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UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated July 2023
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DIVISION 35 - WATERWAY AND MARINE CONSTRUCTION

SECTION 35 45 02.00 10

SUBMERSIBLE PUMP, AXIAL-FLOW AND MIXED-FLOW TYPE

05/21, CHG 1: 08/23

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SECTION 35 45 02.00 10

SUBMERSIBLE PUMP, AXIAL-FLOW AND MIXED-FLOW TYPE
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****
NOTE: This guide specification covers the requirement for submersible axial-flow and mixed-flow pumps for a turbid water pumping station. This section was originally developed for USACE Civil Works projects.

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

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

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

PART 1 GENERAL

****
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 standard, and the minimum for manufacturers' compliance, for the manufacture, material, design, test, and performance specifications. The vibration analysis often required of pumps is eliminated and a vibration limit specified.

Hydraulic Institute (HI) Standards have been referenced as the primary reference standard, and the minimum for manufacturers' compliance, for the manufacture, material, design, test, and performance specifications. The vibration analysis often required of pumps is eliminated and a vibration limit specified.

Pertinent HI standards are:

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 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.

****

1.1 SUMMARY

****

NOTES: Insert the name of the Pumping Station.

The other elements of the pumping unit designed for this project should be stated; e.g., electric submersible motor, reduction gear (if needed), and controls.

Coordinate the bar spacing in the trash rack with the structural designer and with pump manufacturers.

The planetary gear reduction unit, on rare occasion, may be required in the larger volume propeller pumps

such that a smaller, high-speed motor can be used. The design of the gear is an integral part of the design of the pumping unit.

Axial and mixed flow pumps are well suited for higher flow and lower head applications. Centrifugal pumps should be considered for higher pressure applications or where larger passing of solids is needed.

****

Design, furnish, and install [_____] identical pumping units for the [_____] Pumping Station shown. Water pumped will be less than [_____] degrees C F, will be relatively turbid, and may contain sand, silt, and trash capable of passing the trashrack [having 41 mm 1-5/8 inch clear openings].

1.2 LUMP SUM PRICE

a. Payment will be made for costs associated with [furnishing] [furnishing and installing] [installing] the submersible pump, axial-flow or mixed-flow type, as specified.

b. Unit of measure: lump sum.

1.3 REFERENCES

****

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

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

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

****

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

AMERICAN 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 B16.5	(2020) Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard
ASME B31.1	(2022) Power Piping
ASME B36.10M	(2022) Welded and Seamless Wrought Steel Pipe
ASME B46.1	(2020) Surface Texture, Surface Roughness, Waviness and Lay
ASME BPVC SEC IX	(2017; Errata 2018) BPVC Section IX-Welding, Brazing and Fusing Qualifications

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C200	(2012) Steel Water Pipe - 6 In. (150 mm) and Larger
AWWA C203	(2020) Coal-Tar Protective Coatings and Linings for Steel Water Pipelines - Enamel and Tape - Hot-Applied
AWWA C207	(2018) Standard for Steel Pipe Flanges for Waterworks Service, Sizes 4 in. through 144 in. (100 mm through 3600 mm)
AWWA C208	(2022) Dimensions for Fabricated Steel Water Pipe Fittings
AWWA E102	(2017) Submersible Vertical Turbine Pumps

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2020; Errata 1 2021) Structural Welding Code - Steel

ASTM INTERNATIONAL (ASTM)

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 A126	(2004; R 2019) Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings
ASTM A216/A216M	(2021) Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High-Temperature Service
ASTM A240/A240M	(2023) Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
ASTM A242/A242M	(2013; R 2018) Standard Specification for High-Strength Low-Alloy Structural Steel
ASTM A276/A276M	(2017) Standard Specification for Stainless Steel Bars and Shapes
ASTM A297/A297M	(2021a) Standard Specification for Steel Castings, Iron-Chromium and Iron-Chromium-Nickel, Heat Resistant, for General Application
ASTM A312/A312M	(2022a) Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes
ASTM A516/A516M	(2017) Standard Specification for Pressure Vessel Plates, Carbon Steel, for Moderate- and Lower-Temperature Service
ASTM A576	(2017) Standard Specification for Steel Bars, Carbon, Hot-Wrought, Special Quality
ASTM A582/A582M	(2022) Standard Specification for Free-Machining Stainless Steel Bars
ASTM A668/A668M	(2023) Standard Specification for Steel Forgings, Carbon and Alloy, for General Industrial Use
ASTM A743/A743M	(2021) Standard Specification for Castings, Iron-Chromium, Iron-Chromium-Nickel, Corrosion Resistant, for General Application
ASTM A890/A890M	(2018) Standard Specification for Castings, Iron-Chromium-Nickel-Molybdenum Corrosion-Resistant, Duplex (Austenitic/Ferritic) for General Application
ASTM B98/B98M	(2013) Standard Specification for Copper-Silicon Alloy Rod, Bar, and Shapes
ASTM B148	(2014) Standard Specification for Aluminum-Bronze Sand Castings

ASTM B584	(2022) Standard Specification for Copper Alloy Sand Castings for General Applications
ASTM D2000	(2018) Standard Classification System for Rubber Products in Automotive Applications
ASTM F1476	(2007; R 2019) Standard Specification for Performance of Gasketed Mechanical Couplings for Use in Piping Applications

HYDRAULIC INSTITUTE (HI)

HI 9.1-9.5	(2021) Pumps General Guidelines for Materials, Sound Testing, and Decontamination - B117
HI 9.6.4	(2009) Rotodynamic Pumps for Vibration Analysis and Allowable Values
HI ANSI/HI 9.8	(2014) Rotodynamic Pumps for Pump Intake Design - A123
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 ELECTRICAL TESTING ASSOCIATION (NETA)

NETA ATS	(2021) Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems

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
ISO 20816-1	(2016) Mechanical Vibration - Measurement and Evaluation of Machine Vibration - Part 1: General Guidelines

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

U.S. ARMY CORPS OF ENGINEERS (USACE)

EM 1110-2-3105 (2020) Engineering and Design -- Mechanical and Electrical Design of Pump Stations

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 3-301-01 (2023) Structural Engineering

1.4 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.

****

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

Contractor's Pump Supplier Qualifications; G[, [_____]]

SD-02 Shop Drawings

Detail Drawings; G[, [_____]]

SD-03 Product Data

Equipment; G[, [_____]]

Spare Parts

Installation Instruction Manual; G[, [_____]]

Impeller Balancing

Factory Tests

Pump Field Tests; G[, [_____]]

General Design Requirements; G[, [_____]]

Paint

Environmentally Acceptable Lubricant; G[, [_____]]

Materials; G[, [_____]]

SD-05 Design Data

Computations; G[, [_____]]

SD-06 Test Reports

Factory Test Report

Intake Model Tests

Field Test Report

Contractor's Installation and Start-Up Engineer

Installation Report

Intake Model Test Report; G[, [_____]]

SD-07 Certificates

Qualified Welders

Contractor's Modeling Engineer Qualifications; G[, [_____]]

SD-10 Operation and Maintenance Data

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

1.5 QUALITY ASSURANCE

1.5.1 Contractor's Pump Supplier Qualifications

****

NOTE: Submersible pumps are designed as a single machine even though specifications may not always recognize that unity. Clearly state that a single manufacturer is to design and supply all parts of the pump unit including pump, motor, discharge tube, reduction gear, and cables. That manufacturer should also have demonstrated capability in sump design for pumps of the larger size.

****

The Contractor's pump manufacturer has overall responsibility to supply the pumping unit (submersible pump/motor, [reducing gear (if needed)], discharge tube, [discharge elbow,] cables, and related [instrumentation and accessories]) that meet the requirements of this specification. Supply a list of similar installations which have been operating for at least 2 years.

1.5.2 Contractor's 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 pumps and the associated equipment specified to act on behalf of the Contractor. Submit the installation and start-up engineer's qualifications. The Contractor's 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 Contractor's installation engineer initiates instructions for actions necessary for proper receipt, inspection, handling, uncrating, assembly, and testing of equipment. Submit an installation report including a record of measurements taken during erection and furnish one copy to the Contracting Officer upon request or upon the completion of the installation of assembly or part. The erecting engineer conducts training on the operation and maintenance features of the pump units.

1.5.3 Detail Drawings

Submit drawings within [90] [_____] days of Notice of Award for review and approval. 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 which are intended for the Contractor's 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.

1.5.4 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.

1.6 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.

1.7 EXTRA MATERIALS

****

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.

****

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.

c. Submit copies of parts list showing all parts, spare parts, and bulletins for each pump. Clearly show all details, parts, and adequately describe parts or have proper identification marks. Provide the parts lists [on good quality 216 by 279 mm 8-1/2 by 11 inch paper][on optic disk with default letter print size of, 8-1/2 by 11 inch], bound separately from the Operation and Maintenance manual[with a flexible, durable cover]. Drawings incorporated in the parts lists may be reduced to page size provided they are clear and legible[, or they may be folded to page size and inserted into the bound lists]. Photographs or catalog cuts of components may be included for identification.

1.8 WARRANTY

****

Consider including an extended or hourly based warranty for the pumping equipment if there is a likelihood that the pumping equipment will be operated very little during the first years due to a lack of water, ongoing interconnected projects, or permitting issues.

****

Provide a warranty for the submersible 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 notifies the Contractor within a reasonable time after its discovery, the Contractor must 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 Contractor and the Government. The Contractor is liable during the warranty period for the direct cost of removal of the equipment from the installed location, transportation to the Contractor's factory or service shop for repair and return, and reinstallation on site. The Contractor must be given the opportunity to perform the removal and reinstallation and to select the means of transportation. The expense of work required to perform warranty repair e.g., removing adjacent equipment, installing spare equipment, supplying temporary service is not included in this warranty provision.

PART 2 PRODUCTS

2.1 SYSTEM REQUIREMENTS

****

NOTE: The designer should include in this section those factors of the project design that relate to the specification of the pump. These are factors that will be data inputs to the manufacturer, and are examined during the pump selection procedure. The specifications as written are for water of normal chemistry and abrasive quality. The Contractor must be informed in the specification of any unusual project conditions.

****

2.1.1 Pumping Unit Description

****

NOTE: Provide a pumping plant design that will accommodate the available pumps and their structural and hydraulic requirements. Pumps are designed to be contained in a discharge tube and able to be lifted from the discharge tube for maintenance and repair.

****

Each pumping unit includes a pump/motor, discharge tube, [discharge elbow], air vent, [lifting chain], cable, and controls. Each pump must be of the vertical, axial, or mixed-flow submersible type for [storm water,] [flood control,] [attached to the same shaft with a submersible electric motor] [direct coupled through a reducing gear to a submersible motor]. Use an electrically operated pump/motor installed in a discharge tube. Except as otherwise stated or noted, the terms pump and pump/motor both refer to a pump/motor integral unit.

2.1.2 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.

2.1.3 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.

2.1.4 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.

2.1.5 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.

2.1.6 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.

[2.1.7 Factory Test Location

Factory testing facility must be in the continental United States. Submit

the proposed testing facility as a shop drawing.

]2.1.8 General Design Requirements

a. Provide the pump meeting head, capacity, speed, efficiency, range of operation, cavitation, and vibration requirements as specified.[Reduction gears or adjustable impeller blades may be utilized to meet the specification performance requirements.]

b. Design the pump for runaway speed as calculated for the system shown and specified. Calculate the reverse speed assuming a power failure and the discharge valves fail to close.

c. The pump must, as a minimum, meet the applicable design, materials, and manufacturing requirements of HI 9.1-9.5, HI ANSI/HI 14.1-14.2, HI ANSI/HI 14.3, AWWA E102 and these specifications.

d. The pumping unit design and performance must have been demonstrated by previous successful operation of pumps of the required type and of equal design complexity by the Contractor.

e. Operate the pump in a discharge tube that fits within the dimensions shown, and 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.

f. Design the pump for the calculated hydraulic pressure including a water hammer to which the pump parts are exposed.

g. The pump must have a continuously rising head characteristic with decreasing capacity over the required range of operation specified. The pump must not have an unstable operating characteristic over the required range of operation.

h. The pump must meet all requirements for net positive suction head required (NPSHR) and operate without surging.

i. Use associated pumping equipment including, but not limited to, electrical controls, instrumentation, [and pump control center] that is suitable for [indoor] [outdoor] operation.

[j. Include water hammer calculations.]

[2.1.9 Design of Discharge System

****

NOTE: A number of installation designs are possible depending on the project site conditions. The designer normally designs the discharge system but, has the option to allow the Contractor to design as much of the discharge system as desired. The calculations must be in accordance with EM 1110-2-3105, with the hydraulic definitions as stated in the HI standards. If used it is the designer's responsibility to develop FIGURE 1.

****

a. [Discharge the pumping unit into the discharge system indicated. The system loss curve is included as FIGURE 1 at the end of this section

to permit determination of total head. Determine losses within the pumping unit.] [The pump discharge system downstream of the pumping unit must be designed by the pump manufacturer; of the type indicated and fitting within limiting dimensions and elevations indicated. Determine all losses for the discharge system and submit the design head loss computations. Provide sufficient hydraulic computations to substantiate pump selection and demonstrate that the selected pump will meet the project design and operating requirements as specified. Determine losses within the pumping unit.] [Discharge the pumping unit into the discharge chamber indicated. The system loss curve(s) furnished includes all losses beyond the pumping unit. Determine losseswithin the pumping unit.]

[b. Accomplish priming of the siphon without the assistance of vacuum equipment.]

]2.1.10 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.

2.1.11 Performance Requirements

a. The maximum level of vibration of the assembled pumping unit cannot be greater than the value of the lower limit of the good range of vibration severity per ISO 20816-1. Take measurements at pump operating speed during the Factory Test and the field start-up test.

b. The pump must be capable of operating without instability over the required range of head.

2.1.12 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.

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. 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 [_____]kW 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.

2.1.13 Efficiency

****
NOTES: In the last bracketed option, specify the point at which the efficiency percentage should be reached.
****

The pump must have an efficiency of not less than [_____] percent at [_____].

2.1.14 Equipment

Submit, within 60 days of Notice of Award, a list of equipment as specified, catalog data, performance capacities, and other relevant information for the machinery and other equipment contemplated to be incorporated into the work.

2.2 METALWORK FABRICATION

****
NOTE: Refer to HI 9.1 and ANSI/AWWA E102 for design assistance with material selection.
****

Submit a list designating materials to be used for each pump part. If deviation from specified materials is desired, submit complete specifications for the proposed deviating materials after award of the contract.

[Provide materials and fabrication conforming to the requirements specified herein and to Section 08 31 00 ACCESS DOORS AND PANELS and Section 05 50 15 CIVIL WORKS FABRICATIONS and to additional specified requirements.] Classifications and grade of material incorporated in the work must be in accordance with designated specifications. Submit deviations from the specified materials in accordance with paragraph SUBMITTALS.

The materials of construction must comply with the following:

TABLE 1 - MATERIALS OF CONSTRUCTION

PART	MATERIAL
[Discharge Elbow] [Discharge Pipe]	[Cast iron] [cast steel] [chromium-nickel cast stainless steel] [duplex stainless steel] [super duplex stainless steel]
Surface Plate	[quality steel]

TABLE 1 - MATERIALS OF CONSTRUCTION	
PART	MATERIAL
Pipe Column	[Cast iron] [cast steel] [chromium-nickel cast stainless steel] [duplex stainless steel] [super duplex stainless steel]
Intermediate Bowl	[Cast iron] [cast steel] [chromium-nickel cast stainless steel] [duplex stainless steel] [super duplex stainless steel]
Impeller	[Cast iron] [aluminum bronze] [chromium-nickel cast stainless steel] [duplex stainless steel] [super duplex stainless steel]
Shaft	[Cold-rolled carbon steel] [stainless steel]
Wearing Ring	[aluminum bronze] [Manufacturer's standard]
O-rings	Nitrile rubber
Mechanical seal	Tungsten carbide

2.2.1 Designated Materials

Designated materials must conform to the following specifications, grades, and classifications.

MATERIALS	SPECIFICATION	GRADE, CLASS
Aluminum-Bronze	ASTM B148	Alloy No. C95500 Castings
Cast Iron	ASTM A48/A48M	Class 35B
Cast Steel	ASTM A216/A216M	WCB
Chromium-nickel Cast Stainless Steel	ASTM A743/A743M	CF-8, CF-8M or CN-7M
Coal Tar Protective Coatings	AWWA C203	
Cold-Rolled Steel Bars	ASTM A108	min, Wt. Strm 450 MPa 65,000 psi
Copper Alloy Castings	ASTM B584	Alloy No. C93700

MATERIALS	SPECIFICATION	GRADE, CLASS
Corrosion-Resistant Alloy Casting	ASTM A297/A297M	Grade CA-15, CAGNN and CF-8M
Dimensions for Steel Water Piping Fittings	AWWA C208	
Duplex Stainless Steel	ASTM A890/A890M	Grade 1B or 3A
Hot-Rolled Stainless	ASTM A576	Graded G10200, G10450, and G11410
Ring Flanges	AWWA C207	Class B
Rubber Products in Automotive Applications	ASTM D2000	
Seamless and Welded Austenitic Stainless Steel Pipe	ASTM A312/A312M	
Stainless Bars and Shapes	ASTM A276/A276M or ASTM A582/A582M	Grades S30400 and S41000
Steel Forging	ASTM A668/A668M	Class F
Steel Pipe 150 mm 6 inch and Larger	AWWA C200	
Steel Plates, Pressure Vessel	ASTM A516/A516M	Grade 55
Steel Plate	ASTM A242/A242M	
Stainless Steel Plate	ASTM A240/A240M	UNS S30400
Super Duplex Stainless Steel	ASTM A890/A890M	Grade 5A
Quality Steel	ASTM A36/A36M	
Surface Texture	ASME B46.1	

2.2.2 Bolted Connections

2.2.2.1 Bolts, Nuts, and Washers

Bolts, nuts, and washers must conform to requirements herein specified and paragraphs SUBMERSIBLE PUMP, DISCHARGE TUBE [AND DISCHARGE ELBOW], and subparagraph, NUTS AND BOLTS for types required. Use beveled washers where bearing faces have a slope of more than 1:20 with respect to a plane normal to bolt axis.

2.2.2.2 Materials Not Specifically Described

Conform materials not specifically described to the latest ASTM specification or to other listed commercial specifications covering class or kinds of materials to be used.

2.2.2.3 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.

2.2.2.4 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.

2.2.2.5 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.

2.2.3 Flame Cutting of Material

Flame cutting of material, other than steel, is subject to Contracting Officer approval. Accurately perform shearing, and neatly finish all portions of work. Steel may be cut by mechanically guided or hand-guided torches, provided an accurate profile with a smooth surface free from cracks and notches is secured. Prepare surfaces and edges to be welded in accordance with Section 3 of AWS D1.1/D1.1M. Chipping and grinding are not permitted except where specified and as necessary to remove slag and sharp edges of technically guided or hand-guided cuts not exposed to view. Chip, grind, or machine visible or exposed hand-guided cuts to metal free of voids, discontinuities, and foreign materials.

2.2.4 Alignment of Wetted Surfaces

Exercise care to ensure that the correct alignment of wetted surfaces being joined by a flanged joint is being obtained. Where plates of the water passage change thickness, provide a transition on the outer surface, leaving the inner surface properly aligned. When welding has been completed and welds have been cleaned, but prior to stress relieving, carefully check joining of plates in the presence of a Government inspector for misalignment of adjoining parts.

2.2.5 Metallic Zinc Coatings

Apply zinc coatings in 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.

2.3 SUBMERSIBLE PUMP

2.3.1 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 submersible pump may be either of cast or fabricated construction. The level of manufacture must be consistent with the standards referenced in the specifications. 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.

2.3.2 Speed

****

NOTE: HI 2000 bases the maximum operating pump speed calculations on a value of suction-specific speed of 8500. EM 1110-2-3105, Appendix B uses 8000. When calculating the maximum specified pump speed use the more conservative value of suction-specific speed for application where pumps will operate continuously or for extended periods of time above or below point of optimum efficiency.

****

2.3.2.1 Pump Speed

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

2.3.2.2 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.

2.3.3 Pump Construction

2.3.3.1 General

The major pump components must be of materials as described in Table 1. [Design the entire support assembly in accordance with UFC 3-301-01 [and Sections 13 48 73 SEISMIC CONTROL FOR MISCELLANEOUS EQUIPMENT and 23 05 48.19 [SEISMIC] BRACING FOR HVAC].] All 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.

2.3.3.2 Pump Lifting Handle And Lifting Lugs

Design the lifting handle to bear the entire weight of the pumping unit at a factor of safety of 5. Provide lifting lugs where the weight of the separate part requires a lug.

2.3.3.3 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 B-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.

2.3.3.4 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 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 not require maintenance or adjustment, but be easy to inspect and replace. Shaft seals without positively driven rotating members are not considered acceptable or equal.

2.3.3.5 Lubricant Housing

****

NOTE: The designer will need to consider the use of Environmentally Acceptable Lubricant (EAL) based on current local requirements. EAL installation is specified in EM 1110-2-1424. EAL may affect the seal material for compatibility.

****

Provide an oil housing with oil, as recommended by the Contractor's pump manufacturer, to lubricate the shaft sealing system and to dissipate the heat generated by the motor and bearings. [Oil must be environmentally acceptable lubricant (EAL). EAL must meet the requirements of EPA 800-R-11-002 or VGP (Vessel General Permit). The oil must have performance characteristics that are suitable for this application, meets the compatibility requirements for the system components, and is technically acceptable by the pump manufacturer. Submit the physical and performance properties as well as the certification that the oil meets the above requirements.]

2.3.3.6 Impeller

The impeller design and manufacture must be standard to the Contractor's proposed pumps. 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. 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 9.6.4, except that a two-plane balance is required. Submit the results of impeller balancing.

2.3.3.7 Shaft

The shaft must be [one piece integral with the motor] [two piece with gear reduction] of high-strength cold-rolled carbon steel or stainless steel with a factor of safety of five measured against the ultimate strength. Design the shaft for all torque conditions during normal operation and for runaway speed during reverse flow.

2.3.3.8 Bowl Assembly

****

NOTE: This portion of the pump is composed of the venturi section and consists of the suction bell, pump bowl, and discharge bowl. The entire unit acts as a venturi to hydraulically guide and stabilize the flow as it passes through the pump. Heads and stresses are low, and its major design consideration is for rugged, reliable, and long-lived materials.

****

The bowl assembly may be cast or fabricated. The hydraulic design must be the design shown in the submitted general drawings. The general manufacture quality relating to flange design, drilling, bolts, alignments, must be in accordance with industry standard practice.

[2.3.3.9 Column Check Valve

Provide a spring loaded column check valve within 20 feet above the bowl section.

][2.3.3.10 Flow Shroud

Provide a flow shroud to direct flow to pump over motor surface for motor

cooling.

][2.3.3.11 Strainer

Provide a strainer to prevent large objects from entering the pump. The maximum opening of the strainer must not be more than 75 percent of the maximum opening of the water passage through the bowl or impeller.

]2.3.4 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, [_____] 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. Use a service factor of 1.0. 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.

2.3.4.1 Torque

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.

2.3.4.2 Support

Provide thrust bearing support of sufficient strength and rigidity to support the weight of the entire rotating element of the motor, pump impeller and shaft, and the hydraulic thrust.

2.3.5 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 [_____] 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.

2.3.6 Pump Control and Monitoring

Provide a self-contained pump control and monitoring system. Provide pump controls and control panels in accordance with [Section [_____]] [_____]. Provide independent local indication of the alarm and separate contacts for the remote indication of each alarm and local reset. Sensors must alarm and shut down the pump at an abnormal operating condition. provide separate red alarm indicator lamps and green pump running lamps and label

in the enclosure specified in [Section [_____]] [_____]. Provide the following sensors:

[2.3.6.1 Thermal Sensor

A thermal sensor in the gear reduction unit (if used) to monitor oil temperature.

]2.3.6.2 Temperature Sensor

Temperature sensors in the stator windings to protect the motor against overheating.

Temperature sensors to monitor the main and support bearings.

2.3.6.3 Float Switch Sensor

Float-switch sensor positioned between the bearings and the stator-end coils to detect if liquid penetrates the stator housing.

2.3.6.4 Detectors

A junction box leakage detector and a water-in-oil detector.

2.3.7 Air Vent

Provide an air vent and a combination air and vacuum valve type. The valve must be a minimum 862 kPa 125 lb class and sized for the design flow rate. Provide an isolation valve at the valve's inlet. Materials of construction must be cast iron for the valve body; stainless steel for the internal linkage, float, and float stem; and Buna-N for the needle and seat. The valve must provide a dual function to release air during pump start-up and to permit air to re-enter to break the vacuum during pump shutdown.

2.4 DISCHARGE TUBE [AND DISCHARGE ELBOW]

2.4.1 General

a. Design, manufacture, and install the discharge tube [and discharge elbow]. For purposes of performance and this specification it is treated as part of the pumping unit. Provide the discharge tube of such size to accommodate the dimensions of the pump supplied in accordance with its specific requirements. Furnish the discharge tube with lifting points to aid in the handling and installation of the tube. Permanently install it in the pump sump as indicated.

b. Design so the pumps are automatically and firmly connected to the discharge tube when lowered into place and in accordance with the pump manufacturer's instructions. Provide a locking device that prohibits rotational movement of the pump within the tube.

c. The pumps must be easily removable for inspection or service without need to enter the pump sump. The pumps must not require any bolts, nuts, or fasteners for connection to the discharge housing. Provide stiffening, guides, or other features at the pump support to ensure concentric positioning of the pump in the discharge tube. provide means such that an effective seal is obtained between the pump and discharge tube. Power cable penetrations must be watertight.

[d. Install a sole plate as indicated. Design the entire support assembly to the requirements of UFC 3-301-01 and Sections 13 48 73 SEISMIC CONTROL FOR MISCELLANEOUS EQUIPMENT and 23 05 48.19 [SEISMIC] BRACING FOR HVAC.]

2.4.2 Flanged Joints

Design flanged joints to be airtight and watertight, without the use of preformed gaskets, except that the use of a gasketing compound will be permitted. Mating flanges must be male/female rabbet type or doweled with not less than four tapered dowels equally spaced around the flange. Machine flanges and drill bolt holes concentric with the centerline, having a tolerance of plus or minus 1/4 of the clearance between the bolt and the bolt hole. When fabricated from steel plate, flanges must not be less than 40 mm 1-1/2 inch thick after machining. Flange machining must not vary more than 10 percent of the greatest flange thickness. Construct fabricated flanges, as a minimum, to the dimensions of AWWA C207, Class B. Connect flanges to the column tube [and discharge elbow] with two continuous fillet welds, one at the inside diameter of flange-to-pump-tube and the other at the outside diameter of pump-tube-to-flange. Machine mating flanges parallel to a tolerance of 0.05 mm 0.002 inch. Finish the machine mating flange surface to 125 microns or better.

2.4.3 Nuts and Bolts

Use hexagonal type nuts and bolts; with bolts, including assembly, anchor, harness, and dowels of 300 stainless steel. Provide bronze nuts and 300 series stainless steel washers.

[2.4.4 Bolted Lid

Provide a watertight lid, hinged and bolted to the top of the discharge tube.

][2.4.5 Harnessed Coupling

Provide a flexible mechanical coupling or split-sleeve type coupling that either conforms to ASTM F1476, Type II, Class 3, or ASTM F1476, Type 1, to connect the pump discharge elbow to the [transition section] [wall thimble] [discharge piping]. Finish the middle ring without pipe stop to facilitate the installation and removal of the coupling. Install a minimum of four harness bolts at each coupling.

]2.4.6 Wall Thimble

****

NOTE: This alternative is used when the discharge piping includes the piece that will be embedded in the wall of the station. The size of vent to be used is determined from information in EM 1110-2-3105.

****

Each wall thimble must have one plain end to accommodate the flexible mechanical coupling and one flanged end to mate with the [flap gate] [multiple shutter gate] [discharge piping]. Match the plain end with the pump discharge elbow in thickness and diameter and drill the flanged end to match, and be capable of supporting without distortion, the [flap gate]

[multiple shutter gate]. Provide the seal ring on the wall thimble located so that it is centered in the wall when embedded. In addition, furnish a [_____] mm inch flanged vent nozzle equipped with an ASME B16.5 standard 125 pound flange and locate where indicated. Fabricate the wall thimble from steel plates.

2.4.7 Discharge Piping

****
NOTE: Include applicable discharge pipe description.
****

[Provide discharge piping consisting of a transition section and a wall thimble. Transition section must have one plain end and one flanged end, and provide a change in cross section from round to [square] [rectangular]. The plain end must match the pump discharge elbow in thickness and diameter. Arrange the wall thimble for embedment and with the flanges on each end. One end mates with the flange on the transition section and the other end mates with flap gate. Fabricate the discharge flange with a minimum dimension of AWWA C207, Class D, and drill to match. The discharge flange must be capable of supporting, without distortion, the multiple shutter gate. Provide a seal ring on the wall thimble and locate it so that it is centered in the wall when embedded. In addition, furnish a [_____] mm inch flanged vent nozzle equipped with an ASME B16.5 standard 125 pound flange and locate it where shown. Fabricate discharge piping from steel plate.]

[Install the discharge piping as indicated. Match the plain end of each discharge pipe to the pump discharge elbow in thickness and diameter, and configured to allow a flexible mechanical coupling to connect it to the pump discharge elbow. [Terminate the discharge piping in a flanged end to mate with a flap gate. Drill the flanged end to match, and configure to be capable of supporting the flap gate without distortion.] [Terminate the discharge piping in an open end.] The discharge pipe must have pipe supports or cradles as recommended for the Contractor's selected pumps. Locate the supports between the flexible coupling and the wall, as indicated. Provide suitably-sized thrust restraints at each flexible coupling as indicated. The supports must provide support for the weight of the pipe, the water that will pass through the pipe, and any dynamic forces that may develop due to water flowing through the pipe. Furnish a minimum [_____] mm inch flanged vent nozzle equipped with an ASME B16.5 standard 125 pound flange and locate as indicated. The discharge pipe must be non-galvanized piping of welded or seamless pipe or welded steel plate. The steel pipe must conform to AWWA C200 with dimensional requirements as given in ASME B36.10M. Fittings must comply with AWWA C208.]

2.4.8 Flap Gate

Design the flap gate for pump discharge service with flange-frame with a resilient seat of neoprene or nitrile butadiene rubber to prevent closing shock. Size the flap gate to be the same as the discharge pipe size. [The body of the valve and the flap must be cast iron ASTM A126. The hinge arms must be high-tensile bronze ASTM B584- CA 865. Design the hinge pins in double shear and of silicon bronze, ASTM B98/B98M- CA 655.] [Fabricate the flap gate entirely of stainless steel. Use only stainless steel hardware.] Provide lubrication fittings on the hinge arms. Extend the grease lines to a convenient location for lubricating. provide an anti-locking bar to prevent excessive rotation about the lower hinge pin. provide a stainless steel leaf spring with rubber pad to safely limit the

travel of the flap gate during pumping.

2.4.9 Dissimilar Metals

When dissimilar metals are used in intimate contact, apply suitable protection against galvanic corrosion. Protect the anodic member by proper electrical insulation of the joint.

2.5 INTAKE DESIGN

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NOTE: Information on intake design is available in EM 1110-2-3105, Hydraulic Institute standards, manufacturers' catalogs, and model tests from the U.S. Army Engineer Research and Development Center (ERDC). The designer should be aware of net positive suction head available (NPSHA) and NPSHR from pump performance curves and the plant design operation. If the approach inlet conditions to the pumping station are unique or unusual, the designer should consider having the contractor perform a model intake test, or the contractor may consult ERDC about the need for a model test or to learn about results from previous testing.

Detailed design information about using a formed suction intake is available in EM 1110-2-3105.

****

2.5.1 General

The intake sump design will be provided by the Government. Supply a pump that will meet the performance requirements without undue modifications to the sump as indicated on the drawings. Any such modifications are at no cost to the Government and must receive prior approval.

[2.5.2 Formed Suction Intake (FSI)

Provide an FSI for each pump to the dimensional requirements and arrangement shown on the drawings. Connect the FSI to the inlet of the discharge tube. Use flanged joint as specified in paragraph FLANGED JOINTS as the method of connection. Assume the FSI has a K value of 0.15 for head loss calculations. Construct the FSI of [fabricated steel], [cast iron], [a combination of fabricated steel and cast iron]. Any stiffeners used must be on the outside of the FSI to allow smooth flow within. Use stainless steel bolts with bronze nuts. The minimum thickness of fabricated material must be [10 mm 3/8 inch] [12 mm 1/2 inch] [16 mm 5/8 inch] [19 mm 3/4 inch]. Provide grout holes in the floor [and sides] of the FSI to permit grouting during installation.

][2.6 INTAKE TESTING

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NOTE: Delete this paragraph if a model test of the intake to the pumping system(s) is not required.

****

Provide complete performance model testing of the pump intake systems.

Use the model testing to confirm the configuration of the intake systems, including the proposed intake conduit, hydraulic losses to the pump, the position of the pump in the intake bay, and to confirm the selection of the pump. The Contracting Officer will witness the final tests confirming the geometry for the intake conduit. Notify the Contracting Officer with at least 14 days notice of the time and location for the final tests.

[2.6.1 Contractor's Modeling Engineer Qualifications

Perform the modeling work in a hydraulic laboratory located within the United States where this type of work has been performed for a period of at least ten years. The individual in responsible charge of the modeling work must be a registered professional engineer in any U.S. state with at least ten years of experience in pump and intake modeling work for similar projects. The engineer must seal and sign all reports and data documents generated as a part of the test work prior to submitting them.

][2.6.2 Intake Model Setup and Objectives

The model intake setup must be of the intake system, custom designed for this installation and suitable for operation at atmospheric pressure for observation of the intake basin performance. The intake model must be suitable for use with a model pump. Use clean and clear water for the test to allow proper observation. The temperature of the water during any test cannot exceed 30 degrees C 85 degrees F.[For the FSI, provide a setup to determine flow patterns in the suction basin approaching the intake, along with losses to the pump. Provide further tests to identify flow patterns in the intake itself and approach patterns at the entrance to the pump.] In the intake model, include all items in the intake path, including, but not limited to: models of the trash rack, stoplog slots, access ladders, and the stilling wells in the intake bays.

][2.6.3 Intake Model Tests

The objective of the modeling work is to define the performance of the proposed pumping unit and to confirm the geometry to be used for the pump intake. The model must have a model-to-prototype Froude number ratio of 1, based upon the pump impeller diameter. Arrange the model in the same relative orientation as the prototype structure and include the bay configuration and screening system. Perform all testing with the same model.

[Intake Tests: For the formed suction intake geometry shown on the drawings, use the model setup to determine flow characteristics in the suction basin intake bay and at the entrance to the FSI at all specified operating conditions. In addition, use the model to determine the effect of the intake system on pump operating characteristics. Use a siphon generated by a separate pump to examine flow characteristics in the intake bay using Froude relationships to model intake operation in the first set of tests. Use second test to develop information on the effect of the intake on pump operation. Use these values to forecast the performance of the pump-intake conduit combination.

][Alternate Intake Geometry: If an intake geometry differing from that indicated is proposed, or other modifications such as baffling, test the proposed intake and/or modifications to demonstrate its suitability for use in the project and compliance with Appendix I in EM 1110-2-3105. For that reason, design the laboratory setup specifically to monitor free and sub-surface vortices, swirl and pre-rotation approaching the pump

impeller, flow separation at hydraulic surfaces in the intake conduit and at the hydraulic surfaces approaching the pump impeller, and axial velocity distribution at the entrance to the impeller.

] a. The intake conduit and pump inlet must contain several clear windows and similar appurtenances and adequate lighting at all critical areas to allow visual determination of the presence of vortices, turbulence, and other defects. Make provisions to insert dye at intervals in the intake conduit and at the entrance to the impeller during operation of the test. Reynolds and Weber numbers for all model runs must be greater than 30,000 and 120, respectively. The manufacturer must develop scale factors for velocity, flow, and time for use in evaluation of model results. Scale factors are subject to review by the Contracting Officer. In addition to model runs at all specified operating conditions, conduct no fewer than five runs at 1.5 times Froude-scaled flows after final geometrics for the intake conduit and intake bays have been established, keeping the submergences at the geometrically scaled values. Track and document circulation contributing to development of vortices.

b. Determine vortex formation in the model every 15 seconds extending over a period of 10 minutes. Classify vortices in accordance with the strength classification system in HI ANSI/HI 9.8 for both surface and subsurface vortices, using dye wand injection to assist in classification. Provide both photographic and video documentation of vortex formation. Direct particular attention to subsurface vortex formation at the intake conduit entrance and on intake conduit surfaces leading to the impeller entrance.

c. Provide a swirl meter or other satisfactory device to determine liquid rotation (swirl) at the entrance to the impeller. Obtain swirl readings at intervals of 20 seconds for a period of not less than 10 minutes after the model has achieved steady-state operation at any specified operating condition. Swirl angle is defined by the relationship:

swirl angle = (1/(tan))(pi*d*n)÷ u

Where:
u = average axial velocity at the swirl meter.
d = diameter of the conduit at the swirl meter.
n = revolutions/second at the swirl meter.

d. Headloss Measurements: Measure headloss from the upstream model boundary to just upstream of the pump inlet for each documentation test and include a minimum of the following conditions:

Pump No.	Avg On/Off El. (m) (feet)	Individual Pump Q (cubic m per second) (fps)	Total Pump Q (cubic m per second) (fps)

****
NOTE: Provide an expected order of pump operations and expected intake elevations at start-up for each pump.
****

e. Also record the head loss from just upstream of the FSI to the throat of one model pump for a minimum of 10 flow rates after the model Euler number is determined to be constant and at least one point (near the middle of the data) must be within 2 percent of the scaled rated flow of the pump. Measure head loss with a differential manometer or differential stilling basin. Install a minimum of four pressure taps around the pump throat measurement point and joined to form an average pressure reading. Calculate a dimensionless head loss coefficient for the formed inlet that includes the entrance loss into the formed inlet.

f. Determine the velocity profile in the channel cross section approaching the intake and performing the velocity traverses on perpendicular axes at the intake throat, just upstream from the impeller. Velocity measurement instruments must be capable of an accuracy of plus or minus 2 percent.

g. Use the following as criteria for acceptance of the proposed design:

(1) Free surface and sub-surface vortices entering the pump intake must be less severe than Type 1, as defined in HI ANSI/HI 9.8, unless dye core vortices appear for less than 10 percent of the time or only for pump operating conditions that are expected to be infrequent, such as the listed maximum or minimum operating conditions.

(2) Swirl angles, both maximum and average, indicated by swirl meter readings, must be less than 5 degrees. Swirl angles as great as 7 degrees will be accepted if occurring less than 10 percent of the time or for operating conditions that are expected to be infrequent, such as the listed maximum or minimum operating conditions.

(3) Velocities at points of equal radii at the throat of the intake conduit must be within 10 percent of each other.

(4) Determine NPSHR on the basis of a one percent reduction of efficiency.

(5) Time-varying velocity fluctuation (turbulence) levels as defined by a standard deviation over average velocity at a point within the pump throat must be less than 10 percent.

h. Unless otherwise specified, conform accuracy of all measurements to the levels established in HI ANSI/HI 11.6.

]2.6.4 Recommendations from the Model Test

Submit an intake model test report. If the results of the intake model testing indicate that any features of the design are deficient, report this to the Contracting Officer in writing immediately. If the intake modeler has recommendation for improving the flows in the pumps, provide them in the Intake Model Test Report. Flag these as important information that requires the Contracting Officer's immediate attention. Note all recommendations considered major changes. provide any minor recommended changes to the intake as variations in the shop drawings.

]2.7 MOTOR TESTING

Field test the motors per NETA ATSNETA ATS. For induction motors test per

part 7.15.1. For synchronous motors test per part 7.15.2.

2.8 SHOP ASSEMBLY

Assemble the discharge tube [and discharge elbow] to ensure the proper fitting and alignment of all parts. Prior to disassembly, match-mark all parts to facilitate the correct assembly in the field.

2.9 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.

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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 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.]

2.9.1 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 applicable provisions of HI ANSI/HI 11.6. Use water for testing at approximately the same temperature (68 degrees F) for all tests run and record it during test runs.

2.9.1.1 Performance of the Pump

Determine performance of the pump by a minimnum of 5 test points sufficient 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.

2.9.1.2 Test Results

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 gpmas 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 under

this contract have been fulfilled at the best efficiency point, preferred operating region, and the acceptable operating region of the pump on the plotted curves developed during the factory performance testing. 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.

[2.9.2 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 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 3 percent drop in performance occurs. The value of NPSHR must be 1 m 3.3 ft less than the corresponding net positive suction head available (NPSHA). Use the temperature of the water at the time the tests are run in determining the NPSHR. Use the water elevations specified in paragraph CAPACITIES to determine the NPSHA for pumps.

][2.9.3 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 in is 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.]

][2.9.4 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.

][2.9.5 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.

]2.9.6 Factory Test Report

Submit, within 30 days of receipt of approval of the witnessed factory test,[bound] [digital] copies of a report covering test setup and performance tests. Include the specified information in the factory test report that meets the guidance identified in HI ANSI/HI 11.6.

2.10 PAINT

Paint the pump/motor in accordance with the Contractor's 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. Submit paint catalog data. Paint the discharge tube [and discharge elbow] and appurtenances in accordance with Section 09 97 02 PAINTING: HYDRAULIC STRUCTURES.[Provide the manufacturers standard coating which is rated for use in brackish conditions.]

[2.11 CORROSION PROTECTION

Provide mounted zinc anodes on the pump casing to prevent against corrosion for pumps which will operate in brackish conditions. Size zinc anodes with enough material to last for at least 3 years of normal operation.[Verify with potential tests the effictiveness of the mounted zincs.]

]PART 3 EXECUTION

3.1 INSTALLATION

Perform correct installation and assembly of the pumping unit in accordance with the drawings and with the 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- and/or wet-testing 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 Contractor's 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.

[3.3.1 Dry Test

Test each pumping unit in the dry in accordance with the pump's instructions to determine whether it has been properly installed. 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 [noise (in accordance with HI 9.1-9.5),] motor-bearing temperatures, voltage, and current for each pump. Measured parameters must be within the pump's published limits. make vibration measurements at the top of the discharge tube [and flange of the discharge elbow] for each pump. Vibration limits must not exceed those recommended by HI 9.6.4.

3.3.3 Field Test Report

Submit the field test report that summarizes results of the testing.

3.3.4 Operation and Maintenance Manual

Prepare and submit the field test report and a manual of Operating and Maintenance Instructions for the completed system. Submit the instructions containing complete information on operation, lubrication, adjustment, routine and special maintenance disassembly, repair, reassembly, and trouble diagnostics of pump and auxiliary equipment. [Print the operation and maintenance manual and both parts lists on good quality ANSI size A 216 by 280 mm 8-1/2 by 11-inch paper, bound separately between flexible, durable covers.] [Provide the operation and maintenance

manual and both parts lists on optical disc, formatted to print on ANSI size A 216 by 280 mm 8-1/2 by 11-inch paper.]Drawings incorporated in manual or parts lists, may be reduced to page size provided they are clear and legible[, or may be folded into the manual to page size]. Photographs or catalog cuts of components may be included for identification.

3.3.5 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 --