplied as appropriate.
- D. The SCR units shall be heavy duty type suitable for handling the full current rating of the motors and brief acceleration current.
- E. The assembly shall be mounted on a heat sink but insulated therefrom.
- F. Power supply to the SCR controllers shall be 115 volts, single phase, 60 Hz.
- G. Each unit shall be factory wired and tested with all leads brought out to terminal strips to facilitate connections to the motors and local control stations.
- H. Each SCR unit shall include the following features:
 - 1. Full wave rectification.
 - 2. Power cube containing all power semi-conductors in a single component.
 - 3. Armature contactor with auxiliary normally open and normally closed contacts.
 - 4. Circuit breaker to provide overload protection.
 - 5. Surge suppressers to protect semi-conductors from line surges and transients.
 - 6. Adjustable current limit.
 - 7. Adjustable IR compensation.
 - 8. Voltage level and current capacities shall meet the requirements of the connected equipment (i.e. 90V DC output for 90V DC motors).

2.8 GEAR REDUCTION UNITS

- A. Gears of gear reduction units shall be made of highest quality alloys treated for hardness and severe service. All gear reduction units on equipment shall be selected for Class II or more severe service as classified by the American Gear Manufacturers Association.
- B. Unless otherwise specified, the complete reduction unit shall be fully enclosed in a heavy cast-iron or fabricated steel housing with gears running in oil. All bearings shall be of the anti-friction type.
- C. The actual and rated horsepower, torque, overhang capacity, or bearing capacity of each reduction unit shall be not less than the horsepower rating of the drive motor, nor less than that which will be encountered under full load or under the most severe loading conditions of the equipment. The Engineer may reject any gear reduction unit that does not meet the above requirements. The manufacturer of gear reduction units shall be long established with a good reputation.
- D. Unless otherwise specified, all gear reduction units shall be helical or spiral bevel helical combinations. The planetary gear units and worm gear type units may be used only where specified. Class of service shall be Class II or heavier, as determined by the manufacturer or as directed by the Engineer.
- E. The equipment manufacturer shall furnish the Engineer with complete engineering information, catalog data, design features, loading capacities, and mechanical efficiency ratings for every gear reduction unit incorporated in the work.

2.9 LUBRICATION FITTINGS

- A. All lubrication fittings shall be brought to the outside of all equipment so that they are readily accessible from the outside without the necessity of removing covers, plates, housings, or guards, or without creating falling hazards by unusual elevations. Fittings shall be buttonhead type. Lubrication fittings shall be mounted together wherever possible.
- B. Pressure grease-lubricated fittings shall be the "Zerk Hydraulic" type or the "Alemite" type.
- C. Housings of grease-lubricated bearings shall be automatically exhausted to the atmosphere to prevent excessive greasing.
- D. Oil drains shall be piped to a location outside the equipment frame for ease of draining. Provide ball valve for positive shutoff. Pipe shall be type-L copper or galvanized steel.

2.10 SPARE PARTS AND SPECIAL TOOLS

- A. For each type of equipment furnished by him, the Contractor shall provide spare parts, as specified on the respective sections of the Division, and a complete set of all special tools (including grease guns or other lubricating devices) which may be necessary for the adjustment, operation, maintenance, and disassembly of such equipment. Tools shall be high-grade, smooth, forged, alloy, tool steel. Grease guns shall be lever type.
- B. Special tools are considered to be those tools which because of their limited use are not normally available, but which are necessary for the particular equipment.

- C. All spare parts and special tools shall be delivered at the same time as the equipment to which they pertain. The Contractor shall properly store and safeguard such spare parts and special tools until completion of the work, at which time they shall be delivered to the Owner.
- D. Spare parts shall be appropriately labeled and containerized, and shall be properly packaged for long term storage.

2.11 EQUIPMENT DRIVE GUARDS

- A. All equipment driven by open shafts, belts, chains, or gears shall be provided with all-metal guards enclosing the drive mechanism. Guards shall be securely installed but shall be removable with quick open latches.
- B. Guards shall be constructed of galvanized sheet steel or galvanized woven wire or expanded metal set in a frame of galvanized steel members, unless otherwise specified.
- C. Guards shall be secured in position by steel braces or straps which will permit easy removal for servicing the equipment.
- D. The guards shall conform in all respects to all applicable safety codes and regulations.

2.12 PROTECTION AGAINST ELECTROLYSIS

- A. Where dissimilar metals are used in conjunction with each other, suitable insulation shall be provided between adjoining surfaces so as to eliminate direct contact and any resultant electrolysis.
- B. The insulation shall be bituminous impregnated felt, heavy bituminous coatings, nonmetallic separators or washers, or other acceptable materials.

2.13 NAMEPLATES

- A. Each piece of equipment shall be provided with a substantial nameplate of noncorrodible metal, securely fastened in place and clearly and permanently inscribed with the manufacturer's name, model or type designation, serial number, principal rated capacities, electrical or other power characteristics, and similar information as appropriate.
- B. An enlarged paper copy of all the nameplate data on equipment and motors shall be provided in the Shop Drawings and Operation and Maintenance Manuals.

2.14 SURFACE PREPARATION AND SHOP COATINGS

- A. Provide surface preparation and shop coatings in accordance with Specification Section 09905.

2.15 ELECTRICAL CONTROLS

- A. Additional controls for various items of equipment are specified under Division 13 and/or Division 16, as indicated on the Drawings, and as specified. Due to potential differences in electrical requirements for equipment of various manufacturers, the Contractor shall coordinate the electrical requirements of the equipment supplied with the work specified in Division 13 and/or Division 16.

- B. Provide auxiliary contacts as required for remote status and alarm conditions. Contractor shall coordinate each piece of equipment. Refer to the Electrical and Instrumentation Drawings.
- C. Electrical controls for all equipment shall comply with the requirements of Division 16 and the National Electric Code, including provisions to allow each piece of equipment to be locked out/tagged out for maintenance or repairs.

2.16 GAUGES

- A. General:
 - 1. Gauge assemblies shall be complete with 1/2-inch brass pipe and fittings, 1/2-inch ball valve with bronze body, stainless steel ball, Teflon seats and a tee with a brass test cock with female outlet end all arranged to allow field checking with a 4½-inch test gauge. For chemical feed systems, material of construction shall be compatible with chemical.
 - 2. All gauges shall be equipped with snubbers or other protective throttling device(s) to dampen workings and pointer. If single snubber does not correct pulsing, provide additional snubbers in series.
 - 3. All gauges shall meet requirements as outlined hereinafter.
 - 4. All gauges provided are to be from the same manufacturer.
- B. Water for Disinfection and Dechlorination Systems:
 - 1. Gauges shall be 2 1/2 - inch (63 mm), 1/4 - inch stem mount, liquid (glycerin) filled, all stainless steel (bourdon tube, socket, ring, etc.) with a polycarbonate window, black numbers and pointer, and white painted dial. Accuracy 1.0 to 1.6% of full range.
 - 2. Where gauges are connected to lines carrying fluids that are corrosive to the gauge or could clog the gauge stem or tube; factory mounted liquid (glycerin) filled stainless steel diaphragm seals and piping assemblies shall be used.
 - 3. Where the gauges are connected to lines with wide fluctuations in pressure and frequent pressure pulsation's, the gauges shall be furnished with protective throttling devices to dampen the vibration of the gauge internal workings and pointer. Throttling screws, pulsation dampness or snubbers will be utilized depending on the application.
 - 4. The ranges of the gauges shall be suitable for any range of pressure that can occur during operation. Typically the maximum rated gauge capacity should be about twice the operating pressure and maximum peak pressures about 75% of the rated gauge capacity.
- C. Gauges shall be manufactured by:
 - 1. Ametec U.S. Gauge Division
 - 2. Ashcroft
 - 3. Terice
 - 4. or equal.
- D. Contractor shall provide a gauge schedule listing all gauges, functions, locations, scales, etc., as part of the shop drawing submittal package.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Carefully inspect receiving structures and anchor supports for defects in workmanship prior to equipment arrival.
- B. Carefully inspect all equipment for:
 - 1. Damage in shipping.
 - 2. Defects in workmanship and materials.
 - 3. Tightness of all nuts and bolts.
- C. Inspection shall include, but not be limited to, the following as applicable:
 - 1. Soundness (without cracked or damaged parts).
 - 2. Correctness of setting, alignment, and relative arrangement of various parts.
 - 3. Adequacy and correctness of packing, sealing and lubricants.
 - 4. Completeness in all details, as specified.
- D. Field Quality Control
 - 1. As part of the equipment cost, the Contractor shall provide the services of the manufacturer's service representative to assist the Contractor with equipment adjustment, start-up, and necessary testing to prove that the equipment is in proper and satisfactory operating condition.
 - 2. On completion of his work, the manufacturer's service representative shall provide written certification that the equipment conforms to the requirements of the Contract and is ready for permanent operation and that nothing in the installation will render the manufacturer's warranty null and void, as outlined in the attached equipment certification form.
 - 3. As part of the start up services, the manufacturer's services representative shall provide the Owner's personnel with training in the proper operation and maintenance of all associated equipment. The equipment training certification form shall be used for this purpose.
 - 4. When the work is substantially complete the Contractor will be required to demonstrate, to the satisfaction of the Engineer, the ability of all equipment to operate as intended without defect including binding, vibration, jamming, overheating, etc.
 - 5. All equipment found defective by the Engineer shall be replaced by the Contractor at no expense to the Owner.

3.2 PREPARATION

- A. Provide all required adhesives, sealants, insulation, lubricants, waterproofing, fireproofing or other protection specified in each Section of this Division.

3.3 INSTALLATION

- A. Contractor shall install equipment in accordance with manufacturer's requirement.
- B. Do not install equipment until all defects or inadequacies in receiving structure have been corrected to meet Specifications.

- C. Erect and lubricate equipment in strict accordance with the manufacturer's instruction. Installation shall include all oil and grease required for proper operation.
- D. All equipment mechanisms shall withstand all stresses that may occur during fabrication, erection, and intermittent or continuous operation.
- E. Contractor to furnish and install supports as indicated on the Drawings, and as required by the equipment manufacturer.
- F. Thoroughly clean all equipment and appurtenant piping to remove all dirt, grease, mill scale, and other foreign matter and touch up factory finish to the satisfaction of the Engineer.

3.4 STARTUP AND TESTING

- A. Test and adjust all equipment in accordance with the general requirements of Specification Section 01800, and the specific requirements of the various Division 11 Specification Sections.
- B. Contractor shall provide necessary water or other materials needed for testing.
- C. Demonstrate the equipment's ability to operate without overloading jamming, excessive vibration, etc. during normal operation conditions.
- D. Demonstrate the equipment's ability to meet all the performance requirements specified for the equipment system to make a complete operational system, suited for its intended use.

3.5 EXISTING EQUIPMENT RELOCATION

- A. All relocated equipment shall be reconditioned and serviced prior to operation in the new locations. Equipment shall be cleaned, rust removed, reprimed and painted in accordance with Section 09900, balanced, lubricated, oiled, calibrated and properly wired and plumbed to provide the intended service. Start up of relocated equipment shall be done in accordance with the manufacturers instructions.

END OF SECTION