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USACE / NAVFAC / AFCEC / NASA | **UFGS-23 21 23 (August 2017)**

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UFGS-43 21 13 (January 2008)
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UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2021
****

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SECTION 23 21 23

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08/17

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SECTION 23 21 23

HYDRONIC PUMPS
08/17

****
NOTE: This guide specification covers the requirements for hydronic pumps primarily designed for chilled water, hot water and condenser water service in building HVAC systems.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).
****

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 Reference Identifier (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 SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 189.1	(2014) Standard for the Design of High-Performance Green Buildings Except Low-Rise Residential Buildings

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B1.1	(2003; R 2018) Unified Inch Screw Threads (UN and UNR Thread Form)
ASME B4.1	(1967; R 1994; R 2004; R 2009; R 2020) Preferred Limits and Fits for Cylindrical Parts
ASME B4.2	(1978; R 1994; R 2004, R 2009; R 2020) Preferred Metric Limits and Fits
ASME B16.1	(2020) Gray Iron Pipe Flanges and Flanged Fittings Classes 25, 125, and 250

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA E103	(2015) Horizontal and Vertical Line-Shaft Pumps

ASTM INTERNATIONAL (ASTM)

ASTM A48/A48M	(2003; R 2016) Standard Specification for Gray Iron Castings
ASTM A53/A53M	(2020) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A123/A123M	(2017) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A153/A153M	(2016a) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A159	(1983; R 2020) Standard Specification for Automotive Gray Iron Castings

ASTM A307	(2014; E 2017) Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength
ASTM A536	(1984; R 2019; E 2019) Standard Specification for Ductile Iron Castings
ASTM A582/A582M	(2012; R 2017) Standard Specification for Free-Machining Stainless Steel Bars
ASTM B584	(2014) Standard Specification for Copper Alloy Sand Castings for General Applications

HYDRAULIC INSTITUTE (HI)

HI 1.1-1.2	(2014) Rotodynamic (Centrifugal) Pump for Nomenclature and Definitions
HI 1.3	(2013) Rotodynamic (Centrifugal) Pump Applications
HI 9.6.4	(2009) Rotodynamic Pumps for Vibration Analysis and Allowable Values
HI ANSI/HI 2.1-2.2	(2014) Rotodynamic Vertical Pumps of Radial, Mixed, and Axial Flow Types for Nomenclature and Definitions
HI ANSI/HI 9.6.3	(2017) Rotodynamic Pumps - Guideline for Operating Regions - B120
HI ANSI/HI 14.6	(2011) Rotodynamic Pumps for Hydraulic Performance Acceptance Tests - A136

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA MG 1	(2018) Motors and Generators
NEMA Z535.4	(2011; R 2017) Product Safety Signs and Labels

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2020; ERTA 20-1 2020; ERTA 20-2 2020; TIA 20-1; TIA 20-2; TIA 20-3; TIA 20-4) National Electrical Code

NSF INTERNATIONAL (NSF)

NSF 372	(2016) Drinking Water System Components - Lead Content

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC Paint 21	(1982; E 2004) White or Colored Silicone Alkyd Paint (Type I, High Gloss and Type II, Medium Gloss)

SSPC Paint 25	(1997; E 2004) Zinc Oxide, Alkyd, Linseed Oil Primer for Use Over Hand Cleaned Steel, Type I and Type II

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910.219	Mechanical Power Transmission Apparatus

UNDERWRITERS LABORATORIES (UL)

UL 778	(2016; Reprint Jun 2020) UL Standard for Safety Motor-Operated Water Pumps

1.2 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters 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.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

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" or "S" classification. Submittals not having a "G" or "S" classification are [for Contractor Quality Control approval.][for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government.] Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

System Coordination; G[, [_____]]

SD-03 Product Data

Instructions; G[, [_____]]

Equipment Data; G[, [____]]

Training Period; G[, [_____]]

SD-06 Test Reports

Factory Tests

Field Quality Control

SD-07 Certificates

Manufacturer's Representative

SD-10 Operation and Maintenance Data

Operation and Maintenance Manuals; G[, [_____]]

Training; G[, [____]]

1.3 QUALITY ASSURANCE

1.3.1 Manufacturer Services

Provide the services of a manufacturer's representative experienced in the installation, adjustment, and operation of the equipment specified. The representative must supervise the installation, adjustment, testing of the equipment, and conduct training.

Submit the names and qualifications of the manufacturer's representative and training engineers and written certification from the manufacturer that the representative and trainers are technically qualified.

1.3.2 Standard Products

Provide material and equipment which are the standard products of a manufacturer regularly engaged in the manufacture of such products and that essentially duplicate equipment that has been in satisfactory HVAC operation at least 2 years prior to issuance of this solicitation. Support equipment with a service organization that is reasonably convenient to the jobsite. Pumps [and] [motors] of the same types must each be the product of one manufacturer.

1.3.3 Conformance with Agency Requirements

Where materials or equipment are specified to be an approved type, attach the seal or label of approval from a nationally recognized testing agency, adequately equipped and competent to perform such services. A written certificate from the testing agency must accompany the materials or equipment and be submitted stating that the items have been tested and

that they conform to the applicable requirements of the specifications and to the standards listed herein. The certificate must indicate the methods of testing used by the testing agency. In lieu of a certificate from a testing agency, published catalog specification data, accompanied by the manufacturer's certified statement to the effect that the items are in accordance with the applicable requirements of the specifications and the referenced standards, will be considered and may be acceptable as evidence that the items conform with agency requirements.

1.4 DELIVERY, STORAGE, AND HANDLING

Protect equipment, delivered and designated for storage, from the weather, humidity and temperature variations, dirt and dust, or other contaminants.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

Hydronic pumps used for heating and air conditioning applications are defined by the type of impeller, number of impellers, type of casing, method of connection to the driver, and mounting position. Provide centrifugal water pumps of the types indicated and specified. Use an electric motor driving unit for each pump as indicated and specified.

2.1.1 Selection Criteria

Select pumps at a point within the maximum efficiency for a given impeller casing combination. Deviations within 3 percent of maximum efficiency are permissible, provided the lesser efficiency is not less than the scheduled efficiency in the construction design documents. Pumps having impeller diameters larger or smaller than manufacturer's published maximum and minimum impeller diameters for a given impeller casing combination will be rejected. Pump performance data, as shown in performance curves, must be based on factory tests using precision instrumentation and exacting procedures as detailed in HI ANSI/HI 14.6.

2.1.2 System Coordination

Submit drawings containing complete wiring and piping schematic diagrams and any other details required to demonstrate that the system has been coordinated and will properly function as a unit. Show the proposed layout and anchorage of equipment and appurtenances, and equipment relationship to other parts of the work including clearances for maintenance and operation. Provide a complete listing of equipment, materials and miscellaneous components including mechanical seals, bearings, and couplings.

2.1.3 Safety Requirements

Fully enclose or guard couplings, projecting set-screws, keys, and other rotating parts, that pose an entangling hazards..

2.2 MATERIALS AND EQUIPMENT

2.2.1 Nameplates

Securely affix a standard nameplate to pumps and motors in a conspicuous place showing the manufacturer's name, address, type or style, model, serial number, and catalog number. In addition, for each pump show the

capacity in L/second gpm at rated speed in rpm and total head in mm feet of water. For each electric motor show at least the minimum information required by NEMA MG 1. Show such other information as the manufacturer may consider necessary to complete identification on the nameplate. Pumps must be listed and labeled by UL, and comply with UL 778 for pumps not using universal motors rated more than 250 volts such as circulating pumps.

2.2.2 Framed Instructions

Submit proposed diagrams, instructions, and other sheets, prior to posting. Post approved wiring and control diagrams showing the complete layout of the entire system, including equipment, piping valves, and control sequence, framed under glass or in approved laminated plastic, where directed. Provide condensed operating instructions explaining preventive maintenance procedures, methods of checking the system for normal safe operation, and procedures for safely starting and stopping the system, framed as specified above for the wiring and control diagrams, and posted beside the diagrams. Post the framed instructions before acceptance testing of the systems.

2.2.3 Pump Characteristic

****
NOTE: Characteristics of each pump will normally be specified by a minimum of two points on the head-capacity curve. The blanks for liters per second gpm and total head in mm feet will be filled in appropriately. If two or more pumps are to operate in parallel or in series, and a system head curve is shown, the appropriate brackets will be removed indicating pumps will match the system curve.
****

Construct hydronic water pumps in accordance with HI 1.1-1.2 and HI ANSI/HI 2.1-2.2. The pumps must be capable of discharging quantities at total discharge heads measured at the discharge flange, between the following limits:

Operate pumps at optimum efficiencies to produce the most economical pumping system under the conditions encountered [and size to make optimum match with the system head curve as shown].[Suction lift on Pump No. [_____] must not be more than [_____] mm feet.] Pumps must furnish not less than 150 percent of rated capacity at a total discharge head of not less than 65 percent of total rated head.[The shutoff total head must not be greater than 120 percent of total rated head.] Operate pumps at specified system fluid temperatures without vapor binding and cavitation. Operate pumps to HI ANSI/HI 9.6.3 standard for Preferred Operationg Region (POR).

2.2.4 Pump Drivers

Provide electric motors as indicated for each pump and in compliance with Section [26 20 00 INTERIOR DISTRIBUTION SYSTEM] [26 60 13.00 40 LOW-VOLTAGE MOTORS].

2.2.5 Equipment Data

Submit manufacturer's descriptive data and technical literature, performance charts and curves for all impeller sizes for a given casing,

catalog cuts, and installation instructions. Provide spare parts data for each different item of material and equipment specified, after approval of the detail drawings and not later than [_____] months prior to the date of beneficial occupancy. Include a complete list of parts and supplies, with current unit prices and local source of supply with contact information.

Submit catalog information, certified pumps curves, rated capacities, final impeller dimensions, and accessories provided for the product indicated. Indicate operating point of each pump on curves. Furnish pump curves for each pump and combination of pumps designed to operate in parallel. The pump curve must show as a minimum; bhp, flow, total dynamic head, efficiency, NPSH, impeller diameter and system curve (individually and in combination for each pump operating in a parallel application). Select pumps operating in parallel operation to cross the system curve when operating individually.

2.3 HYDRONIC PUMPS

****
NOTE: Enter the pump numbers shown on the drawings in the appropriate blanks. Delete inapplicable configurations.
****

Provide centrifugal, [single-stage type,][or][multi-stage type,] designed for HVAC service in the following configurations:

Configuration	Pump No.
Circulator	[_____]
Small In-Line	[_____]
Large In-Line	[_____]
Base-Mounted, Flexible Coupled, End Suction	[_____]
Base-Mounted, Close Coupled, End Suction	[_____]
Base-Mounted, Flexible Coupled, Double Suction, [Horizontally] [and] [Vertically] Split	[_____]
Vertical Lineshaft Turbine	[_____]
Automatic Cooling Coil Condensate Pump Units	[_____]

2.3.1 Circulator

****
NOTE: These pumps deliver up to 10 L per second 150 gpm and up to 10 m 35 feet head. They are most often used for low flow rates in small systems and are available in a wet rotor or three piece oil

lubricated design. Wet rotor circulators use system fluid for cooling and lubrication. They do not require oiling and are less expensive; however, impeller can stick after a prolonged shutdown. Three piece circulators are oil lubricated with the potential for longer life if properly lubricated and can overcome a stuck impeller after a prolonged shutdown; however, there is potential maintenance of mechanical seals and coupling assembly.
****

Provide pumps with capacities as indicated of a horizontal, [in-line, three piece oil lubricated] [wet rotor] circulator type specifically designed for quiet operation. Suitable for 107 degrees C 225 degrees F operation at [860][_____] kPa [125][_____] psig working pressure. The pump must be single stage with [flanged] [union] piping connections. The pump internals must be capable of being serviced without disturbing piping connections.

****
NOTE: Insert the following paragraph for three piece oil lubricated circulator pumps.
****

[a. The three piece pump must be composed of three separable components a motor, bearing assembly, and [cast iron] [lead free bronze certified in accordance with NSF 372 pump end (wet end). The motor shaft must be connected to the pump shaft via a replaceable flexible coupler.]
]
****
NOTE: Insert the following paragraph for wet rotor circulators used for potable water service.
****

[b. Wet rotor circulator for potable water service must be lead content certified in accordance with NSF 372.
]
2.3.1.1 Seal Assembly

****
NOTE: Retain this paragraph for wet rotor circulators used for potable water service.
****

Pump must be equipped with an internally flushed mechanical seal assembly. Seal assembly must have a brass housing, Buna bellows and seat gasket, stainless steel spring, and be of a carbon ceramic design with the carbon face rotating against a stationary ceramic face.

2.3.1.2 Motor Mount

****
NOTE: Include this paragraph for three piece oil lubricated circulators.
****

To ensure alignment, mount the motor to the bearing assembly via a bolted motor bracket assembly. Use a replaceable resilient rubber motor mount to assist in aligning the motor shaft with the pump shaft.

2.3.1.3 Motors

Motors must meet scheduled horsepower, speed, voltage, and enclosure design. Motors must be drip proof, maintenance free, premium efficiency and meet NEMA MG 1 specifications.

****
NOTE: Include the following paragraph for variable speed pumps with ECM motors.
****

[Pump must be driven by an electrically commutated electrical motor (ECM) with permanent magnet rotor. The rotor magnets must be time stable, non-toxic ceramic magnets. Drive the electrically commuted electrical motor by a frequency converter with an integrated PFC filter.
]

2.3.2 Small In-Line

****
NOTE: These pumps deliver up to 12.5 L per second 200 gpm and 17 m 55 feet head. Pump motor shaft must stay horizontal, but pump body can be repositioned for horizontal or vertical discharge. These pumps are designed for 1750 rpm and indoor service using open drip proof enclosure electric motors.
****

Provide pumps with capacities as indicated,suitable for 107 degrees C 225 degrees F operation at [1204][_____] kPa [175][_____] psig working pressure. The pump must be single stage, in-line design, in cast iron bronze fitted construction. The pump internals must be capable of being serviced without disturbing piping connections.

2.3.2.1 Pump Shaft

The pump must have a solid steel shaft with a coupler between the pump and motor shafts. For non-stainless steel shafts, employ a non-ferrous shaft sleeve to completely cover the wetted area under the seal.

2.3.2.2 Bearing

The bearing assembly must house maintenance-free permanently lubricated bearings.

2.3.2.3 Seal Assembly

Equip the pump with an internal self-flushing mechanical seal assembly. Seal assembly must have Buna bellows and seat gasket, stainless steel spring, and be of a carbon ceramic design with the carbon face rotating against a stationary ceramic face.

2.3.2.4 Impeller

Provide impeller of cast bronze or brass material. Impeller must be hydraulically and dynamically balanced to HI 9.6.4 balance grade G6.3, keyed to the shaft and secured by a locking capscrew or nut.

2.3.2.5 Volute

Pump volute must be of cast iron. The connection style on cast iron pumps must be flanged.

2.3.2.6 Motor Mount

To ensure alignment, mount the motor to the bearing assembly via a bolted motor bracket assembly. Use a replaceable resilient rubber motor mount to assist in aligning the motor shaft with the pump shaft.

2.3.2.7 Motors

NEMA MG 1; premium efficiency; non-overloading at any point on the pump curve; maintenance free with permanently lubricated bearings; and resilient mounted for smaller sizes, rigid mounted otherwise.

2.3.3 Large In-Line

****

NOTE: Large In-Line pumps can deliver up to 158 L per second 2500 gpm and 38 m 125 ft head at 1750 rpm. The use of large In-Line pumps is discouraged due to difficulty in providing routine servicing and repair. Large in-line pumps including motor can be more expensive than the preferred base-mounted, flexible coupled end suction pumps. In some cases floor space is limited so large in-line pumps may need to be used. Large In-Line pumps come in two basic configurations - split coupled and close coupled. Split coupled configuration allows mechanical seal maintenance without disturbing the pump or motor. However, split coupled pumps only allow the motor shaft to be oriented vertically with motor shaft down. Close coupled pumps may be mounted with the motor shaft vertical or horizontal but do not allow mechanical seal maintenance without disturbing the pump or motor. When mounted horizontally, it is critical that adequate support be provided to avoid strain on pump parts and piping.

****

Provide pumps with capacities as indicated; [split-coupled] [closed coupled], in-line, single stage, for installation in [vertical] [horizontal (where close coupled)] position, and. suitable for 107 degrees C 225 degrees F operation at [1204][_____] kPa [175][_____] psig working pressure. The pump internals must be capable of being serviced without disturbing piping connections.

2.3.3.1 Casing

Provide pump casing complying with ASTM A48/A48M Class 30 cast iron, suitable for [1204][_____] kPa [175][_____] psig working pressure with integral cast iron flanges drilled for ASME B16.1 [ANSI Class 125] [ANSI Class 250] flanges, with an integrally-cast support ring matching an Class 125 flange for pump support. The pump volute must include gauge tappings at suction and discharge nozzles along with vent and drain tappings at top and bottom.

2.3.3.2 Pump Shaft

Provide carbon or stainless steel pump shaft, guided by a carbon graphite lower throttle bushing. Carbon steel pump shaft must have a bronze shaft sleeve that completely covers the wetted area under the seal.

2.3.3.3 Seal Assembly

Equip the pump with a mechanical seal assembly consisting of a carbon seal rotating ring, stainless steel spring, ceramic seat and flexible bellows and gasket. The liquid cavity must have a tapped flush line with manual valve to remove air from the seal chamber to allow fast initial start-up and insure mechanical seal cooling.

2.3.3.4 Spacer Coupling

****
NOTE: Delete paragraph specifying spacer coupling below when close coupled pumps are used.
****

The axially split spacer coupling must be of high tensile aluminum, split to allow the servicing of the seal without disturbing the pump or motor. Pump coupler must be aligned by the manufacturer before shipment. The motor bracket must contain a carbon steel coupler guard conforming to 29 CFR 1910.219 standards for safety.

2.3.3.5 Impeller

****
NOTE: Bronze impellers should not be used for pumping temperatures in excess of 120 degrees C 250 degrees F. Consult manufacturer for temperatures exceeding 120 degrees C 250 degrees F.
****

Hydraulically and dynamically balance the impeller to HI 9.6.4 balance grade G6.3, closed, single suction, fabricated from cast bronze, keyed to the shaft and secured by a locking capscrew.

2.3.3.6 Motor

****
NOTE: Motor enclosure will usually be open drip proof where motor is located in dry, clean, well ventilated indoor area. Use totally enclosed fan cooled motor enclosure for outdoor service.
****

Electric motors must meet NEMA MG 1 and the horsepower, speed, voltage, indicated. Motor enclosure must be open drip proof[, totally enclosed fan cooled], with heavy duty grease lubricated ball bearings completely adequate for the maximum load for which the motor is designed. Motor must be non-overloading at any point on the pump curve and premium efficiency. Provide open drip proof motor efficiencies as shown in ASHRAE 189.1. Totally enclosed fan cooled motor efficiencies must be as shown in NEMA MG 1.

Include one-piece combination motor bracket and volute coverplate in the

assembly to ensure concentric alignment of the motor to the pump casing.

2.3.4 Base-Mounted, Flexible Coupled, End suction

Provide pumps with capacities as indicated; base mounted, separately-coupled, end suction designed with volute housing mounted to the frame to allow for pump service without relocating the motor or disturbing piping connections. Bearings and seals must be serviceable without disturbing piping. Pump must be factory hydrostatically tested in accordance with Hydraulic Institute standards and thoroughly cleaned.

2.3.4.1 Casing

****
NOTE: Cast iron casings should not be used for pumping temperatures in excess of 120 degrees C 250 degrees F. Consult manufacturer for temperatures exceeding 120 degrees C 250 degrees F.
****

Provide radially split pump casing ASTM A48/A48M Class 30 cast iron suitable for [1204][1720][_____] kPa [175][250][_____] psig working pressure with integral cast iron flanges drilled for ASME B16.1 [ANSI Class 125] [ANSI Class 250] flanges, with an integrally-cast pedestal support foot. The pump volute must include gauge tappings at suction and discharge nozzles along with vent and drain tappings at top and bottom.

2.3.4.2 Pump Shaft

****
NOTE: Carbon steel shaft should not be used for pumping temperatures in excess of 120 degrees C 250 degrees F. Consult manufacturer for temperatures exceeding 120 degrees C 250 degrees F.
****

Carbon steel pump shaft with a replaceable [bronze][stainless steel] shaft sleeve completely covering the wetted area of the shaft under the seal.

2.3.4.3 Bearing

****
NOTE: Regreasable ball bearings are discouraged. Studies have indicated that contamination and ineffective lubrication are responsible for approximately half of all bearing replacements. Concerns include the following; excessive grease will cause bearings to overheat, bearings are required to be regreased on a regular interval (2500 operating hours or every six months), impurities can be introduced when regreasing bearings, and grease added must be compatible with grease applied previously.
****

Incorporate maintenance free, permanently lubricated and sealed bearings in the pump bearing frame. [Regreasable ball bearing type with provision for purging or flushing through the bearing surface and greased while running after start-up.]

2.3.4.4 Seal Assembly

****

NOTE: When fluid used to internally flush seals exceeds 107 degrees C 225 degrees F, provide a heat exchanger to decrease the temperature of the seal flushing water to 107 degrees C 225 degrees F in order that the seal life does not get shortened.

****

Equip with an integrally flushed mechanical seal assembly or a positive pressure external seal flushing line. Provide a mechanical seal with ceramic seal seat and carbon seal ring. Seal assembly must be rated up to 107 degrees C 225 degrees F.

2.3.4.5 Baseplate

Baseplate must be of steel construction fully enclosed at sides and ends with welded cross members and fully open grouting area for field grouting. Minimum base plate stiffness must conform to HI 1.3 for horizontal baseplate design standards.

2.3.4.6 Coupler

Provide a flexible-type coupler between the pump and motor, capable of absorbing torsional vibration and variable speed operation between the pump and motor. The coupler must allow replacement with no need to move the hubs. Coupler must have natural rubber or neoprene type element materials with a maximum misalignment capability of 4 degrees angular and 3 mm 0.125 inches parallel. Provide donut shaped elastomer element with preassembled flanges mechanically clamped to reinforced element and preassembled spacer center assembly. Secure flexible donut shaped element of coupler in place with radial clamp ring screws. Couplers must be rated for required maximum rpm, amperage horsepower and torque. The coupler must be shielded by a coupler guard securely fastened to the base. Provide coupler guard in compliance with current national safety standards including 29 CFR 1910.219 and NEMA Z535.4. Guards cannot have gaps greater than 6 mm 0.250 inches, must be safety orange in color, and have an NEMA Z535.4 compliant warning label.

2.3.4.7 Impeller

****

NOTE: Cast bronze impellers should not be used for pumping temperatures in excess of 120 degrees C 250 degrees F. Consult manufacturer for temperatures exceeding 120 degrees C 250 degrees F.

****

Hydraulically and dynamically balance to HI 9.6.4 balance grade G6.3, closed, overhung, single suction, fabricate from cast bronze, key to shaft and secured by a locking capscrew.

2.3.4.8 Motor

****

NOTE: Motor enclosure will usually be open drip proof where motor is located in dry, clean, well ventilated indoor area. Use totally enclosed fan

cooled motor enclosure for outdoor service.
****

Electric Motors must meet NEMA MG 1 and be the wattage horsepower, speed, and voltage indicated. Motor enclosure must be open drip proof [totally enclosed fan cooled]. Motor must have heavy duty grease lubricated ball bearings completely adequate for the maximum load for which the motor is designed. Motor must be non-overloading at any point on the pump curve and premium efficiency. Open drip proof motor efficiencies must comply with ASHRAE 189.1. [Totally enclosed fan cooled motor efficiencies must comply with NEMA MG 1.]

2.3.5 Base-Mounted, Close Coupled, End Suction

****
NOTE: Use of base-mounted, close coupled, end suction pumps is discouraged. This type of pump takes up less floor space than base-mounted, flexible coupled, end suction pumps and should only be considered when floor space is extremely limited. Close coupled pumps do not have a pump shaft and pump bearing assembly. Motor bearings must be able to handle both motor rotating element and impeller forces. This requires a special motor with bearings designed to handle additional impeller loads and shaft that extends into the volute. This type of pump can be about the same cost as the preferred base-mounted, flexible coupled, end suction pump.
****

Provide pumps with capacities as indicated. Pump must be base mounted, close coupled, single stage, end suction design capable of being serviced without disturbing piping connections.

2.3.5.1 Casing

Provide pump volute of Class 30 cast iron suitable for [1204][_____] kPa [175][_____] psig working pressure. Include vent, drain and gauge tappings.

2.3.5.2 Seal Assembly

Seal off the liquid cavity at the motor shaft by an internally flushed mechanical seal or a positive pressure external seal flushing line with ceramic seal seat and carbon seal ring, suitable for continuous operation at 107 degrees C 225 degrees F. A replaceable shaft sleeve of bronze alloy must completely cover the wetted area under the seal.

2.3.5.3 Impeller

Provide cast bronze or 304 stainless steel impeller, enclosed type, hydraulically and dynamically balanced to HI 9.6.4 balance grade G6.3, keyed to shaft and secured by a locking capscrew.

2.3.5.4 Motor

****
NOTE: Motor enclosure will usually be open drip

proof where motor is located in dry, clean, well ventilated indoor area. Use totally enclosed fan cooled motor enclosure for outdoor service.

****

Electric Motors must comply with NEMA MG 1 and be thewattage horsepower, and voltage indicated. Motor enclosure must be [open drip proof] [totally enclosed fan cooled]. provide with heavy duty grease lubricated ball bearings completely adequate for the maximum load for which the motor and pump impeller is designed. Motor must be non-overloading at any point on the pump curve and premium efficiency. Provide open drip proof motor efficiencies in compliance with ASHRAE 189.1. Totally enclosed fan cooled motor efficiencies must be as shown in NEMA MG 1.

2.3.6 Base-Mounted, Flexible Coupled, Double Suction[,] [Horizontally Split][and][Vertically Split]

Provide pumps with capacities as indicated; base mounted, flexible coupled, double-suction, [horizontal] [and] [vertical] split case design, single stage centrifugal pump. Construction must be cast iron - bronze fitted, equipped with mechanical seals. Bearings and seals must be serviceable without disturbing piping or motor. Factory hydrostatically test the pump in accordance with Hydraulic Institute standards and thoroughly clean.

2.3.6.1 Casing

****

NOTE: Cast iron casings should not be used for pumping temperatures in excess of 120 degrees C 250 degrees F. Consult manufacturer for temperatures exceeding 120 degrees C 250 degrees F.

****

Provide ASTM A48/A48M Class 30 or ASTM A159 cast iron pump casing, suitable for [1204][_____] kPa [175][_____] psig working pressure, with integral cast iron flanges drilled for ASME B16.1 [ANSI Class 125] [ANSI Class 250] flanges. Supply the pump volute with plugged vent, drain, and gauge tappings.

2.3.6.2 Bearings

****

NOTE: The use of regreasable ball bearings are discouraged. Studies have indicated that contamination and ineffective lubrication are responsible for approximately half of all bearing replacements. Concerns include the following; excessive grease will cause bearings to overheat, bearings are required to be regreased on a regular interval (2500 operating hours or every six months), impurities can be introduced when regreasing bearings, and grease added must be compatible with grease applied previously.

****

Incorporate maintenance free, permanently lubricated and sealed bearings with an L10 life of 60,000 hours minimum in the pump bearing frame.[

Incorporate regreasable ball bearing type pump bearing frame with provision for purging or flushing through the bearing surface and greased while running after start-up.]

2.3.6.3 Seal Assembly

****

NOTE: When fluid used to internally flush seals exceeds 107 degrees C 225 degrees F, provide a heat exchanger to decrease the temperature of the seal flushing water to 107 degrees C 225 degrees F so that the seal life does not get shortened.

****

Seal off liquid cavity by an internally-flushed seal assembly. Seal assembly must have a brass housing, Buna bellows and seat gasket, stainless steel spring, and be of a carbon face rotating against a stationary silicon carbide seat. Provide replaceable mechanical seals without disturbing the upper casing half and system piping. Seals must be suitable for continuous operation at 107 degrees C 225 degrees F. Arrange to assure that seal leakage cannot enter the bearing housings.

2.3.6.4 Coupler

Provide a flexible-type coupler between the pump and motor capable of absorbing torsional vibration and variable speed operation. The coupler must allow replacement with no need to move the hubs. Coupler must have natural rubber or neoprene type element materials with a maximum misalignment capability of 4 degrees angular and 3 mm 0.125 inches parallel. Provide donut shaped elastomer element and with preassembled flanges mechanically clamped to reinforced element and preassembled spacer center assembly. Secure flexible donut shaped element of coupler in place with radial clamp ring screws. Couplers must be rated for required maximum rpm, wattage horsepower and torque. Shield the coupler by a coupler guard securely fastened to the base. Coupler guard must comply with current national safety standards including 29 CFR 1910.219, and NEMA Z535.4. Provide guards with gaps no greater than 6 mm 0.250 inches, of safety orange in color, and have an NEMA Z535.4 compliant warning label.

2.3.6.5 Base Plate

Provide baseplate of steel construction fully enclosed at sides and ends with welded cross members and fully open grouting area for field grouting. Minimum base plate stiffness must conform to HI 1.3 for horizontal baseplate design standards.

2.3.6.6 Impeller

****

NOTE: Cast bronze impellers should not be used for pumping temperatures in excess of 120 degrees C 250 degrees F. Consult manufacturer for temperatures exceeding 120 degrees C 250 degrees F.

****

Bronze or brass enclosed double suction type, both hydraulically and dynamically balanced to HI 9.6.4 grade G6.3, keyed to shaft and fixed in an axial position. Hub must have sufficient metal thickness to allow machining for installation of impeller rings.

2.3.6.7 Motor

****
NOTE: Motor enclosure will usually be open drip proof where motor is located in dry, clean, well ventilated indoor area. Use totally enclosed fan cooled motor enclosure for outdoor service.
****

Provide electric motor conforming to NEMA MG 1 and of the wattage horsepower, and voltage indicated. Motor enclosure must be open drip proof [totally enclosed fan cooled]; with heavy duty grease lubricated ball bearings completely adequate for the maximum load for which the motor is designed. Motor must be non-overloading at any point on the pump curve and premium efficiency. Open drip proof motor efficiencies must be as shown in ASHRAE 189.1. Totally enclosed fan cooled motor efficiencies must be as shown in NEMA MG 1.

2.3.6.8 Pump Shaft

Provide pump shaft of solid 416 stainless steel shaft or solid carbon steel shaft with replaceable bronze or 304 stainless steel shaft sleeve covering wetted area of shaft.

2.3.7 Vertical Lineshaft Turbine

Provide pumps with capacities as indicated. Pump must be vertical lineshaft turbine manufactured for lubrication of the line-shaft bearings by the water being pumped. Design and manufacture the pumping unit in accordance with HI ANSI/HI 2.1-2.2 standards AWWA E103.

2.3.7.1 Bowl Assembly

Flange type construct the intermediate bowls, discharge cases and suction bowls from ASTM A48/A48M Class 30 close grain cast iron. They must be free of defects and accurately machined and fitted to ASME B4.2 ASME B4.1 close tolerances. Epoxy enamel coat the intermediate bowls waterways for maximum efficiency. Thread all threaded discharge cases for water lubricated column assembly. All assembly bolting must be stainless steel. Provide intermediate bowl bearings.

2.3.7.2 Pump Shaft

Construct the bowl shaft from ASTM A582/A582M type 416 stainless steel, precision ground and polished with surface finish better than 40 RMS.

2.3.7.3 Lineshaft

Vertical pump lineshaft must be open and constructed from ASTM A582/A582M type 416 stainless steel. Straighten lineshaft sections to 0.13 mm per 300 mm 0.0005inch/foot total runout. Lineshaft sections must not exceed 3 m 10 feet in length and must be coupled with threaded stainless steel couplings. Design the diameter of the lineshaft and coupling in accordance with AWWA E103.

2.3.7.4 Impeller

Provide impellers of ASTM B584 silicon bronze or stainless steel, the

enclosed type. They must be free from defects, machined, and balanced to HI 9.6.4 balance grade G6.3 for optimum efficiency and performance. Securely fasten to the bowl shaft with stainless steel taper lock collets. The impellers must be adjustable by means of a top shaft adjusting nut or adjustable solid shaft coupling.

2.3.7.5 Discharge Head

Construct the discharge head, sized for pump capacity, of ASTM A48/A48M Class 30 high grade ductile iron or fabricated steel of the high profile type with an integral motor base which allows the head shaft to be coupled to the top shaft above the stuffing box. A separate motor stand is not acceptable. The discharge head must have an ASME B16.1 (for cast iron) or Class 150 (for steel) discharge flange supplied with dual 6 mm 1/4 inch NPT ports at the top. Thread the head to accept the column pipe.

2.3.7.6 Stuffing Box

****

NOTE: Stuffing box is recommended over mechanical seals for vertical turbine pumps due to the many variables encountered in mechanical seal applications with this type of pump. Abrasives are commonly found in condenser water open loop systems, where this type of pump is used, that cause premature mechanical seal failure.

****

Provide stuffing box of cast or ductile iron, ASTM A536 class 65, and containing a minimum of five rings of packing; with an available fitting for pressure relief. The packing follower gland must be stainless steel and secured in place by stainless steel studs and nuts. The packing box bearing must be bronze. Provide a water slinger to operate on the top shaft, above the packing gland.

2.3.7.7 Mechanical Seal

Provide a mechanical seal.

2.3.7.8 Column Pipe

Provide column pipe of ASTM A53/A53M grade B steel pipe not less than Schedule 30. Machine the column ends with threads and faced parallel to the threads to ensure proper alignment. Connect the pipe with threaded sleeve type ductile iron couplings or flanges that will accept 20 mm 3/4 inch stainless steel or bonze bearing retainers. Lineshaft bearings must be fluted rubber retained in a centering spider retainer.

2.3.7.9 Basket Strainer

Provide and attach a stainless steel basket strainer of a suitable size to the pump suction with stainless steel fasteners. Strainer must have a net inlet area equal to at least three times the impeller inlet area. The maximum opening must not be more than 75 percent of the maximum opening of the water passage through the bowl or impeller.

2.3.7.10 Motor

Electric motor must meet NEMA MG 1 and be the size and voltage indicated.

Provide [1800RPM] [_____] motor with NEMA Class B or Class F insulation. The motor must have a vertical hollow (or solid) shaft motor with space heaters and a non-reverse ratchet (or self-release coupling) to prevent reverse rotation. The motor must have an angular contact thrust bearing to meet the designed pump's hydraulic thrust load plus the weight of the rotating parts under operating conditions. Provide high efficiency motor with a weather protected WP-1 enclosure, [230/460] [_____] volt, [3] [1] phase, 60HZ, and a [1.15] [_____] service factor. Motor must be non-overloading at any point on the pump curve and premium efficiency. Provide motor with efficiencies in compliance with NEMA MG 1.

2.3.8 Cooling Coil Condensate Pump Units

Provide pumps with capacities as indicated. Cooling Coil Condensate Pump Unit must be a packaged unit including a corrosion-resistant pump, plastic tank with cover, and automatic controls. Include [factory] [field] installed check valve and a 1800 mm 72 inch minimum, electrical power cord with plug for 120V/1PH/60HZ electrical service.

2.3.8.1 Motor

Electric motor must comply with NEMA MG 1 and be the size, voltage and enclosure indicated. Provide heavy duty grease lubricated ball bearings completely adequate for the maximum load for which the motor is designed.

2.4 ELECTRICAL WORK

Provide electrical motor driven equipment specified herein complete with motors, motor starters, and controls. Provide electric equipment and wiring in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Electrical characteristics must be as indicated. Provide motor starters complete with properly sized thermal overload protection in each phase and other appurtenances necessary for the motor control specified. Each motor must be of sufficient capacity to drive the equipment at the specified capacity without exceeding the nameplate rating of the motor when operating at proper electrical system voltage and frequency. Manual or automatic control and protective or signal devices required for the operation herein specified and any control wiring required for controls and devices but not indicated must be provided under this section of the specifications.

2.5 ELECTRICAL EQUIPMENT

Provide electrical equipment in conformance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Provide electrical motor driven equipment herein specified complete with motors, motor starters, and controls. Motor controls, equipment, and wiring must be in accordance with NFPA 70.

2.5.1 Electric Motors

Drive each electric motor-driven pump by a continuous-duty electric motor with enclosure type for specific service as defined in paragraph HYDRONIC PUMPS. Motor must have a [1.5] [_____] service factor. Provide [squirrel-cage induction][synchronous] motors having normal-starting-torque and low-starting-current characteristics, and of sufficient size so that the nameplate wattage horsepower rating will not be exceeded throughout the entire published pump characteristic curve. Integral size motors must be the premium efficiency type in accordance with NEMA MG 1. Pump electric motor efficiencies must meet or exceed the

requirements of ASHRAE 189.1, Table C-13. Motor bearings must provide smooth operations under the conditions encountered for the life of the motor. Provide adequate thrust bearing in the motor to carry the weight of all rotating parts plus the hydraulic thrust and be capable of withstanding upthrust imposed during pump starting[and under variable pumping head conditions specified]. Motors must be rated [_____] volts, [_____] phase, 60 Hz and such rating must be stamped on the nameplate. Provide motors in conformance with NEMA MG 1.

2.5.2 Control Equipment

[Manually controlled pumps must have START-STOP pushbutton in cover.][Automatically controlled pumps must have three-position "MANUAL-OFF-AUTOMATIC" selector switch in cover.] Provide additional controls or protective devices as indicated. [Install a pump low-water cutoff [in the well][on the suction pipe] and must shut the pump off when the water level in the well reaches the level shown.]

2.5.3 Variable Speed Control

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NOTE: If any of the motors have a variable speed control, then include this paragraph.
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The variable speed motor controllers must meet the requirements of UFGS 26 29 23 ADJUSTABLE SPEED DRIVE SYSTEMS UNDER 600 VOLTS.

2.6 EQUIPMENT APPURTENANCES

2.6.1 Attachments

Furnish all necessary bolts, nuts, washers, bolt sleeves, and other types of attachments with the equipment for the installation of the equipment. Bolts conform to the requirements of ASTM A307 and hexagonal nuts of the same quality as the bolts used. Threads must be clean-cut and conform to ASME B1.1. Bolts, nuts, and washers specified to be galvanized or not otherwise indicated or specified, must be zinc coated after being threaded, by the hot-dip process conforming to [ASTM A123/A123M][ASTM A153/A153M] as appropriate. Bolts, nuts, and washers specified or indicated to be stainless steel must be Type 316.

2.6.2 Equipment Guards

Provide equipment driven by open shafts, belts, chains, or gears with all-metal guards enclosing the drive mechanism. Secure guards in position with steel braces or straps that permit easy removal for servicing the equipment. Coupler guards must comply with current national safety standards including 29 CFR 1910.219 and NEMA Z535.4. Provide guards with gaps no greater than 6 mm 0.250 inches, safety orange in color, and have an NEMA Z535.4 compliant warning label.

2.6.3 Tools

Furnish a complete set of all special tools which may be necessary for the adjustment, operation, maintenance, and disassembly of all equipment. 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. Special tools must be high-grade, smooth, forged,

alloy, tool steel. Furnish one pressure grease gun for each type of grease required. Deliver all tools at the same time as the equipment to which they pertain. Properly store and safeguard such tools until completion of the work, at which time deliver them to the Contracting Officer.

2.7 FINISHES

All motors, pump casings, and similar parts of equipment must be thoroughly cleaned, primed, and given two finish coats of paint at the factory in accordance with the recommendations of the manufacturer. Give ferrous surfaces not to be painted a shop coat of grease or other suitable rust-resistant coating.

[2.8 FACTORY TESTS

****
NOTE: Factory Tests for specific pumps shipped to construction site are not normally required unless the pumps are used for a critical application where precise performance is required. Manufacturers' performance data is based on factory tests using precision instrumentation and exacting procedures as detailed in Hydraulic Institute Standard ANSI/HI 1.6 Centrifugal Pump Tests for each typical pump model. Delete the following paragraph unless required.
****

Pumps must be tested by the manufacturer or a nationally recognized testing agency in compliance with HI 1.3. Submit certified test results.

]PART 3 EXECUTION

3.1 EXAMINATION

After becoming familiar with all details of the work, verify all dimensions in the field and advise the Contracting Officer of any discrepancy before performing the work.

3.2 INSTALLATION

****
NOTE: Pump and driver shaft alignment on base mounted, long-coupled pumps is critical to reduce vibration, increase bearing life, increase coupler life, and increase mechanical seal life. Although shafts are typically aligned at factory, some misalignment will occur during shipping and lifting. Dial indicators or laser devices are called out to accurately perform final alignment of pump and driver shafts. Scales, straight edges and calipers provide less accurate alignment and are only suitable for initial alignment.
****

Install each pump and motor in accordance with the written instructions of the manufacturer[and under the direct supervision of the manufacturer's representative]. Provide access space around the device for servicing no less than the minimum recommended by the manufacturer.

[3.2.1 Base Mounted, Long-Coupled Pumps

Set the pump baseplate as follows.

a. Place two sets of shims or wedges for each foundation bolt. Lower baseplate onto foundation bolts and level baseplate both lengthwise and across by adding or removing shims or mount wedges. A maximum difference of 3 mm 0.125 inches lengthwise and 1.5 mm 0.059 inches across is allowable.

b. Mount pump and driver on baseplate if not already mounted at factory. Pump and driver shafts must have initial cold (pump and driver at ambient temperature) alignment check and final hot (pump and driver at operating temperature) alignment check. Perform cold alignment check before baseplate is grouted, after baseplate is grouted, and after piping is connected. Perform final alignment check when pump and driver are at operating temperature. Move or shim only the driver to make adjustments to prevent strain on the piping installations. Initial alignment may be performed with scales, straight edges and calipers. Final alignment must be done with dial gauges or laser alignment devices. Final alignment misalignment may not exceed coupling manufacturer's maximum parallel and angular misalignment values. When using variable frequency drives, reduce the manufacturer's misalignment values by 50 percent. Remove flexible coupling when performing alignment.

c. Support the connecting piping to ensure that there are no piping loads at the pump flange connections and connecting piping is not forced into position. [Use concrete for equipment foundations as specified in Section 03 30 00 CAST-IN-PLACE CONCRETE. Provide concrete foundations that are integral with and of the same class as that of the building floor unless otherwise indicated. Use concrete having a compressive strength of at least 17 MPa 2,500 psi in foundations that are entirely separated from the surrounding floor. Install a premolded filler strip between the foundation and floor slab as shown. Furnish foundation bolts, as required, for proper positioning during the placement of the concrete.]

]3.3 FIELD QUALITY CONTROL

After installation of the pumping units and appurtenances, including coupling guard, is complete, carry out operating tests to assure that the pumping installation operates properly.[Make arrangements to have the manufacturer's representatives present when field equipment tests are made.] Give each pumping unit a running field test in the presence of the Contracting Officer for a minimum of 2 hours. Operate each pumping unit at its rated capacity or such other point on its head-capacity curve selected by the Contracting Officer. Provide an accurate and acceptable method of measuring the discharge flow. Tests must assure that the units and appurtenances have been installed correctly, that there is no objectionable heating, vibration, or noise from any parts, and that all manual and automatic controls function properly. If any deficiencies are revealed during any tests, correct such deficiencies and reconduct the tests.

Submit test reports in booklet form showing all field tests performed to adjust each component and all field tests performed to prove compliance with the specified performance criteria, upon completion and testing of

the installed system. Each test report must indicate the final position of controls.

3.4 FIELD PAINTING

Do not paint stainless steel, galvanized steel, and nonferrous surfaces.

3.4.1 Touch-up painting

Factory painted items requiring touching up in the field must be thoroughly cleaned of all foreign material, and primed and topcoated with the manufacturer's standard factory finish.

3.4.2 Exposed Ferrous Surfaces

Paint exposed ferrous surfaces with two coats of enamel paint conforming to SSPC Paint 21. Solvent clean factory primed surfaces before painting. Surfaces that have not been factory primed must be prepared and primed with one coat of SSPC Paint 25 or in accordance with the enamel paint manufacturer's recommendations.

3.5 CLOSEOUT ACTIVITIES

3.5.1 Operation and Maintenance Manuals

Submit one complete set at the time the tests procedure is submitted; remaining sets before the contract is completed. Permanently bind each in a hard cover. Inscribe the following identification on the covers: the words "OPERATING AND MAINTENANCE INSTRUCTIONS," name and location of the building, name of the Contractor, and contract number. Place flysheets before instructions covering each subject. Use 216 by 279 mm 8-1/2 by 11 inches paper for instruction sheets, with large sheets of drawings folded in.

Include, but do not limit to, the following in the Instructions:

a. System layout showing piping, valves, and controls.

b. Approved wiring and control diagrams[including variable frequency drives].

c. A control sequence describing startup, operation, and shutdown.

d. Operating and maintenance instructions for each piece of equipment, including task list for routine maintenance, routine inspections, intermediate inspections, and annual inspections; lubrication instructions; and troubleshooting guide.

e. Manufacturer's bulletins, cuts, and descriptive data; and parts list and recommended spare parts.

3.5.2 Training

Upon completion of the work, and at a time designated by the Contracting Officer, provide the services of one or more competent engineers for a training period of not less than [_____] hours to instruct a representative of the Government in the contents of the operation and maintenance manuals for the equipment furnished under these specifications. These field instructions must cover all the items

contained in the bound instructions. Submit the training course curriculum and training instructions 14 days prior to the start of training.

-- End of Section --