

Section 405. PUMP STATION CONSTRUCTION

405.01 Description. This work consists of constructing pump stations.

405.02 Materials. Materials shall meet the following requirements.

Concrete	701
Mortar	702
Asphaltic Materials	904
Steel Reinforcement	905
Structural Steel	906
Miscellaneous Metals	908
Storm Drain and Sewer Pipe	909
Masonry Units	913
Joint and Waterproofing Materials	914
Electrical Conduit, Flexible	918

The aggregate used in concrete for Pump Stations shall be 6AA.

The grease used for lubricating the installed pumps shall be Lubriplate 630AA or an approved equal.

A. **Mechanical Equipment.** Mechanical equipment consists of pumps, supports, bearings, discharge pipes and lubrication systems. Mechanical equipment for vertical pumps also consists of suction bowls, line shafts, discharge bowls and impeller, columns, motor stand, motor box plates, pump motors, shaft housings, and pump base rings. Also included are miscellaneous metal work, field painting for miscellaneous metal work, and shop painting for mechanical equipment when shown on the plans or called for in the proposal when no separate contract item has been provided.

1. **Pumps General.** The design of principal components of pumps in multiple pump installations of like capacity shall be interchangeable.

a. **Vertical Pumps.** The pump motor shall incorporate a thrust bearing capable of withstanding the hydraulic thrust produced by the pump. The pumps shall be designed so that damage will not occur in the event of reverse rotation caused by backflow of water through the pump. The pump system shall be equipped with a lubrication system that runs from the motor room to the pumps to allow greasing of the pump bearings and other pump lubrication to be manually completed from the motor room. Gaskets for pump base rings and flexible type couplings shall be impervious to petroleum products.

b. **Submersible Pumps.** Systems shall be explosion-proof, Class I, Division I, Group D construction and shall carry a FM or UL certification. Equipment furnished shall include submersible pumps, discharge piping and supports, pump mounting stand rail supports, lifting chain with appurtenances, corrosion-resistant nameplate, and watertight cable. The pump shall be easily removable for inspection or service, requiring no bolts, nuts or other fasteners to be removed for this purpose. Each

pump shall be fitted with a stainless steel chain of adequate strength and length to permit raising the pump for inspection and removal.

Pump components such as the stator casing, oil casing, sliding bracket, volute and impeller, shall be manufactured of gray cast iron meeting ASTM A 48, Class 35B with smooth surfaces free of blow holes or other irregularities. All exposed nuts and bolts shall be AISI Type 304 stainless steel or brass. Guide bars shall be of stainless steel pipe. All fittings shall be provided with nitrile or viton rubber o-ring gaskets.

Rectangular cross sectioned gaskets requiring specific torque limits to achieve compression shall not be allowed. Secondary seating compounds, elliptical o-rings, grease or other devices shall not be used.

2. Pump Design.

- a. **Vertical Pumps.** The pumps shall be vertical submerged axial flow propeller/mixed flow type provided with no more than two stages. The discharge pipe shall be plain and suitable for a flexible pipe flanged or grooved for a rigid pipe coupling. Flare the suction inlet (suction bowl) to resist the formation of damaging vortices. The complete pump unit shall operate within the specified head range free of vibration, cavitation, and noise. The enclosing column section shall be flanged with a gasket to provide a watertight connection. Flanges shall be registered and machined on centers to ensure positive alignment when connected to mating parts. The column section length shall not exceed 10 feet. The pump shaft, impeller, connecting bolts, key, and retaining and split rings shall be manufactured of stainless steel.
- b. **Submersible Pumps.** The pumps shall be automatically and firmly connected to the discharge connection by one or two guide bars extending from the top of the station to the discharge connection. A sliding guide bracket shall be an integral part of the pumping unit.

The pump casing shall have a machined flange to connect with the cast iron discharge connection, one of which will be fitted with a positively connected gasket to achieve a water tight connection. The discharge pipe shall be bolted to the sump floor and designed to automatically receive the pump without the need of fasteners. The guide rail system shall be designed to lower and seal the pump unit to the discharge pipe by a single linear downward motion.

Pump Cooling System. Each unit shall be provided with an adequately designed cooling system approved by UL. The cooling media channels and parts shall be non-clogging and shall have provision for external cooling and seal flushing. The cooling system shall provide for continuous pump operation in liquid temperature of up to 80 °F.

Pump Bearings. The pump shaft shall rotate on a permanently lubricated bearing system that consists of one row of upper bearing with single roller and two row angular contact lower bearings to compensate for axial thrust and radial forces.

The lower bearing housing shall include an independent thermal sensor to monitor the bearing temperatures. If a higher temperature occurs, the sensor shall activate an alarm and shut the pumps down.

Mechanical Seal. Each pump shall be provided with a tandem mechanical shaft seal system consisting of two independent seal assemblies. The seals shall operate in an oil reservoir that hydrodynamically lubricates the lapped seal faces at a constant rate. The lower, primary seal unit, located between the pump and the oil chamber, shall contain one stationary and one positively driven rotating silicon carbide or tungsten-carbide ring. The lower seal incorporates a protective cup to prevent deleterious material from interfering with the mechanical seal. The upper, secondary seal unit, located between the oil chamber and the motor housing, shall contain one stationary tungsten-carbide or carbon seal ring and one positively driven rotating tungsten-carbide or hardened polished chrome steel or carbon seal ring. All seal interfaces shall be held in contact by its own spring system. The seals shall require neither maintenance or adjustment nor depend on the direction of rotation for sealing.

Each pump shall be provided with an oil chamber for the shaft sealing system. The oil chamber shall be designed to prevent overfilling and to provide oil expansion capacity. The drain and inspection plug, with positive anti-leak seal, shall be easily accessible from the outside. The seal system shall not rely upon the pumped media for lubrication. The motor shall be able to operate dry without drainage while pumping under load. Cartridge type bearing systems are not allowed. Seal system lubricant shall be FDA approved non-toxic oil.

Pump Shaft. The pump shaft shall be of high quality one piece AISI Type 416 stainless steel, machined straight at the impeller to ensure a tight fit of the impeller to the shaft. The pump shaft and the motor shaft shall be one unit without couplings. The pump shaft shall be completely isolated from the pumping effluent.

Impeller. The impeller shall be dynamically balanced, one piece, single suction, double shrouded non-clogging, enclosed radial flow design with well rounded leading vane edges having a long through-let without acute turns and thick hydrofoil shape with large openings to prevent the accumulation of solids and stringy material through the impeller. A wear ring designed for abrasion resistance, shall be installed at the inlet of the pump to provide protection against wear to the impeller. Impellers shall be fully vaned non-vortex type keyed to the shaft, retained with an expansion ring and shall be capable of passing a minimum of 3-inch diameter solids, fibrous and grit material, found in storm sewers.

Mass moment of inertia calculations shall be provided by the pump manufacturer, upon request.

Volute. The pump volutes shall be a non-eccentric design with smooth passages large enough to pass any solids that may enter the impeller.

Wear-rings. Each pump shall be equipped with a stainless steel wear-ring or contra-block system or a brass or nitrile rubber coated steel ring insert that is drive fitted to the volute inlet. The pump shall also have a stainless steel impeller wear ring heat-shrink fitted onto the suction inlet of the impeller.

Leakage Sensor Protection. A float leakage sensor, a small float switch, shall be provide to detect water in the stator chamber. When activated, the float leakage sensor shall stop the motor and activate an alarm. The sensor shall be connected to a control and status monitoring unit mounted in the pump control cabinet.

3. **Pump Performance Requirements.** The pumps shall be designed for frequent starting and stopping, and shall be capable of starting against the maximum head and pumping storm water carrying suspended sand. The pump(s) shall be capable of pumping the required discharge at the total dynamic head. The manufacturer is responsible for computing and including internal pump head losses to determine the total dynamic head. The minimum bowl efficiency at the rated total dynamic head shall be 80 percent. At average static head the minimum overall efficiency of the pumps, exclusive of the motors, shall be 70 percent computed using a work output based on static head only. Friction losses in the suction bowl, discharge column, and outlet piping and entrance and exit losses, are not included and must be accounted for by the manufacturer in the pump design.

Pump Station Design Head Definitions.

- a. **Average Static Head.** The distance between the centerline of the pump discharge pipe and the midpoint of the on and off limits of the pump starting first.
 - b. **Maximum Static Head (Total Head).** The distance from the centerline of the pump discharge pipe to the minimum pumping elevation.
 - c. **Starting Static Head.** The distance from the centerline of the pump discharge pipe to the turn on point of the pump starting last.
 - d. **Reduced Static Head.** The distance between the centerline of the pump discharge pipe to a point approximately 2 feet below the crown of road at the lowest point in the depressed section drained.
 - e. **Total Dynamic Head.** The total head plus friction and fitting losses in the discharge system to the point of discharge.
4. **Pump Operating Specifications.** The Contractor shall submit three copies of the manufacturer's performance curves for the proposed pumps showing efficiencies for all design heads and discharge rates within their required performance range. Prior to the final closure of the order for materials, the Contractor shall furnish for review three

prints of the detail drawings of the pumps. Seven copies of the detail drawings shall be furnished after review corrections have been made.

For vertical pumps the detail drawings shall including bowl assembly; motors including flexible shaft coupling joint located at the motor head location; discharge column assembly; columns; shaft enclosing tube; bowl shaft and line shaft; shaft coupling; bearings at line shaft; suction bowl and discharge bowl; enclosing tube tension device; lubrication system including bypass ports with riser, grease line locations with fittings; and the assembly drawing showing the discharge piping.

5. **Factory Testing of Pumps.** Each pump shall be assembled at the factory to ensure fit of adjoining parts. One pump per size of pump, selected at random by a representative of the Department, shall be tested at the factory for operating efficiency. The operating efficiency test, in a similarly configured setup to the actual field installation, shall be performed in the presence of a representative of the Maintenance Division.

A minimum of six test readings shall be taken, one each at maximum static head, starting static head, average static head, 115 percent of maximum static head, 85 percent of starting static head, and at the reduced static head. The tests shall ascertain that the equipment complies with the specification requirements. The manufacturer shall furnish seven certified copies of test reports to the Engineer. Test readings at 115 percent of maximum static head and 85 percent of the starting static head are not required when submersible pumps are called for on the plans.

The Contractor shall furnish in duplicate, applicable maintenance and operational instructions, parts catalogs and a current list of supplies of replacement parts for the mechanical equipment.

Additional Testing for Submersible Pumps.

- a. Execute a standard commercial motor test.
- b. Prior to submergence, the pump shall be dry and be checked for correct rotation.
- c. Pump shall be run for 30 minutes in a submerged condition.
- d. Pump shall be removed from the test tank and checked immediately for moisture. Remove the oil plugs and check the lower seal. Remove the inspection plug and check the upper seal for possible water intrusion of stator housing. If plugs are not provided, check for intrusion of water using a moisture probe.
- e. A written certified test report giving the above information shall be supplied with each pump at the time of shipment.
- f. All ends of pump cables will be fitted with a rubber shrink fit boot to protect cable prior to electrical installation.

- B. Electrical Equipment for Pump Stations.** Electrical equipment for Pump Stations shall consist of control, power and metering equipment, conduit, insulated wire and cable, lighting systems, ventilating fans, power outlets, and the installation of this material from the power sources detailed on the plans to the pump motors. This shall include electrical connection to the pump motors. Unless otherwise specified, all material shall be new and all work and material shall meet National Electric Code, ANSI C1, and National Electric Safety Code, ANSI C2.2.

For connections at motors, conduit shall be flexible conduit of sufficient length to facilitate removal of the assembled pumping units.

The control panel shall be of stainless steel or aluminum construction.

When multiple installations of like capacity are called for in a single contract all parts and components shall be interchangeable.

The Contractor shall submit in triplicate an itemized bill of electrical equipment and materials, showing the rating, make, style, type and catalog cut of each item proposed for use. The Contractor shall also provide a detailed wiring diagram for the work to be done supplementing the wiring diagrams shown on the plans. The Contractor shall furnish seven copies after review of all detailed drawings, bills of material and catalog references.

The Contractor shall not purchase or install electrical equipment until the bill of electrical equipment and material, and the detailed wiring diagram have been reviewed by the Engineer.

405.03 Construction.

- A. General.** Pump station design and construction shall preclude gases from entering the motor room through the pumps. Construct all components to be explosion-proof. Excavation and backfilling, piling, concrete construction, water proofing, sewers and drainage structures detailed on the plans shall be constructed according to the applicable sections of these standard specifications.

Upon receipt of the pump motors at the construction site, the Contractor shall fill the upper and lower motor bearing sumps with turbine oil which meets the operating temperature requirements as shown on the lubrication instruction plate. Suspend the pump from the mounting base plate as detailed on the plans. Suspend the pumping element on a length of column sufficient to empty the sump to the elevations required. Align the center-line of the horizontal discharge above the mounting base plate. The size and location of anchor bolts and pump supports shall be adjusted by the Contractor to ensure proper fit of the pumps and other equipment. Pump supports, outside openings, openings in the supports, the rake and motor room floors shall be sized and positioned to allow, through either roof or side entrance, removal of each pumping unit completely assembled.

A licensed electrical contractor shall perform all electrical work shown on the plans.

All sumps, within and on inlet sewers adjacent to the pump station, shall be cleaned of silt, sand and other debris prior to any operation of the pumping equipment. Lubricating systems, mechanical systems, and electrical overload and control systems shall be fully operative before the electrical system is energized.

- B. **Miscellaneous Metal Work.** Miscellaneous metal work shall include furnishing and installing trash racks, floor drains, drain pipes, brackets, floor plates, sump and roof hatch frames and covers, float guide pipes and brackets, ladder rungs, grab bars, handrails and inserts, ventilators and screens, louvers, sleeves, and all other items designated as such on the plans. All materials used in miscellaneous metal work items specified in the plans shall conform to current ASTM specifications and shall be constructed of galvanized steel, stainless steel, or aluminum. Door hinges shall be stainless steel. Hatches shall be aluminum.
- C. **Field Coating.** All equipment to be field coated shall be cleaned to meet the requirements of SSPC Surface Preparation Specification SSPC-SP1, solvent cleaning.

The coating shall be as recommended by the equipment manufacturer and must be approved by the Engineer before application.

The coating and, if necessary the mixing and thinning and removal of improper coating, shall be in strict accordance with the manufacturer's recommendations. The manufacturer's recommendations shall be supplied to the Engineer before coating begins.

Galvanized steel parts and aluminum parts shall not be coated. Cast iron parts shall be given two field coats of an aluminum-filled moisture-cure urethane. Pump exteriors, the pump motors, and the motor base plates and base rings not shop-painted shall be given one field coat of moisture-cure urethane and one coat of a gray aliphatic urethane topcoat. All other miscellaneous metal work shall be given one field coat, 8 mils thick, of a moisture-cure urethane.

- D. **Shop Painting.** The inside and outside of suction bowl and discharge bowl, outside of the line shaft enclosing tube, inside and outside of pump column, and the inside of the discharge pipes shall be shop painted, after near-white sand blast, with two coats of coal tar epoxy paint 8 mils thick each, for a total of 16 mils thickness. The remainder of the pump exterior, pump motor, motor stand, motor base plate, and base ring shall be given one coat of high-grade gray machinery enamel, 8 mils thick.

Coal tar epoxy touch-up paint may be used to touch up the shop-painted parts in the field after setup, if necessary, at no cost to the Department.

- E. **Field Performance Tests.** Prior to acceptance, the Contractor shall make performance tests on all pumps as directed by the Engineer. The Contractor shall supply the water for testing and provide competent personnel to make any necessary adjustments or alterations according to the operation guarantee.

The Engineer and a representative from the Maintenance Division shall be present during the field performance tests and shall document any alterations made to the equipment.

- F. **Operation Guarantees and Equipment Warranties.** The Contractor shall guarantee satisfactory in-service operation of the mechanical and electrical equipment and related components for a period of six months following acceptance of the total contract, or as defined in the proposal, at which time all unexpired manufacturer's equipment warranties shall be assigned to the Department.

405.04 Measurement and Payment.

Contract Item (Pay Item)	Pay Unit
Pump Station Equipment, Mechanical	Lump Sum
Pump Station Equipment, Electrical	Lump Sum
Pump Station Metal Work, Misc	Lump Sum
Pump Station, Coating	Lump Sum

Excavation, piling, concrete work, backfilling, sewers, drainage structures, waterproofing and all other items necessary to complete pump station construction will be measured and paid for as provided in the applicable sections of these standard specifications.

Pump Station Equipment, Mechanical will include furnishing, testing and installing the equipment described in subsection 405.02.A. Included in this pay item will be supplying the required documents.

Pump Station Equipment, Electrical will include furnishing, installing and supplying the itemized bill and wiring diagram described in subsection 405.02.B.

If the Contractor is required to install miscellaneous metal work or perform field coating that is not shown on the plans or indicated in the proposal as included in a contract item, it will be paid for as extra work.