
USACE / NAVFAC / AFCEA / NASA UFGS-33 32 16.13 (January 2001)

Preparing Activity: NAVFAC Replacing without change
UFGS-11312 (January 2001)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated 18 July 2006

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SECTION 33 32 16.132

PACKAGE [GRINDER PUMP] [LIFT] STATION

04/06

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SECTION 33 32 16.132

PACKAGE [GRINDER PUMP] [LIFT] STATION
04/06

NOTE: This guide specification covers the requirements for Package Lift Stations and Grinder Pump Stations including alarm requirements, station piping, and O&M data packages.

Comments and suggestions on this guide specification are welcome and should be directed to the technical proponent of the specification. A listing of technical proponents, including their organization designation and telephone number, is on the Internet.

Recommended changes to a UFGS should be submitted as a Criteria Change Request (CCR).

Use of electronic communication is encouraged.

Brackets are used in the text to indicate designer choices or locations where text must be supplied by the designer.

PART 1 GENERAL

1.1 REFERENCES

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a RID outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically
be deleted from this section of the project
specification when you choose to reconcile
references in the publish print process.

The publications listed below form a part of this specification to the
extent referenced. The publications are referred to within the text by the
basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS
(AASHTO)

AASHTO M 198 (2005) Joints for Concrete Pipe, Manholes,
and Precast Box Sections Using Preformed
Flexible Joint Sealants

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI B16.11 (1996) Forged Steel Fittings, Socket
Welded and Threaded

ANSI B16.3 (1998) Malleable Iron Threaded Fittings
Classes 150 and 300

ANSI B31.3 (1999) Process Piping

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C104 (1995) Cement-Mortar Lining for
Ductile-Iron Pipe and Fittings for Water

AWWA C110 (2003) Ductile-Iron and Gray-Iron
Fittings, 3 In. Through 48 In. (76 mm
through 1219 mm), for Water

AWWA C111 (2000) Rubber-Gasket Joints for
Ductile-Iron Pressure Pipe and Fittings

AWWA C115 (1999) Flanged Ductile-Iron Pipe With
Ductile-Iron or Gray-Iron Threaded Flanges

AWWA C151 (2002) Ductile-Iron Pipe, Centrifugally
Cast, for Water

AWWA C500 (2002; A C500a-95) Metal-Seated Gate
Valves for Water Supply Service

AWWA C509 (2001) Resilient-Seated Gate Valves for
Water Supply Service

AWWA C600 (2005) Installation of Ductile-Iron Water
Mains and Their Appurtenances

AWWA M23 (2002) Manual: PVC Pipe - Design and
Installation

ASME INTERNATIONAL (ASME)

ASME B1.20.1	(1983; R 2001) Pipe Threads, General Purpose (Inch)
ASME B16.1	(1998) Cast Iron Pipe Flanges and Flanged Fittings Classes 25, 125, and 250

ASTM INTERNATIONAL (ASTM)

ASTM A 123/A 123M	(2002) Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A 126	(2004) Gray Iron Castings for Valves, Flanges, and Pipe Fittings
ASTM A 53/A 53M	(2004a) Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A 536	(1984; R 2004) Ductile Iron Castings
ASTM A 615/A 615M	(2005a) Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
ASTM C 443/C 443M	(1998) Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets
ASTM C 478/C 478M	(1999; Rev A) Precast Reinforced Concrete Manhole Sections
ASTM D 1784	(2003) Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
ASTM D 1785	(2005) Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120
ASTM D 2241	(2005) Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series)
ASTM D 2464	(1999e1) Threaded Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
ASTM D 2466	(2005) Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40
ASTM D 2467	(2005) Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
ASTM D 3139	(1998; R 2005) Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals
ASTM F 477	(2002e1) Elastomeric Seals (Gaskets) for Joining Plastic Pipe

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA MG 1	(2003; R 2004) Motors and Generators
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1.2 DESCRIPTION OF WORK

The work includes providing submersible sewage[grinder] pump station and related work. Provide system complete and ready for operations. [Grinder] pump station system including equipment, materials, installation, and workmanship shall be as specified herein.

1.3 SUBMITTALS

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list to reflect only the submittals required for the project. Submittals should be kept to the minimum required for adequate quality control.

A "G" following a submittal item indicates that the submittal requires Government approval. Some submittals are already marked with a "G". Only delete an existing "G" if the submittal item is not complex and can be reviewed through the Contractor's Quality Control system. Only add a "G" if the submittal is sufficiently important or complex in context of the project.

For submittals requiring Government approval on Army projects, a code of up to three characters within the submittal tags may be used following the "G" designation to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy, Air Force, and NASA projects.

Choose the first bracketed item for Navy, Air Force and NASA projects, or choose the second bracketed item for Army projects.

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are [for Contractor Quality Control approval.][for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government.] The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Pipe and fittings[; G][; G, [_____]]

Check valves[; G][; G, [_____]]

Gate valves[; G][; G, [_____]]

Submersible sewage[grinder] pumps[; G][; G, [_____]]

Pump motor[; G][; G, [_____]]

Flexible flanged coupling[; G][; G, [_____]]

SD-10 Operation and Maintenance Data

Submersible Sewage[Grinder] Pumps Data Package 3[; G][; G, [_____]]

Submit in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.

Include pumps, alarms, and motors. Include all information on all equipment, alarm panel and controls, pumps and pump performance curves, and station layout in data for submersible sewage[grinder] pump station.

1.4 DELIVERY, STORAGE, AND HANDLING OF MATERIALS

1.4.1 Delivery and Storage

Inspect materials delivered to site for damage. Unload and store with minimum handling. Store materials in enclosures or under protective covering. Store rubber gaskets not to be installed immediately under cover, out of direct sunlight. Do not store materials directly on the ground. Keep interior of pipes and fittings free of dirt and debris.

1.4.2 Handling

Handle pipe, fittings, valves, and other accessories in such manner as to ensure delivery to the trench in sound, undamaged condition. Avoid injury to coatings and linings on pipe and fittings; make satisfactory repairs if coatings or linings are damaged. Carry pipe to the trench; do not drag it.

1.5 EXCAVATION, TRENCHING, AND BACKFILLING

Provide in accordance with Section 31 00 00 EARTHWORK, except as specified herein.

PART 2 PRODUCTS

2.1 PIPE AND FITTINGS

Provide pressure piping, air release valves, and related accessories for force main piping outside the sewage wet well and valve vault in accordance with Section 33 30 00 SANITARY SEWERS.

2.1.1 Ductile-Iron Pipe

AWWA C151, thickness Class 52.

2.1.1.1 Flanged Pipe

AWWA C115, ductile iron.

2.1.1.2 Fittings

AWWA C110, flanged. Provide flanged joint fittings within wet well and

valve vault as indicated. Provide mechanical joint fittings outside valve vault enclosure as indicated. Use fittings with pressure rating at least equivalent to that of the pipe.

2.1.1.3 Joints

AWWA C115 for flanged joints. Use bolts, nuts, and gaskets for flanged connections recommended in the Appendix to AWWA C115. Flange for setscrewed flanges shall be of ductile iron, ASTM A 536, Grade 65-45-12, conforming to the applicable requirements of ASME B16.1, Class 250. Setscrews for setscrewed flanges shall be 1310 MPa 190,000 psi tensile strength, heat treated, and zinc-coated steel. Gasket for setscrewed flanges shall conform to the applicable requirements for mechanical-joint gaskets specified in AWWA C111. Use setscrewed gasket designed to provide for confinement and compression of gasket when joint to adjoining flange is made.

2.1.2 PVC Plastic Pressure Pipe and Associated Fittings

2.1.2.1 Pipe and Fittings Less Than 4 inch 100 mm Diameter

Use pipe, couplings and fittings manufactured of materials conforming to ASTM D 1784, Class 12454-B.

- (1) Screw-Joint: Use pipe conforming to dimensional requirements of ASTM D 1785 Schedule 80, with joints meeting requirements of 1.03 MPa 150 psi working pressure, 1.38 MPa 200 psi hydrostatic test pressure, unless otherwise shown or specified. Use threaded pipe fittings conforming to requirements of ASTM D 2464, threaded to conform to the requirements of ASME B1.20.1 for use with Schedule 80 pipe and fittings. Test pipe couplings when used, as required by ASTM D 2464.
- (2) Push-On Joint: ASTM D 3139, with ASTM F 477 gaskets. Fittings for push-on joints: AWWA C110 or AWWA C111. Iron fittings and specials: cement-mortar lined (standard thickness) in accordance with AWWA C104.
- (3) Solvent Cement Joint: Use pipe conforming to dimensional requirements of ASTM D 1785 or ASTM D 2241 with joints meeting the requirements of 1.03 MPa 150 psi working pressure and 1.38 MPa 200 psi hydrostatic test pressure. Use fittings for solvent cement jointing conforming to ASTM D 2466 or ASTM D 2467.

2.1.3 Insulating Joints

Provide between pipes of dissimilar metals a rubber gasket or other approved type of insulating joint or dielectric coupling to effectively prevent metal-to-metal contact between adjacent sections of piping.

2.1.4 Accessories

Provide flanges, connecting pieces, transition glands, transition sleeves, and other adapters as required.

2.1.5 Flexible Flanged Coupling

Provide flexible flanged coupling applicable for sewage as indicated. Use flexible flanged coupling designed for a working pressure of 2.41 MPa 350

psi.

2.2 VALVES AND OTHER PIPING ACCESSORIES

2.2.1 Gate Valves in Valve Vault

AWWA C500 and AWWA C509. Valves conforming to AWWA C500 shall be outside-screw-and-yoke rising-stem type with double disc gates and flanged ends. Valves conforming to AWWA C509 shall be outside-screw-and-yoke rising-stem type with flanged ends. Provide valves with handwheels that open by counterclockwise rotation of the valve stem. Bolt and construct stuffing boxes to permit easy removal of parts for repair. Use valves from one manufacturer.

2.2.2 Check Valves Less Than 100 mm 4 Inch Diameter

Neoprene ball check valve with integral hydraulic sealing flange, designed for a hydraulic working pressure of 1.21 MPa 175 psi.

[2.2.3 Check Valves 100 mm 4 in and Larger Diameter

Nonclogging swing check valve rated for not less than 175 psig working pressure capable of passing 76-mm 3-inch diameter solids. Cast iron conforming to ASTM A 126. Buna-N disc and integral seat. Flanged ends conforming to AWWA C110.

]2.2.4 Identification Tags and Plates

Provide valves with tags or plates numbered and stamped for their usage. Use plates and tags of brass or nonferrous material and mounted or attached to the valve.

2.2.5 Pipe Support

Use pipe support schedule 40 galvanized steel piping conforming to ASTM A 53/A 53M. Provide either ANSI B16.3 or ANSI B16.11 galvanized threaded fittings.

2.2.6 Miscellaneous Metals

Use stainless steel bolts, nuts, washers, anchors, and supports for installation of equipment.

2.2.7 Quick Disconnect System with Hydraulic Sealing Flange

Use quick disconnect system consisting of a steel base plate for supporting the pumps, a hydraulic sealing flange, pump guide rails and the discharge pipe supports. Use two guide rails of galvanized steel in accordance with ASTM A 123/A 123M. Provide a steel lifting chain for raising and lowering the pump in the basin. Build guides onto pump housing to fit the guide post to assure perfect alignment between pump and guide rails.

2.2.8 Wet Well Vent

Galvanized ASTM A 53/A 53M pipe with insect screening.

2.3 SUBMERSIBLE SEWAGE[GRINDER] PUMPS

NOTE: When Grinder Pumps are required select the first and third bracketed options and delete the second option.

Provide submersible sewage pumps[with grinder units] as shown on the drawings. Provide submersible, centrifugal sewage pumps [of the non-clogging type with passageways designed to pass [76] [____] mm[3] [____] inch diameter spheres without clogging][and grinder units capable of grinding all materials found in normal domestic sewage, including plastics, rubber, sanitary napkins, disposable diapers, and wooden articles into a finely ground slurry with particle dimensions no greater than [6] [____] mm [1/4] [____] inch]. Pump capacity and motor characteristics as [indicated][specified]. Design pump to operate in a submerged or partially submerged condition. Provide an integral sliding guide bracket and two guide bars capable of supporting the entire weight of the pumping unit.

2.3.1 Casing

Provide hard, close-grained cast iron casing which is free from blow holes, porosity, hard spots, shrinkage defects, cracks, and other injurious defects. Design casings to permit replacement of wearing parts. Design passageways to permit smooth flow of sewage and to be free of sharp turns and projections.

2.3.2 Impeller

Provide non-clogging type cast-iron[, or bronze] impeller. Make impeller with smooth surfaces, free flowing with the necessary clearance to permit objects in the sewage to pass. Fit and key, spline, or thread impeller on shaft, and lock in such manner that lateral movement will be prevented and reverse rotation will not cause loosening.

2.3.3 Shaft and Shaft Seals

Provide shaft of stainless steel. Provide mechanical seal of double carbon and ceramic construction with mating surfaces lapped to a flatness tolerance of one light band. Hold rotating ceramics in mating position with stationary carbons by a stainless steel spring. Oil lubricate bearings.

2.3.4 Bearings

Provide heavy duty ball thrust bearing or roller type bearing of adequate size to withstand imposed loads. Oil lubricate bearings.

2.3.5 Pump and Motor

NOTE: When grinder pumps are required include the bracketed text.

Use pump and motor assembled on a single stainless steel shaft in a heavy duty cast-iron shell. Use free standing pump support legs of cast-iron[providing enough clearance for the solids to get into the grinder].

2.4 PUMP MOTOR

Provide submersible sewage pumps in wet well NEMA MG 1, [____] RPM, [____] volt, [____] phase, and [____] Hz cycle and for submersible pumps. Motor horsepower shall be not less than pump horsepower at any point on the pump performance curve. Fit motors with lifting "eyes" capable of supporting entire weight of pump and motor.

2.5 PUMP CONTROL SYSTEM

Provide a sealed mercury float switch control system as indicated. Automatically alternate operation from one pump to the other and start second pump in the event first pump cannot handle incoming flow. Provide manual "on-off" switch for each pump. Provide independent adjustable high and low water level switches. Provide floats, supports, and alarm. Metal parts, if used, shall be of bronze or equivalent corrosion resistant material.

2.5.1 Float Assembly Description

Use a direct acting float switch consisting of a normally-open mercury switch enclosed in a float. Use pipe mounted float assembly. Use float molded of rigid high-density polyurethane foam, color-coded and coated with a durable, water and corrosion-resistant jacket of clear urethane. Provide connecting cable and support pole in accordance with manufacturers recommendations. Provide a cast aluminum NEMA Type 4 junction box to connect float assembly. Use box with a gasketed cover with tapped float fitting and conduit entrance pipe threaded opening. Mount floats at fixed elevations as shown. Use floats designed to tilt and operate their switches causing sequential turn-on turn-off of the pump, when the liquid level being sensed rises or falls past the float.

2.5.2 Alternator

Provide an alternator control switch to operate in connection with each float. Use alternator control switch to alternate the operation of the pumps and operate both pumps if the water level rises above the second high water level. Incorporate time delay function and devices in the alternator controls such that both sewage pumps cannot be started simultaneously for an adjustable period of 10 to 120 seconds after shutdown. Use delay function designed to operate in any condition of start-up in either normal or emergency operational mode.

2.5.3 Sewage Pump Alarm and Control Panel

Enclose alarm panel in NEMA IV enclosure and with a flashing red light with long life bulb in guarded enclosure and 15 mm 6 inch diameter horn. Horn shall emit 120 DB at 3 meters 10 feet. Power alarm horn and light from 12V DC power supply with battery backup. Provide a rechargeable battery rated to power both the horn and light for a minimum of two hours upon loss of main power. Provide circuitry to automatically recharge the battery after main power is restored. Full charge of battery shall take no more than 20 hours. Use panel switch power on light, push to test button for horn and light and push to silence button for horn and light with automatic reset for next alarm. Use alarm designed to activate under the following conditions:

- a. High liquid level as sensed by float switch

b. Loss of main power

c. No flow light as sensed by limit switch on the check valve

2.5.4 Electrical Requirements

Furnish motors with their respective pieces of equipment. Motors, controllers, contactors, and disconnects shall be as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Furnish internal wiring for components of packaged equipment as an integral part of the equipment. Provide power wiring and conduit for field installed equipment.

2.5.5 Electric Motor

Use hermetically sealed electric motor. The power cable shall be sealed inside the motor end bell. The cable shall be neoprene covered with a flexible metal cover over it for its full length.

2.6 UNDERGROUND EQUIPMENT ENCLOSURE

2.6.1 Access Hatch Cover

Provide [aluminum][] access hatch cover as indicated. The access hatch shall include lifting mechanism, automatic hold open arm, slam lock with handle, and flush lift handle with red vinyl grip. Use automatic hold open arm that locks in the 90 degree position. Use cover that is 6 mm 1/4 inch diamond plate with 6 mm 1/4 inch channel frame and continuous anchor flange. Use access hatch cover capable of withstanding a live load of 1500 kg/sq. meter 300 lbs./sq. ft. Provide stainless steel cylinder lock with two keys per lock. Key all the locks the same.

2.6.2 Wet Well[and Valve Vault]

Provide [fiberglass reinforced polyester resin basin][concrete wet well [and Valve Vault]] with inside diameter [as indicated][of [] mm [] inch]. [Precast structures may be provided in lieu of cast-in-place structures.]

[2.6.2.1 Cast-In-Place Concrete Structures

Provide wet well[and valve vault] with a compressive strength of 25 MPa 3000 psi at 28 days as specified in Section 03 30 00.00 20 CAST-IN-PLACE CONCRETE.

] [2.6.2.2 Precast Concrete Structures

ASTM C 478/C 478M, except as specified herein. Provide precast concrete structures with a compressive strength of 30 MPa 4000 psi at 28 days and an air entrainment of 6 percent, plus, or minus 2 percent and a minimum wall thickness of 125 mm 5 inches. ASTM A 615/A 615M reinforcing bars. ASTM C 443/C 443M or AASHTO M 198, Type B gaskets for joint connections. Use monolithic base and first riser.

] 2.6.3 Wet Well Base Material

Provide crushed stone as indicated and specified in Section 31 00 00 EARTHWORK. Provide polyethylene vapor barrier as indicated and specified in Section 03 30 00.00 20 CAST-IN-PLACE CONCRETE.

PART 3 EXECUTION

3.1 INSTALLATION

Provide pump station in accordance with drawings and requirements of the respective equipment manufacturers. Dampen and isolate equipment vibration.

3.1.1 Installation of Ductile-Iron Pressure Lines

Unless otherwise specified, install pipe and fittings in accordance with paragraph entitled, "General Requirements for Installation of Pipelines" of Section 33 30 00 SANITARY SEWERS, and with the requirements of AWWA C600 for pipe installation, joint assembly, and valve-and-fitting installation.

- a. Make flanged joint with gaskets, bolts, and nuts specified for this type joint. Make flanged joints up tight, taking care to avoid undue strain on flanges, fittings, and other accessories. Align bolt holes for each flanged joint. Use size bolts for the bolt holes; use of undersized bolts to make up for misalignment of bolt holes or for any other purpose will not be permitted. Do not allow adjoining flange faces to be out of parallel to such degree that the flanged joint cannot be made watertight without overstraining the flange.

3.1.2 Installation of PVC Plastic Pressure Pipe and Fittings

Unless otherwise specified, install pipe and fittings in accordance with paragraph entitled "General Requirements for Installation of Pipelines" of this section and with the recommendations for pipe joint assembly and appurtenance installation in AWWA M23, Chapter 7, "Installation."

- a. Pipe Less than 100 mm 4 Inch Diameter:

- (1) Make threaded joints by wrapping the male threads with joint tape or by applying an approved thread lubricant, than threading the joining members together. Tighten joints with strap wrenches that will not damage the pipe and fittings. Do not tighten joint more than 2 threads past hand-tight.

- (2) Push-On Joints: Bevel ends of pipe for push-on joints to facilitate assembly. Mark pipe to indicate when the pipe is fully seated. Lubricate gasket to prevent displacement. Exercise care to ensure that the gasket remains in proper position in the bell or coupling while making the joint.

- (3) Solvent-weld joints shall comply with the manufacturer's instructions.

3.1.3 Valves

Installation of Valves: Install gate valves conforming to AWWA C500 in accordance with AWWA C600 for valve-and-fitting installation and with the recommendations of the Appendix ("Installation, Operation, and Maintenance of Gate Valves") to AWWA C500. Install gate valves conforming to AWWA C509 in accordance with AWWA C600 for valve-and-fitting installation and with the recommendations of the Appendix ("Installation, Operation, and Maintenance of Gate Valves") to AWWA C509. [Install check valves in accordance with the applicable requirements of AWWA C600 for valve-and-fitting installation [, except as otherwise indicated].] [Make

and assemble joints to gate valves [and check valves] as specified for making and assembling the same type joints between pipe and fittings.]

3.1.4 Steel Piping

Install steel piping in accordance with ANSI B31.3. Use PTFE pipe thread paste or PTFE powder and oil for jointing compound for pipe threads.

3.1.5 Force Main

Provide in accordance with Section 33 30 00 SANITARY SEWERS.

3.1.6 Equipment Installation

Install equipment in accordance with these specifications and the manufacturer's installation instructions. Grout equipment mounted on concrete foundations before installing piping. Install piping to avoid imposing stress on any equipment. Match flanges accurately before securing bolts.

3.2 FIELD TESTS AND INSPECTIONS

Perform all field tests, and provide all labor, equipment, and incidentals required for testing, except that water and electric power needed for field tests will be furnished as set forth in Division 01. Produce evidence, when required, that any item of work has been constructed in accordance with contract requirements. Allow concrete to cure a minimum of 5 days before testing any section of piping where concrete thrust blocks have been provided.

3.2.1 Testing Procedure

Test piping in accordance with the Section 33 30 00 SANITARY SEWERS. Test in operation all equipment to demonstrate compliance with the contract requirements.

3.2.2 Sewage [Grinder Pump] [Lift] Station

Test pumps and controls, in operation, under design conditions to insure proper operation of all equipment. Provide all appliances, materials, water, and equipment for testing, and bear all expenses in connection with the testing. Conduct testing after all equipment is properly installed, electrical services and piping are installed, liquid is flowing, and the pump station is ready for operation. Correct all defects discovered to the satisfaction of the Contracting Officer, and all tests repeated, at the expense of the Contractor, until the equipment is in proper working order.

-- End of Section --