

Preparing Activity: USACE

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated October 2012

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DIVISION 33 - UTILITIES

SECTION 33 52 43.23

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02/10

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SECTION 33 52 43.23

AVIATION FUEL PUMPS
02/10

NOTE: This guide specification covers the requirements for refueling pumps used in aircraft refueling systems constructed to the requirements of the DoD Type III/IV/V, and Cut'n Cover Hydrant Refueling System Standards

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 items(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

NOTE: DoD Type III systems shall conform to Standard Design 078-24-28 PRESSURIZED HYDRANT FUELING SYSTEM (TYPE III). DoD Type IV/V systems shall conform to Standard Design 078-24-29 AIRCRAFT DIRECT FUELING SYSTEM (TYPE IV) DESIGN.

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 in the text by basic
designation only.

AMERICAN BEARING MANUFACTURERS ASSOCIATION (ABMA)

ABMA 7 (1995; R 2008) Shaft and Housing Fits for
Metric Radial Ball and Roller Bearings
(Except Tapered Roller Bearings)
Conforming to Basic Boundary Plan

AMERICAN PETROLEUM INSTITUTE (API)

API STD 682 (2004; Errata 2006) Pumps Shaft Sealing
Systems For Centrifugal and Rotary Pumps

API Std 610 (2010; Errata 2011) Centrifugal Pumps for
Petroleum, Petrochemical, and Natural Gas
Industries

ASME INTERNATIONAL (ASME)

ASME B16.5 (2009) Pipe Flanges and Flanged Fittings:
NPS 1/2 Through NPS 24 Metric/Inch Standard

ASME BPVC SEC IX (2010) BPVC Section IX-Welding and Brazing
Qualifications

ASME BPVC SEC VIII D1 (2010) BPVC Section VIII-Rules for
Construction of Pressure Vessels Division 1

ASTM INTERNATIONAL (ASTM)

ASTM A182/A182M (2012a) Standard Specification for Forged
or Rolled Alloy-Steel Pipe Flanges, Forged
Fittings, and Valves and Parts for
High-Temperature Service

ASTM A276 (2010) Standard Specification for
Stainless Steel Bars and Shapes

ASTM A356/A356M (2011) Standard Specification for Steel
Castings, Carbon, Low Alloy, and Stainless

	Steel, Heavy-Walled for Steam Turbines
ASTM A487/A487M	(1993; R 2012) Standard Specification for Steel Castings Suitable for Pressure Service
ASTM A582/A582M	(2012) Standard Specification for Free-Machining Stainless Steel Bars
ASTM A743/A743M	(2006; R 2010) Standard Specification for Castings, Iron-Chromium, Iron-Chromium-Nickel, Corrosion Resistant, for General Application
ASTM C827/C827M	(2010) Change in Height at Early Ages of Cylindrical Specimens from Cementitious Mixtures
HYDRAULIC INSTITUTE (HI)	
HI M100	(2009) HI Pump Standards Set
INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)	
IEEE 112	(2004) Standard Test Procedure for Polyphase Induction Motors and Generators
NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)	
NEMA MG 1	(2011) Motors and Generators
NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)	
NFPA 70	(2011; Errata 2 2012) National Electrical Code
THE SOCIETY FOR PROTECTIVE COATINGS (SSPC)	
SSPC PA 1	(2000; E 2004) Shop, Field, and Maintenance Painting of Steel
SSPC SP 10/NACE No. 2	(2007) Near-White Blast Cleaning
U.S. DEPARTMENT OF DEFENSE (DOD)	
MIL-DTL-24441	(2009; Rev D) Paint, Epoxy-Polyamide, General Specification for
MIL-PRF-4556	(1998; Rev F; Am 1 1999; Notice 1 2011) Coating Kit, Epoxy, for Interior of Steel Fuel Tanks

1.2 ADMINISTRATIVE REQUIREMENTS

NOTE: Add number of days below. For COE Projects, include in MOU specific AIR FORCE REPRESENTATIVES to be notified when factory test dates are submitted by the CONTRACTING OFFICER.

Design conditions shall be as specified in Section 33 52 43.11 AVIATION FUEL MECHANICAL EQUIPMENT.

- a. Tests: Hydrostatic, performance, vibration, and NPSH tests shall be conducted at the factory on each pump in accord with API 610. Test each pump with the actual motor which will drive the pump in the field, unless the water test media will cause overload of the motor. If so, provide vibration test report for motor separately. Vertical turbine pump vibration test must be run with field driver. All tests will be observed by the Contracting Officer or the designated representative. Provide the Contracting Officer [_____] days notice prior to performance of factory tests in order to schedule observing such tests. Performance testing shall not occur prior to acceptance of shop drawing submittal.
- b. Test reports shall bear the serial number of both pump and driver. Submit manufacturer's certified reports of hydrostatic, performance, and NPSH tests. Submit manufacturer's [certified test curves](#)..
- c. [Operation and Maintenance Manuals](#) shall be submitted for the pumps and appurtenance specified herein. Refer to Section 01 78 23.33 OPERATION AND MAINTENANCE MANUALS FOR AVIATION FUEL SYSTEMS for the information to be submitted.
- d. Motors, manual or automatic motor control equipment, except where installed in motor control centers, and protective or signal devices required for the operation specified herein shall be provided under this section in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Any wiring required for the operation specified herein, but not shown on the electrical plans, shall be provided under this section in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Motors shall be high efficiency type and in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

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.

The Guide Specification technical editors have designated 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 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.] [information only. When used, a designation following the "G" designation 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

Fueling Pumps (FP-1 through FP-5) [; G] [; G, [____]].
Offload Pumps [; G] [; G, [____]].
Fuel Transfer Pump [; G] [; G, [____]].
Water Draw-off Pump [; G] [; G, [____]].

SD-03 Product Data

Fueling Pumps (FP-1 through FP-5) [; G] [; G, [____]].
Offload Pumps [; G] [; G, [____]].
Fuel Transfer Pump [; G] [; G, [____]].
Water Draw-off Pump [; G] [; G, [____]].

SD-06 Test Reports

Certified Test Curves

SD-07 Certificates

Fueling Pumps (FP-1 through FP-5) [; G] [; G, [____]].
Offload Pumps [; G] [; G, [____]].
Fuel Transfer Pump [; G] [; G, [____]].
Water Draw-off Pump [; G] [; G, [____]].

SD-10 Operation and Maintenance Data

Operation and Maintenance Manuals [; G] [; G, [____]].

PART 2 PRODUCTS

2.1 FUELING PUMPS (FP-1 through FP-5)

2.1.1 Capacity

NOTE: Insert site specific pump requirements.

Capacity shall be 45 L/s 600 gpm against a total head of [____] m feet

when driven at 3600 rpm. Overall efficiency at design conditions of pump and driver, connected, shall be minimum of [_____] percent. Pump head capacity shall be continually rising and shall be free of dips and valleys from design point to shut-off head. Pump shut-off head shall have a 10 to 20 percent head rise to shut off. Pump shall be capable of at least a 10 percent head increase at rated conditions by installing a new impeller. Pumps shall not overheat or be damaged in any way while operating continuously at a minimum flow condition of 11 L/s 150 gpm and continuously at a maximum flow condition of 125 percent required capacity. The unit will also be required to operate at a flow of 12.5 percent required capacity GPM without exceeding the vibration limits given in API Std 610 at that flowrate. These pumps are for parallel operation and shall have equal head at minimum continuous stable flow, plus or minus 2 percent.

2.1.2 General Requirements

- a. The pumps shall meet the requirements of API Std 610, latest edition. Whenever the information contained herein conflicts with said standard, the information herein shall govern. The pumps shall run at a nominal 3600 rpm and shall be single stage centrifugals, horizontally mounted, vertical or radial split case, enclosed impeller, with end suction and top vertical discharge. Pumps shall be of the back pull-out design to permit removing case half from rear for access to internal parts without disturbing the suction or discharge piping or the driver. All parts shall be factory inspected so that parts are interchangeable. Pumps and motors shall be furnished as complete units as herein specified. Pump assembly shall be statically and dynamically balanced for all flow rates from minimum flow to 120 percent of design flow.
- b. The pump shall require no more than 4.6 m 15-feet of net positive suction head (NPSHR) when it is operated with water at a capacity of 45 L/s 600 gpm at rated head and speed. A hydrocarbon reduction or correction factor shall not be used. Pump suction specific speed shall be less than 12,000.
- c. The pump shall be horizontal, single stage, single suction with double volute construction to assure radial balance. It shall be designed to permit removal of the impeller, shaft, bearings and bearing housing as an assembly, without disconnecting the suction or discharge piping.
- d. The pump case shall be end suction, centerline discharge type for ease of piping alignment. Flange ratings shall be class 105 kg 300-pound per ASME B16.5. The case shall be designed for maximum discharge pressure at pumping temperature but not less than 3.8 MPa 550 psig, with a minimum corrosion allowance of 3 mm 1/8-inch. The suction and discharge flanges as well as the cover bolting surfaces shall be backfaced or spotfaced for positive bolt seating. The radial case to cover split shall be a metal-to-metal fit with a confined, controlled compression gasket.
- e. The pump cover shall contain a stuffing box designed to accept an unbalanced mechanical seal. The stuffing box shall have a minimum of 75 mm 3-inch studs for seal gland bolting. The gasket fit for seal gland to stuffing box shall be of the controlled compression type with metal-to-metal joint contact.
- f. Both case and cover are to be fitted with renewable wear rings.
- g. The impeller shall be of the enclosed type, dynamically and

hydraulically balanced. It shall be key driven, held in place by a positive lock, threaded against rotation. The running clearance between the impeller and case-cover wear rings shall be no less than **1.4 mm 0.018-inches**.

- h. Mechanical Seal: A single unbalanced mechanical seal per **API Std 610** code USTHN, unbalanced single seal with throttle bushing seal gland, a nitrile seal-ring-to-sleeve gasket and carbon against silicon carbide faces, of multiple spring design shall be supplied. The seal gland shall be tapped for three connections and each shall be stamped for identification as follows: Q for quench; F for flush; and D for drain. A non-sparking throttle bushing pressed into the seal end plate against an outside shoulder shall be provided to minimize leakage on complete seal failure.
- i. Bearing Housing: Oil lubricated anti-friction, radial and thrust bearings of standard design shall be supplied. The bearings shall be selected to give a minimum L-10 rating life of 25,000 hours in continuous operation. Bearings shall be retained on the shaft and fitted into housings in accordance with **ABMA 7**. Locking of the ball thrust bearing to the shaft shall be by series W tank type washer. Minimum spacing between bearing centerlines shall be **162 mm 6.5-inches**.
- j. A sight glass for checking oil level with a permanent indication of proper oil level shall be supplied.
- k. Bearing housings shall be equipped with labyrinth type end seals and deflectors where the shaft passes through the housing; lip-type seals shall not be used. Deflectors shall be made of non-sparking material. The deflector design shall effectively retain oil in the housing and prevent entry of foreign material into the housing.
- l. Shafts shall be of ample size to transmit the maximum torque required under specified operating conditions, and to withstand continuously all stresses resulting from supported weights, thrusts and starting, including across-the-line motor starting. It shall be key seated to provide positive drive for the coupling, shaft sleeve and impeller. The shaft stiffness factor shall be under 70. The radial bearing centerline to impeller centerline, distance and the pump shaft diameter under the sleeve shall be provided to calculate the factor.
- m. A spacer coupling shall be supplied. The spacer length shall permit the removal of the assembled pullout element without disturbing the driver or the suction and discharge piping. Couplings shall be properly keyed in place. Cylindrical fits shall be light enough to permit easy removal of the hub in the field without the need for heating. A service factor of at least 1.5 shall be used in selecting couplings based on manufacturer's ratings.
- n. Removable coupling guards of the non-sparking type shall be supplied. They shall comply with the requirements of OSHA.
- o. Total indicated shaft runout at coupling end shall be **0.025 mm 0.001-inches** or less. Total shaft deflection shall be no more than **0.050 mm 0.002-inches** at face of stuffing box.
- p. Baseplate: The baseplate shall be of fabricated steel construction. It shall be of the drain pan style, sloping from back to front. Connections for a drain shall be tapped (**25 mm1-inch** minimum) at the

pump end and located to accomplish complete drainage. A grout hole of at least 200 mm 8-inches minimum diameter shall be supplied and shall have 13 mm 1/2-inch minimum raised lip edge. Pump pedestals shall be trapezoidal in design.

- q. Materials: No zinc, brass, bronze or other copper bearing alloy shall come in contact with the fuel. Materials shall be material class C-6, unless otherwise noted.
- r. The case and cover shall be constructed of stainless steel
ASTM A487/A487M GR CF8M or ASTM A487/A487M GR CA6NM or aluminum
ASTM A356/A356M GR T6.
- s. Impeller material shall be stainless steel ASTM A487/A487M GR CF8M or
ASTM A743/A743M CA 6NM or CA 15.
- t. Wear rings shall be stainless steel ASTM A182/A182M GR F6 or ASTM A276
TP410 or 416.
- u. Shaft shall be stainless steel ASTM A276 type 410 or 416 or
ASTM A582/A582M Type 410 or 416.
- v. Testing: All shop testing shall be performed in accordance with the
API Std 610.

2.1.3 Service Nameplate

A pump service nameplate, of type 18-8 stainless steel or monel, attached by stainless steel pins at an accessible point on the pump, shall be furnished in addition to the identification nameplate. The pump service nameplate shall be stamped with the following information:

Manufacturer's name
Serial number of pump
Capacity, L/s gpm
Pumping head, mft.
Maximum specific gravity of fluid to be pumped
Revolutions per minute
Horsepower of driver

2.1.4 Identification Nameplate

A pump identification nameplate of Type 18-8 stainless steel or monel shall be provided and securely attached by stainless steel pins to a conspicuous place on the pump head. Tagging in letters 6 mm 1/4-inch high shall bear the equipment number as shown on the drawings.

2.1.5 Exterior Primer Coat

Exterior surfaces of the baseplate shall be primed by the manufacturer. Coating shall be applied meeting requirements of SSPC PA 1. Surface cleaning shall meet requirements of SSPC SP 10/NACE No. 2. Metal primer shall be zinc rich paint conforming to specification MIL-DTL-24441, Type 1, Class 3. Dry film thickness shall be 0.05 to 0.10 mm 2 to 4 mils.

2.1.6 Exterior Topcoat

Manufacturer's standard exterior topcoat shall be applied at factory to the base plate.

2.1.7 Motors

- a. Motor shall be furnished by the pump manufacturer and shall be non-overloading with 10 percent head increase, and suitable for the environment and operating conditions to which it will be subjected. Motors for vertical turbine pumps shall be provided with anti-reversing ratchet. Provide space heaters suitable for operation on 460 or 120 volts as indicated on the drawings within the motor enclosure to prevent moisture condensation after shut-down. Motor shall be UL listed for use in Class 1, Division 1, Group D hazardous areas, and shall have a maximum temperature rating of T2D (218 degrees C 419 degrees F) as defined by NFPA 70. The motor nameplate shall include the temperature rating of the motor and locked-rotor indicating code letters in accordance with NFPA 70, Table 430-7(b).
- b. Voltage rating shall be 460 volts, 3 phase, 60HZ. Motor nominal speed shall match pump. Motors shall be capable of delivering rated horsepower output successfully and continuously under conditions of voltage variations of 10 percent above or below rated voltage.
- c. Pump manufacturer shall assure the specified output and proper operation of the pump without being overloaded at unity service factor when operating at any point on the pump performance curve. In addition to having sufficient horsepower-output rating at rated speed, motor shall have performance characteristics which will allow, without injurious overheating of the motor, accelerating the load from standstill to rated speed under conditions of 10 starts per hour. Attention is specifically directed to the fact that thermal characteristics of motors with regard to capability for accelerating the load may vary greatly from motor manufacturer to motor manufacturer, notwithstanding that the horsepower rating may be the same. It is the pump manufacturer's responsibility to provide motors with adequate thermal starting characteristics as well as adequate rated-speed operating characteristics. Service factors shall conform with NEMA standards; however, service factors are only applicable at rated nameplate voltage and frequency. Since all system voltages are subject to variation, service factors above unity shall not be applied in sizing motor.
- d. Motor shall be squirrel-cage induction type. Motor shall be NEMA Design B (normal-torque, low starting current).
- e. Motor insulation shall be non-hygroscopic, NEMA Class H, 180 degrees C 82 degrees F for motors over 7.5 kW 10 hp and NEMA Class F, 150 degrees C 302 degrees F for 7.5 kW 10 hp and smaller. Stator windings shall be epoxy impregnated. The impregnations shall be applied by the vacuum and pressure process.
- f. Winding temperature rise, (based on a maximum ambient temperature of 40 degrees C 4 degrees F at 1006 m 3300-feet altitude) shall not exceed 80 degrees C 176 degrees F.
- g. Bearings shall be ABMA minimum L10 life of 60,000 hours or L50 life of 300,000 hours suitable for the size, type, and application when the pump is operating at the specified flow and head.
- h. Motor enclosures shall be totally enclosed, weather sealed, fan cooled, explosion-proof and shall be listed and labeled for Class 1, Group D

areas. Provide bronze ground bolt on motor enclosure. All motor external electrical connections shall be terminated within a single terminal housing.

- i. The dynamic balance, overspeed withstand capability, and sound power levels of the motor shall conform with NEMA standard requirements.
- j. The pump manufacturer shall furnish the Contracting Officer with the recommended minimum run time for the motor.
- k. Pump motor shall be provided with temperature limiting thermostats within the motor frame when required to meet Class 1, Group D requirements.
- l. Pump motor shall be furnished with lifting lugs on the motor casing.
- m. Unless indicated otherwise, motors for conventional applications over 15 horsepower shall be the premium efficient type. This requirement is not applicable to hermetically sealed motors, integrally mounted motors, motors specified as part of energy efficient equipment, wound rotor motors, or any application involving special construction or performance. Guaranteed minimum full load efficiencies shall be (based on 3600, 2 pole, totally enclosed):

15 kW20 hp	92.0%	56 kW75 hp	95.5%
19 kW25 hp	92.0%	75 kW100 hp	93.5%
22 kW30 hp	92.0%	93 kW125 hp	94.5%
30 kW40 hp	92.0%	112 kW150 hp	94.5%
37 kW50 hp	92.5%	149 kW200 hp	94.5%
45 kW60 hp	92.5%	447 kW600 hp	94.5%

- n. Other motors of different speed or housing classification shall also be of the premium efficient type, as advertised by the motor manufacturer, with efficiency greater than the standard line. Motor efficiencies shall have been verified in accordance with NEMA MG 1, 12.53.a., and determined using the dynamometer method as described in IEEE 112, Method B. All shop drawing submittals on motor driven equipment shall include the motor efficiency.

2.2 FUELING PUMP (VERTICAL TURBINE) (FP)

2.2.1 Capacity

NOTE: Insert site specific pump requirements.

Capacity shall be [45] [68] L/s [600] [900] gpm against a total head of [____] m feet for the Fueling Pump, when driven at 1800 rpm. Overall efficiency at design conditions of pump and driver, connected, shall be minimum [____] percent. Pump head capacity shall be continually rising and shall be free of dips and valleys from design point to shut-off head. Pump shall be capable of at least 5 percent head increase at rated conditions by

installing a new impeller.

2.2.2 Assembly

The pump for this service shall meet the requirements of [API Std 610](#), latest edition, seventh edition for vibration. Wherever the information contained herein conflicts with said standard, the information herein shall govern. The pump for this service shall run at a nominal 1800 rpm and shall be a multi-stage, vertical turbine pump. Pump and motor shall be furnished as a complete unit as herein specified. Pump assembly shall be statically and dynamically balanced for all flow rates from minimum flow to 120 percent of design flow. Flanged column, shaft, and bearing spacing shall not exceed [1.5 m](#) [5-foot](#) sections to facilitate pump disassembly within pump room.

2.2.3 Materials

The materials of construction for the pump shaft and the impeller shall be stainless steel. All other materials shall be material class S-1 with the wetted ferrous parts such as the bowl interiors enamel-lined, bowl exteriors, column interior and exterior, discharge head interior epoxy-coated per [MIL-PRF-4556](#), and discharge head exterior epoxy-coated per [MIL-DTL-24441](#).

2.2.3.1 Mechanical Seal

[API STD 682](#), balanced type, API Class Code BSTHN.

2.2.4 Construction

Castings used for any part of pumps shall be sound and free of shrink or blow holes, scale, blisters, and other similar casting defects. The surfaces of casting shall be cleaned by sand or shot blasting, pickling, or other standard methods used by the manufacturer. All mold parting fins and remains of gates and risers shall be either chipped, filed, or ground flush with the surface of the casting. The repair of casting leaks and defects by peening or by the use of cement compounds is prohibited. All welding to be per [ASME BPVC SEC IX](#).

2.2.4.1 Couplings

Couplings shall be flanged, rigid spacer type, CPAT or equal. The couplings shall be of the spacer-type with a spacer of sufficient length to permit replacement of the mechanical seal assembly without removing the motor. The pump half coupling shall be of such design that it can be removed without the use of heat. Coupling halves shall fit tightly to the shafts of the pump and the driver so as not to become loose during operation. The coupling shall be provided with an OSHA approved coupling guard.

2.2.4.2 Impeller

Impeller shall be enclosed and double keyed to the shaft for radial loads and fixed in the axial position by shaft sleeve nuts, or other positive positioning device. Impellers shall be held to the shaft so that the impeller will not become loose should the pump accidentally rotate in reverse direction. The impeller shall be statically and dynamically balanced to 8 W/N.

2.2.4.3 Wear Rings

Renewable stainless steel wearing rings shall be positively locked on the impeller. Wearing rings shall fit with close tolerances so as to permit a minimum of recirculation. Wear ring hardened surfaces differential shall be at least Brinell 50. Positive locking case wearing rings shall be provided so that the case wearing rings will not rotate or change position in the case. Clearances shall be established for hydrocarbon (Jet Fuel) service.

2.2.4.4 Shaft

Shaft shall be designed with a high safety factor to easily withstand the torsional loads and other stresses to which it may be subjected. It shall be so designed that there will be no detrimental vibration stresses. Surfaces shall be ground to accurate dimensions. Shaft deflection shall be limited to 0.05 mm 0.0020-inch maximum when measured at the face of the mechanical seal under the operating condition of zero flow at shut off head. Seal piping from the discharge to the mechanical seal shall be provided. The pump shaft shall be in maximum 1.5 m 5 foot sections, and couplings shall be keyed and split ring type, not threaded.

2.2.4.5 Finishing

Passageways and impellers shall be finished to permit maximum efficiency and provide noise reduction. Overall sound levels shall not exceed OSHA limits.

2.2.4.6 Bearings

Bearings shall be product-lubricated. Sleeve type, carbon graphite shall be provided. Bearing spacing shall be per API Std 610, eight edition, but shall not exceed 1.5 m 5-foot in any case.

2.2.4.7 Drilling and Tapping

Casting shall be drilled and tapped for drain and seal recirculation lines. All connections shall be provided with plugs.

2.2.4.8 Mounting Flange

Mounting flange shall be coordinated with the tank's mounting flange, and shall be ANSI or API pattern, and contain a 25 mm 1-inch tapping for air eliminator discharge.

2.2.4.9 Pump Discharge

Pump discharge head shall include a 25 mm 1 inch tapping at the highest point with valve, 100 mesh strainer, and air eliminator valve, as specified in Section 33 52 43.13, AVIATION FUEL PIPING, with check valve on outlet.

2.2.4.10 Special Tools

Pumps shall be furnished with special tools necessary to dismantle and reassemble the unit.

2.2.4.11 Service Nameplate

A pump service nameplate, of type 18-8 stainless steel or monel, securely

attached by stainless steel pins at an easily accessible point on the pump, shall be furnished in addition to the identification nameplate. The pump service nameplate shall be stamped with the following information:

Manufacturer's name
Serial number of pump
Capacity, L/s gpm
Pumping head, m ft.
Maximum specific gravity of fluid to be pumped
Revolutions per minute
Horsepower of driver

2.2.4.12 Identification Nameplate

A pump identification nameplate of Type 18-8 stainless steel or monel shall be provided and securely attached by stainless steel pins to a conspicuous place on the pump head. Tagging in letters 6 mm 1/4-inch high shall be the equipment number as shown on the drawings.

2.2.4.13 Primer Coat

Surfaces of the pump and baseplate shall be primed by the manufacturer. Surface cleaning shall meet requirements of SSPC SP 10/NACE No. 2. Metal primer shall be zinc rich paint conforming to specification MIL-DTL-24441 Type 1, Class 3. Dry film thickness shall be 0.05 to 0.2 mm 2 to 4 mils.

2.2.4.14 Topcoat

Topcoat shall be factory applied and shall be white and conforming to specification MIL-DTL-24441.

2.2.5 Motor

- a. Motor shall be furnished by the pump manufacturer and shall be suitable for the environment and operating conditions to which it will be subjected and be provided with anti-reversing ratchet. Provide space heaters suitable for operation on 460 or 120 volts as indicated on the drawings within the motor enclosure to prevent moisture condensation after shut-down. Motor shall be UL listed for use in Class 1, Division 1, Group D hazardous areas, and shall have a maximum temperature rating of "T2D 216 degrees C 419 degrees F " as defined by NFPA 70. The motor nameplate shall include the temperature rating of the motor and locked-rotor indicating code letters in accordance with NFPA 70, Table 430-7(b).
- b. Voltage rating shall be 460 volts, 3 phase, 60HZ. Motor nominal speed shall match pump. Motors shall be capable of delivering rated horsepower output successfully and continuously under conditions of voltage variations of 10 percent above or below rated voltage.
- c. Pump manufacturer shall assure the specified output and proper operation of the pump without being overloaded at unity service factor when operating at any point on the pump performance curve based on the future potential of a 5% head increase. In addition to having sufficient horsepower-output rating at rated speed, motor shall have performance characteristics which will allow, without injurious overheating of the motor, accelerating the load from standstill to rated speed under conditions of 10 starts per hour. Attention is specifically directed to the fact that thermal characteristics of

motors with regard to capability for accelerating the load may vary greatly from motor manufacturer to motor manufacturer, notwithstanding that the horsepower rating may be the same. It is the pump manufacturer's responsibility to provide motors with adequate thermal starting characteristics as well as adequate rated-speed operating characteristics. Service factors shall conform with NEMA standards; however, service factors are only applicable at rated nameplate voltage and frequency. Since all system voltages are subject to variation, service factors above unity shall not be applied in sizing motor.

- d. Motor shall be squirrel-cage induction type, high thrust vertical P base, unless bearing frame pump is utilized. Motor shall be NEMA Design B (normal-torque, low starting current).
- e. Motor insulation shall be non-hygroscopic, NEMA Class F, 150 degrees C 302 degrees F for motors. Motor windings shall be supplied with extra dips and bakes.
- f. Winding temperature rise, (based on a maximum ambient temperature of 40 degrees C 104 degrees F at 1006 m 3300-feet altitude) shall not exceed 80 degrees C 176 degrees F.
- g. Bearings shall be ABMA minimum L10 life of 60,000 hours or L50 life of 300,000 hours suitable for the size, type, and application when the pump is operating at the specified flow and head.
- h. Motor enclosures shall be totally enclosed, weather sealed, fan cooled, explosion-proof and shall be listed and labeled for Class 1, Group D areas. Provide bronze ground bolt on motor enclosure. All motor external electrical connections shall be terminated within a single terminal housing.
- i. The motors shall be dynamically balanced and vibration measured per NEMA MG 1, vibration and balance under category "precision". Motor overspeed withstand capability and sound power levels of the motor shall conform with NEMA standard requirements.
- j. The pump manufacturer shall furnish the Contracting Officer with the recommended minimum run time for the motor.
- k. Pump motor shall be provided with temperature limiting thermostats within the motor frame when required to meet Class 1, Group D requirements.
- l. Pump motor shall be furnished with lifting lugs on the motor casing.
- m. Unless indicated otherwise, motors for conventional applications over 15 horsepower shall be the premium efficient type. This requirement is not applicable to hermetically sealed motors, integrally mounted motors, motors specified as part of energy efficient equipment, wound rotor motors, or any application involving special construction or performance. Guaranteed minimum full load efficiencies shall be (based on 1800 rpm, 4 pole, totally enclosed):

15 kW20 hp	92.0%	56 kW75 hp	95.5%
19 kW25 hp	92.0%	75 kW100 hp	93.5%

22 kW30 hp	92.0%	93 kW125 hp	94.5%
30 kW40 hp	92.0%	112 kW150 hp	94.5%
37 kW50 hp	92.5%	149 kW200 hp	94.5%
45 kW60 hp	92.5%	447 kW600 hp	94.5%

- n. Other motors of different speed or housing classification shall also be of the premium efficient type, as advertised by the motor manufacturer, with efficiency greater than the standard line. Motor efficiencies shall have been verified in accordance with NEMA MG 1, 12.53.a., and determined using the dynamometer method as described in IEEE 112, Method B. All shop drawing submittals on motor driven equipment shall include the motor efficiency.

2.3 OFFLOAD PUMPS

2.3.1 Capacity

NOTE: Insert site specific pump requirements. Pump capacity to be provided by MAJCOM.

Capacity shall be [45] [23] L/s [600] [300] gpm against a total head of [_____] m feet when driven at 3600 rpm. Overall efficiency at design conditions of pump and driver, connected, shall be minimum of 60 percent. Pump head capacity shall be continually rising and shall be free of dips and valleys from design point to shut-off head. Pump shut-off head shall have a 10 to 20 percent head rise to shut off. Pump shall be capable of at least a 10 percent head increase at rated conditions by installing a new impeller. Pumps shall not overheat or be damaged in any way while operating continuously at a minimum flow condition of 11 L/s 150 gpm and continuously at a maximum flow condition of 125 percent required capacity L/s GPM. The unit will also be required to operate at a flow of 12.5 percent required capacity without exceeding the vibration limits given in API Std 610. These pumps are for parallel operation and shall have equal head at minimum continuous stable flow, plus or minus 2 percent.

2.3.2 General Requirements

- a. The pumps for this service shall meet the requirements of API Std 610, latest edition. Whenever the information contained herein conflicts with said standard, the information here in shall govern. The pumps for this service shall run at a nominal 3600 rpm and shall be single stage centrifugals, horizontally mounted, vertical or radial split case, enclosed impeller, vertical-in-line with end suction and discharge. All parts shall be factory inspected so that parts are interchangeable. Pumps and motors shall be furnished as complete units as herein specified. Pump assembly shall be statically and dynamically balanced for all flow rates from no flow to 120 percent of design flow.
- b. The pump shall require no more than 4.7 m 15.5-feet of net positive suction head (NPSHR) when it is operated with water at a capacity of [45] [23] L/s [600] [300] gpm at rated head and speed. A hydrocarbon reduction or correction factor shall not be used. Pump suction specific speed shall be less than 12,000.

- c. The pump shall be vertical in-line, single stage, single suction with double volute construction to assure radial balance. It shall be designed to permit removal of the impeller, shaft, bearings and bearing housing as an assembly, without disconnecting the suction or discharge piping.
- d. The pump case shall be vertical in-line type for ease of piping alignment. Flange ratings shall be class 100 kg 300-pound per ASME B16.5. The case shall be designed for maximum discharge pressure at pumping temperature but not less than 3.8 MPa 550 psig, with a minimum corrosion allowance of 3mm 1/8-inch. The suction and discharge flanges as well as the cover bolting surfaces shall be backfaced or spotfaced for positive bolt seating. The radial case to cover split shall be a metal-to-metal fit with a confined, controlled compression gasket.
- e. The pump cover shall contain a stuffing box designed to accept an unbalanced mechanical seal. The stuffing box shall have a minimum of 75 mm 3-inch studs for seal gland bolting. The gasket fit for seal gland to stuffing box shall be of the controlled compression type with metal-to-metal joint contact.
- f. Both case and cover are to be fitted with renewable wear rings.
- g. The impeller shall be of the enclosed type, dynamically and hydraulically balanced. It shall be key driven, held in place by a positive lock, threaded against rotation.
- h. Mechanical Seal. A single unbalanced mechanical seal per API Std 610 code USTHN of multiple spring design shall be supplied. The seal gland shall be tapped for three connections and each shall be stamped for identification as follows: Q for quench; F for flush; and D for drain. A non-sparking throttle bushing pressed into the seal end plate against an outside shoulder shall be provided to minimize leakage on complete seal failure.
- i. Bearing Housing. Grease lubricated anti-friction, radial and thrust bearings of standard design shall be supplied. The bearings shall be selected to give a minimum L-10 rating life of 25,000 hours in continuous operation. Pumps may be provided with or without bearing brackets.
- j. Shafts shall be of ample size to transmit the maximum torque required under specified operating conditions, and to withstand continuously all stresses resulting from supported weights, thrusts and starting, including across-the-line motor starting. It shall be key seated to provide positive drive for the line motor starting. It shall be key seated to provide positive drive for the coupling, shaft sleeve and impeller. The shaft stiffness factor shall be under 70. The radial bearing centerline to impeller centerline, distance and the pump shaft diameter under the sleeve shall be provided to calculate the factor.
- k. A rigid type spacer coupling shall be supplied. The spacer length shall permit the removal of the assembled pullout element without disturbing the driver or the suction and discharge piping. Couplings shall be properly keyed in place. Cylindrical fits shall be light enough to permit easy removal of the hub in the field without the need for heating. A service factor of at least 1.5 shall be used in

selecting couplings based on manufacturer's ratings.

- l. Removable coupling guards of the non-sparking type shall be supplied. They shall comply with the requirements of OSHA.
- m. Total indicated shaft runout at coupling end shall be 0.025 mm 0.001-inches or less. Total shaft deflection shall be no more than 0.05 mm 0.002-inches at face of stuffing box.
- n. Materials. No zinc, brass, bronze or other copper bearing alloy shall come in contact with the fuel.
- o. The case and cover shall be constructed of stainless steel ASTM A487/A487M GR CF8M or ASTM A487/A487M GR CA6NM or aluminum ASTM A356/A356M GR T6.
- p. Impeller material shall be stainless steel ASTM A487/A487M GR CF8M or ASTM A743/A743M CA 6NM.
- q. Wear rings shall be stainless steel ASTM A182/A182M GR F6 or ASTM A276 TP410 or 416.
- r. Shaft shall be stainless steel ASTM A276 type 410 or 416 or ASTM A582/A582M Type 410 or 416 with renewable shaft sleeve of ASTM A276 type 316L with hard facing under mechanical seal gasket.
- s. Testing. All shop testing shall be performed in accordance with the HI M100.

2.3.3 Service Nameplate

A pump service nameplate, of type 18-8 stainless steel or monel, attached by stainless steel pins at an accessible point on the pump, shall be furnished in addition to the identification nameplate. The pump service nameplate shall be stamped with the following information:

Manufacturer's name
Serial number of pump
Capacity, L/s gpm
Pumping head, m ft.
Maximum specific gravity of fluid to be pumped
Revolutions per minute
Horsepower of driver

2.3.4 Identification Nameplate

A pump identification nameplate of Type 18-8 stainless steel or monel shall be provided and securely attached by stainless steel pins to a conspicuous place on the pump head. Tagging in letters 6 mm 1/4-inch high shall bear the equipment number as shown on the drawings.

2.3.5 Exterior Primer Coat

Exterior surfaces of the baseplate shall be primed by the manufacturer. Coating shall be applied meeting requirements of SSPC PA 1. Surface cleaning shall meet requirements of SSPC SP 10/NACE No. 2. Metal primer shall be zinc rich paint conforming to specification MIL-DTL-24441, Type 1, Class 3. Dry film thickness shall be 0.05 to 0.1 mm 2 to 4 mils.

2.3.6 Exterior Topcoat

Manufacturer's standard exterior topcoat shall be applied at factory to the base plate.

2.3.7 Motors

- a. Motor shall be furnished by the pump manufacturer and shall be suitable for the environment and operating conditions to which it will be subjected. Provide space heaters suitable for operation on 460 or 120 volts as indicated on the drawings within the motor enclosure to prevent moisture condensation after shut-down. Motor shall be UL listed for use in Class 1, Division 1, Group D hazardous areas, and shall have a maximum temperature rating of T2D (216 degrees C 419 degrees F) as defined by NFPA 70. The motor nameplate shall include the temperature rating of the motor and locked-rotor indicating code letters in accordance with NFPA 70, Table 430-7(b).
- b. Voltage rating shall be 460 volts, 3 phase, 60HZ. Motor nominal speed shall match pump. Motors shall be capable of delivering rated horsepower output successfully and continuously under conditions of voltage variations of 10 percent above or below rated voltage.
- c. Pump manufacturer shall assure the specified output and proper operation of the pump without being overloaded at unity service factor when operating at any point on the pump performance curve. In addition to having sufficient horsepower-output rating at rated speed, motor shall have performance characteristics which will allow, without injurious overheating of the motor, accelerating the load from standstill to rated speed under conditions of 10 starts per hour. Attention is specifically directed to the fact that thermal characteristics of motors with regard to capability for accelerating the load may vary greatly from motor manufacturer to motor manufacturer, notwithstanding that the horsepower rating may be the same. It is the pump manufacturer's responsibility to provide motors with adequate thermal starting characteristics as well as adequate rated-speed operating characteristics. Service factors shall conform with NEMA standards; however, service factors are only applicable at rated nameplate voltage and frequency. Since all system voltages are subject to variation, service factors above unity shall not be applied in sizing motor.
- d. Motor shall be squirrel-cage induction type. Motor shall be NEMA Design B (normal-torque, low starting current).
- e. Motor insulation shall be non-hygroscopic, NEMA Class F, 150 degrees C 300 degrees F for motors. Stator windings shall be epoxy impregnated. The impregnations shall be applied by the vacuum and pressure process.
- f. Winding temperature rise, (based on a maximum ambient temperature of 40 degrees C 104 degrees F at 1006 m 3300-feet altitude) shall not exceed 80 degrees C 176 degrees F.
- g. Bearings shall be ABMA minimum L10 life of 60,000 hours or L50 life of 300,000 hours suitable for the size, type, and application when the pump is operating at the specified flow and head.
- h. Motor enclosures shall be totally enclosed, weather sealed, fan cooled, explosion-proof and shall be listed and labeled for Class 1, Group D

areas. Provide bronze ground bolt on motor enclosure. All motor external electrical connections shall be terminated within a single terminal housing.

- i. The dynamic balance, overspeed withstand capability, and sound power levels of the motor shall conform with NEMA standard requirements.
- j. The pump manufacturer shall furnish the Contracting Officer with the recommended minimum run time for the motor.
- k. Pump motor shall be provided with temperature limiting thermostats within the motor frame when required to meet Class 1, Group D requirements.
- l. Pump motor shall be furnished with lifting lugs on the motor casing.
- m. Unless indicated otherwise, motors for conventional applications over 15 horsepower shall be the premium efficient type. This requirement is not applicable to hermetically sealed motors, integrally mounted motors, motors specified as part of energy efficient equipment, wound rotor motors, or any application involving special construction or performance. Guaranteed minimum full load efficiencies shall be (based on 3600 rpm, 2 pole totally enclosed):

15 kW20 hp	92.0%	56 kW75 hp	95.5%
19 kW25 hp	92.0%	75 kW100 hp	93.5%
22 kW30 hp	92.0%	93 kW125 hp	94.5%
30 kW40 hp	92.0%	112 kW150 hp	94.5%
37 kW50 hp	92.5%	149 kW200 hp	94.5%
45 kW60 hp	92.5%	373 kW500 hp	94.5%

- n. Other motors of different speed or housing classification shall also be of the premium efficient type, as advertised by the motor manufacturer, with efficiency greater than the standard line. Motor efficiencies shall have been verified in accordance with NEMA MG 1, 12.53.a., and determined using the dynamometer method as described in IEEE 112, Method B. All shop drawing submittals on motor driven equipment shall include the motor efficiency.

2.4 FUEL TRANSFER PUMP (FTP-1) AND WATER DRAW-OFF PUMP (WSP-1 AND WSP-2)

2.4.1 Capacity

NOTE: Insert site specific pump requirements.

Capacity shall be 3.8 L/s 50 gpm against a total head of [_____] m feet for the Fuel Transfer Pump, and 3.8 L/s 50 gpm against a total head of [_____] m feet for the Water Draw-off Pump, when driven at 1800 rpm. Overall efficiency at design conditions of pump and driver, connected, shall be minimum [_____] percent. Pump head capacity shall be continually rising and shall be free of dips and valleys from design point to shut-off head.

Pump shall be capable of at least 10 percent head increase at rated conditions by installing a new impeller.

2.4.2 Assembly

NOTE: Select pump stage requirements.

The pump for this service shall meet the requirements of **API Std 610**, latest edition, seventh edition for vibration. Wherever the information contained herein conflicts with said standard, the information herein shall govern. The pump for this service shall run at a nominal 1800 rpm and shall be a [single stage] [multi-stage], vertical turbine pump. Pump and motor shall be furnished as a complete unit as herein specified. Pump assembly shall be statically and dynamically balanced for all flow rates from minimum flow to 120 percent of design flow.

2.4.3 Materials

The materials of construction for the pump shaft and the impeller shall be stainless steel. All other materials shall be material class S-1 with the wetted ferrous parts such as the bowl interiors enamel-lined, bowl exteriors, column interior and exterior, discharge head interior epoxy-coated per **MIL-PRF-4556**, and discharge head exterior epoxy-coated per **MIL-DTL-24441**.

2.4.3.1 Mechanical Seal

API STD 682, balanced type, API Class Code BSTHN.

2.4.4 Construction

Castings used for any part of pumps shall be sound and free of shrink or blow holes, scale, blisters, and other similar casting defects. The surfaces of casting shall be cleaned by sand or shot blasting, pickling, or other standard methods used by the manufacturer. All mold parting fins and remains of gates and risers shall be either chipped, filed, or ground flush with the surface of the casting. The repair of casting leaks and defects by peening or by the use of cement compounds is prohibited by **ASME BPVC SEC VIII D1**.

2.4.4.1 Couplings

Couplings shall be flanged, rigid spacer type, CPAT or equal. The couplings shall be of the spacer-type with a spacer of sufficient length to permit replacement of the mechanical seal assembly without removing the motor. The pump half coupling shall be of such design that it can be removed without the use of heat. Coupling halves shall fit tightly to the shafts of the pump and the driver so as not to become loose during operation. The coupling shall be provided with an OSHA approved coupling guard.

2.4.4.2 Impeller

Impeller shall be keyed to the shaft for radial loads and fixed in the axial position by shaft sleeve nuts, or other positive positioning device. Impellers shall be held to the shaft so that the impeller will not become loose should the pump accidentally rotate in reverse direction. The

impeller shall be statically and dynamically balanced.

2.4.4.3 Wear Rings

Renewable wearing rings shall be positively locked on the impeller. Wearing rings shall fit with close tolerances so as to permit a minimum of recirculation. Positive locking case wearing rings shall be provided so that the case wearing rings will not rotate or change position in the case.

2.4.4.4 Shaft

Shaft shall be designed with a high safety factor to easily withstand the torsional loads and other stresses to which it may be subjected. It shall be so designed that there will be no detrimental vibration stresses. Surfaces shall be ground to accurate dimensions. Shaft deflection shall be limited to 0.05 0.0020-inch maximum when measured at the face of the mechanical seal under the operating condition of zero flow at shut off head. Shaft shall be protected through the mechanical seal by means of a shaft sleeve. Seal piping from the discharge to the mechanical seal shall be provided.

2.4.4.5 Finishing

Passageways and impellers shall be finished to permit maximum efficiency and provide noise reduction. Overall sound levels shall not exceed OSHA limits.

2.4.4.6 Bearings

Bearings shall be product-lubricated. Sleeve type, carbon graphite shall be provided. Bearing spacing shall be per API Std 610.

2.4.4.7 Drilling and Tapping

Casting shall be drilled and tapped for drain and seal recirculation lines. All connections shall be provided with plugs.

2.4.4.8 Mounting Flange

Mounting flange shall be coordinated with the tank's mounting flange, and shall be ANSI or API pattern.

2.4.4.9 Special Tools

Pumps shall be furnished with special tools necessary to dismantle and reassemble the unit.

2.4.4.10 Service Nameplate

A pump service nameplate, of type 18-8 stainless steel or monel, securely attached by stainless steel pins at an easily accessible point on the pump, shall be furnished in addition to the identification nameplate. The pump service nameplate shall be stamped with the following information:

Manufacturer's name
Serial number of pump
Capacity, L/s gpm
Pumping head, m ft
Maximum specific gravity of fluid to be pumped

Revolutions per minute
Horsepower of driver

2.4.4.11 Identification Nameplate

A pump identification nameplate of Type 18-8 stainless steel or monel shall be provided and securely attached by stainless steel pins to a conspicuous place on the pump head. Tagging in letters 6 mm 1/4-inch high shall be the equipment number as shown on the drawings.

2.4.4.12 Exterior Primer Coat

Exterior surfaces of the pump and baseplate shall be primed by the manufacturer. Surface cleaning shall meet requirements of SSPC SP 10/NACE No. 2. Metal primer shall be zinc rich paint conforming to specification MIL-DTL-24441 Type 1, Class 3. Dry film thickness shall be 0.05 to 0.1 mm 2 to 4 mils.

2.4.4.13 Exterior Topcoat

Manufacturer's standard exterior topcoat shall be factory applied and shall be white.

2.4.5 Motor

Refer to paragraph, Motors for the Fueling Pumps.

PART 3 EXECUTION

3.1 PREPARATION FOR SHIPMENT

3.1.1 Rust Preventative

Exterior machine surfaces shall be coated with a rust preventative. Pumps shall be disassembled after the shop running tests and inspected, and internal parts shall be coated with a rust preventative before reassembling.

3.1.2 Closure of Openings

Threaded openings shall be provided with metallic plugs or caps. Flanges shall be gasketed with rubber and closed with 4.8 mm 3/16-inch thick plate of the same outside diameter as the match flange. A minimum of four full-diameter bolts shall hold closure in place.

3.1.3 Assembly

Pumps shall be shipped assembled or a field service engineer shall be furnished to supervise the field assembly at no additional cost to the Government.

3.1.4 Bracing

Each unit shall be suitably prepared for shipment, supported and braced, with auxiliary equipment secured to prevent damage during shipment.

3.1.5 Vapor Inhibiting Wraps

Exposed shafts and shaft couplings shall be wrapped with waterproof moldable waxed cloth or vapor inhibitor paper. The seams shall be sealed

with adhesive tape.

3.1.6 Shipping Identification

Each pump shall be identified with a metal tag showing the item number. Material shipped separately shall be marked with a metal tag indicating the item number for which it is intended.

3.2 INSTALLATION

Install equipment and components true to line, level and plumb, and measured from established benchmarks or reference points. Follow manufacturer's recommended practices for equipment installation. Provide required clearances between equipment components. Equipment, apparatus, and accessories requiring normal servicing or maintenance shall be easily accessible.

3.2.1 Anchoring

Anchor equipment in place as indicated on the drawings or per manufacturer's recommendations. Minimum anchor bolt size is 127 mm 5 inch. Check alignment of anchor bolts and/or bolt holes before installing equipment and clean-out associated sleeves. Do not cut bolts due to misalignment. Notify the Contracting Officer of errors and obtain the Contracting Officer's acceptance before proceeding with corrections. Cut anchor bolts of excess length to the appropriate length without damage to threads.

3.2.2 Grouting

Equipment which is anchored to a pad shall be grouted in place. Before setting equipment in place and before placing grout, clean surfaces to be in contact with grout, including fasteners and sleeves. Remove standing water, debris, oil, rust, coatings and other materials which impair bond. Clean contaminated concrete by grinding. Clean metal surfaces of mill scale and rust by hand or power tool methods. Provide formwork for placing and retaining grout. Grout to be non-metallic, non-shrink, fluid precision grout of a hydraulic cementitious system with graded and processed silica aggregate, portland cement, shrinkage compensating agents, plasticizing and water reducing agents; free of aluminum powder agents, oxidizing agents and inorganic accelerators, including chlorides; proportioned, pre-mixed and packaged at factory with only the addition of water required at the project site. Grouting to meet requirements of ASTM C827/C827M. Perform all grouting in accord with equipment manufacturer's and grout manufacturer's published specifications and recommendations.

3.2.3 Leveling and Aligning

Level and align equipment in accord with respective manufacturer's published data. Do not use anchor bolt, jack-nuts or wedges to support, level or align equipment. Install only flat shims for leveling equipment. Place shims to fully support equipment. Wedging is not permitted. Shims to be fabricated flat carbon steel units of surface configuration and area not less than equipment bearing surface. Shims to provide for full equipment support. Shim to have smooth surfaces and edges, free from burrs and slivers. Flame or electrode cut edges not acceptable.

3.2.4 Direct Drives

Alignment procedure follows.

3.2.4.1 Rotation Direction and Speed

Check and correct drive shaft rotation direction and speed.

3.2.4.2 End Play

Run drive shafts at operational speed. Determine whether axial end play exists. Run drive shaft at operational speed and mark drive shaft axial position when end play exists. Block drive shaft in operating position when aligning drive shaft with driven shaft.

3.2.4.3 Shaft Leveling and Radial Alignment

Check shaft leveling by placing a straightedge across the two coupling half faces in both horizontal and vertical planes.

3.2.4.4 Angular Alignment and End Clearance

Pump alignment shall be accomplished by the factory technician or a millwright trained in pump alignment, and with the use of dial gauges or laser alignment equipment.

3.2.4.5 Final Recheck

Check adjustments with dial indicator after completing recheck. Align shafts within 0.05 0.002-inch tolerance, except as otherwise required by more stringent requirements of equipment manufacturer.

3.2.5 Start-up Representative

NOTE: Consult with COMMAND FUEL FACILITIES Engineer
to determine if additional training is required.

A manufacturer's field service representative shall be provided at no additional cost to the Government to check the pumps for proper operation prior to start-up and also to witness, as a minimum, the first two days of operation. Any additional time required due to delays or corrections shall be provided at no additional cost to the Government. The manufacturer's field service representative shall also instruct the required personnel in the proper operation and maintenance of the pumps.

-- End of Section --