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DEPARTMENT OF THE ARMY
U.S. ARMY CORPS OF ENGINEERS

CEGS-15140 (04/99)

Superseding
CEGS-15140 (11/98)

GUIDE SPECIFICATION FOR CONSTRUCTION

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SECTION TABLE OF CONTENTS

DIVISION 15 - MECHANICAL

SECTION 15140

PUMPS, FUELING SYSTEM

04/99

-- End of Section Table of Contents --

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GUIDE SPECIFICATION FOR CONSTRUCTION

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SECTION 15140

PUMPS, FUELING SYSTEM
04/99

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NOTE: This guide specification covers the requirements for refueling pumps used in aircraft refueling systems. This guide specification is to be used in the preparation of project specifications in accordance with ER 1110-345-700 for military construction and in accordance with ER 1110-2-1201 for Civil Works construction.

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PART 1 GENERAL

(Waiver to Use MilStds and MilSpecs in Air Force Fuel Projects, HQ AFCESA/CESM (01/29/96))

1.1 REFERENCES

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NOTE: Issue (date) of references included in project specifications need not be more current than provided by the latest change (Notice) to this guide specification. During the reference reconciliation process, SPECSINTACT will automatically remove references from this paragraph that have been removed from the text.

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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.

ANTI-FRICTION BEARING MANUFACTURERS ASSOCIATION (AFBMA)

AFBMA 7 (1988) Shaft and Housing Fits for Metric Radial Ball and Roller Bearings

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B16.5 (1988; Errata-Oct 1988) Pipe Flanges and Flanged Fittings

AMERICAN PETROLEUM INSTITUTE (API)

API STD 610	(1995; 8th Edition) Centrifugal Pumps for General Refining Service

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A182/A182M	(1996e) Forged or Rolled Alloy-Steel Pipe Flanges, Forged Fittings and Valves and Parts for High Temperature Service
ASTM A276	(1996) Stainless Steel Bars and Shapes
ASTM A356/A356M	(1996) Heavy-Walled, Carbon Low Alloy, and Stainless Steel Castings or Steam Turbines
ASTM A487/A487M	(1993) Steel Casing for Pressure Service
ASTM A582/A582M	(1995b) Free-Machining Stainless Steel Bars
ASTM A743/A743M	(1995) Castings, Iron-Chromium, Iron-Chromium-Nickel, Corrosion Resistant, for General Application
ASTM C827	(1987) Standard Test Method for Change in Height at Early Ages of Cylindrical Specimens from Cementitious Mixtures

HYDRAULIC INSTITUTE (HI)

HI-01	(1983; 14th Ed.) Standard for Centrifugal, Rotary, and Standard Reciprocating Pumps

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE Std 112	(1996) Test Procedure for Polyphase Induction Motors and Generators

MILITARY SPECIFICATIONS (MS)

MS MIL-P-24441	(1991; Rev. B, Supp. 1) Paint Epoxy - Polyamide, General Specification for

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA MG 1	(1993; Rev 1) Motors and Generators

NATIONAL FIRE PROTECTION AGENCY (NFPA)

NFPA 70	(1996) National Electrical Code

STEEL STRUCTURES PAINTING COUNCIL (SSPC)

SSPC PA 1	(1991) Paint Application Specification No. 1 Shop, Field, and Maintenance

SSPC SP 10	(1991) Surface Preparation Specification No. 10 Near-White Blast Cleaning

1.2 SUBMITTALS

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NOTE: Submittals must be limited to those necessary for adequate quality control. The importance of an item in the project should be one of the primary factors in determining if a submittal for the item should be required.

Indicate submittal classification in the blank space using "GA" when the submittal requires Government approval or "FIO" when the submittal is for information only.
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Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Fueling Pump (FP-1 through FP-5); GA.

Fuel Transfer Pump (FTP-1); GA.

SD-04 Drawings

Fueling Pump (FP-1 through FP-5); GA.

Fuel Transfer Pump (FTP-1); GA.

SD-13 Certificates

Fueling Pump (FP-1 through FP-5); GA.

Fuel Transfer Pump (FTP-1); GA.

SD-09 Reports

Certified Test Curves; FIO.

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NOTE: ADD NUMBER OF DAYS. FOR COE PROJECTS, INCLUDE IN MOU SPECIFIC AIR FORCE REPRESENTATIVES TO BE NOTIFIED WHEN FACTORY TEST DATES ARE SUBMITTED BY THE CONTRACTING OFFICER.
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Hydrostatic, performance, and NPSH tests shall be conducted at the factory on each pump in accord with Hydraulic Institute Standard for Centrifugal, Rotary and Reciprocating Pumps. Test each pump with the actual motor which will drive the pump in the field. 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 curve. All tests shall be observed by the Contracting Officer or his designated representative. The Contractor shall give the Contracting Office [__] days notice prior to conductance of factory tests in order to schedule observing of factory test.

SD-19 Operation and Maintenance Manuals

Operation and Maintenance Manuals; GA.

Operation and maintenance information shall be submitted for the pumps and appurtenance specified herein. Refer to Section 01730 FACILITY OPERATION AND MAINTENANCE MANUAL for the information to be submitted.

1.2.1 Submittal Sequence

Performance testing shall not occur prior to acceptance of shop drawing submittal.

1.3 ELECTRICAL WORK

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 16415 ELECTRICAL WORK, INTERIOR. 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 16415 ELECTRICAL WORK, INTERIOR. Motors shall be high efficiency type and in accordance with Section 16415 ELECTRICAL WORK, INTERIOR.

PART 2 PRODUCTS

2.1 DESIGN CONDITIONS

Shall be as specified in Section 15050 MECHANICAL EQUIPMENT, FUEL SYSTEM.

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

2.2.1 Capacity

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NOTE: INSERT SITE SPECIFIC PUMP REQUIREMENTS.
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Capacity shall be 600 gpm against a total head of [__] 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 percent 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 150 gpm and continuously at a maximum flow condition of 125 percent required capacity GPM. 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. These pumps are for parallel operation and shall have equal head at minimum continuous stable flow, plus or minus 2

percent.

2.2.2 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, 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 no flow to 120 percent of design flow.

b. The pump shall require no more than 15-feet of net positive suction head (NPSHR) when it is operated with water at a capacity of 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 300-pound per ASME B16.5. The case shall be designed for maximum discharge pressure at pumping temperature but not less than 550 psig, with a minimum corrosion allowance of 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 three-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 .018-inches.

h. Mechanical Seal. A single unbalanced mechanical seal per API STD 610 code USTFM of multiple spring design shall be supplied. The seal gland shall be taped 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 \-AFBMA 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 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 replaceable hooked-type shaft sleeve, locked in place by the impeller shall extend under the mechanical seal and gland.

n. 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.

o. Removable coupling guards of the non-sparking type shall be supplied. They shall comply with the requirements of OSHA.

p. Total indicated shaft runout at coupling end shall be 0.001-inches or less. Total shaft deflection shall be no more than 0.002-inches at face of stuffing box.

q. 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 (1-inch minimum) at the pump end and located to accomplish complete drainage. A grout hole of at least 8-inches minimum diameter shall be supplied and shall have 1/2-inch minimum raised lip edge.

r. Materials. No zinc, brass, bronze or other copper bearing alloy shall come in contact with the fuel.

s. 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.

t. Impeller material shall be stainless steel ASTM A487/A487M GR CF8M or ASTM A743/A743M CA 6NM.

u. Wear rings shall be stainless steel ASTM A182/A182M GR F6 or ASTM A276 TP410 or 416.

v. 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.

w. Testing. All shop testing shall be performed in accordance with the HI-01.

2.2.3 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, gpm
Pumping head, ft.
Maximum specific gravity of fluid to be pumped
Revolutions per minute
Horsepower of driver

2.2.4 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 1/4-inch high shall bear the equipment number as shown on the drawings.

2.2.5 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. Metal primer shall be zinc rich paint conforming to specification MS MIL-P-24441, Type 1, Class 3. Dry film thickness shall be 2 to 4 mils.

2.2.6 Exterior Topcoat

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

2.2.7 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 I, Division 1, Group D hazardous areas, and shall have a maximum temperature rating of "T2D - 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% 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 ten (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-hydroscopic, NEMA Class H, 180 degrees C for motors over 10 hp and NEMA Class F, 150 degrees C for 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 at 3300-feet altitude) shall not exceed 80 degrees C.

g. Bearings shall be AFBMA 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 I, 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 I, 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 energy 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, open drip proof):

20 hp	92.0%	75 hp	95.5%
25 hp	92.0%	100 hp	93.5%
30 hp	92.0%	125 hp	94.5%
40 hp	92.0%	150 hp	94.5%
50 hp	92.5%	200 hp	94.5%
60 hp	92.5%	600 hp	94.5%

n. Other motors of different speed or housing classification shall also be of the energy 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 Std 112, Method B. All shop drawing submittals on motor driven equipment shall include the motor efficiency.

2.3 FUEL TRANSFER PUMP (FTP-1)

2.3.1 Capacity

****
NOTE: INSERT SITE SPECIFIC PUMP REQUIREMENTS.
****

Capacity shall be 50 gpm against a total head of [__] feet 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% head increase at rated conditions by installing a new impeller.

2.3.2 Assembly

****
NOTE: SELECT PUMP STAGE REQUIREMENTS.
****

The pump for this service shall meet the requirements of \-API STD 610-\, latest edition. 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 no flow to 120 percent of design flow.

2.3.3 Materials

The materials of construction for the pump shaft shall be stainless steel. All other materials shall be of non-corrosion materials.

2.3.3.1 Mechanical Seal

Balanced type.

2.3.4 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.

2.3.4.1 Couplings

Couplings shall be flexible and self-aligning. 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.

2.3.4.2 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 and be provided with anti-reversing rachet.

2.3.4.3 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.

2.3.4.4 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 0.0020-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.

2.3.4.5 Finishing

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

2.3.4.6 Bearings

Bearings shall be product-lubricated. Heavy duty ballbearings with a high safety factor shall be provided. Provide double row thrust bearing to handle thrust and limit end play and provide graphite alloy throat bushing to assist in maintaining shaft alignment and to prevent contaminants from entering the mechanical seal area.

2.3.4.7 Drilling and Tapping

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

2.3.4.8 Baseplate

Baseplate shall be suitable for pedestal mounting. Anchor bolt holes shall be 7/8-inch diameter.

2.3.4.9 Special Tools

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

2.3.4.10 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, gpm
Pumping head, ft.
Maximum specific gravity of fluid to be pumped
Revolutions per minute
Horsepower of driver

2.3.4.11 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 1/4-inch high shall be the equipment number as shown on the drawings.

2.3.4.12 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. Metal primer shall be zinc rich paint conforming to specification \-MS MIL-P-24441-\ Type 1, Class 3. Dry film thickness shall be 2 to 4 mils.

2.3.4.13 Exterior Topcoat

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

2.3.5 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 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. 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. 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

Check angular alignment and en clearance by inserting a feeler gage at 4 points, 90 degrees apart around outer edges of coupling halves.

3.2.4.5 Final Recheck

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

3.2.5 Start-up Representative

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NOTE: CONSULT WITH COMMAND FUEL FACILITIES ENGINEER TO DETERMINE IF ADDITIONAL TRAINING IS REQUIRED.

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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 by the Contractor 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 --