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USACE / NAVFAC / AFCEC **UFGS-35 45 03.00 10 (May 2022)**

Preparing Activity: USACE **Superseding**
UFGS-35 45 03.00 10 (February 2016)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
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DIVISION 35 - WATERWAY AND MARINE CONSTRUCTION

SECTION 35 45 03.00 10

SPEED REDUCERS FOR STORM WATER PUMPS

05/22

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SECTION 35 45 03.00 10

SPEED REDUCERS FOR STORM WATER PUMPS
05/22

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

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)**.**
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PART 1 GENERAL

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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.

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1.1 UNIT PRICES

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NOTE: If Section 01 20 00 PRICE AND PAYMENT PROCEDURES 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 20 00.

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1.1.1 Speed Reducers for Storm Water Pumps

Make payments for costs associated with [furnishing] [furnishing and installing] [installing] the speed reducers for storm water pumps as specified.

1.2 REFERENCES

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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.

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

AMERICAN BEARING MANUFACTURERS ASSOCIATION (ABMA)

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

AMERICAN GEAR MANUFACTURERS ASSOCIATION (AGMA)

AGMA 6013	(2006A; R2016) Standard for Industrial Enclosed Gear Drives

AGMA 6123	(2016C) Design Manual for Enclosed Epicyclic Gear Drives
ANSI/AGMA 6025	(1998D; R 2010) Sound for Enclosed Helical, Herringbone and Spiral Bevel Gear Drives
ANSI/AGMA 6113	(2016B) Standard for Industrial Enclosed Gear Drives (Metric Edition)
ANSI/AGMA 9000	(2011D) Flexible Couplings - Potential Unbalance Classification
ANSI/AGMA 9005	(2016) Industrial Gear Lubrication

AMERICAN PETROLEUM INSTITUTE (API)

API RP 686	(2009) Recommended Practice for Machinery Installation and Installation Design

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B31.1	(2024) Power Piping

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

ISO 4406	(2021) Hydraulic Fluid Power - Fluids - Method for Coding the Level of Contamination by Solid Particles
ISO 16889	(2022) Hydraulic Fluid Power - Filters - Multi-Pass Method for Evaluating Filtration Performance of a Filter Element
ISO 20816-3	(2022) Mechanical Vibration - Measurement and Evaluation of Machine Vibration - Part 3: Industrial Machinery with a Power Rating Above 15 kW and Operating Speeds Between 120 r/min and 30 000 r/min

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(2020) Enclosures for Electrical Equipment (1000 Volts Maximum)

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code

U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)

EPA 800-R-11-002	(2011) Environmentally Acceptable Lubricants

1.3 SYSTEM DESCRIPTION

1.3.1 General Product Requirements

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This section is intended to be used along with Section 35 45 01 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 35 45 01 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 35 45 01. Pump and reducer alignment is described in Section 35 45 01. 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.

****

Provide speed reducers which are designed and manufactured by an organization that is regularly engaged in the manufacture of speed reducers of the type utilized for these installations which conform to the requirements of ANSI/AGMA 6113AGMA 6013 or AGMA 6123. Submit complete computations, design loads, and catalog data. Display the certified Contractor's manufacturer's ANSI/AGMA insignia as evidence of conformance to these standards on the reducers nameplate. Cite the Contractor's selected manufacturer's name, model designation, serial number, unit rating, application factor, reduction ratio, and other applicable information on the nameplate. Provide a [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. Equip the reducer with a thrust bearing where upthrust is possible during pump startup or shutdown. Provide a backstop to prevent reverse rotation of the pump.

1.3.2 Design Conditions

1.3.2.1 Operating Conditions

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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.

****

Include the following operating conditions 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], 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

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

****

Design the speed reducer to withstand backstop failure and maximum pump reverse runaway speed for a period of [30] [_____] minutes.

1.3.3 Arrangement

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NOTE: In making choices as to the reducer arrangement, the designer must coordinate with the pump (Section 35 45 01) 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.

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

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 and Air Force 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.

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Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are 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-02 Shop Drawings

Speed Reducers; G, [_____]

Lubrication System; G, [_____]

Instrumentation; G, [_____]; G, [_____]

SD-03 Product Data

System Description; G, [_____]

Bearings; G, [_____]

Gears; G, [_____]

Shafts; G, [_____]

[Couplings] [Universal Joints]; G, [_____]

Backstop; G, [_____]

Housing; G, [_____]

Lubrication System; G, [_____]

Instrumentation; G, [_____]

Speed Reducers; G, [_____]

Lubricating Oil; G, [_____]

SD-06 Test Reports

Shop Testing

Field Testing

SD-10 Operation and Maintenance Data

Operations and Maintenance (O&M) Manual; G, [_____]

1.5 DELIVERY, STORAGE, AND HANDLING

Protect material and equipment from weather, humidity, temperature variation, dirt, dust, and other contaminants during delivery and storage.

1.6 EXTRA MATERIALS

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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.

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Submit the following: [_____]

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

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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.

ISO 20816-3 was added in the event any vibration testing may be required by the designer.

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Provide new materials and equipment which are the standard products of the Contractor's manufacturers who are 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. Submit detail drawings consisting of a complete list of equipment and materials, including 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. Rate the reducer assembly in accordance with ANSI/AGMA 6113AGMA 6013 or AGMA 6123 as applicable. Provide reducers which are equal to or exceed the maximum input power times an application factor[of [1.25][1.75] for reducers driven by electric motors][[1.5][2.0] for reducers driven by diesel engines.][For vibration testing conform to ISO 20816-3.]

2.2 BEARINGS

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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.

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2.2.1 Thrust Bearings

Provide thrust bearings which are either hydrodynamic fluid film type or antifriction type. Antifriction thrust type bearings can be either tapered roller or spherical roller type. Size the thrust bearing for the pump thrust plus the weight of the impeller and shaft. Size the bearings to be able to sustain continuous operational load as well as startup and shutdown loads. For hydrodynamic fluid film thrust bearings 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

Use antifriction type radial bearings for spiral bevel and parallel shaft reducers. Use either hydrodynamic fluid film type or antifriction type radial bearings for epicyclic reducers.

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 can not exceed 2400 kPa 350 psi for the maximum load. Where hydrodynamic fluid film thrust bearings are used, make suitable hydrostatic lift provisions if required to prevent bearing damage during startup. Provided thrust bearings with either spring loaded or embedded instrumentation to monitor operating temperatures.

2.2.4 Antifriction Bearings

Use antifriction bearings which are rated for an L-10 life of 100,000 hours at the operating load of the reducer. Conform to ABMA 9 for ball bearing load ratings. Conform to ABMA 11 for roller bearing load ratings.

2.3 GEARS

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

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[Provide double helical designs for Epicyclic gearing.] [Provide helical designs for parallel shaft gearing.][Provide spiral bevel designs for right angle gearing.] Gas nitride or carburize, then harden and ground spiral bevel, helical, and double helical gears. For epicyclic gearing the annulus ring may be cut by gear shaper. Crown the pinion or gear of each helical set to eliminate end loading. For helical gears, use standard normal diametral pitches. In addition to rating the gears according to ANSI/AGMA 6113AGMA 6013 or AGMA 6123 as applicable, ensure gear stresses do not exceed 80 percent of yield strength for any overload, motor stall, or engine overload condition. Use 350 percent of motor rated torque for motor stall condition minimum.

2.4 SHAFTS

Provide heat treated alloy steel for gear shafts. Ensure input shaft sizes and configurations are compatible with the motor or engine and clutch. Ensure output shaft sizes and configurations are compatible with the pump. Welded shafts are not acceptable.

2.5 [COUPLINGS] [UNIVERSAL JOINTS]

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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.

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Connect the speed reducer to the motor (engine) by [flexible coupling] [universal joints]. Specify a service factor of 2 based on maximum rated load for [couplings] [universal joints]. Do not exceed 80 percent of yield strength at maximum overload conditions. [Provide couplings which 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.] [Provide universal joints which have forged steel yokes and spiders and sealed needle roller bearings. Install universal joints in pairs. Conform the angles between each shaft and the intermediate shaft as required. Set the driving pins on the yokes attached to the intermediate shaft parallel to each other.] [Enclose and seal couplings to exclude contaminants and retain the lubricant under both static and operating conditions.] [Provide ANSI/AGMA 9000 class 7 or better flexible couplings with grease unless self-lubricated.]

2.6 BACKSTOPS

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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.

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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 apply a service factor of 2.0 to the equipment's published rating. In addition provide a backstop which is suitable for continuous operation at engine idle speed of [800] [_____] rpm that's of a type with cylindrical rollers on inclined cam planes or drop-pin type. Arrange the backstop with the outer race moving and the inner race fixed. The backstop temperature cannot exceed 160 degrees F under all operating conditions with an ambient temperature up to 40 degrees C 100 degrees F. Provide a circulating oil lubrication system with sufficient flow to provide the required cooling. The lubrication system may be part of the gear reducer lubrication system.

2.7 HOUSING

2.7.1 General

Provide a housing made from cast or fabricated steel. Stress relieve prior to machining, and reinforce to carry all applied loads and to maintain gear alignment. Provide a sole plate under the reducer. Level and grout the sole plate in accordance with API RP 686. Use jacking bolts for leveling before grouting, and back off jacking bolts after leveling to transfer the load to the grout pad. Provide an anchor bolt layout to aid in placement of the anchor bolts. Machine the housing bottom. Paint the interior of the reducer with an oil compatible coating. Paint the exterior with the Contractor's standard coating system. Provide an oil fill connection and a drain connection with a magnetic plug. Provide lifting lugs for lifting the entire reducer assembly and any subassembly or component which cannot be lifted using web slings.

2.7.2 Seals

Use a drywell design seal for vertical down output shafts. Use a lip seal on the input shaft to prevent leakage of oil and exclude dirt and utilize hardened steel wear sleeves.

2.7.3 Inspection Covers

Provide 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

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NOTE: Consult with EM 1110-2-1424 when designing an Enviromentally Acceptable Lubricant (EAL) system.

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2.8.1 General

Provide an oil lubrication system that will provide continuous lubrication to the gears, bearings, and oil lubricated-type backstop consisting of an oil circulating pump, [oil-to-water][air] heat exchanger, piping, filters, and controls for each reducer driven directly from the speed reducer shaft. The maximum oil sump temperature at rated speed allowable is 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 Lubricating Oil

Provide mineral oil or Polyalphaolefine (PAO) synthetic hydrocarbon lubricating oil as recommended in ANSI/AGMA 6113AGMA 6013 or AGMA 6123 for an ambient temperature range of [minus 10 to plus 50 degrees C 15 to 125 degrees F][_____] for use in the gear reducer(s) and backstop(s). Provide viscosity rating and necessary lubricant additives as recommended by the Contractor's fabricator. [Provide environmentally acceptable lubricant in accordance with EPA 800-R-11-002 which is compatible with the lubrication system.] Submit catalog data for the proposed lubricant.

Provide a manufacturer of oil which has a minimum of 15 years of experience in the processing and manufacture of similar oil. Provide gear oil which is the standard product of the manufacturer and from a standard product line.

Provide gear oil which meets all requirements of ANSI/AGMA 9005 which can operate at both extreme high temperatures and low temperatures. Use gear oil which provides rust and corrosion protection for the gear sets and bearings. Submit lubrication manufacturer data which clearly indicates the lubrication meets the general performance requirements.

a. Thermal and oxidative stability under high temperatures
b. Operation under extreme low temperatures
c. Operation under high temperature
d. Extreme pressure and extreme wear properties to protect the gears and bearings
e. Operation under boundary lubrication to protect gear sets
f. High viscosity index
g. Sludge protection
h. Resistance to water and moisture
i. Hydrolytic stability and water separability data
j. Resistance to foaming

Provide oil with a cleanliness rating that conforms to ISO 4406 and meets the following three digit rating code: 17/15/13. Acceptable water content is below 300 ppm. Provide at least 3 random samples and corresponding test data of gear oil from each delivery to show it conforms to the cleanliness rating and water concentration requirements.

2.8.3 Oil Pumps

Provide positive displacement type oil pumps equip with a relief valve which discharges to the sump which is reversible so it continues to function during a runaway condition.

2.8.4 Prelubrication Pump

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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.

****

Provide a prelubrication pump which is positive displacement. [Provide a hand-operated type where antifriction thrust bearings are used.][Provide a positive displacement electric motor-driven pump where hydrodynamic thrust bearings are used]. Provide an electric motor-driven pump capable of delivering sufficient pressure to lift the thrust bearing runner from the shoes. Provide the means to operate in manual and automatic modes. Automatic mode consists of automatically supplying oil prior to reducer startup, operating at least 30 seconds after reducer startup, then automatically shutting down. Manual mode, consists of the prelubrication pump being 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.] Supply oil from the lubrication system prior to reducer startup. Utilize zero-leakage check valves to isolate it from the lubrication system during operation of the reducer. Valve operation is not permitted to execute the prelubrication cycle or to return to normal operation.

2.8.5 Oil and Breather Filters

Provide two oil filters on the pump outlet side, one for removing particles and the other for water removal. Provide a particle filter with a Beta rating of B6 greater than 200 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.] Incorporate an oil-filled differential pressure gauge to indicate the pressure drop across the filter. Equip the filter with an internal magnetic element. Provide a water removal filter which can maintain a water content in the oil to no greater than 200 ppm. Size all filter assemblies so the pressure drop across the clean filter is no greater than 30 kPa 4 psi. Size the particle filter to avoid bypass at a startup oil temperature of 25 degrees C 80 degrees F. Provide a filter bypass setting of 300 to 400 kPa 45 to 60 psi. The minimum element collapse rating 1050 kPais 150 psi. Provide a breather filter with a Beta rating of B6 greater than 75 and a desiccant chamber to remove water.

2.8.6 Heat Exchanger

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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.

****

[Provide a heat exchanger which is either a water-cooled shell and tube type, water-cooled plate type, or internal water-cooled coils within the reducer sump. Compose heat exchanger tubes of [90-10 Copper Nickel Alloy][70-30 Copper Nickel Alloy] with a minimum tube thickness of 1.519 mm 0.0598 inch (16 gauge) which adequate for the specified pressure rating. Provide heat exchanger plates type 316 corrosion resistant steel. Circulate water through the tubes or plates. Provide a design which will allow tubes or plates to be cleaned. Maximum temperature of cooling water provided is [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][_____]. Strain the cooling water to a maximum [3 mm 1/8 inch][_____] particle size. The maximum pressure drop through the clean heat exchanger allowable is [55 kPa (gage) 8 psig][_____]. Design the heat exchanger for a working pressure of [550 kPa (gage) 80 psig][_____]. Pressure test the heat exchanger to 150 percent of the design pressure for a period of 4 hours and monitor the heat exchanger for leakage during the test. Any leakage will be cause for rejection.]

[Provide an oil-to-air type heat exchanger with size based upon a maximum ambient temperature of 40 degrees C 100 degrees F. composed of copper or copper alloy tubes. Design the heat exchanger to withstand a test pressure of 150 percent of the design pressure held for a period of 4 hours and monitor the heat exchanger for leakage during the test. Leakage is cause for rejection. Include a fan, motor, and controls in the oil-to-air heat exchanger system for maintaining the specified oil temperature.]

2.8.7 Cooling Water Control Valve

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

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Provide a thermo-mechanical control valve 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.

2.8.8 Piping and Tubing

Use seamless steel tubing oil lines up to 50 mm 2 inches o.d. with 37 degree flare or flareless fittings. Use steel pipe with welded fittings where pipe sizes of 50 mm 2 inches and over are required. Use copper or copper alloy with brazed or 95-5 soldered joints for water pipes. Ensure all piping, tubing, and fittings conform to ASME B31.1. Use vibration isolating tubing and piping supports. Keep oil tubing or ports within the gear case where feasible. Keep dissimilar metals electrically isolated to prevent corrosion.

2.8.9 Oil Heater

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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.

****

Install a thermostatically operated oil heater to maintain the oil at a temperature of 25 degrees C 80 degrees F. Size the heater based on a minimum ambient temperature of [minus 10 degrees C 15 degrees F] [_____]. Equip the heater with the ability to be shut off if the unit is to be out of service for an extended period. The heaters watt density can not be greater than 9300 W/square m 6 W/inch squared.

2.9 INSTRUMENTATION

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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.
****

Provide instrumentation for the reducer supplied and installed as a complete working package. Conform electrical work to NFPA 70. Provide NEMA 250, Type 4 electrical enclosures. Provide an electrical termination cabinet. [Available power is 120 V, 1 ph.] Provide the following devices within the speed reducer at 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 Contractor's manufacturer.

b. Oil pressure gauge.

    (1) After oil pump.

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

    (3) Gauges which are oil or glycerin filled and with snubbers and isolation valves.

c. Thermometer. Mercury is not allowed.

    (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

Submit a shop test report fully documenting the test. In addition to or as part of the Contractor's normal shop testing procedure, test the reducer at rated speed with no load to check for potential problems prior to field testing. Check gear contact patterns, sound level, lubrication and cooling, and all other operational characteristics. [90 dBA is the maximum sound pressure level of the speed reducer and prime mover allowed in the shop test measured at a distance of 1 m 3 feet from the equipment.] Measure sound in accordance with ANSI/AGMA 6025. Provide any preventative measures to control background noise. Notify the Contracting Officer 2 weeks prior to performing the shop test.

[3.1.1.1 Critical Speeds

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NOTE: Dynamic analysis of the pump, reducer, and engine or motor assembly will be performed by the pump manufacturer as described in Section 35 45 01 VERTICAL PUMPS, AXIAL-FLOW AND MIXED-FLOW IMPELLER-TYPE. If the reducer is purchased separately from the pump, this paragraph should be deleted and responsibility for dynamic analysis, if done, is that of the designer.

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Perform dynamic analysis of the pump, reducer, and motor (engine) assembly. 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.

]3.1.2 Installation

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NOTE: If the reducer is not furnished installed,

this paragraph must be modified or eliminated.
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Install the speed reducer under the supervision of the reducer Contractor's representative and ensure all features and systems are operational. Provide all necessary lifting devices, attachments, and special tools required for maintenance. Submit an OPERATIONS AND MAINTENANCE (O&M) 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.

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. Ensure the duration of the test is long enough to reveal verifiable gear contact patterns. Inspected gear contact patters and provide to the Contracting Officer. Ensure gear contact patterns are at least 70 percent of face width. Ensure spiral bevel gears have a central toe contact pattern with contact of 50 percent of face width at full load. Photograph and include as part of the field test report the observed gear contact patterns. 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.

3.2 OPERATIONS AND MAINTENANCE DATA

[For specifications on the furnishing, installation, operations and maintenance instructions, refer to Section 01 78 23 OPERATION AND MAINTENANCE DATA. Unless otherwise specified, all operation and maintenance manuals are to be comprehensive to the gear reducer system with independent sections for each unique piece of equipment. Operation and Maintenance manuals are to comply with the requirements of Data Package 3 in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.

] a. Safety precautions
b. Operator prestart
c. Startup, shutdown, and post-shutdown procedures
d. Normal operations
e. Emergency operations
f. Environmental conditions
g. Lubrication data
h. Preventive maintenance plan and schedule
i. Cleaning recommendations
j. Troubleshooting guides and diagnostic techniques
k. Wiring diagrams and control diagrams
l. Maintenance and repair procedures
m. Removal and replacement instructions
n. Spare parts and supply list

o. Product submittal data
p. O&M submittal data
q. Parts identification
r. Warranty information
s. Testing equipment and special tool information
t. Testing and performance data
u. Contractor information

Submit six copies of the OPERATIONS AND MAINTENANCE (O&M) MANUAL [in accordance with paragraph OPERATIONS AND MAINTENANCE MANUALS and] in compliance with Data Package 3 in Section 01 78 23 OPERATION AND MAINTENANCE DATA.

-- End of Section --