****
USACE / NAVFAC / AFCESA / NASA **UFGS-33 45 00.00 10 (April 2008)**

Preparing Activity: USACE (CW) **Superseding**
UFGS-33 45 00.00 10 (April 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2009
****

SECTION TABLE OF CONTENTS

DIVISION 33 - UTILITIES

SECTION 33 45 00.00 10

SPEED REDUCERS FOR STORM WATER PUMPS

04/08

-- End of Section Table of Contents --

****
USACE / NAVFAC / AFCESA / NASA **UFGS-33 45 00.00 10 (April 2008)**

Preparing Activity: USACE (CW) **Superseding**
UFGS-33 45 00.00 10 (April 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2009
****

SECTION 33 45 00.00 10

SPEED REDUCERS FOR STORM WATER PUMPS
04/08

****
NOTES: This guide specification covers the requirements for speed reducers used with vertical impeller pumps.

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 and suggestions on this guide specification are welcome and should be directed to the technical proponent of the specification. A listing of technical proponents**, including their organization designation and telephone number, is on the Internet.**

Recommended changes to a UFGS should be submitted as a Criteria Change Request (CCR)**.**
****

PART 1 GENERAL

****
NOTE: This guide specification, as written, is for use in construction contracts for the building of pumping stations. If it is to be used in supply contracts, it should be changed as appropriate.

The pump, motor, base, electrical power, engine, and clutch (if used) are all related components but are not included in this specification.

The epicyclic reducer is reliable and especially well suited to high power applications. It should not normally be deleted as an option if the prime mover has a vertical shaft.
****

1.1 UNIT PRICES

****
NOTE: If Section 01 22 00.00 10 MEASUREMENT AND PAYMENT is included in the project specifications, this paragraph title (UNIT PRICES) should be deleted from this section and the remaining appropriately edited subparagraphs below should be inserted into Section 01 22 00.00 10.
****

1.1.1 Speed Reducers for Storm Water Pumps

Payment will be made for costs associated with [furnishing] [furnishing and installing] [installing] the speed reducers for storm water pumps as specified.

1.1.2 Measurement

Speed reducers for storm water pumps will be measured for payment based upon each speed reducer [furnished] [furnished and installed] [installed].

1.1.3 Unit of Measure

Unit of measure: each.

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.
****

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 11	(1990; R 1999) Load Ratings and Fatigue Life for Roller Bearings

ABMA 9	(1990; R 2000) Load Ratings and Fatigue Life for Ball Bearings

AMERICAN GEAR MANUFACTURERS ASSOCIATION (AGMA)

AGMA 6013	(2006) Standard for Industrial Enclosed Gear Drives
AGMA 6025	(1998d; R 2004) Sound for Enclosed Helical, Herringbone and Spiral Bevel Gear Drives
AGMA 6113	(2006) Standard for Industrial Enclosed Gear Drives (Metric Edition)
AGMA 6123	(2006b) Design Manual for Enclosed Epicyclic Gear Drives

AMERICAN PETROLEUM INSTITUTE (API)

API RP 686	(1996) Recommended Practice for Machinery Installation and Installation Design

ASME INTERNATIONAL (ASME)

ASME B31.1	(2007; Addenda 2008) Power Piping

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

ISO 16889	(2008) Hydraulic Fluid Power - Multi-Pass Method for Evaluating Filtration Performance of a Filter Element

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(2003) Enclosures for Electrical Equipment (1000 Volts Maximum)

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2007; AMD 1 2008) National Electrical Code - 2008 Edition

1.3 SYSTEM DESCRIPTION

1.3.1 General Product Requirements

****

NOTES: Where possible to meet the required pump speed with the given prime mover speed, and when the prime mover has a horizontal shaft, a single reduction spiral bevel gear reducer should be chosen. Reduction ratios of up to 7:1 are practical. Ratios of up to 10:1 are possible but should be used only after consultation with manufacturers. Double reduction reducers may be required when required reduction ratios are too high. Where a vertical shaft prime mover is to be used, the designer should choose between a parallel

shaft reducer or an epicyclic reducer. In some cases, this choice may be left to the supplier to allow them to make the most economical selection. Both of these types of reducers will provide reliable service. Epicyclic reducers become the preferred choice for high wattage (horsepower) vertical shaft prime movers (above approximately 750 kW (1,000 hp)). Again, single reduction reducers should be used where feasible.

This section is intended to be used along with Section 22 10 00.00 10 VERTICAL PUMPS, AXIAL-FLOW AND MIXED-FLOW IMPELLER-TYPE. The designer is responsible for determining whether a speed reducer is required or whether a direct drive vertical induction motor can be used to drive the pump. Guidance for making this decision is EM 1110-2-3105, MECHANICAL AND ELECTRICAL DESIGN OF PUMPING STATIONS. An additional section for the prime mover, an electric motor or diesel engine, is also normally added. The intention is for these components to be purchased and installed by the Construction Contractor. Purchase of the three components in a single contract allows the supplier to obtain the most optimum combination of components thus reducing costs while not sacrificing reliability. This also makes it feasible for the Contractor to perform dynamic analysis as described in Section 22 10 00.00 10 and be solely responsible for acquiring the necessary data to perform such analysis. The dynamic analysis is important to ensure the pump, reducer, and motor or engine combination is free of detrimental vibration. If the reducer and prime mover are purchased separately, the designer is responsible to provide additional plans and specifications covering reducer instrumentation. Provisions for a pump, reducer, and Provisions for a pump, reducer, and prime mover base plate are described in Section 22 10 00.00 10. Pump and reducer alignment is described in Section 22 10 00.00 10. The "Buy American Act" which will be included in the non-technical portion of the contract will preclude the use of nondomestic reducers and appurtenances.

****

The speed reducers shall be designed and manufactured by a firm that is regularly engaged in the manufacture of speed reducers of the type utilized for these installations. The reducer shall display the certified manufacturer's AGMA insignia as evidence of conformance to these standards. The nameplate shall bear the manufacturer's name, model designation, serial number, unit rating, application factor, reduction ratio, and other applicable information. The speed reducer shall be [single reduction spiral bevel] [spiral bevel primary, helical secondary stage] [single reduction parallel shaft] [double reduction parallel shaft] [epicyclic] gear type equipped with thrust bearings to make the speed reducer suitable for use with a vertical impeller pump. Where upthrust is possible during pump startup or shutdown, the thrust bearing shall be designed to resist this load. The speed reducer shall be able to withstand all of the specified operating conditions without damage. A backstop shall be provided to pre-vent reverse rotation of the pump. The gear reducer shall conform to the requirements of AGMA 6113AGMA 6013 or AGMA 6123 as applicable.

1.3.2 Design Conditions

1.3.2.1 Operating Conditions

****

NOTES: The speed reducer, pump, and prime mover are intended to be purchased together; responsibility for establishing operating loads should be placed on the Contractor. If the speed reducer is purchased separately, the designer must determine the operating loads from pump and prime mover data.

For motor stall torque, 350 percent of rated load should be used for induction motors. For diesel engines, the maximum torque should equal the slip torque of the overload protection device. An air actuated clutch should be used as overload protection.

****

Obtain the operating conditions from the pump and prime mover suppliers. Operating conditions which shall be considered include (as a minimum): maximum input power, motor or engine speed, speed reducer ratio, maximum pump reverse overspeed, low-speed shaft downward thrust including weight, low-speed shaft momentary upward thrust during startup or shutdown (if applicable), high-speed shaft direction of rotation, low-speed shaft direction of rotation, overhung load, motor stall torque, or maximum engine overload torque transmitted through the clutch, reverse torque load on the backstop.

1.3.2.2 Runaway

****

NOTE: Delete this paragraph for engine-driven units. If emergency closure might not be achieved within 30 minutes, this time period must be increased.

****

The speed reducer shall be designed to withstand backstop failure and maximum pump reverse runaway speed for a period of [30] [_____] minutes.

1.3.2.3 Critical Speeds

****

NOTE: Dynamic analysis of the pump, reducer, and engine or motor assembly will be performed by the pump manufacturer as described in Section 22 10 00.00 10 VERTICAL PUMPS, AXIAL-FLOW AND MIXED-FLOW IMPELLER-TYPE. If the reducer is purchased separately from the pump, this paragraph will be deleted and responsibility for dynamic analysis, if done, is that of the designer.

****

Dynamic analysis of the pump, reducer, and motor (engine) assembly shall be performed by the pump manufacturer. The reducer manufacturer shall coordinate with the pump manufacturer in performing the dynamic analysis. The reducer manufacturer shall make any design modifications to the reducer which are necessary to avoid resonances in the system. A torsional or lateral natural frequency within 25 percent of normal operating speed of any shaft or gear mesh frequency is unacceptable.

1.3.3 Arrangement

****

NOTE: In making choices as to the reducer arrangement, the designer must coordinate with the pump (Section 22 10 00.00 10) and prime mover specifications. These contain statements on shaft configuration. The hollow output shaft arrangement is preferred for ease of installation. If the reducer is purchased separately from the pump and prime mover, the designer is responsible for determining input and output shaft details and ensuring the reducer will be compatible. For reducers driven by a diesel engine, an air actuated clutch is recommended. The clutch should be part of the diesel engine specification.

****

[The arrangement shall use a true hollow low-speed shaft where the pump shaft passes concentrically through the reducer shaft allowing finite impeller elevation adjustment.] [The speed reducer output shaft shall be connected to the pump using a rigid coupling.] [The speed reducer input shaft shall be connected to the motor shaft by a flexible coupling.] [The speed reducer input shaft shall be connected to the engine with two universal joints and an intermediate shaft.] [The speed reducer input shaft shall be connected to the engine with a flexible coupling.] Ensure compatibility and fit of the reducer high- and low-speed shafts with that of the pump and prime mover. The speed reducer mounting shall be designed to permit removal of the reducer and reinstallation without requiring realignment of the reducer and shafting. Before assembly, each gear and shaft assembly shall be dynamically balanced.

1.4 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list to reflect only the submittals required for the project. Submittals should be kept to the minimum required for adequate quality control.

A "G" following a submittal item indicates that the submittal requires Government approval. Some submittals are already marked with a "G". Only delete an existing "G" if the submittal item is not complex and can be reviewed through the Contractor's Quality Control system. Only add a "G" if the submittal is sufficiently important or complex in context of the project.

For submittals requiring Government approval on Army projects, a code of up to three characters within the submittal tags may be used following the "G" designation to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy, Air Force, and NASA projects.

Choose the first bracketed item for Navy, Air Force and NASA projects, or choose the second bracketed item for Army projects.
****

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for [Contractor Quality Control approval.][information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government.] Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Speed Reducers[; G][; G, [_____]]
Lubrication System[; G][; G, [_____]]
Instrumentation[; G][; G, [_____]]

Detail drawings of sufficient size for easy reading and consisting of a complete list of equipment and materials, including manufacturer's descriptive and technical literature; performance charts and curves; catalog cuts; and installation instructions. Show on the drawings proposed layout and anchorage of equipment and appurtenances, and equipment relationship to other parts of work including clearances for maintenance and operation.

SD-03 Product Data

System Description[; G][; G, [_____]]
Bearings[; G][; G, [_____]]
Gears[; G][; G, [_____]]
Shafts[; G][; G, [_____]]
[Couplings] [Universal Joints][; G][; G, [_____]]
Backstop[; G][; G, [_____]]
Housing[; G][; G, [_____]]
Lubrication System[; G][; G, [_____]]
Instrumentation[; G][; G, [_____]]
Speed Reducers[; G][; G, [_____]]
Lubricant[; G][; G, [_____]]

Complete computations, design loads, and catalog data.

SD-06 Test Reports

Shop Testing[; G][; G, [_____]]

A shop test report fully documenting the test.

Field Testing[; G][; G, [_____]]

A field test report documenting all data for load and speed measurement, lubrication oil temperature and flow, cooling water temperature and flow, gear contact patterns, adjustment of component settings, and otherwise showing compliance with specified performance criteria.

SD-10 Operation and Maintenance Data

Operation and Maintenance Manual

Operation and Maintenance Manual which provides detailed startup and operating procedures, lubrication instructions, installation and alignment procedures, routine maintenance requirements and procedures, complete detailed procedures for disassembly and assembly of the reducer, parts list for all parts detailed, assembly drawings of the reducer showing all parts, suppliers for all parts, settings and adjustment for protective devices, and a list of all tools, handling devices, and spare parts furnished.

1.5 DELIVERY, SORAGE, AND HANDLING

Material and equipment shall be protected from weather, humidity, temperature variation, dirt, dust, and other contaminants during delivery and storage.

1.6 EXTRA MATERIALS

****

NOTE: The designer is responsible for providing a list of spare parts requirements. This should be based on consideration of whether the purchase of a complete spare reducer is justified and the consequences of downtime of one or more units. Spare parts might otherwise include spare gears, bearings, seals, lubrication system parts, instrumentation components, or heat exchanger. The designer should consult with the end user of the system to determine spare parts requirements.

****

Submit the following: [_____]

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

****

NOTE: Application factors of 1.25 (electric motor) and 1.50 (diesel engine) are the values recommended by EM 1110-2-3105 MECHANICAL AND ELECTRICAL DESIGN OF PUMPING STATIONS. These are suitable for most applications. Where reducer operating conditions are considered severe, the application factors of 1.75 (electric motor) and 2.0 (diesel engine) may be

used to increase reliability.
****

Provide materials and equipment which are the standard products of manufacturers regularly engaged in the production of gear reducers for vertical pump drives and that essentially duplicate products which have been in prior satisfactory use for at least 2 years prior to bid opening. All products shall be new. The reducer assembly shall be rated in accordance with AGMA 6113AGMA 6013 or AGMA 6123 as applicable. The unit rating shall be equal to or exceed the maximum input power times an application factor. The application factor shall be [1.25][1.75] for reducers driven by electric motors and [1.5][2.0] for reducers driven by diesel engines.

2.2 BEARINGS

****
NOTE: The selection of thrust bearing type should be left to the reducer manufacturer. The selection of bearing type is based upon thrust load. For very high thrust loads, a hydrodynamic fluid film thrust bearing may be needed. If the designer has specific experience which relates to which bearing type is best for the application, one of the options for thrust bearing type may be omitted.
****

2.2.1 Thrust Bearings

Provide thrust bearings which are either hydrodynamic fluid film type or antifriction type. Antifriction thrust bearings shall be either tapered roller or spherical roller type. The thrust bearing shall be sized for the pump thrust plus the weight of the impeller and shaft. The thrust bearing size and arrangement shall be coordinated with the pump supplier. The bearings shall be able to sustain continuous operational load as well as startup and shutdown loads. Hydrodynamic fluid film thrust bearings shall use pivoted segmental shoes with the babbitted face surfaced as recommended by the bearing manufacturer to maintain an optimum oil film.

2.2.2 Radial Bearings

Radial bearings for spiral bevel and parallel shaft reducers shall be antifriction type. Radial bearings for epicyclic reducers shall be either hydrodynamic fluid film type or antifriction type.

2.2.3 Hydrodynamic Fluid Film Bearings

Design the bearings to have a minimum oil film thickness of 12.5 µm 0.0005 inch under the most severe operating conditions. The bearing loads shall not exceed 2400 kPa 350 psi for the maximum load. Where hydrodynamic fluid film thrust bearings are used, suitable hydrostatic lift provisions shall be made if required to prevent bearing damage during startup. Thrust bearings shall be provided with either spring loaded or embedded instrumentation to monitor operating temperatures.

2.2.4 Antifriction Bearings

Antifriction bearings shall be rated for an L-10 life of 100,000 hours at the operating load of the reducer. Ball bearing load ratings shall conform to ABMA 9. Roller bearing load ratings shall conform to ABMA 11.

2.3 GEARS

****
NOTE: Designer must delete inapplicable statements which pertain to the gear types not used.
****

[Epicyclic gearing shall be of the double helical design.] [Parallel shaft gearing shall be of the helical design.][Right angle gearing shall be of the spiral bevel design.] Spiral bevel, helical, and double helical gears shall be gas nitrided or carburized, hardened and ground. For epicyclic gearing the annulus ring may be shaper cut. The pinion or gear of each helical set shall be crowned to eliminate end loading. For helical gears, standard normal diametral pitches shall be used. In addition to rating the gears according to AGMA 6113AGMA 6013 or AGMA 6123 as applicable, gear stresses shall not exceed 80 percent of yield strength for any overload, motor stall, or engine overload condition. No less than 350 percent of motor rated torque shall be used for the motor stall condition.

2.4 SHAFTS

Each shaft shall be heat treated alloy steel. Input shaft size and configuration shall be compatible with the motor or engine and clutch. Output shaft size and configuration shall be compatible with the pump. Welded shafts are not acceptable.

2.5 [COUPLINGS] [UNIVERSAL JOINTS]

****
NOTE: The designer must delete inapplicable statements. Couplings are to be used with electric motor prime movers. Universal joints are to be used with diesel engine prime movers. In some cases, flexible couplings may be used with diesel engines.
****

The speed reducer shall be connected to the motor (engine) by [flexible coupling] [universal joints]. The [couplings] [universal joints] shall have a service factor of 2 based on maximum rated load. In addition, at maximum overload conditions, stresses shall not exceed 80 percent of yield strength. [Couplings shall transmit torque by means of a steel grid spring fitted into groves in the periphery of the coupling hubs or by means of external gears on hubs engaging in internal gears on the coupling sleeves or by hubs engaged with flexible self-lubricating members. Couplings with sleeves held in place by snap rings are not acceptable.] [Universal joints shall have forged steel yokes and spiders and shall have sealed needle roller bearings. Universal joints shall be installed in pairs. The angles between each shaft and the intermediate shaft shall be equal and shall not exceed the manufacturer's recommendation. The driving pins on the yokes attached to the intermediate shaft shall be set parallel to each other.] [Couplings shall be enclosed and sealed to exclude contaminants and retain the lubricant under both static and operating conditions.] The [couplings] [universal joints] shall be dynamically balanced to AGMA balance classification 7 or better and shall be grease lubricated unless self-lubricated.

2.6 BACKSTOPS

****

NOTE: Mounting of the backstop with the inner member and rollers stationary will decrease wear and heat generation and consequently increase the life of the backstop. The outward radial load on the rollers is decreased in this mounting situation. This mounting method can be obtained without undue cost but is not the standard mounting method for these backstops. The designer may opt for the standard method (inner member and rollers rotating) but is advised that better life has been obtained with the inner member stationary. For smaller wattage (horsepower) units (375 kW (500 hp) and below), the drop-pin type backstop is a satisfactory alternative and may be added to the specification. Spragtype backstops perform adequately in many installations but have been more prone to problems such as wear and excessive heat generation than the other types and are not listed as an option here. If a diesel engine is used, the idle speed and duration should be listed for proper consideration during backstop sizing.

****

Provide a backstop on the output shaft to prevent reverse rotation of the pump. For double reduction reducers, the backstop may be mounted on the output or intermediate shaft. Size the backstop for the resulting torque at the reducer during maximum reverse flow at pump and a service factor of 2.0 shall be applied to the manufacturer's published rating. In addition the backstop shall be suitable for continuous operation at engine idle speed of [800] [_____] rpm. The backstop shall be of a type with cylindrical rollers on inclined cam planes or drop-pin type. The backstop shall be mounted with the outer race moving and the inner race fixed. The backstop shall operate at a temperature of less than 70 degrees C 160 degrees F under all operating conditions with an ambient temperature up to 40 degrees C 100 degrees F. The backstop shall be provided with a circulating oil lubrication system and shall have sufficient flow rate to provide the required cooling. The lubrication system may be part of the gear reducer lubrication system.

2.7 HOUSING

2.7.1 General

The housing shall be cast or fabricated steel, stress relieved prior to machining, and reinforced to carry all applied loads and to maintain gear alignment. A sole plate [as shown on the drawings] shall be provided under the reducer. The sole plate shall be installed, leveled and grouted in accordance with API RP 686, Chapter 5 - Mounting Plate Grouting. Jacking bolts shall be provided for leveling the sole plate. All leveling jacking bolts shall be backed off after grouting so that they do not support any part of the load. An anchor bolt layout shall be provided to aid in placement of the anchor bolts. The housing bottom shall be machined. The interior of the reducer shall be painted with an oil compatible coating. The exterior shall be painted with the manufacturer's standard coating system. Color shall be light gray. The housing shall have an oil fill connection and a drain connection with a magnetic plug. Lifting lugs shall be provided for lifting the entire reducer assembly and any subassembly or component which cannot be lifted using web slings.

2.7.2 Seals

Vertical down output shafts shall have a drywell design seal. The input shaft shall have a lip seal to prevent leakage of oil and exclude dirt. Lip seals shall utilize hardened steel wear sleeves to preclude shaft repair or replacement if the seal wears the shaft.

2.7.3 Inspection Covers

The housing shall have inspection holes with cover plates located above the maximum oil level to permit viewing of gear teeth allowing evaluation of the contact patterns of each gear mesh and to allow inspection of internal features of the lubrication system.

2.8 LUBRICATION SYSTEM

2.8.1 General

The speed reducer shall be provided with an oil lubrication system that will provide continuous lubrication to the gears, bearings, and oil lubricated-type backstop. The system shall consist of an oil circulating pump, [oil-to-water][air] heat exchanger, piping, filters, and controls. Each reducer shall be provided with its own system. The oil circulating pump shall be driven directly from the speed reducer shaft. The maximum oil sump temperature at rated speed and load shall be 70 degrees C 160 degrees F at an ambient temperature of 40 degrees C 100 degrees F. If a hydrodynamic thrust bearing is used, its lubrication system may be part of the gear reducer lubrication system, or a separate lubrication system may be provided.

2.8.2 Oil Pumps

The oil pumps shall be positive displacement type. Each pump shall have a relief valve which discharges to the sump. The pump shall be reversible so it continues to function during a runaway condition.

2.8.3 Prelubrication Pump

****
NOTE: An electric motor-driven prelubrication pump is recommended where hydrodynamic thrust bearings will be used to ensure an optimum oil film is developed prior to startup. Many applications with hydrodynamic thrust bearings do not use electric motor-driven pumps. The designer has the option of omitting the requirement for an electric motor-driven pump.
****

The reducer shall be prelubricated prior to startup. The prelubrication pump shall be positive displacement, hand-operated type where antifriction thrust bearings are used. Where hydrodynamic thrust bearings are used, the prelubrication pump shall be an electric motor-driven positive displacement type. The electric motor-driven pump shall deliver sufficient pressure to lift the thrust bearing runner from the shoes. The pump shall operate in manual and automatic modes. In automatic mode, the prelubrication pump shall supply oil prior to reducer startup, shall continue operation at least 30 seconds after reducer startup, then shall automatically shut down. In manual mode, the prelubrication pump shall be started and stopped from a local push button station. Available power for the pump and controls will be 480 V, 3 Ph, 60 Hz and 120 V, 1 Ph, 60 Hz. The pump shall supply oil through the lubrication system prior to reducer startup. The pump shall utilize zero-leakage check valves to isolate it from the lubrication system during operation of the reducer. The prelubrication system shall not require valve operation to execute the prelubrication cycle or to return to normal operation.

2.8.4 Oil and Breather Filters

The lubricating system shall have two oil filters on the pump outlet side. One filter shall be for removing particles and the other for water removal The filter for particles shall have a Beta rating of B6 greater than 75 at 400 kPa 60 psi differential tested in accordance with ISO 16889. The reducer manufacturer may propose an alternate Beta rating by submitting proof that B6 greater than 75 is unsuitable for the lubricant to be used. Each filter shall incorporate an oil-filled differential pressure gauge to indicate the pressure drop across the filter. The filter shall have an internal magnetic element. The water removal filter shall maintain a water content in the oil of no greater than 200 ppm. All filter assemblies shall be sized so the pressure drop across the clean filter is no greater than 30 kPa 4 psi. The particle filter shall be sized to avoid bypass at a startup oil temperature of 25 degrees C 80 degrees F. Filters shall have a bypass setting of 300 to 400 kPa 45 to 60 psi. Element collapse rating shall not be less than 1050 kPa 150 psi. The breather filter shall have a Beta rating of B6 greater than 75 and a desiccant chamber to remove water.

2.8.5 Heat Exchanger

****

NOTES: When using an oil-to-air heat exchanger, use the second bracketed paragraph.

The designer must consider the water source. Where possible, potable water is the first choice. When flows are excessive, other sources must be used. Depending on the turbidity of the water, different methods will be needed to clean the water such as a cyclonic separator. If the water through the heat exchanger tubes is turbid, velocities should be kept above 2 m/s (7 fps) to prevent clogging. Where the water is brackish or otherwise highly corrosive, 70-30 tube material should be used. Plate heat exchangers should be left as an option as they are generally easier to maintain. Where suitable cooling water is unavailable or may cause maintenance problems, an oil-to-air heat exchanger should be used.

****

[The heat exchanger shall be either a water-cooled shell and tube type, water-cooled plate type, or internal water-cooled coils within the reducer sump. Heat exchanger tubes shall be [90-10 Copper Nickel Alloy][70-30 Copper Nickel Alloy]. Heat exchanger plates shall be type 316 corrosion resistant steel. Minimum tube thickness shall be 1.519 mm 0.0598 inch (16 gauge) and shall be adequate for the specified pressure rating. Water shall be circulated through the tubes or plates and the design shall be such that the tubes or plates can be cleaned. Cooling water will be provided at a maximum temperature of [25 degrees C 80 degrees F][_____], at a pressure of [550 kPa 80 psi][_____], at a maximum flow rate of [0.6 L/s 10 gpm][_____]. The cooling water shall be strained to a maximum [3 mm 1/8 inch][_____] particle size. The pressure drop through the clean heat exchanger shall not exceed [55 kPa (gage) 8 psig][_____]. The heat exchanger shall be designed for a working pressure of [550 kPa (gage) 80 psig][_____]. The heat exchanger shall withstand a test pressure of 150 percent of the design pressure for a period of 4 hours during which time the heat exchanger shall be checked for leakage. Any leakage will be cause for rejection.]

[The heat exchanger shall be an oil-to-air type with size based upon a maximum ambient temperature of 40 degrees C 100 degrees F. Heat exchanger tubes and fins shall be copper or copper alloy. Working pressure shall exceed the oil pump working pressure. The heat exchanger shall withstand a test pressure of 150 percent of the design pressure held for a period of 4 hours during which time the heat exchanger shall be checked for leakage. Any leakage shall be cause for rejection. The oil-to-air heat exchanger system shall include a fan, motor, and controls for maintaining the specified oil temperature.]

2.8.6 Cooling Water Control Valve

****
NOTE: Delete if an oil-to-air heat exchanger is used.
****

A thermo-mechanical control valve shall be provided to adjust the flow rate of water through the heat exchanger to maintain a minimum oil temperature of 50 degrees C 120 degrees F in the housing sump.

2.8.7 Piping and Tubing

Oil lines up to 50 mm2 inches o.d. shall be seamless steel tubing with 37 degree flare or flareless fittings. Where pipe sizes of 50 mm 2 inches and over are required, steel pipe with welded fittings shall be used. Water piping shall be copper or copper alloy with brazed or 95-5 soldered joints. All piping, tubing, and fittings shall conform to ASME B31.1. Vibration isolating tubing and piping supports shall be used. Oil tubing or ports shall be kept within the gear case where feasible. Dissimilar metals shall be electrically isolated to prevent corrosion.

2.8.8 Oil Heater

****
NOTE: In regions where the temperature during flood season is rarely below 10 degrees C (50 degrees F), consideration may be given to omission of the oil heater. However, omission of the oil heater is generally not recommended because it results in poor oil circulation at startup and it is impractical to size the filter to avoid a bypass condition at temperatures below 20 to 25 degrees C (70 to 80 degrees F). Accumulated contaminants can be passed at unacceptable concentrations during a bypass condition. The oil heater should be used since it

will help ensure adequate oil flow during unit startup. Caking of the oil on the heater is prevented by using a low watt density heater, 9300 watts per square meter (6 watts per square inch).

****

A thermostatically operated oil heater shall be installed to maintain the oil at a temperature of 25 degrees C 80 degrees F. The heater shall be sized based on a minimum ambient temperature of [minus 10 degrees C 15 degrees F] [_____]. The heater shall be capable of being shut off if the unit is to be out of service for an extended period. The heater shall have a watt density no greater than 9300 W/square m 6 W/inch squared.

2.8.9 Lubricating Oil

****

NOTE: Ambient temperature range shall be limited to one of the standard temperature ranges listed in AGMA 6113 (AGMA 6013) or AGMA 6123 and should be limited to the actual temperature range in which the reducers are expected to operate. The selection of EP (extreme pressure) and other additives should be left to the manufacturer. EP oil is normally necessary. Lubricant shall also be suitable for use with the oil lubricated hydrodynamic fluid film-type backstop. EP oils will work acceptably in roller-inclined ramp backstops. The oil must also be compatible with the hydrodynamic thrust bearing if one is used. Generally, gear oil is not optimum for these bearings but is acceptable. The manufacturer should generally not be precluded from utilizing a separate lubrication system for this bearing if the bearing requires a lighter oil.

****

Lubricating oil shall be mineral oil or synthetic hydrocarbon as recommended in AGMA 6113AGMA 6013 or AGMA 6123 for an ambient temperature range of [minus 10 to plus 50 degrees C 15 to 125 degrees F][_____]. The lubricant shall be suitable for the entire temperature range without change of lubricant. Lubricant additives shall be used as recommended by the reducer manufacturer. Lubricant shall also be suitable for use with the backstop. Lubricant used for the hydrodynamic thrust bearing shall be suitable for the bearing. Catalog data of the proposed lubricant shall be submitted for approval in accordance with paragraph SUBMITTALS.

2.9 INSTRUMENTATION

****

NOTE: Provided that the prime mover and reducer are purchased and installed under a single contract, the Contractor must deliver the instrumentation as a complete working package. If the reducer is purchased separately, the designer is responsible for taking care of additional plans and specifications for the instrumentation. On noncritical applications, consideration may be given by the designer to delete the high temperature switch, flow switch, and vibration switch. The designer would then delete all electrical

requirements for instrumentation.
****

Instrumentation for the reducer shall be supplied and installed as a complete working package, coordinated with the pump and prime mover supplier. All electrical work shall conform to NFPA 70. Electrical enclosures shall be NEMA 250, Type 4. An electrical termination cabinet shall be provided. Available power is 120 V, 1 ph. The speed reducer shall have the following devices as a minimum:

a. High oil temperature switch in unit sump.

(1) Alarm at 80 degrees C 180 degrees F.

(2) Shut down prime mover at 95 degrees C 200 degrees F.

(3) Lower settings may be used if recommended by the reducer manufacturer.

b. Oil pressure gauge.

(1) After oil pump.

(2) Electric motor-driven prelubrication pump (if used).

(3) Gauges shall be oil or glycerin filled and shall have snubbers and isolation valves.

c. Thermometer. Mercury shall not be used in thermometers.

(1) Sump

(2) Oil line after heat exchanger

(3) Backstop

d. Oil Level Sight Gauge, with built in reflector.

e. Resistance Temperature Detector (RTD), Hydrodynamic Thrust Bearing, if used.

(1) Alarm at 80 degrees C 180 degrees F.

(2) Shut down prime mover at 95 degrees C 200 degrees F.

(3) Lower settings may be used if recommended by the reducer and bearing manufacturers.

f. Oil Flow Switch.

(1) Alarm at 80 percent of design flow.

(2) Shut down prime mover at 60 percent of design flow.

g. Vibration Switch - Alarm at 13 mm/s 0.5 inch/sec or at baseline level recommended by the reducer manufacturer.

PART 3 EXECUTION

3.1 TESTS, INSPECTIONS, AND VERIFICATIONS

3.1.1 Shop Testing

In addition to or as part of the Contractor's normal shop testing procedure, the reducer shall be tested at rated speed, no load to check for potential problems which shall be eliminated prior to field testing. Gear contact patterns, sound level, lubrication and cooling, and all other operational characteristics shall be checked. The sound pressure level of the speed reducer and prime mover used in the shop test shall not exceed 90 dBA measured at a distance of 1 m 3 feet from the equipment. Sound shall be measured in accordance with AGMA 6025. Provide any preventative measures to control background noise. Notify the Contracting Officer 2 weeks prior to performing the shop test.

3.1.2 Installation

****
NOTE: If the reducer is not furnished installed, this paragraph must be modified or eliminated.
****

Install the speed reducer and ensure all features and systems are operational. The speed reducer shall be installed under the supervision of the reducer manufacturer's representative. The speed reducer shall be designed for ease of handling and installation. All necessary lifting devices, attachments, and special tools required for maintenance shall be provided by the Contractor. Submit an Operation and Maintenance Manual as specified in the Submittals paragraph.

3.1.3 Field Testing

Field test the speed reducer at rated speed and load to demonstrate that reducer operation, lubrication, cooling, and instrumentation meet contract requirements. The duration of the testing shall be sufficient to develop verifiable gear contact patterns. Gear contact patterns shall be inspected and shown to the Contracting Officer. Gear contact patterns for helical gears shall be at least 70 percent of face width. Spiral bevel gears shall have a central toe contact pattern with contact of 50 percent of face width at full load. Gear contact patterns shall be photographed and included as part of the field test report. The report shall document all data collected for load and speed measurement, lubrication, oil temperature and flow, ambient temperature, cooling water temperature and flow, gear contact patterns, and any other data required to show compliance with specifications. Should there be insufficient water available to perform the test, the Contracting Officer may delay the test for up to 9 months or waive the test.

-- End of Section --