UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated July 2023
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Preparing Activity: USACE New

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SUBMERSIBLE PUMP, CENTRIFUGAL TYPE
11/20

NOTE: This guide specification covers the requirements for submersible centrifugal pumps for a turbid water pumping station. Note that the guide specification for submersible axial flow and mixed flow pumps is provided in Section 35 45 02.00 10 SUBMERSIBLE PUMP, AXIAL-FLOW AND MIXED-FLOW TYPE.

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 as a Criteria Change Request (CCR).

PART 1 GENERAL

NOTE: This guide specification is for use in construction contracts. It may be used in supply contracts, but should be changed as appropriate. Differences between the technical paragraphs written for Contractor-supplied pumps versus Corps supply specification should be minimal.

This pump specification will be used with the design criteria in EM 1110-2-3105, "Mechanical and Electrical Design of Pumping Stations", and the references listed in those publications. To the

extent possible the Hydraulic Institute (HI) Standards have been referenced as the primary reference standards, and the minimum for manufacturers' compliance, for the manufacture, material, design, test, and performance specifications:

HI/ANSI 9.1-9.5	**General Design**
HI/ANSI 9.6.4	**Vibration Analysis**
HI/ANSI 11.6	**Testing**
HI/ANSI 14.1-14.2	**Nomenclature and Definitions**
HI/ANSI 14.3	**Design and Application**

The vibration analysis often required of pumps is eliminated and a vibration limit specified.

The pumps are of the pre-engineered (catalog) type, used at flood control and storm water projects. Over specifying can prove costly and even double the cost of an otherwise inexpensive pump. In general, the two most important attributes to a successful specification will be to obtain a qualified, experienced manufacturer and to properly specify the pumping conditions so that the correct pump is obtained.

Model testing is not included as an alternative for these pumps. Manufacturers assemble and performance test the pumps at the factory. The pumps are shipped assembled.

Witness tests and factory visits have been limited to one visit during the performance test and a pump inspection at the time of the test.

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1.1 SUMMARY

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NOTES: Centrifugal pumps have greater solid passing capability and are well suited for higher pressure applications. However if this is not a concern then axial flow or mixed flow pumps should be considered.

This specification is for flood risk management pumping stations or similar applications. Specifications for centrifugal solids handling sanitary sewerage pumps are available at Section 22 13 29 SANITARY SEWERAGE PUMPS.

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Design, furnish, and install [_____] identical pump/motors. Water pumped will not exceed [_____] degrees C F, will be relatively turbid, and may contain sand, silt, and trash and fibrous materials with spherical solids up to [three] inches in diameter.

1.2 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.

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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 BEARING MANUFACTURERS ASSOCIATION (ABMA)

ABMA 9	(2015) Load Ratings and Fatigue Life for Ball Bearings
ABMA 11	(2014) Load Ratings and Fatigue Life for Roller Bearings

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B4.1	(1967; R 1994; R 2004; R 2009; R 2020) Preferred Limits and Fits for Cylindrical Parts
ASME B31.1	(2022) Power Piping
ASME BPVC SEC IX	(2017; Errata 2018) BPVC Section IX-Welding, Brazing and Fusing Qualifications

ASTM INTERNATIONAL (ASTM)

ASTM A27/A27M	(2020) Standard Specification for Steel Castings, Carbon, for General Application
ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel
ASTM A48/A48M	(2003; R 2021) Standard Specification for Gray Iron Castings
ASTM A108	(2013) Standard Specification for Steel

	Bar, Carbon and Alloy, Cold-Finished
ASTM A123/A123M	(2017) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A193/A193M	(2023) Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service and Other Special Purpose Applications
ASTM A194/A194M	(2023) Standard Specification for Carbon Steel, Alloy Steel, and Stainless Steel Nuts for Bolts for High-Pressure or High-Temperature Service, or Both
ASTM A276/A276M	(2017) Standard Specification for Stainless Steel Bars and Shapes
ASTM A285/A285M	(2017) Standard Specification for Pressure Vessel Plates, Carbon Steel, Low- and Intermediate-Tensile Strength
ASTM A516/A516M	(2017) Standard Specification for Pressure Vessel Plates, Carbon Steel, for Moderate- and Lower-Temperature Service
ASTM A564/A564M	(2019) Standard Specification for Hot-Rolled and Cold-Finished Age-Hardening Stainless Steel Bars and Shapes
ASTM A576	(2017) Standard Specification for Steel Bars, Carbon, Hot-Wrought, Special Quality
ASTM A668/A668M	(2023) Standard Specification for Steel Forgings, Carbon and Alloy, for General Industrial Use
ASTM B584	(2022) Standard Specification for Copper Alloy Sand Castings for General Applications

HYDRAULIC INSTITUTE (HI)

HI ANSI/HI 9.1-9.5	(2021) Pumps General Guidelines for Materials, Sound Testing, and Decontamination - B117
HI ANSI/HI 9.6.4	(2022) Rotodynamic Pumps for Vibration Analysis and Allowable Values
HI ANSI/HI 11.6	(2016) Rotodynamic Submersible Pumps for Hydraulic Performance, Hydrostatic Pressure, Mechanical, and Electrical Acceptance Tests
HI ANSI/HI 14.1-14.2	(2019) Rotodynamic Pumps for Nomenclature and Definitions

HI ANSI/HI 14.3	(2019) Rotodynamic Pumps for Design and Application

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

ISO 1940-1	(2003; R 2008) Mechanical Vibration - Balance Quality Requirements for Rotors in a Constant (Rigid) State - Part 1: Specification and Verification of Balance Tolerances

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA MG 1	(2021) Motors and Generators
NEMA WC 70	(2021) Power Cable Rated 2000 Volts or Less for the Distribution of Electrical Energy
NEMA WC 72	(1999; R 2020) Continuity of Coating Testing for Electrical Conductors

1.3 SUBMITTALS

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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.

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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-01 Preconstruction Submittals

Pump Supplier Qualifications; G[, [_____]]

SD-02 Shop Drawings

Detail Drawings; G[, [_____]]

SD-03 Product Data

Materials; G[, [_____]]

Installation Instruction Manual; G[, [_____]]

Impeller Balancing; G[, [_____]]

Factory Tests; G[, [_____]]

Pump Field Tests; G[, [_____]]

Spare Parts; G[, [_____]]

Special Tools; G[, [_____]]

SD-06 Test Reports

Factory Test Report; G[, [_____]]

Field Test Report; G[, [_____]]

Installation and Start-Up Engineer; G[, [_____]]

SD-07 Certificates

Qualified Welders; G[, [_____]]

Warranty; G [, [_____]]

SD-10 Operation and Maintenance Data

Operating and Maintenance Instructions; G[, [_____]]

1.4 QUALITY CONTROL

1.4.1 Pump Supplier Qualifications

The pump manufacturer has overall responsibility to supply the pumping unit (submersible pump/motor, discharge elbow, and cables) that meet the requirements of this specification. Thus, during start-up, installation,

and performance evaluation, the pump manufacturer is the sole responsible party. The pump manufacturer must supply a list of installations at which pumps of his manufacture, and ones similar to those specified, have been operating for at least two years. The components and materials of the pumping unit may occur at different facilities, and be the product of other manufacturers.

1.4.2 Installation and Start-up Engineer

Furnish a competent installation engineer (including those from Contractor's suppliers) who is knowledgeable and experienced with the installation and start-up procedures for submersible centrifugal pumps and the associated equipment specified. Submit the installation and start-up engineer's qualifications. When so requested, the installation engineer is responsible for providing complete and correct direction during installation, initial starting, and subsequent operation of equipment until field tests are completed. The installation engineer initiates instructions for actions necessary for proper receipt, inspection, handling, uncrating, assembly, and testing of equipment.

1.4.3 Detail Drawings

Submit drawings of sufficient size to be easily read, within [90] days of Notice of Award. Submit information in the English language. Dimension in the metric (SI) with English conversion inch-pound-second system. Furnish the following:

a. Outline drawings of the pump showing dimensions and weight of the pump/motor.

b. Drawings showing details and dimensions of pump mounting design and layout including any embedded items and lifting connections.

c. Cross-sectional drawings of each different size of pump, showing each component, and major or complicated sections of the pump in detail. On each drawing indicate an itemized list of components showing type, grade, class of material used, and make and model of the standard component used. Include detail and assembly drawings of entire pumping unit assembly.

d. Provide drawings covering the installation that is intended for the installation engineer.

e. Indicate efficiency,kW bhp, and NPSHR with the capacity-head curve.

f. Motor characteristic curves or tabulated data (test or calculated) to indicate the speed, power factor, efficiency, current, and kilowatt input, all plotted or tabulated against percent load as abscissas.

g. Submit shop drawings for each size access cover supplied. Include all dimensional data necessary for installation. Include installation details for access cover shop drawings.

1.4.4 Welding

Weld structural members in accordance with Section 05 05 23.16 STRUCTURAL WELDING. For all other welding, qualify procedures and welders in accordance with ASME BPVC SEC IX. Welding procedures qualified by others, and welders and welding operators qualified by a previously qualified

employer may be accepted as permitted by ASME B31.1. Perform welder qualification tests for each welder whose qualifications are not in compliance with the referenced standards. Notify the Contracting Officer 24 hours in advance of qualification tests. Perform the qualification tests at the work site if practical. The welder or welding operator must apply their assigned symbol near each weld made as a permanent record. Submit the names of all qualified welders, their identifying symbols, and the qualifying procedures for each welder including support data such as test procedures used, standards tested to.

1.4.5 Operating and Maintenance Instructions

Prior to delivery of any pumps, submit manuals containing complete information in connection with the operation, lubrication, adjustment, routine and special maintenance, disassembly, repair, and re-assembly of the pumps and accessories. Submit a total of [five] copies for each pump size and type. Include a listing of special tools required for working on the pumps. Include comprehensive as built drawings, photographs, factory test results, and sketches of the pumps. Include complete diagnostic information on the pumps and all approved shop drawing submittals on the pumps. Include in the Operation and Maintenance Instructions all approved shop drawings on the access covers, interface modules, and sump pumps.

a. Parts list: provide a complete parts list for the pumps including furnished spare parts and special tools. Clearly show all details and parts. Provide identification markings and sources for all parts.

b. Provide manuals with hard cover post type binders or 3-ring binders and printed on 8-1/2 inch by 11 inch high quality paper with indexed, tabbed section dividers. Provide large sheets that are neatly folded and installed with post hole reinforcements such that sheets can unfold without need to open binder posts. Drawings, sketches, and parts lists incorporated in the manual may be reduced to page size provided such reductions are clear and easily legible, otherwise they may be folded into the manual.

1.5 DELIVERY, STORAGE, AND HANDLING

Inspect each pump for damage or other distress when received at the project site. Store each pump and associated equipment indoors as recommended by the pump manufacturer, protected from construction or weather hazards at the project site. Provide adequate short-term storage for each pump and equipment in a covered, dry, and ventilated location prior to installation. Follow the manufacturer's instructions for extended storage. Supply proper equipment for handling the pump and consider the equipment as special tools if not completely standard. Follow the manufacturer's recommendations for handling of the pump.

1.6 EXTRA MATERIALS

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NOTE: The spare parts noted herein are from other Corps documents. For any specific project, it would be appropriate to discuss an adequate spare parts list during the designer's plant visitations or discussions with the end user as suggested by EM 1110-2-3105.

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a. Furnish the following spare parts:

(1) One complete set of bearings and seals for each size pump.
(2) Replacement wearing rings and O-rings for each size pump.
[(3) One impeller for each size pump.]

b. Furnish one set of all special tools required to completely assemble, disassemble, or maintain the pumps. Special tools refers to oversized or specially dimensioned tools, special attachments or fixtures, or any similar items. Furnish lifting devices required for use in conjunction with the [overhead] [truck] crane. Provide the tools in a toolbox or toolboxes.

1.7 WARRANTY

Provide a manufacturer's warranty for the submersible centrifugal pumps and all equipment furnished under this section against defective workmanship, materials, design, and performance for a period of [_____] years from the date the equipment is accepted. If the equipment or any part thereof does not conform to these warranties, and the Government so notifies the manufacturer within a reasonable time after its discovery, the manufacturer must thereupon promptly correct such nonconformity by repair or replacement. Coordinate the down time for the equipment with the Government, and keep to a minimum duration that is mutually agreed to by the manufacturer and the Government. The manufacturer is liable during the warranty period for the direct cost of removal of the equipment from the installed location, transportation to the manufacturer's factory or service shop for repair and return, and reinstallation on site. The manufacturer must be given the opportunity to perform the removal and reinstallation and to select the means of transportation. For instance, the expense of removing adjacent apparatus, installing spare equipment, costs of supplying temporary service, is not included in this warranty provision.

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS

2.1.1 Spare Pumps

Provide a total of [_____] spare pumps. Spare pumps must be identical to the other pumps provided under this contract. For the spare pumps only, access covers and the guide rail systems are not required. Tag and label spare pumps as spares.

2.1.2 Service Availability

The pumps furnished must be supported by a service organization. Service and parts must be available within [500] miles of the [_____] area. Provide this information in a shop drawing.

2.1.3 Pump Station Start-up Services

The installation and start-up engineer must be present at the installation for each location. Provide for two days on-site for each location. In addition, provide for two days for pump/motor start-up at each location.

2.1.4 Name Plates

Secure a name plate to each major item of equipment to include the manufacturer's name, address, type/style, model, serial number, and catalog number. Provide nameplates made of corrosion resisting metal with raised or depressed lettering on a contrasting colored background.

2.1.5 Instruction Plates

As necessary, equip each item of equipment with suitably installed instruction plates including warnings and cautions describing special and important procedures to be followed during starting, operating, and servicing the equipment. Provide plates made of corrosion resisting metal with raised or depressed lettering on a contrasting colored background.

2.1.6 Factory Test Location

Factory testing facility must be in the continental United States. Submit the proposed testing facility as a shop drawing.

2.2 SYSTEM REQUIREMENTS

2.2.1 Pumping Unit Description

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NOTE: Pumps are designed to be lifted from the sump for maintenance and repair.

****

Each pumping unit includes a pump/motor, discharge elbow, guide rail system, and cable. Each pump must be of the centrifugal submersible type for [storm water,] [flood control,] attached to the same shaft with a submersible electric motor. Except as otherwise stated or noted, the terms pump and pump/motor both refer to an assembled pump motor unit complete with discharge elbow, guide rail system, and cable.

2.2.2 Design Requirements

a. The pump must, as a minimum, meet the applicable design, materials, and manufacturing requirements of HI ANSI/HI 9.1-9.5, HI ANSI/HI 14.1-14.2, HI ANSI/HI 14.3, and these specifications.

b. Operate the pump so that installation and maintenance can be carried out by an [overhead bridge] [jib] [mobile] crane. The weight of the pump/motor integral unit must not exceed [_____] kg lb.

2.2.3 Operating Conditions

a. The pump must be capable of operating in the dry (for the purpose of maintenance and operating checks) for short periods of time as stated in the manufacturer's operating instruction.

b. The pump manufacturer establishes and states in the operating manual the procedures for starting and stopping the pumps, including setting of valves or any sequential operations.

2.2.4 Capacities

****

NOTES: The Corps' policy and procedures for plant design and pump selection are explained in detail in EM 1110-2-3105. Using the data from hydrology and hydraulic studies, the designer will establish the performance requirements of the pumps. Using the manufacturers' catalogs that tabulate the characteristics of their pre-engineered units, select a pump. The designer should then locate other pumps with the described characteristic and establish contact with manufacturers.

Any pump selected results from careful analysis of the relationships of speed, net positive suction head (NPSH) (cavitation), head-capacity, range of plant operation, sump design requirement, and to a lesser extent, efficiency. During the selection process the manufacturer's input to the design is obtained and integrated into the selection.

The specification will then state specific values to be attained so that a pump with the desired performance can be obtained. It is necessary to state the requirements so that more than one manufacturer can respond. All manufacturers must meet the previous experience and manufacturing standards requirements.

Compliance with the performance requirements will be established using procedures stated in the HI Standards and at the time when the pump is assembled and tested at the factory. Efficiency, heads, and other hydraulic values for purpose of specification should conform to HI definitions, even though Corps manuals are used for the purpose of design criteria.

Centrifugal submersible pumps can range in size from approximately 500 gpm to over 25,000 gpm. Horsepower can range from under 10 hp to over 200 hp. The designer should be aware that for the larger size pumps over 200 hp and 25,000 gpm the weight of the pump and motor combination can be significant. The designer should compare against vertical mixed flow pumps for these size pumps.

Each pump installation will be uniquely different and may require a slightly different head-capacity specification to establish that the correct pump will be obtained. During the pump selection procedure, the designer will establish certain capacities that must be met over a range of heads. The designer may state more than one operating point on the performance curve or utilize different points on the curve such as rated head, design head best efficiency point (BEP), maximum head, and minimum head. The heads defined are as stated in EM 1110-2-3105 and applicable HI standards.

ANSI/HI 11.6 provides various acceptance grades for testing tolerances. Class 2B would be acceptable

for most pumping stations that have pumps greater than 10 hp and less than 124 hp. Larger pumps could use class 1B. In accordance with the standard, pumps smaller than 10 hp would have a greater tolerance band as defined in the standard, unless otherwise specified.

ANSI/HI 11.6 allows the option of either verifying the minimum pump efficiency, or verifying the maximum power input, but not both. The efficiency and power requirements would be for the guarantee point only unless otherwise stated. Also, the efficiency and power requirement would need to be defined if the units were a combined pump and motor unit, or just the pump. HI ANSI/HI 14.6 provides guidance for testing in Appendix D.

The selection of pumps for flood and storm water projects will not usually depend on the economics of efficiency. However, a low efficiency can usually be correlated with poor pump hydraulics resulting in a shortened pump life. Therefore, an efficiency relating to the values from the manufacturer's catalog curves should be specified.
****

a. The guarantee point is [_____] L/s gpm with a differential pressure of [_____] m ft. [The minimum pump and motor unit efficiency is [_____] m percent.] [The maximum power pump unit input power is [_____] m hp.] The tolerance band is HI ANSI/HI 11.6 class [1B][1E][1U][2B][2U][3B].

[b. The pumps must continuously pump water without signs of distress, including cavitation, with a Net Positive Suction Head Available (NPSHA) of [_____] m ft.]

2.3 MATERIALS

****
NOTE: The designer usually establishes communication with pump manufacturers concerning materials and design details appropriate for a specific site. Consideration needs to be given to the end user's input. The designer should utilize appropriate HI Standards. Additionally, AWWA Standards 101-88 (withdrawn) and E102-17 (Vertical Pumps) have useful guidance.
****

Submit the generic material for all parts and material specifications including class and grade for all major components (casing, impeller, discharge elbow, shaft, and wear rings) of the pump assembly. Include the latest ASTM specification or to other listed commercial specifications covering class or kinds or materials to be used. Materials must be consistent with the guidelines of HI ANSI/HI 9.1-9.5 and HI ANSI/HI 14.3. Designated items must conform to the following

ITEMS	REQUIREMENTS
Cast Iron	ASTM A48/A48M, Class No. 30A, 30B and 30C
Cast Steel	ASTM A27/A27M, Grade 65 35, annealed
Copper Alloy Castings	ASTM B584, Alloy No. C93700 or C86300
Structural Steel	ASTM A36/A36M
Cold Rolled Steel Bars	ASTM A108, Minimum Working Strength 65,000 psi
Hot Rolled Steel Bars	ASTM A576, Grades: G10200, G10450, G11410
Hot Rolled Stainless	ASTM A564/A564M, Grade 517400
Bars and Shapes:	
Steel Plates, Structural	ASTM A285/A285M, Grade B
Steel Plates, Pressure Vessel	ASTM A516/A516M, Grade 55
Steel Forgings	ASTM A668/A668M, Class F

2.4 SUBMERSIBLE PUMP

2.4.1 Design and Manufacture

****

NOTE: Under paragraph PUMP SUPPLIER QUALIFICATIONS the Contractor is required to submit names of previous installations where the selected manufacturer has documented the operating performance for pumps of this design. While the general venturi configuration of the pumps built by different suppliers is similar, the details (e.g., number of bearings, wearing ring design, cast versus fabrication, impeller design, and materials) can be different. Based on design details available, there seems to be little justification to prefer one manufacturer's design over another. The pump portion of the specification is a low tech design compared with the motor and housing internal design, 70 to 80 percent of the cost may be contained in the motor. The emphasis on the pump portion should be on rugged, reliable, long-lasting components that are trouble-free.

The design elements described in this section are taken from drawings, manuals, catalogs, and brochures requested from two manufacturers, one domestic and one foreign. Both have over 30 years of experience and thousands of operating pumps worldwide. A primary concern in the specification was to avoid making it restrictive and yet to ensure that only qualified manufacturers would respond.

****

The submersible pump may be either of cast or fabricated construction. The level of manufacture skill must be consistent with the standards referenced in the specifications. All work performed in the manufacturing of the pumps must be in a skillful and workmanlike manner in accordance with the best modern shop practice and manufacturing of finished products similar in nature to those specified herein. The Government reserves the

right to observe and witness the manufacturing of the pumps and to inspect the pumps for compliance with contract requirements during factory assembly.

2.4.2 Speed

2.4.2.1 Pump Speed

Rotative speed of the pump cannot be greater than [_____] rpm.

2.4.2.2 Runaway Speed

Design the pump to sustain full runaway speed without damage at maximum head difference across the pump. Based on the system design as indicated, the manufacturer must compute the maximum reverse runaway speed, and design the pump and motor to sustain that reverse rotation without damage.

2.4.3 Pump Construction

2.4.3.1 General

All the exposed nuts and bolts must be stainless steel. Machine and fit all mating surfaces where watertight sealing is required with nitrile rubber O-rings. The fitting must be such that the sealing is accomplished by metal-metal contact between machined surfaces which results in controlled compression of the O-rings. Sealing compounds, grease, or secondary devices are not acceptable.

2.4.3.2 Casing

The casing may be of cast or fabricated manufacture. The hydraulic design must be the manufacturer's standard design as used in previous operating installations. The general manufacture quality relating to flange design, drilling, bolts, alignments, must be in accordance with industry standard practice.

2.4.3.3 Discharge Elbow

The maintenance pump discharge elbow must be furnished by the pump supplier. The elbow must be matched marked to its respective pump and shipped and crated with the pump. Manufacture the discharge elbow of either cast iron or cast steel. Include a flange for automatically mating with the pump discharge bowl when the pump is lowered into place. Elbow must be a long radius type. Include a cast iron or cast steel shoe for anchoring to the sump floor. The seal between the pump volute and discharge shoe must remain tight and intact under any pump thrust. Pump thrust must not be induced on the guide rails. Provide installation instructions for setting the discharge elbow.

2.4.3.4 Trash Stand

The trash stand must be furnished by the pump supplier. The trash stand must be bolted to the bottom of the pump at the inlet. The trash stand mustsupport the pump/motor assembly and keep the pump positioned above the bottom of the sump.

2.4.3.5 Shaft

The shaft must be one piece integral with the motor of [stainless steel]

[high-strength cold-rolled carbon steel]. Design the shaft for all torque conditions during normal operation and for runaway speed during reverse flow.

2.4.3.6 Impeller

The impeller design and manufacture must be the manufacturer's standard. The impeller surface must be smooth, without holes and fabrication offsets. The attachments to shaft must be with keys or other fasteners that are made of stainless steel, and of sturdy construction designed to not loosen, but be easily removed for maintenance. The impeller construction may be cast or fabricated. The impellers must be capable of handling solids found in storm water such as trash and fibrous materials. Impellers must be capable of passing [three] inch solids. At the time of assembly the impeller clearances must be those shown on assembly drawings and may be checked in the field or at the factory at the Contracting Officer's option. Balance the impeller at the design operating speed. The standard balance quality grade is G6.3 in accordance with ISO 1940-1. Balance in accordance with the procedure in HI ANSI/HI 9.6.4, except that a two-plane balance is required. Submit the results of impeller balancing.

2.4.3.7 Wear Ring

A wear ring system must be installed to provide efficient sealing between the volute and impeller. The wear ring must consist of a stationary ring made of bronze insert press fitted into the volute inlet, and a rotating stainless steel ASTM A276/A276M, Type 316 ring force fitted into the impeller runner.

2.4.3.8 Nuts and Bolts

Provide bolts used in assembling each pump and its supporting members of corrosion resisting steel and hexagonal type. Stainless steel cap screws conforming to ASTM A276/A276M, Type 316, and used with silicon bronze nuts or stainless steel nuts will be permitted as will silicon bronze cap screws with tapped casting holes.

2.4.3.9 Pump Lifting Handle And Lifting Lugs

Design the lifting handle to bear the entire weight of the pumping unit at a conservative factor of safety. Provide lifting lugs where the weight of the separate part requires a lug.

2.4.3.10 Pump and Motor Bearing Arrangement

The pump and motor bearings must be the standard design of the manufacturer for the pump supplied under this specification. The type and number must be of proven design as used in previous operating units supplied by the manufacturer. Provide bearings of the grease lubricated and sealed type; having a minimum L-10 bearing life of 50,000 hr. Each bearing must be of the correct design to resist the radial and thrust loads applied. Provide enough bearings to ensure the pump rotating elements are supported so that the possibility of excessive vibration is eliminated. Conform ball and roller bearings life and load ratings to ABMA 9 and ABMA 11.

2.4.3.11 Mechanical Seals

Provide a mechanical rotating shaft seal system between the impeller and

motor to ensure the motor housing is sealed properly. The mechanical seals must be in tandem, lapped and face type seals running in lubricant reservoirs for cooling and lubrication. The mechanical seals must contain both stationary and rotating tungsten carbide face rings unless otherwise specified. In order to avoid seal failure from sticking, clogging, and misalignment from elements contained in the mixed media, only the seal faces of the outer seal assembly and its retaining clips can be exposed to the mixed media. Contain all other components in the lubricant housing. All seal faces must be solid material capable of being relapped. The seals must require neither maintenance nor adjustment, but be easy to check and replace. Shaft seals without positively driven rotating members are not considered acceptable or equal.

2.4.3.12 Lubricant Housing

Provide an oil housing with oil, as recommended by the pump manufacturer, to lubricate the shaft sealing system and to dissipate the heat generated by the motor and bearings.

2.4.3.13 Guide Rail System

Furnish each maintenance pump with a stainless steel guide rail system for lifting the pump in and out of the wetwell and connecting to the discharge elbow. The guide rail system must be either a single or double rail system. Guide bars (pipe) must be Type 304 stainless steel. The upper guide bar brackets and intermediate guide bar brackets must be furnished by the pump manufacturer. Match Mark the guide bar brackets to their respective pump. Ship the brackets with the pumps. Brackets must be Type 304 stainless steel. Provide a stainless steel lifting chain of adequate length for removing and installing the pump unit.

2.4.3.14 Cooling System

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NOTE: An air cooled system could be considered depending on the application.
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Each pump unit must have an adequately designed cooling system, consisting of a water jacket which encircles the stator housing. Provide a water jacketwith a separate circulation of the pumped liquid. Cooling media channels and ports must be non-clogging by virtue of their dimensions. All cooling paths or ports must be internal to the pump and motor water jacket to preclude clogging or physical abuse. Design the cooling system to allow for continuous pump operation at rated capacity with the external water level at the minimum pump submergence level.

2.4.4 Motor

The motor must be submersible and conform to the requirements of NEMA MG 1. Size the motor to avoid overload when operating at any point along the characteristic curve of the pump. Provide 3-phase, 60-Hz, [480][_____]V, squirrel cage induction type motors, NEMA Design B Type. Insulate the stator windings and stator leads with a moisture-resistant Class F insulation with temperature resistance of 155 degrees C 311 degrees F. The motor must have a service factor of [1.15]. The temperature rise above ambient for continuous full load rated conditions and for the class of insulation used cannot exceed the values in NEMA MG 1. The motor must be rated for continuous duty when submerged and also be capable of

operation in the dry for short periods of time for testing and maintenance purposes. Starting torque must be sufficient to start the pump, but in no case less than 60 percent of full-load torque. Break-down torque cannot be less than 150 percent of full-load torque.

2.4.5 Cable

a. Specifically design power and instrumentation cable for use with a submersible pump application and conform to the requirements of NEMA WC 70 and NEMA WC 72. Use submersible cable suitable for continuous immersion in water at the maximum depth encountered. Cable must have an ampacity of not less than 125 percent of the motor full load current. The cable length must be determined by the pump manufacturer for the installation shown but cannot be less than [_____] m ft.

b. Power and instrumentation cables must enter the motor through a sealing system that prevents water entry into the unit and provides strain relief. The cable entry may be comprised of rubber bushings, flanked by stainless steel washers, having a close tolerance fit against the cable outside diameter and the entry inside diameter for sealing by compression of the bushing, or the entry may be sealed by other gland compression methods.

2.4.6 Alarms

Provide the following alarm features for all the pump/motors.

a. Over temperature alarm: The motor over temperature alarm circuit must be actuated by three thermal sensors embedded in the stator windings of the pump motor (one switch in each stator phase). The pump motor must stop on over temperature and not restart until the over temperature alarm is manually reset and the motor temperature has cooled to the appropriate temperature.

b. Overload alarm: The motor overload circuit on the pump motor must stop the motor upon overload and not restart until the overload condition is corrected and manually reset.

c. Lower seal failure alarm: Provide a leakage sensor in the oil chamber. The sensor must activate an alarm when water concentration exceeds 30 percent.

d. Stator Leakage Sensor: Sensor must activate an alarm and stop the motor when any water is detected.

2.4.7 Pump Interface Modules

The pump supplier must furnish any electrical interface modules necessary for the pump sensors to communicate with the motor control center and control system. Interface modules must be adaptable to any type of standard control system. Match mark interface modules to each pump.

2.4.8 Painting

Paint the pump/motor in accordance with the pump manufacturer's standard coating system. External unmachined and non-mating machined surfaces (except for stainless steel) must be thoroughly cleaned and painted with a hydrocarbon-resistant, anti-corrosive (lead and chromate free) primer and

topcoat. Painting external surfaces of nonferrous parts and components is not required but is permissible to avoid excessive masking. Identification plates must not be painted or oversprayed.

2.5 PUMP ACCESS HATCHES (COVERS)

The pump supplier must furnish the access hatches required for each pump. Match mark the access covers to their respective pump. Ship and crate the access covers with the pump. Hatch sizes must be adequate to install or remove pumps in a single action without tipping or tilting the pumps. Covers must be minimum 1/4" thick, extruded 6061 aluminum construction, and designed for incorporating the guide rail system for each pump. Cover must be double leaf design and rated for 300 pounds per square foot and have diamond tread surfacing. Hatches must be complete including framing, flush locking mechanism, handles, and hardware. Frame must be extruded aluminum, minimum 1/4" thick, with concrete anchors as part of the extrusion. All hardware must be stainless steel. Covers must have stainless steel hinges and open to 90 degrees and lock automatically in the open position. Covers must close flush with the frame, resting on a 1/2" wide lip around the entire perimeter of the frame. Attach a stainless steel safety chain to both cover leafs. The chain must help prevent a person from falling into the wetwell when the hatch covers are open. Provide installation manuals for the access covers as noted.

2.6 FABRICATION AND MACHINING

2.6.1 Machine Work

All tolerances, allowances, and gauges for metal fits between plain, non-threaded cylindrical parts must conform to ASME B4.1 for the class of fit required.

2.6.2 Castings

Each casting must have a mark number cast or stamped upon it. In addition, each casting weighing more than 500 pounds must have the heat number cast or stamped upon it. Warped or otherwise distorted castings that are oversize to an extent that could interfere with proper fit with other parts of the machinery or structure will be rejected. Cracked castings of non-weldable materials (i.e., cast iron) will be rejected. Repairs to castings must not be made without prior approval.

2.6.3 Casting Repair

Remove all unsound material or defects from castings by chipping, machining, air arc gouging, or grinding; and repair by welding. Conform welding repairs to the welding procedures that have been submitted and approved for the type material involved. Accomplish stress relief annealing, where required, prior to final machining.

2.6.4 Bolted Connections

Conform bolts, nuts, and washers to the applicable requirements of ASTM A193/A193M and ASTM A194/A194M for the types required.

2.6.5 Regular Bolt Holes

Holes for regular bolts must be drilled or sub-drilled and reamed in the shop. Holes must be accurately located, smooth, perpendicular to the

member, and cylindrical.

2.6.6 Fitted Bolt Holes

Match ream or drill holes for fitted bolts in the shop. Holes must be smooth, perpendicular to the member, and cylindrical. Remove burrs resulting from reaming . The threads must be entirely outside of the holes. The body diameter of the bolt must have tolerances as recommended by ASME B4.1 for the class of fit required. Fitted bolts must be fitted in reamed holes by selective assembly to provide an LN 2 fit.

2.6.7 High Strength Bolt Holes

Holes for high strength bolts must be accurately spaced, perpendicular to the member, and cylindrical. If the thickness of the material is greater than the diameter of the bolt, the holes must be either drilled full size or must be sub-drilled and then reamed to full size. Poor matching of holes will be cause for rejection. Drifting done during assembly must not distort the metal or enlarge the holes. For slight mismatching, reaming to a larger diameter for the next standard size bolt will be allowed.

2.6.8 Metallic Coating

Apply zinc coatings sin a manner, thickness, and quality conforming to ASTM A123/A123M. Where the zinc coating is destroyed by cutting, welding, or other causes, re-galvanize the affected areas to the thickness and quality required for the original zinc coating

2.7 FACTORY TESTS

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NOTE: The designer should specify performance testing of the assembled pump in the factory to check that the requirements of the specification have been met.

The Performance Test is a required test, whereas the Cavitation, Hydrostatic, Submersible Motor Integrity, and Vibration tests are optional. The designer should be familiar with ANSI/HI 11.6 to determine which tests are needed to balance technical adequacy and cost.

The Cavitation test, or NPSHR test, is costly due to the complexity. The designer should include cavitation testing whenever the cavitation characteristics of the proposed pump have not been determined (by test) by any one of the prospective suppliers. Testing should be conducted on a full-scale (prototype) pump. It should also establish the structural and operating integrity of the complete pumping unit. The prototype pump would be the first pump built. This test may not be necessary if there is sufficient inlet head pressure and the pump has a stated NPSHR that would be acceptable with a suitable margin (see ANSI/HI 9.6.1). The pump could be tested at the minimum design head pressure to verify that the guaranteed head and power at the specific rate of flow instead

of performing the NPSHR test. HI ANSI/HI 14.6 provides guidance for testing in Appendix D.
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Perform the following factory tests in accordance with HI ANSI/HI 11.6. [Testing is nonwitnessed factory testing. The pump manufacturer is responsible for maintaining all test results, however reporting of these test results is not required.][Testing is certified nonwitnessed factory testing. The pump manufacturer must provide certification and data to indicate that the testing meets the testing standard.][Testing must be witnessed by a Government Representative. When satisfied that the pump performs in accordance with the specified requirements, notify the Contracting Officer, [two weeks] in advance, that the witness tests are ready to be run and furnish two copies of curves required in paragraph TEST RESULTS. If the tests reveal that the pump does not perform in accordance with the specifications, make necessary changes before again notifying the Contracting officer that witness tests are ready to be run. Provide copies of all data taken during the witness testing and plotted preliminary curves to the Contracting Officer with the factory test report.]

2.7.1 Performance Test

Compliance with specifications will be determined from curves required by paragraph TEST RESULTS. Test procedures, except as herein specified, must be in accordance with HI ANSI/HI 11.6. Use clean water for testing at approximately the same temperature (68 F) for all test runs and record it during test runs.

2.7.1.1 Performance of the Pump

Determine performance of each pump by a minimum of 5 test points to develop a constant speed curve over the range of total heads corresponding to the requirements of paragraph CAPACITIES. Testing must be inclusive for the speed involved. Perform tests using the heads and suction water elevation specified in paragraph CAPACITIES. Test results with this sump elevation must meet all specified conditions of capacity, head, and bkW bhp.

2.7.1.2 Test Results

Submit the factory test report for performance testing in accordance with HI ANSI/HI 11.6. Plot test results to show the total head, static heads, bkW bhp, and efficiency as ordinates. Plot the results against pump discharge in L/s gpm as the abscissa. Plot curves showing pump performance to a scale that will permit reading the head directly to 0.15 m [0.5] ft, capacity to 30 L/s [500] gpm, efficiency to [1] percent, and power input to 20 bkW [25 bhp]. Establish that the performance requirements of these specifications and the warranties under this contract have been fulfilled. Perform the performance test with the pump and motor assembled as an operating unit to simulate field installation unless otherwise approved in writing by the Contracting Officer. Conduct the test in accordance with accepted practices at full speed; and, unless otherwise specified, conform to HI ANSI/HI 11.6 procedure and instruments.

[2.7.2 Cavitation Test

Use the testing procedures provided in HI ANSI/HI 11.6 to determine the net positive suction head required (NPSHR) by the pump. Select the test arrangement and procedure, from the choices provided in HI ANSI/HI 11.6,

that best suits the test facility. NPSHR must, as a minimum, be determined for five or more capacities over the total range of the specified operating conditions. Plot the test results and define NPSHR as the point where a three percent drop in performance occurs. The value of NPSHR must be 0.6 m [3.3] ft less than the corresponding NPSHA. Use the temperature of the water at the time the tests are run in determining the NPSHR. Refer to the paragraph CAPACITIES for the NPSHA.

][2.7.3 Hydrostatic Test

Perform a hydrostatic test of the pump to verify the absence of leakage from the pressure containing walls and the joints of the pump assembly is in accordance with HI ANSI/HI 11.6. The hydrostatic test pressure is based on the differential pressure of the pump as specified in paragraph CAPACITIES. [Submit the certification that the Hydrostatic Test meets the requirements of HI ANSI/HI 11.6 with no visible signs of leakage.] [Submit a full report of the Hydrostatic Test in accordance with HI ANSI/HI 11.6.]

][2.7.4 Submersible Motor Integrity Test

Perform a submersible motor integrity test to verify the sealing and electrical integrity of a submersible motor in accordance with HI ANSI/HI 11.6. Submit the certification that the Submersible Motor Integrity Test meets the requirements of HI ANSI/HI 11.6.

][2.7.5 Vibration Test

Perform a vibration test to verify that the tested pump does not exceed a guaranteed vibration velocity level as specified in HI ANSI/HI 11.6. Submit the certification that the Vibration Test meets the requirements of HI ANSI/HI 11.6 and summarize findings in a report.

]PART 3 EXECUTION

3.1 INSTALLATION

Perform correct installation and assembly of the pumping unit in accordance with the drawings and with the manufacturer's installation instruction manual. Submit, no later than 30 days prior to time of pump delivery, three copies of a typed and bound manual describing procedures to be followed by the installation engineer in assembling, installing, and dry- or wet-testing or both of the pump. Coordinate and consolidate the description of the pump with similar descriptions for other specified pump parts. The description must be of such a nature that it may be comprehended by an engineer or mechanic without extensive experience in erecting or installing pumps of this type. The description must be a step-by-step explanation of operations required, and include, where applicable, such things as alignment procedures, bolt torque values, recommended instrument setups, recommended gauges and instruments, and similar details. Furnish all bolts, shims, tools, and other devices necessary for installing the pumping units. The manufacturer's representative(s) familiar with the equipment being installed must supervise the handling, installation, start-up, and testing of the equipment as required in the paragraph INSTALLATION AND START-UP ENGINEER.

3.2 CLEANUP PRIOR TO START

After the pumping unit is installed and prior to start-up, completely

clean the sump area of any accumulated construction debris. This final cleaning of the sump area will be witnessed by a representative of the Government. Correct any damage to the pumping units or related equipment during initial start-up due to foreign objects left in the sump areas.

3.3 PUMP FIELD TESTS

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NOTES: Compliance with specification performance has been made a part of the factory tests; therefore, field tests are for the purpose of baseline measurements. Pump integrity, vibration, , and inspection of manufacturing quality are witnessed at the factory.

Perform field testing to ensure proper alignment and installation, start-up and shutdown procedures, checking out controls, and establishing baseline measurements. Two field test methods are available, dry or wet testing, depending on availability of water. Wet testing is preferred, but dry testing may be all that is possible when the pumps are prepared for initial start-up.

If a wet test cannot be conducted at the time of initial start-up because of a lack of water, it should be conducted at a later time, if possible, and does not unduly extend the contract period.

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Submit a field test plan prior to field testing. Field testing must be conducted by an experienced field test engineer and will be witnessed by the Contracting Officer. Before initially energizing the pump/motors, ensure that all pumping plant control, monitoring, and protective circuits have been successfully tested. This thorough electrical checkout procedure must follow a detailed step-by-step approved test plan. Also check the motor and other pumping unit elements undergoing tests at this time. Field test the plan prior to field testing. Submit the Field Test Report that summarizes the results of the testing.

[3.3.1 Dry Test

Test each pumping unit in the dry in accordance with the pump manufacturer's instructions to determine whether it has been properly installed. Conduct such test when, and as, directed by Contracting Officer. Operate the pump at full rated speed. If tests reveal a design or installation deficiency or a manufacturing error in pumping unit components, promptly correct the problem.

]3.3.2 Wet Test

Test each unit under load for a period of at least [_____] hours or as directed by the Contracting Officer. Conduct the tests to be witnessed by the Government. During the tests, observe, measure, and record the operation of the pumping units, motor-bearing temperatures, voltage, and current for each pump. Measured parameters must be within the pump manufacturer's published limits.

3.3.3 Pump Removal and Installation

Install and remove each maintenance pump unit a minimum of three times to demonstrate proper pump alignment and installation. Verify that the pump can be removed and installed without sticking or binding. Verify proper sealing at the discharge elbow.

-- End of Section --