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USACE / NAVFAC / AFCESA / NASA **UFGS-35 01 41.00 10 (April 2006)**

Preparing Activity: USACE **Replacing withouth change UFGS-11283A (August 2005)**

UNIFIED FACILITIES GUIDE PECIFICATIONS

References are in agreement with UMRL dated 1 April 2006
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DIVISION 35 - WATERWAY AND MARINE CONSTRUCTION

35 01 41.00 10

ELECTROMECHANICAL OPERATING MACHINERY FOR LOCKS

04/06

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35 01 41.00 10

ELECTROMECHANICAL OPERATING MACHINERY FOR LOCKS
04/06

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NOTE: This guide specification covers the requirements for mechanical power systems to operate gates and other mechanisms at navigational lock structures in accordance with EM 1110-2-2610 LOCKS AND DAMS GATE OPERATING & CONTROLS SYSTEMS and EM 1110-2-3200 WIRE ROPE SELECTION CRITERIA FOR GATE OPERATING DEVICE. For hydraulic power systems, see Section 41 24 27.00 10 HYDRAULIC POWER SYSTEMS FOR CIVIL WORKS STRUCTURES and EM 1110-2-1424 LUBRICANTS AND HYDRAULIC FLUIDS FOR CIVIL WORKS PROJECTS.

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).

Use of electronic communication is encouraged.

Brackets are used in the text to indicate designer choices or locations where text must be supplied by the designer.
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PART 1 GENERAL

1.1 REFERENCES

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

Use the Reference Wizard's Check Reference feature

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

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

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

AMERICAN GEAR MANUFACTURERS ASSOCIATION (AGMA)

AGMA 2001	(2004b) Fundamental Rating Factors and Calculation Methods for Involute Spur and Helical Gear Teeth
AGMA 2003	(1997b) Rating the Pitting Resistance and Bending Strength of Generated Straight Bevel, ZEROL Bevel, and Spiral Bevel Gear Teeth
AGMA 2015/915-1	(2001a)Accuracy Classification System - Tangential Measurement Tolerance Tables for Cylindrical Gears
AGMA 6010	(1997f) Standard for Spur, Helical, Herringbone, and Bevel Enclosed Drives
AGMA 9002	(2004b) Bores and Keyways for Flexible Couplings (Inch Series)
AGMA 9005	(2002e) Industrial Gear Lubrication
AGMA 908	(1989b, R 1999) Information Sheet: Geometry Factors for Determining the Pitting Resistance and Bending Strength of Spur, Helical and Herringbone Gear Teeth

ASME INTERNATIONAL (ASME)

ASME B17.1	(1967; R 2003) Keys and Keyseats

ASTM INTERNATIONAL (ASTM)

ASTM B 584	(2004) Copper Alloy Sand Castings for General Applications
ASTM E 165	(2002) Liquid Penetrant Examination
ASTM E 709	(2001) Magnetic Particle Examination

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

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

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA MG 1	(2003; R 2004) Motors and Generators

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

FS RR-W-410	(Rev E) Wire Rope and Strand

1.2 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.

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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.] The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Detail Drawings[; G][; G, [_____]]

Equipment dimensional drawings, assembly drawings, catalog cuts, and material data and shop drawings showing arrangement, construction details and ratings for factory built [miter gate] [and] [[tainter] valve] machinery;[sector gear drive pinion profile (involute) charts and tooth alignment (lead) charts for all sector gear drive pinions;] test rig details; proposed and final shop test procedures and data sheets; and proposed and final field [cable tensioning and] operating test procedures and data sheets shall be submitted to the Contracting Officer for approval. All details of fabrication and assembly shall be provided. Shop drawings lacking this information will be rejected. Approval of the material submitted shall in no way relieve the Contractor from the responsibility of complying with the requirements of the specifications as to the suitability and quality of materials and workmanship and the adequacy of capacity, operating speed and other essential characteristics of the [gate] [and] [valve] drives. Drawings, catalogs, and design data necessary to clearly show the details of any changes proposed by the Contractor shall be submitted for approval in conformity with the requirements of this specification. Equipment, materials, and articles of construction installed or used without such approval shall be at the risk of subsequent rejection. The Contractor shall furnish to the Contracting Officer for approval the names of the manufacturers of all machinery and other equipment which it contemplates incorporating into the work, together with performance capacities and other pertinent information pertaining to the equipment. The submittals shall include the following information:

1) BRAKES

a. Manufacturer's Name
b. Type
c. Model Number
d. Continuous Duty Torque Rating
e. Torque Adjustment Range
f. Supply Voltage
g. Type of Conduit Box - [Standard] [Watertight]
h. Type of Lining
i. Type of Bearings
j. Type of External Brake Release Mechanism
k. Brake Wheel Size
l. Type of Bore - [Straight] [Tapered]
m. Bore Size
n. Brake Wheel Material
o. Brake Wheel Model Number
p. Space Heater Manufacturer/Type/Size (KW)
q. Space Heater Supply - Volts, Phase, Cycle
r. Type of Enclosure
s. Enclosure Model Number
t. Torque Gauge Included [Yes] [No]
u. Torque Scale Included [Yes] [No]
v. Weight of Brake
w. Weight of Enclosure
x. Outline Dimensional Print of Brake
y. Outline Dimensional Print of Enclosure
z. Quantity Being Furnished

2) SPEED REDUCERS

a. Manufacturer's Name
b. Type
c. Model Number
d. Exact Ratio
e. Efficiency
f. Mechanical Rating - Durability - HP, Specify SAC
g. Mechanical Rating - Strength - HP, Specify SAT
h. Rating Calculations
i. Life Factors CL, KL
j. Reliability Factors CF, KR
k. Type of Gearing and Heat-Treatment
l. Type of Bearings
m. Minimum L-10 Bearing Life
n. Method of Lubrication
o. Size and Number of Mounting Bolts
p. Weight and Air Volume of Unit without Oil
q. Weight and Air Volume of Unit with Oil
r. Outline Dimensional Print
s. Type of Breather
t. Quantity Being Furnished

3) SECTOR GEAR AND DRIVE PINION

a. Manufacturer's Name
b. Pinion P.D. and Pinion D.P.
c. Number of Pinion Teeth
d. Face Width of Pinion
e. Pinion Material
f. Pinion Heat Treatment
g. BHN of Pinion
h. Sector Gear P.D. and Sector Gear D.P.
i. Number of Sector Gear Teeth
j. Face Width of Sector Gear
k. Type of Construction - Cast/Fabricated
l. Sector Gear Materials of Construction
m. Sector Gear Heat Treatment
n. BHN of Sector Gear Teeth
o. Mechanical Rating of Gear Set - Durability - HP, Specify SAC
p. Mechanical Rating of Gear Set - Strength - HP, Specify SAT
q. Percentage of Material Yield Point Based on maximum Motor Full Load Torque
r. Life Factors CL, KL
s. Reliability Factors CF, KR
t. I Factor
u. J Factor
v. Number of Reduction Set
w. Outline Dimension Print
x. Weights of Gear and Pinion
y. Quantity Being Furnished

4) ELECTRIC MOTORS

a. Manufacturer's Name
b. Type
c. Frame Number
d. Unique Serial Number
e. Certified Factory Motor Test Data, High Speed & Low Speed

f. Motor Performance Curves, High Speed & Low Speed
g. Enclosure Type
h. Input Voltage, Phases, Frequency
i. Full Load Amps, High Speed & Low Speed
j. Locked Rotor Amps, High Speed & Low Speed
k. Insulation Type
l. Temperature Rise
m. Drive Output Shaft Size and Tolerances
n. Space Heater Manufacturer/Type/Size (KW)
o. Input KW, Input Voltage
p. Conduit Box Size-Motor
q. Conduit Box Size-Heater
r. Drain Description (Manufacturer and Type)
s. Full Load Torque, High Speed & Low Speed
t. Upper Limit Torque, High Speed & Low Speed
u. Lower Limit Torque, High Speed & Low Speed
v. Locked Rotor Torque, High Speed & Low Speed
w. Percentage Slip, High Speed & Low Speed
x. Outline Dimensional Print
y. Weight of Motor
z. Quantity Being Furnished

5) MOTOR DRIVE UNIT COUPLINGS (HIGH AND LOW SPEED SHAFTS)

a. Manufacturer's Name
b. Type
c. Model Number
d. Bore Sizes and Tolerances
e. Number of Keyways
f. Keyway Sizes and Tolerance
g. Recommended Shaft Size and Tolerance
h. Recommended Key Size and Tolerance
i. Recommended Key Material
j. Keyways Filleted [Yes] [No]
k. Materials of Construction
l. Catalog Rating - Torque, HP/100 RPM
m. Service Factor Based on Catalog Rating
n. Angular Misalignment
o. Parallel Offset Misalignment
p. Axial Movement
q. Torque and HP/100 RPM Capacity of Low Speed Coupling with Anticipated Shaft Fits
r. Type of Lubrication
s. Assembly Procedure of Hub with Shaft
t. Weight
u. Outline Dimensions Print
v. Quantity Being Furnished

6) TORQUE LIMITING COUPLINGS

a. Manufacturer's Name
b. Type
c. Model Number
d. Bore Sizes and Tolerances
e. Number of Keyways
f. Keyway Sizes and Tolerance
g. Recommended Shaft Size/Tolerance
h. Recommended Key Size and Tolerance
i. Recommended Key Material

j. Keyways Filleted [Yes] [No]
k. Materials of Construction
l. Catalog Rating - Slip Torque Range, lb-in
m. Slip Torque Setting, lb-in
n. Service Factor Based on Catalog Rating
o. Angular Misalignment
p. Parallel Offset Misalignment
q. Axial Movement
r. Torque Capacity
s. Type of Lubrication
t. Weight
u. Outline Dimensions Print
v. Quantity Being Furnished

7) PILLOW BLOCK BEARING

a. Manufacturer's Name
b. Type
c. Model Number and Size
d. Bearing Housing Material
e. Bearing Bore Diameter
f. Bearing Bore [Fixed] [Floating]
g. Type of Bearing
h. Static Capacity of Bearing
i. Thrust Capacity of Bearing
j. Basic Dynamic Capacity of Bearing
k. [Load Capacity of Bearing]
l. L-10 Life of Bearing
m. Type of Seals
n. Type of Lubrication
o. [Grease Grooves Included [Yes] [No]]
p. Weight
q. Outline Dimensional Print
r. Quantity Being Furnished

8) [WIRE ROPE]

a. [Size]
b. [Type and Construction]
c. [Material]
d. [Lay]

1.3 GENERAL REQUIREMENTS

****
NOTE: This guide specficifation covers operating machinery for lock miter gate and tainter type culvert valves. It can be revised as needed to accommodate other types of gates or valves.
****

The equipment to be furnished under this specification consists of [[4] [_____] miter gate units, [2] [_____] upper gate units and [2] [_____] lower gate units [and spares]] [and] [[4] [_____] [tainter] valve units [and spares]]. The units shall be furnished complete, including base supports, geared drives, portable filtering unit, brakes, motors, shafts, bearings, [wire rope,] electrical equipment, controls, covers, guards, and other necessary items. Design and manufacture of the [miter gate] [and] [tainter] [valve] machinery units shall be provided to the Contractor by a

firm that has been normally and regularly engaged in design, assembly, and manufacture of heavy machinery over the preceding [5] [_____] years. Dimensions shown on the drawings [and in the Bill of Materials for the Miter Gate Machinery] [and] [Bill of Materials for the [Tainter] Valve Machinery] (including structural supports) shall not be changed without written approval from the Contracting Officer. Each piece of equipment shall be provided with a [metallic] [_____] nameplate firmly attached. The nameplate shall bear the manufacturer's name, model designation, serial number, unit rating, application factor, reduction ratio's, and any other applicable information. Detail Drawings shall submitted as specified in the Submittals paragraph.

1.3.1 Operations and Maintenance (O&M) Manuals

****
NOTE: Collective O&M Manuals are usually compiled from the individual O&M manuals for each piece of equipment.
****

For specifications on the furnishing of installation, operations and maintenance instructions, see Section [_____] MACHINERY MAINTENANCE AND OPERATING INFORMATION.

1.3.2 Storage of Equipment

****
NOTE: This paragraph covers storage of equipment when delivered to the jobsite and storage of spares.
****

For specifications on storage of equipment see Section [_____] STORAGE OF [MITER] [_____] GATE AND [TAINTER] [_____] VALVE MACHINERY AND EQUIPMENT.

1.3.3 Delivery of Components/Systems [Required for Lock Shutdown Period]

****
NOTE: Many custom and catalog selected items require long lead times that may affect the construction schedule. If this is the case, use the following paragraph.
****

The Contractor is hereby notified that many of the components required for the electrical and mechanical equipment at a Lock and Dam have long delivery times. Per other requirements shown on Sheet [_____] and in Section [_____], paragraph titled, "COMMENCEMENT, PROSECUTION AND COMPLETION OF WORK", a large percentage of the lock electrical and mechanical work must be accomplished only during critical times [(lock shutdown period may be required)]. To ensure that all work required during this time period is accomplished, the Contractor shall, within [120] [_____] calendar days after receiving notice to proceed, present to the Contracting Officer written copies of finalized purchase agreements with component manufacturers (NOT SUPPLIERS) for the components and systems noted below. If any of these components/systems or other items, not listed but required, have a delivery time longer than would be provided by submission of purchase agreements [120] [_____] calendar days after receiving notice to proceed, the Contractor shall accelerate its procurement procedures to provide delivery as needed to accomplish the work.

COMPONENTS

(1) Speed Reducers
(2) Motors
(3) High and Low Speed Couplings
(4) Torque Limiting Couplings
(5) Brakes and Control Units
(6) Bearings
[(7) Sector gear [rework]]
[(8) Sector Arm]
[(9) Strut Arm]
[(10) Pinions]
[(11) Wire Rope Drums]
[(12) Wire Rope]

These purchase agreements shall include a confirmed delivery date and point of contact at the particular manufacturer. The manufacturer shall be required to furnish a monthly report (a copy of which shall be submitted to the Contracting Officer on the 10th of each month) of progress on the particular component/system and any delays in the previously specified delivery date. The reporting requirements specified herein shall be included in the requirements of Section 01 32 01.00 10 PROJECT SCHEDULE.

1.4 DESIGN CRITERIA

1.4.1 General

****
NOTE: If only miter gate equipment is being procured, remove the brackets from paragraph c and delete paragraph d. If only valve machinery is being procured, delete paragraph c and remove the brackets from paragraph d.
****

a. Equipment, where modified by the Contractor and submitted for approval, shall be designed for the normal loads using factors of safety applicable to the type of service and the particular part with a minimum factor of safety of 5 based on the ultimate strength of the material. In addition, each part component, including speed reducers [(excluding wire rope)], shall be designed for a unit stress not in excess of 75 percent of the yield point of the material under loads resulting from the maximum torque of the motor. [Both the normal loads and loads resulting from the maximum torque of the motor shall be considered for miter gate machinery.] [Both the normal loads and loads resulting from the maximum torque of the motor shall be considered as divided [75/25] [_____] between the two drums of a hoist for [tainter] valve machinery.] Allowances for shock and impact will not be required. All equipment modification design calculations shall be submitted for approval.

b. All equipment will be located outside and be expected to operate between ambient temperatures from [-23] [-12] to 43 degrees C [-10] [10] to 110 degrees F.

[c. The normal load on the miter gate machinery is approximately [_____] kg pounds applied as a tangential force at the drive pinion. The miter gate drive machinery is required to open and close the miter

gates at a sector gear speed of approximately [_____]/[_____] revolutions per minute (RPM). This is based on full load motor speeds of [_____] and [_____] RPM for high and low speeds, respectively.]

[d. The normal design load on each hoist drum is [_____] kg pounds. The loads are composed of the dead weight of the gate, hydraulic forces, [ice,] and seal friction. The hoists are required to raise the ropes at a speed of [_____] m/sec feet/minute.]

1.4.2 Miter Gate Operation

1.4.2.1 Sequence of Operation

Intended as additional design information only.

a. Miter Gate Opening

(1) Gearbox lubrication pump is energized and operates for [3] [_____] to [4] [_____] seconds prior to gearbox operation.

(2) Motor and brake are energized (brake is released).

(3) Motor starts in low speed mode and runs in low speed mode for the first [5] [_____] percent of the miter gate travel.

(4) Motor shifts to high speed mode and runs in the high speed mode until the miter gate is [95] [_____] percent open.

(5) Motor shifts to low speed mode and runs in low speed mode until the miter gate is fully open (last [5] [_____] percent of miter gate travel).

(6) Motor and brake are de-energized (brake is engaged).

b. Miter Gate Closing

The sequence for closing the gate is identical to that for opening, except the gate moves to the mitered (closed) position.

1.4.2.2 Design Considerations

The Contractor shall assume the following as normal operations of the miter gates for the purpose of designing the motors: Normal operations consist of [3] [_____] cycles per hour with [2] [_____] starts and [2] [_____] stops per cycle. A cycle is defined as moving the miter gate from the fully closed position to the fully opened position and back to the fully closed position.

PART 2 PRODUCTS

2.1 ELECTRICAL EQUIPMENT

Electrical equipment, including limit switches, motor starters, conduit, conductors, controls, [slack cable safety devices] etc., shall conform to the requirements of Section 33 70 01.00 10 ELECTRICAL DISTRIBUTION SYSTEM, AERIAL and/or the drawings.

2.2 SPEED REDUCERS

2.2.1 Miter Gate Speed Reducers

2.2.1.1 General

The speed reducer shall be a [single] [double] [triple] [quadruple] reduction, [right angle,] [parallel shaft,] [spiral bevel/helical gear] [helical gear] [right angle worm gear] type, entirely self contained in an oil tight, steel housing designed to maintain shafts and bearings in accurate alignment. The gear ratio shall be as indicated plus or minus [1.5] [_____] percent. [The [vertical] [horizontal] output shaft shall be [single] [double] extended and shall [be coupled to the pinion shaft] [have the pinion mounted on the output shaft]]. [The [vertical up] [horizontal] shaft shall be [19] [_____] mm [3/4] [_____] inches in diameter, shall protrude through the [top] [side] of the reducer housing, and shall drive a rotary cam limit switch.] [The input shaft shall be [_____] mm inches in diameter.] Speed reducers shall be rated as indicated on the drawings. The speed reducers shall be designed, rated and manufactured in accordance with AGMA 6010. The gearing shall be rated in accordance with AGMA 2003 and AGMA 6010. AGMA 2001 is not to be used for rating and design of the components of the speed reducers. In all cases where these standards or this specification are in conflict with one another the more conservative design standard shall take precedence.

2.2.1.2 Reducer Housing

The reducer housing shall be heavy duty cast steel or welded steel construction and shall have dowel pins at all parting seams for accurate gear and bearing alignment. [The reducer housing shall be of the dry well type design for the vertical down output shaft.] [The dry well shall be designed such that the speed reducer can be completely filled with oil while in storage and the oil can be drained out of the dry well when the speed reducer is to be put into service.] The base of the reducer shall be of sufficient thickness and width in order to reduce the stress on the mounting bolts. All surfaces shall be smooth and flat and easy to clean. The upper and lower housings shall have large, rugged lifting lugs. [A machined steel bracket for mounting the rotary cam limit switch shall be provided and mounted as indicated.] All required oil drains, fill ports, breathers, heater ports, filtering ports, and inspection covers shall be provided in the housing. A main oil drain shall be provided at as low a point as possible on the reducer housing. The main oil drain shall be fitted with a 25 mm 1-inch stainless steel ball valve with a pressure-temperature rating of 13.8 MPa 2000 psig at 38 degrees C 100 degrees F. The valve shall be plugged on the open end. [Housing shall include 25 mm 1-inch filter ports with 25 mm 1-inch stainless steel ball valve to be connected to the portable filtering unit when required, otherwise the ends shall be capped.] The lower bearings shall also be provided with drainable deepwell bearing end caps as indicated. The drains shall be manifolded and piped to a single point with a shutoff valve and threaded cap on the exterior of the housing so that it is easily accessible. The design of the reducer housing should minimize potential for water intrusion as the reducers will be continuously exposed to the out-of-doors ambient conditions. This shall include raising the upper bearing caps on top of the housing to prevent standing water from seeping into the enclosure. Top side inspection covers are not acceptable. Side inspection access covers shall be provided. All dimensions indicated shall remain as shown as a minimum for proper machinery alignment [as well as interchangeability with other reducers within the [_____] District.]

2.2.2 [Tainter] Valve Speed Reducers

2.2.2.1 General

The speed reducer shall be a [single] [double] [triple] [quadruple] reduction, [right angle,] [parallel shaft,] [spiral bevel/helical gear] [helical gear] [right angle worm gear] type, entirely self-contained in an oil tight steel housing designed to maintain shafts and bearings in accurate alignment. The gear ratio shall be as indicated plus or minus [1] [_____] percent. [The reducer shall have double extended [input] [and] [output] shafts.] [The input shafts shall provide connections for the motor and brake separately.] [The output shafts shall connect to the [drum and cable] [hoist] assemblies as shown on the drawings.] Speed reducers shall be rated as indicated on the drawings. The reducer shall be designed to accommodate a [75/25] [_____] torque split between output shafts based on loads produced by the motor. The speed reducers shall be designed, rated and manufactured in accordance with AGMA 6010. The gearing shall be rated in accordance with AGMA 6010. AGMA 2001 is not to be used for rating and design of the components of the speed reducers. In all cases where standards or this specification are in conflict with one another the more conservative design standard shall take precedence.

2.2.2.2 Reducer Housing

The reducer housing shall be heavy duty cast steel or welded steel construction and shall have dowel pins at all parting seams for accurate gear and bearing alignment. The base of the reducer shall be of sufficient thickness and width to reduce the stress on the mounting bolts. The upper and lower housings shall have large rugged lifting lugs. All required oil drains, fill ports, breathers and inspection covers shall be provided on the housing. A main oil drain shall be provided at as low a point as possible on the reducer housing. The main oil drain shall be fitted with a 25 mm 1-inch stainless steel ball valve with a pressure-temperature rating of 13.8 MPa 2000 psig at 38 degrees C 100 degrees F. The valve shall be plugged on the open end. The design of the reducer housing should minimize potential for water intrusion as the reducers will be continuously exposed to the out-of-doors ambient conditions. Top side inspection covers are not acceptable. Side inspection access covers shall be provided. All dimensions indicated shall remain as shown as a minimum to ensure proper machinery alignment [as well as interchangeability with other reducers within the [_____] District.]

2.2.3 Gearing

All single [helical] gearing shall be made from high strength alloy steel, carburized, hardened, and ground after gear cutting; AGMA Quality [11] [_____] in accordance with AGMA 2015/915-1, minimum. [The [helical] pinions shall be integrally cut on the pinion shaft.] [Spiral bevel gears shall be made from high strength alloy steel with case hardened teeth, crown lapped for quality and smooth operation.]

2.2.4 Reducer Shafts

Shafts shall be made from high-strength alloy steel and shall be of sufficient size and as indicated to insure rigid alignment. All keyways shall have fillet radii. Keys shall be provided for all shafts. All shafts shall have standard keyways and keys in accordance with ASME B17.1, Class II. All fabricated dimensions of the keyways and keys shall be

submitted for review.

2.2.5 Shaft Bearings

The shaft bearings shall be high capacity antifriction roller bearings suitable for both radial and thrust loads. All bearings shall have a minimum L-10 bearing life of [75,000] [_____] hours based on the largest full load motor horsepower provided by the specified motor.

2.2.6 Gearbox Lubrication System

2.2.6.1 Miter Gate Gearbox Lubrication System

****
NOTE: A combination system generally is specified for the miter gate gearbox. If a splash type system is used, delete the requirement for the pump.
****

The lubrication system shall be a [splash] [pressure] [combination pressure/splash] type system using a [synthetic] [petroleum based] hydro-carbon lubricant. [The pressure lubricating system shall consist of an electric motor driven lubricating gear pump and piping assembly which shall lubricate the upper bearings and gear meshes not submerged in oil. The pump shall be a positive displacement internal gear type, cast iron construction. The pump shall be equipped with an overpressure relief valve. The pump shall be externally mounted on the miter gate gear box and shall be provided with the proper seals to operate under the stated conditions. The Contractor shall design the lubrication system. The Contractor shall install external and internal piping as required to provide adequate lubrication to the gear meshes and bearings. The pressure losses, total flow rate, and expected flow rate to each component and/or gear mesh shall be defined, documented, and submitted. A pressure switch and pressure gauge shall be mounted on the pump outlet.] The lubrication system shall be designed to function properly at both nameplate speed ratings using the specified lubricating oil. All gears and lower bearings with the exception of the lower bearing of the vertical (down) output shaft shall be oil lubricated. All upper bearings shall be oil and/or grease lubricated. All required oil slingers, dams, and passages shall be provided. The lower vertical output shaft bearing [shall be housed in the dry well and] shall be grease lubricated. Grease lines and lubrication fittings shall be provided for all grease lubricated bearings and mounted on the reducer housing such that the bearings can be easily identified and lubricated from the side of the reducer housing. The reducer shall be equipped with a sight gauge and dipstick in order to observe and measure the oil level. The speed reducer shall also be fitted with an oil sample valve arrangement. The valve shall be a6 mm 1/4-inch stainless steel ball valve with a pressure-temperature rating of 13.8 MPa 2000 psig at 38 degrees C 100 degrees F and be fitted with a plug on the open end. The oil sample port on the reducer housing shall be located such that an oil sample can be drawn (through the sample valve) from a point that is approximate 1/2 of the operating oil level in the reducer.

2.2.6.2 [Tainter] Valve Gearbox Lubrication System

****
NOTE: A splash type system is generally specified for the valve gearbox. If a splash type system is used, delete the requirement for the pump.

****

The lubrication system shall be a [splash] [pressure] [combination pressure/splash] type system using a [synthetic] [petroleum based] hydrocarbon lubricant. [The pressure lubricating system shall consist of an electric motor driven lubricating gear pump and piping assembly which shall lubricate the upper bearings and gear meshes not submerged in oil. The pump shall be a positive displacement internal gear type, cast iron construction. The pump shall be equipped with an overpressure relief valve. The pump shall be externally mounted on the tainter gate gear box and shall be provided with the proper seals to operate under the stated conditions. The Contractor shall design the lubrication system. The Contractor shall install external and internal piping as required to provide adequate lubrication to the gear meshes and bearings. The pressure losses, total flow rate, and expected flow rate to each component and/or gear mesh shall be defined, documented, and submitted. A pressure switch and pressure gauge shall be mounted on the pump outlet.] Lubrication system shall be designed to function properly at both nameplate speed ratings using the specified lubricating oil. All gears shall be oil lubricated. All bearings shall be grease lubricated. All required oil slingers, dams, and passages shall be provided. The speed reducer shall be equipped with an oil sight gauge and a dip stick in order to observe and measure the oil level. The speed reducer shall also be fitted with an oil sample valve arrangement. The valve shall be a 6 mm 1/4-inch stainless steel ball valve with a pressure-temperature rating of 13.8 MPa 2000 psig at 38 degrees C 100 degrees F and be fitted with a plug on the open end. The oil sample port on the reducer housing shall be located such that an oil sample can be drawn (through the sample valve) from a point that is approximate 1/2 of the operating oil level in the reducer.

2.2.7 Seals

Spring loaded grease-purged dual lip seals shall be provided for all shaft extensions. All seals shall be sized and designed to withstand the pressure head developed when the speed reducer is completely filled with oil (storage condition) without leaking.

2.2.8 Breather

****

NOTE: Standard breather may be provided. However, to help prevent water contamination, a hygroscopic breather is recommended.

****

All reducers shall be provided with a hygroscopic breather with threaded fittings for installation to prevent problems caused by moisture and particulate matter contamination in the reducer when it breathes in and out due to temperature fluctuations. The breather shall filter particles down to 3 microns in size. The hygroscopic agent shall change color signifying when the unit requires replacement, i.e., when the desiccant is saturated with moisture. There shall be no air flow stoppage through the breather under freezing conditions.

2.3 BEARINGS

Except as otherwise specified, bearings may be of the [roller] [self-aligning spherical roller] [ball] [_____] type as indicated and shall be provided with pressure lubrication fittings. The manufacturer's ratings

for loads and speeds shall be used in determining the bearing capacity. The minimum L-10 bearing life shall be [75,000] [_____] hours based on the largest full load motor horsepower provided by the specified motor. Service and installation factors shall be in accordance with the bearing manufacturer's recommendations. All bearings shall be equipped with labyrinth seals to exclude foreign matter and retain lubrication without leakage under both static and dynamic operating conditions. Ball bearing pillow blocks and flange blocks shall have solid cast iron housings with two bolt base. Roller bearing pillow blocks shall be of the split cast iron construction with four bolt bases. Spherical roller bearings shall be either of the fixed or expansion type as indicated. End caps shall be provided as indicated on open ended shafts. Roller bearing housing caps shall be recessed into or dowelled to the bases and secured with not less than 4 bolts, SAE Grade 8.

2.3.1 Brake Shaft Bearings

Brake shaft pillow block bearings shall be of the ball type and shall be provided with pressure lubrication fittings and set screw lock. Bore shall be as indicated. The manufacturer's ratings for loads and speeds shall be used in determining the bearing capacity. The minimum L-10 bearing life shall be [75,000] [_____] hours based on the largest full load motor horsepower provided by the specified motor. Service and installation factors shall be in accordance with the bearing manufacturer's recommendations. Ball bearing bases shall be of single cast iron construction with two bolt base.

2.3.2 Pinion Shaft Bearings

****
NOTE: Pinion shaft bearings are typically slow speed and can be bronze pillow block type. Spherical roller bearings may also be used.
****

Pinion shaft bearings shall be plain bronze type and shall be provided with pressure lubrication fittings for shaft as indicated. Bearing housings shall be of split cast steel construction with 4 bolt base. The bearings shall withstand a total resultant normal load of [_____] kg pounds applied downward at [70] [_____] degrees from vertical at [_____] RPM. Bronze alloy shall conform to ASTM B 584 (C93200) with grease grooves. Bearing caps shall be secured with not less than 4 bolts, SAE Grade 8 and lockwashers.

2.4 SHAFT COUPLINGS

2.4.1 Shaft Couplings

Shaft couplings shall be of the flanged exposed bolt, double engagement, gear type made of forged steel. Couplings shall be of the [vertical] [or] [horizontal] design [depending on the shaft on which they are mounted]. Couplings shall transmit torque by means of external gears on hubs engaging in internal gears on the coupling sleeves. Gears shall be machined in accordance with AGMA 9002 and AGMA 908 standards. Couplings shall be of sufficient capacity to develop the full strength of the shafting which they connect and shall be pressed and keyed thereon. The key fit shall be in accordance with ASME B17.1, Class II. The fabricated dimensions of the key fit shall be submitted for review. Couplings shall be equipped with lube plugs and enclosed and sealed with an elastomeric O-ring to retain the

lubricant and shall be oiltight under both static and dynamic operating conditions. Bolts shall be SAE grade 8. Misalignment for gear couplings shall be minimized by not exceeding the manufacturer's recommendations for installation limits pertaining to gap-hub separation, angular alignment, and parallel offset alignment measurements.

2.4.2 Torque Limiting Couplings

****
NOTE: Torque limiting couplings prevent motor over-torque which could result in damage to the equipment.
****

A [slip] [detent] [_____] type torque limiting coupling shall be installed between the drive motor and brake shaft and shall slip if [the miter gate machinery torque exceeds [_____] N-m inch-pounds] [or] [the [tainter] valve machinery torque exceeds [_____] N-m inch-pound]. The coupling shall continue to slip until the torque drops below this level. The coupling shall be of the flexible type design with steel hubs and a steel grid which fits into the periphery of the coupling hubs. The friction linings shall be of the segmental type design and shall be easily replaced without removing connected equipment. The torque slip range shall be controlled by a spring type mechanism which can be adjusted by means of tightening or loosening the through bolts. The torque slip shall have an adjustment range of plus or minus [20] [_____] percent of the specified load. The spring mechanism shall be equipped with machined spacers of a specific length determined by the required slip setting. The coupling slip setting shall be preset at the factory. The coupling shall be equipped with self lubricated bearings to permit free rotation when slipping. The coupling shall have elastomeric seals that are both water and dust tight and shall have a fitting that allows grease lubrication. Torque limiting couplings shall be broken in after assembly to the motor and reducer shafts. This consists of operating the couplings at a pre-determined number of revolutions at 100 percent slip and then re-setting the spring compression distance as described in the manufacturer's installation instructions. Slip of the torque limiting coupling shall be accomplished by locking the input shaft of the reducer and applying power to the motor in high speed.

2.4.3 Rotary Cam Limit Switch Coupling

****
NOTE: Limit switch coupling would be provided to connect an output shaft to a limit switch input shaft.
****

The coupling shall be a jaw type flexible coupling with a sintered iron hub and bronze insert. The coupling shall have a finished bore and shall have keyways with set screws over the keyways. The couplings shall be furnished complete with the set screws.

2.5 LUBRICATION

Lubricating oil for speed reducers shall be [AGMA 5EP] [_____] in accordance with AGMA 9005 or as recommended by the gearbox manufacturer. It shall have good resistance to foaming under normal operating conditions and shall be non-corrosive to speed reducer components. The oil shall be suitable for infrequent intermittent duty operation of the speed reducers

with an ambient temperature range from [-23] [-12] [_____] to 43 degrees C [-10] [10] [_____] to 110 degrees F. Drain and fill plugs for speed reducers shall be located so as to be readily accessible on the completed units and shall be provided with extension piping where required. Couplings and bearings shall be grease lubricated in accordance with the manufacturer's instructions.

2.6 PINION

The pinion gear shall be of the spur type and shall be cut from solid steel. The normal strength horsepower rating of the pinion shall not exceed 1/2 of the peak strength horsepower rating as determined by AGMA 2001. Durability rating of gears shall be as determined by AGMA 2001 and shall be based on a service factor of one. The pinion shall have a generated tooth form as indicated on the drawings.

2.7 SECTOR GEAR

****

NOTE: If existing sector gears are to be reworked for rehabilitation or repair, use paragraphs 2.7.1 and 2.7.1.1 below and delete the remaining paragraphs. If new sector gears are to be procured, delete paragraphs 2.7.1 and 2.7.1.1 and use the remaining paragraphs. The sector arm and strut arm that connects to the gate are usually fabrications. These items are covered on the drawings and in SECTION 05055A METALWORK FABRICATION, MACHINE WORK, MISCELLANEOUS PROVISIONS.

****

2.7.1 Rework Existing Sector Gears

2.7.1.1 General

The existing sector gears shall be removed and provided to the Government. Government supplied sector gears shall be inspected, remachined, rebushed, and reinstalled as shown on the drawings. The operating pitch diameter shall be [3.66] [_____] m [144] [_____]-inches. The recut sector gear, when meshed with the new pinion shall have a backlash of [0.5] [_____] mm [0.02] [_____]-inch to [1] [_____] mm [0.04] [_____]-inch. The sector gear shall be painted prior to reinstallation.

2.7.1.2 Nondestructive Examination

Magnetic particle and dye penetrant examination shall be performed in accordance with the requirements set forth in ASTM E 709 and ASTM E 165, respectively.

a. Gear Teeth (magnetic particle or dye penetrant). The gear teeth shall be defined as all material on the sector outside a radius of [5] [_] feet [8-1/2] [_] inches. Only indications with major dimensions greater than 1/16-inch shall be considered relevant. The following relevant indications shall be unacceptable: any linear indications greater than 3/16-inch (a linear indication is defined as one whose length is three times its width); rounded indications with dimensions greater than 3/16-inch; four or more relevant indications in a line separated by 1/16-inch or less, edge to edge; and ten or more relevant indications in any 6 square inches of surface with the major dimension

of this area not to exceed 6 inches when taken in the most unfavorable orientation relative to the indications being evaluated.

b. Gear Spokes and Hub (dye penetrant). The gear spokes and hub shall be defined as all material on the sector inside a radius of [1.7] [_____] m [68.5] [_____] inches. Only indications with major dimensions greater than [6] [_____] mm [1/4] [_____]-inch shall be considered relevant. The following relevant indications shall be unacceptable: any linear indications greater than [13] [_____] mm [1/2] [_____]-inch (a linear indication is defined as one whose length is three times its width); rounded indications with dimensions greater than [6] [_____] mm [1/4] [_____]-inch; four or more relevant indications in a line separated by [3] [_____] mm [1/8] [_____]-inch or less, edge to edge; and ten or more relevant indications in any 3870 square mm 6 square inches of surface with the major dimension of this area not to exceed 150 mm 6 inches when taken in the most unfavorable orientation relative to the indications being evaluated.

c. The Contractor shall map and photograph all relevant indications. The results of the nondestructive examination along with the repair procedure shall be submitted for approval prior to gear repair or remachining. Inherent indications resulting from the original fabrication of the gears shall be omitted from repair at the discretion of the Government.

2.7.2 Fabrication of New Sector Gears

2.7.2.1 General

The overall dimensions and configurations of the sector gear, sector arm, sector gear drive pinion, pinion shaft, and clamping collar shall be as shown on the drawings. Each sector gear, sector arm, sector gear drive pinion, and pinion shaft shall be manufactured as matched sets, however, any pinion shall be fully compatible with any sector gear. Each sector gear and sector gear drive pinion shall be factory tested in accordance with the Shop Assembly and Tests paragraphs of this specification. Each mating set shall be match marked.

2.7.2.2 Alternate Designs

If different from the Government furnished design, the sector gear, sector gear drive pinion, and the pinion shaft shall be engineered, designed, and manufactured by a reputable gear manufacturer who has prior experience in designing and supplying this size gearing. The manufacturer shall prepare and submit all required calculations and shop drawings for the design and fabrication of the sector gear and sector gear drive pinion to the Contracting Officer for approval prior to the start of shop fabrication. The sector gear and sector gear drive pinion shall be designed in accordance with AGMA 2003 with life factors CL and KL equal to unity and reliability factors CR and KR equal to 1.00 or greater. The reduction set number used in the design calculations shall not be greater than 3.

2.7.2.3 Drive Pinion, Pinion Shaft, and Clamping Collar

The pinion shall be of the spur tooth design with a [525] [_____] mm [21] [_____]-inch pitch diameter and [one (1)] [_____] diametrical pitch. The pinion shall be made of AISI 4340H steel. The pinion gear teeth shall be through hardened to measure at any point on the tooth face within [360] [_____] to [400] [_____] BHN after finishing. The face width of the pinion

shall be [325] [_____] [13.0] [_____] inches. The ends of the pinion teeth shall be end relieved to prevent end loading. The pinion teeth shall be crowned as defined on the contract drawings. The pinion shaft shall be made from [AISI 4340] [_____] heat treated forged steel with a minimum yield point of [751] [_____] MPa [110,000] [_____] psi. The clamping collar shall be made of AISI 1045 steel. The overall length and diameters of the pinion shaft and clamping collar shall be as shown on the contract drawings. The fasteners for the clamping collar shall be SAE Grade 8 alloy steel socket head cap screws. The keys shall be made of AISI 1018 keystock. The pinion shaft and clamping collar shall be made as shown on the contract drawings. Certified material test results for the drive pinion and drive pinion shaft are required.

2.7.2.4 Sector Gear

The sector gear shall be of the spur tooth design with a [3.6] [_____] m [144] [_____]-inch pitch diameter and [one (1)] [_____] diametrical pitch. The sector gear shall be fabricated steel construction. The sector gear shall have through hardened teeth and shall have a face width of [304] [_____] mm [12] [_____]-inches. The overall dimensions and configurations of the sector gear shall be as shown on the contract drawings. The rim of the sector gear shall be made of AISI 4340 forged steel. The other parts of which the sector gear is comprised shall be determined based on design requirements. The sector gear teeth shall be through hardened to measure at any point on the tooth face within [320] [_____] to [360] [_____] BHN after finishing. Certified material test results for the sector gear's rim are required.

2.7.2.5 Testing

The Contractor shall prepare certified profile (involute) charts and certified tooth alignment (lead) charts for all sector gear drive pinions. These charts shall be accurate to within +/-0.0125 mm 0.0005 inches and shall be drawn directly by an electronic probe type instrument. These charts shall be submitted for both faces of all sector gear drive pinion teeth. The tooth alignment charts shall span the entire face width of the tooth at the pitch line and shall indicate the tooth centerline. The profile charts shall indicate the theoretical involute line and shall span from base circle to tooth tip at the tooth centerline. All charts shall have the scales labeled. All charts shall be traceable to the specific teeth from which they are measured.

2.8 HOIST DRUMS

****
NOTE: If wire rope hoists are specified, use the following paragraph for fabricated drums.
****

For specific requirements see Section 05 50 04 METALS: MISCELLANEOUS, STANDARD ARTICLES, SHOP FABRICATED ITEMS FOR CIVIL WORKS STRUCTURES.

2.9 WIRE ROPE ASSEMBLY

****
NOTE: Section 35 01 43 WIRE ROPE FOR GATE OPERATING DEVICES can be used to specify wire rope and terminations or the following paragraphs can be used.
****

2.9.1 Wire Rope

Wire rope shall conform to the applicable requirements of FS RR-W-410 for Type I, class 3, construction 6; and shall be [6 x 37] [_____], preformed, pre-stretched (prestressed to eliminate "constructional" stretch), independent wire rope core, type 304 stainless steel. The wire rope shall be furnished as matched pairs (one wire rope right regular lay, the other left regular lay) to the lengths indicated. The rope shall have a nominal diameter of [25] [_____] mm [1] [_____]-inch and the breaking strength of the rope shall be not less than kg [_____] pounds. Ropes shall be free of lubricants or coating except for the lubricant required in the manufacturing process. The ropes shall be shop assembled to the valve and drum connecting sockets.

2.9.2 Wire Rope Sockets

The lower wire rope socket shall be of the grooved open spelter type size for [25] [_____] mm [1] [_____]inch diameter wire rope. The material of the socket shall be galvanized forged steel. Each socket shall be provided with a pin and cotter pin. Materials shall be as shown on the drawings.

2.10 SHAFTS

All fabricated shafting, including brake shafts, pinion shafts, and rotary limit switch shafts, shall be [turned or ground,] [hot-rolled or cold-rolled,] [alloy or carbon steel,] as indicated. Fillets shall be provided where changes in section occur. All keyways shall have fillet radii. All shafts shall have standard keyways and keys in accordance with ASME B17.1, Class II. All fabricated dimensions of the keyways shall be submitted for review.

2.11 BRAKE

****
NOTE: Brakes can be either AC or DC type. If AC brakes are specified, delete paragraph 2.11.2 below. If DC brakes are specified, delete paragraph 2.11.1.
****

The brakes shall be self-adjusting, shoe type, spring set, [released by a sealed electrohydraulic actuator] [with DC magnet operated release] and shall be completely enclosed in a water-tight and dust-tight enclosing case arranged for floor mounting. The brake shall be [alternating current] [direct current] type rated for [120] [240] [460]-volts, [1] [3]-phase, 60 Hertz. The brake shall have an operating torque rating of [271] [_____] N-m [200] [_____] foot-pounds with a [250] [_____] mm [10] [_____] inch wheel bored for mounting on the brake shaft. The torque rating shall be based on open construction continuous duty. The brake shall be self-adjusting such that compensation for shoe wear is automatic. Hand release, external to the brake enclosure, shall be provided. The brake torque field setting shall not be less than [125] [150] [_____] percent of the full load torque of the motor when referred to the shaft on which the brake wheel is mounted.

2.11.1 Electrohydraulic Actuator

Electrohydraulic actuator shall consist of an electric motor that drives an impeller inside a fluid filled, heavy-duty, cast aluminum housing. The rotation of the impeller shall hydraulically extend a cylinder which shall

release the brake by overcoming the main spring. An adjustable valve shall be provided to allow setting the brake timing. The actuator shall be completely enclosed in the housing. The fluid shall be suitable for operation in temperatures to [minus] [plus] [4] [_____] degrees C [40] [_____] degrees F.

2.11.2 Release Magnets and Rectifier

The releasing magnets shall be of the DC shunt type and of standard stock design. Direct current shall be supplied by means of a self-contained rectifier unit of proper rating and suitable for operation on [120] [240] [460]-volt, [1] [3]-phase, 60-hertz, alternating current electrical power. The complete unit (brake and rectifier) shall be suitable for connection to the power circuit of the motor with which the brake is used so that the brake will set or release when the motor is de-energized or energized, respectively. The rating of the rectifier and the brake releasing magnet shall be in accordance with the brake rating requirements specified and shall be sufficient to release and hold the brake in the released position with 85 percent of rated voltage impressed on the incoming terminals of the rectifier. The brake shall operate satisfactorily at up to 110 percent of rated voltage. A forcing contactor shall be provided for operation of the DC operated magnet.

2.11.3 Enclosing Case

A NEMA Type 4 enclosing case shall be provided with watertight grease pressure lubricated shaft seals. The cover shall be held in place by heavy hinge bolts and wing nuts. Enclosing case for 115 volt AC space heaters shall be provided. Space heaters total capacity shall be a minimum of [62] [_____] watts. Heaters shall be provided by the brake manufacturer. A bottom mounted drain and breather unit shall be provided on the enclosure to allow condensate water to drain, but prevent outside water from entering the enclosure. The enclosure shall be provided with a shaft seal for each shaft penetration through the enclosure.

2.11.4 Mechanical Construction

Except for brake wheels, shoes, and electrical parts, no cast iron shall be used in brake construction. All pins, fittings and other miscellaneous small metal parts shall be of approved corrosion-resisting metal. Bearings shall be fitted with bronze or other approved bushings to prevent any binding of moving parts. Approved antifriction bearings of corrosion-resisting construction may be used. Approved means for lubrication shall be provided for all bearings, unless bearings are of an approved self or pre-lubricated type. A nameplate of corrosion resisting material shall be provided and attached to a part of the brake which ordinarily will not be replaced. The nameplate shall indicate all necessary information required by this specification. A manual release mechanism shall be provided to allow removal of wheel or permit lining replacement without readjusting torque setting. Magnet coil shall be epoxy coated.

2.12 ELECTRIC MOTORS

****

NOTE: Electric motors are usually provided with the machinery and are specified in this section. The motors have traditionally been two speed with limit switches which trip to change the speeds. More

modern technology could include a single speed motor and use of a variable frequency drive with programmable controller to change the speeds.

****

2.12.1 General

The motors shall be a horizontal shaft, squirrel cage induction, high slip, high torque, [dual] horsepower rated, [two winding,] [two speed,] [460] [_____] volt, 3 phase, 60 Hertz type motor. The motor shall be rated for continuous duty and conform to the applicable requirements of NEMA MG 1. The enclosure shall be totally enclosed, fan cooled, and weatherproof type. The motors shall be provided with a removable stainless steel drain. The drain shall be removed as specified by the motor manufacturer. The motor will be installed in an exterior location subjected to the weather elements. Speed/torque characteristics shall be as described herein. Conduit box for incoming power shall have two [38] [_____] mm [1-1/2] [_____] inch diameter holes for installation of watertight fittings on the power cord. Conduit box for heater power shall have two [19] [_____] mm [3/4] [_____] inch diameter holes for installation of watertight fitting on the heater power cord. Conduit boxes shall be located on the side of the motor as indicated on the drawings. The motor shaft shall be sealed with a labyrinth type seal where the shaft penetrates the front and back of the motor. See miter gate operation sequence in paragraph entitled, "DESIGN CRITERIA".

2.12.2 Ratings

2.12.2.1 Gate Motors

The gate motors shall be rated at [20/6.25] [_____] horsepower at [745/230] [_____] RPM (high/low speed) based on [900/300] [_____] RPM synchronous speeds. The 100 percent full load speed values proposed for the new motor shall not be less than [740] [_____] RPM and not more than [775] [_____] RPM for high speed and not less than [230] [_____] RPM and not more than [260] [_____] RPM for low speed at the specified horsepower values. Locked rotor torque shall be in a range from 200 to 300 percent of full load motor torque for high speed and from 250 to 300 percent of full load motor torque for low speed. [The motor shall have no breakdown torque. It is preferred to optimize characteristics at full load conditions and allow locked rotor torque to be in the previously specified range if there are design trade-off's between full load torque and locked rotor torque values.]

2.12.2.2 Valve Motors

The valve motors shall be rated at [10/3.33] [_] horsepower and [900/300] [_____] RPM synchronous speed at a minimum of 8 percent and maximum of 13 percent slip for both high and low speed windings.

2.12.3 Construction

Motor frame size shall be a minimum of a NEMA [445TS] [_____] for the gates and [405TS] [_____] for the valves. Temperature rise shall be no greater than [80] [_____] degrees C [176] [_____] degrees F. An internal heater of the strip type shall be part of the motor. The heater shall have a minimum capacity of [90] [_____] W and have separate leads terminating in a separate conduit box. Heater power supply shall be 120 volt, 60 Hertz, single phase. Class F insulation shall be used throughout the motor. Motor windings shall be impregnated with the insulating compound by the

vacuum/pressure impregnating method. The procedure shall be repeated until all voids in the winding are completely filled with the insulating material. Motor bearings shall be the antifriction type and shall incorporate a suitable method for lubrication. Bearing ratings shall meet or exceed a L-10 life of 30,000 hours at full radial load. The motor shall be provided with a visible nameplate indicating motor horsepower, voltage, phase, hertz, RPM, full load amps, frame size, manufacturer's name and model number, service factor, and serial number. Motor performance data shall be submitted at the time the motors are submitted for approval. The data shall include: percent efficiency, percent amperes, percent power factor, and percent slip plotted against 0 to 100 percent load for both high and low speed windings; and torque (N-m) (ft-lb.) and amperes plotted against 0-100 percent synchronous speed for both high and low speed windings.

2.12.4 Factory Tests

All motors shall be factory tested to ensure that they are free from electrical and mechanical defects. All tests shall be performed in compliance with IEEE Std 112 and NEMA MG 1. All test results shall be documented in accordance with the guidance indicated in IEEE Std 112 and NEMA MG 1. Testing shall include the following:

(1) No Load Test. For each winding (high and low speed); at no load and rated frequency and 100 percent rated voltage; record the current, voltage, frequency, kilowatt input, and RPM.

(2) Locked Rotor Test. For each winding (high and low speed); with the motor blocked and at rated test frequency and 50 percent rated voltage; record the voltage, current, frequency, and kilowatt input. Repeat for 100 percent rated voltage.

(3) High Potential Test. For each winding (high and low speed): Record voltage and duration.

(4) Stator Winding Resistance Test. For each winding (high and low speed): Record resistance in ohms between the stator winding terminals. Record the temperature in degrees Centigrade.

(5) Additionally, all tests normally conducted by the manufacturer as part of its quality control program, but not specified herein, shall be performed.

2.13 PORTABLE FILTERING UNIT

****
NOTE: Portable oil filtering unit may be desired if the gearbox unit will be exposed to the weather. Moisture can collect in the unit and become suspended in the oil. The liquid water that has separated can be drained off but the oil must be filtered to remove water still in solution. Heaters can be provided to heat the oil. However, they are not energy efficient, can damage the oil, and may not completely prevent moisture intrusion.
****

Contractor is responsible for providing [1] [_____] portable filtering unit[s] for use with [both] [the miter gate] [and] [the [tainter] valve]

reducers.

a. The portable filtering unit shall be 115 volt, high efficiency, positive displacement, rotary internal gear type pump with a mechanical seal. The pump shall be self-priming and designed to handle liquids of 35 SSu to 1000 SSu viscosity, while able to develop 625 mm 25 inches of mercury vacuum at zero MPa psi. The filter shall be equipped with a replaceable 5 micron filter cartridge.

b. The portable filtering unit will separate water from the oil by coalescing and gravity separation. The water will sink to the bottom and will accumulate until it is periodically bled off. The coalescing chamber shall be able to handle dissimilar liquids with a specific gravity difference of 0.09 and greater, leaving the effluent with less than 10 ppm of the discontinuous phase. The coalescing element will have an indefinite life, with replacement required only when it becomes plugged with solid particles.

c. Contractor shall equip the portable filtering unit with all the necessary fittings and pipe to connect the unit to the reducer using standard hand tools.

2.14 GUARDS AND COVERS

Safety guards or covers shall be provided as shown on the drawings where necessary to protect the operators from accidental contact with moving parts. Openings shall be provided in guards and covers as necessary to provide access to parts requiring lubrication or regular maintenance.

2.15 STRUCTURAL BASES AND SUPPORTS

For specific requirements for welded structural steel bases, frames, and supports see Section 05 50 04 METALS: MISCELLANEOUS, STANDARD ARTICLES, SHOP FABRICATED ITEMS FOR CIVIL WORKS STRUCTURES.

2.16 PAINTING

****
NOTE: The interior surfaces of the gearboxes shall be primed with a primer compatible with the oil and environmental conditions.
****

All exposed ferrous surfaces shall be painted as required by the manufacturer or as noted in Section 09 90 00 PAINTS AND COATINGS and touched up after installation. Paint shall at a minimum provide for zinc chromate primer, 2 coats of varnish, and gray enamel to result in a minimum dry film thickness of 0.062 mm 2.5 mils. Painting of nonferrous metals and corrosion resisting steel will not be required unless otherwise specified

PART 3 EXECUTION

3.1 SHOP ASSEMBLY AND TESTS

****
NOTE: Shop tests are necessary to ensure proper assembly.
****

3.1.1 General

Each [miter gate] [and] [[tainter] valve] machinery unit consisting of the motor, brake, reducer, [cable drums, cable,] couplings, and bearings shall be completely assembled on its structural steel base (machinery base as indicated on the contract drawings) in the shop and tested [without the sector gear and pinion assembly,] in the presence of a representative of the Contracting Officer. [The sector gear, pinions, shaft, and bearings, shall be completely assembled, shimmed, and aligned in the shop on the pinion support base.] The Contractor shall notify the Contracting Officer at least [10] [_____] calendar days before testing of each machinery unit. This notification shall include information on how many units will be tested and the estimated time frame involved with each test. The witnessing of a particular test may be waived by the Contracting Officer, however, the approved shop test procedures, notification, and documentation shall still be performed as required by these specifications. Once informed that Government personnel will witness the test(s), the Contractor shall notify the Contracting Officer that a particular test is scheduled as planned a minimum of 48 hours prior to the test(s). The Contractor should perform all necessary preparations and preliminary testing prior to issuing the 48 hour notification. Testing shall commence upon the arrival of Government personnel at the scheduled location and time. The Contractor shall design and furnish a test rig and facilities (within the continental United States) suitable for performing the tests. Details of the test rig and its location shall be submitted for evaluation and approval of the Contracting Officer. The submittal shall address aspects including adequacy of rig strength, including foundations; access to the test rig; availability of suitable power and cranes; how the work will be protected, how the test measurements will be made, and how test results can be verified. All bearing surfaces and lubrication lines shall be cleaned and reducer bearings, couplings, and gears properly lubricated before tests are begun. All speed reducers shall be properly filled with the specified lubricating oil and transfer of lubricating oil from one unit to another will not be allowed. The motors, brakes, and controls shall be electrically connected and operated at rated voltage. The motor, speed reducer, and brake machinery components shall be tested and shipped to the job-site fully assembled on the structural steel base (machinery base as indicated on the contract drawings). [The sector and pinion assembly shall be properly match marked and disassembled prior to shipment.] Machinery that is tested or arrives on site without the machinery base installed will be rejected.

3.1.2 Test Procedure

The Contractor shall submit the test procedure, with a blank test results data sheet, to the Contracting Officer for review and approval prior to the commencement of any tests. The test procedure shall consist of operating the unit with no load at high speed in both directions for 15 minutes and at low speed in both directions for 10 minutes. Each piece of equipment shall be inspected for smooth operation and proper alignment and all necessary clearances checked to ensure binding or excessive heat does not occur in any moving part. During the test, readings of motor current, RPM, voltage, and bearing temperature shall be provided to the Contracting Officer. The test shall be stopped immediately if there is any undue noise, vibration, or heat developed in any of the bearings. After correction of alignment and/or all other causes for the interruption of the test, the unit shall be reinspected and testing shall resume when permitted by the Contracting Officer. Final operating test results for each unit shall be submitted to the Contracting Officer.

3.1.3 Additional Test Procedures for [Tainter] Valve Machinery

The test procedure applies to all units and shall include raising and lowering a [_____] kg pound test load ([_____] kg pounds on each drum) vertically through a distance of [_____] mm feet. The load shall be suspended from the actual hoisting cables. The cable drums shall make [_____] revolutions to raise and the same to lower the load and this shall be done three times in succession at high and low speeds without significant interruption. The cable drums shall be inspected to ensure proper reeving of the cable.

3.2 FIELD ERECTION AND TESTS

Field erection and field tests eill be made by and at the expense of the Contractor under the general supervision of the Erecting Engineer to be furnished by the Contractor under the provisions of the paragraph titled "ERECTING ENGINEER." The Contractor shall submit the [Field Tensioning and] Operating Test Procedure, with a blank test results data sheet, to the Contracting Officer for review and approval prior to the commencement of any field tests. [Each sector and pinion support base shall be shimmed and leveled prior to final grouting with attention given to maintaining the elevations indicated.] [The wire rope field tensioning procedure shall be based on the following steps. Upon connection of the wire rope to the valves, the Contractor shall equalize the tension in the cables by the use of a hydraulic power pack or hydraulic ram to apply an equal horizontal force (perpendicular to the cable axis) on each cable and measuring the cable deflections at the point of force application. The forces shall be applied to the cables at a common elevation when the cables are under load. Adjustments to the cables (to equalize cable tensions) shall be made at the valve drum. Equal tensioning will be considered achieved when the deflections of the two cables are within 5 percent of each other. Measured deflections shall be greater than 63 mm 2-1/2 inches at the time they are considered equal. After fianl tensioning, the cable end socket shall be welded to the drum as indicated in the contract drawings.] After the units have been installed [and the field tensioning tests are complete], each complete gate [and valve] unit will be operated [a sufficient number of] [_____] cycles, as specified on the drawings, to demonstrate to the satisfaction of the Contracting Officer that the requirements of the specifications have been met and that the performance of the equipment is satisfactory for the purpose intended. During the test, readings of motor RPM, current, and voltage shall be provided to the Contracting Officer as data to enable estimation of the motor horsepower developed. Final [field tensioning and] operating test results for each unit shall be submitted to the Contracting Officer.

3.3 ERECTING ENGINEER

a. The Contractor shall furnish the services of a competent erecting engineer to supervise and direct the erection and installation of this equipment. The erecting engineer shall be present for all shop erection, inspections, and tests.

b. The erecting engineer has sole responsibility for the equipment meeting all the requirements of these specifications and fulfilling all the Contractor's guarantees.

c. The erecting engineer shall verify the fit and alignment of mating components prior to erecting in the field and be present during final

connection and field testing for contract compliance. The erecting engineer shall keep records of all measurements taken during installation and testing.

3.4 FIELD TRAINING

Field training shall be provided for operating staff after each system is functionally complete but prior to final acceptance. The training shall be given for a period of [_____] hours. The training shall cover all pieces of equipment and shall include items contained in the operation and maintenance manuals.

3.5 ACCEPTANCE

Upon successful completion of the field tests, the [miter gate] [and] [[tainter] valve] machinery and accessory items and equipment will be examined by the Contracting Officer, and, if found to comply with the contract, they will be accepted and the Contractor will be furnished written notice of such acceptance.

-- End of Section --