UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated April 2021
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DIVISION 35 - WATERWAY AND MARINE CONSTRUCTION

SECTION 35 20 20

ELECTRICAL EQUIPMENT FOR GATE HOIST

01/08

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USACE / NAVFAC / AFCEC / NASA | **UFGS-35 20 20 (January 2008)**

Preparing Activity: USACE | **Superseding UFGS-35 20 20 (April 2006)**

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated April 2021

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SECTION 35 20 20

ELECTRICAL EQUIPMENT FOR GATE HOIST
01/08

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NOTE: This guide specification covers the technical requirements for hoist applications using a squirrel-type induction motor commonly used for control gates for outlet works; penstock gates, crest gates, spillway tainter gates, and other similar applications. This section was originally developed for USACE Civil Works projects.

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

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

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

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PART 1 GENERAL

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NOTE: This specification is to be used as a section of a supply specification for the procurement of hoisting equipment, or, with only minor modification, it may be used as a section in a general contract specification.

The specification is general and covers all types and ratings of hoist applications used by the Corps of Engineers on Civil Works structures where a squirrel cage induction-type hoist motor is used. The specification must be accompanied by a drawing

or drawings showing the schematic wiring diagram of the control system for the particular application, along with a description of the scheme of operation and illustrations showing the several items of electrical equipment.

In adapting this specification to any project, the form and phraseology will be changed as necessary to properly specify the work contemplated. When technical deviations from this specification are considered necessary and the specification is not submitted to Headquarters, US Army Corps of Engineers (HQUSACE), for review, prior approval of (HQUSACE) will be obtained. Instructions for the preparation and submission of specifications for approval are included in ER 1110-2-1200.

The electrical equipment requirements contained herein are based upon experience and information gained from similar equipment now in service and are considered the most suitable for use on hydraulic structures.

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1.1 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 SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B1.1 (2003; R 2018) Unified Inch Screw Threads (UN and UNR Thread Form)

ASTM INTERNATIONAL (ASTM)

ASTM A123/A123M (2017) Standard Specification for Zinc

	(Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A153/A153M	(2016a) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 112	(2017) Standard Test Procedure for Polyphase Induction Motors and Generators

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

ANSI C80.1	(2005) American National Standard for Electrical Rigid Steel Conduit (ERSC)
NEMA FB 1	(2014) Standard for Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable
NEMA ICS 1	(2000; R 2015) Standard for Industrial Control and Systems: General Requirements
NEMA ICS 2	(2000; R 2005; Errata 2008) Industrial Control and Systems Controllers, Contactors, and Overload Relays Rated 600 V
NEMA ICS 6	(1993; R 2016) Industrial Control and Systems: Enclosures
NEMA MG 1	(2018) Motors and Generators

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

CID A-A-50553	(2015; Rev B; Notice 1) Fitting for Conduit, Metal, Rigid (Thick-Wall and Thin-Wall (EMT) Type)

UNDERWRITERS LABORATORIES (UL)

UL 44	(2018) UL Standard for Safety Thermoset-Insulated Wires and Cables
UL 489	(2016) UL Standard for Safety Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures

1.2 SYSTEM DESCRIPTION

All equipment furnished under these specifications will be subjected to [severe moisture] [moderately moist] conditions, [shall operate over a temperature range of [_____] to [_____] degrees C F,] and shall be designed to render it resistant to corrosion. The general requirements to be followed are specified below; any additional special treatment or requirement considered necessary for any individual item is specified under the respective item.

1.2.1 Fastenings and Fittings

Where practicable, all screws, bolts, nuts, pins, studs, springs, washers, and such other miscellaneous fastenings and fittings shall be of an approved corrosion-resisting material or shall be treated in an approved manner to render them resistant to corrosion.

1.2.2 Corrosion-Resisting Materials

Corrosion-resisting steel, copper, brass, bronze, copper-nickel, and nickel-copper alloys are acceptable corrosion-resisting materials. However, contact between dissimilar metals should be avoided as much as practicable, except where one of the dissimilar metals is steel or in the case of wiring and connections.

1.2.3 Corrosion-Resisting Treatments

Hot-dip galvanizing shall be in accordance with ASTM A123/A123M or ASTM A153/A153M as applicable. Other corrosion-resisting treatments may be used if approved by the Contracting Officer.

1.2.4 Frames, Enclosing Cases, and Housings

All surfaces of the enclosing cases or housings of controllers, brakes, limit switches, control stations, and other similar equipment, if other than plastic or stainless steel construction, shall be cleaned of rust, grease, mill scale, and dirt and then treated with an approved iron and zinc phosphate solution followed by rinsing with a chromic acid solution, bonderizing, or equivalent process. Immediately after rinsing and drying, the inside and outside surfaces shall be given one coat of a zinc molybdate primer and cured as required. For items of cast construction, the iron and zinc phosphate treatment may be omitted.

1.2.5 Finish Painting

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NOTE: If severely moist conditions exist, a separate paint system should be specified using Civil Works Guide Specification UFGS Section 09 97 02 PAINTING: HYDRAULIC STRUCTURES, system 21, epoxy finish or equivalent. When such painting is specified, care must be taken to specify a paint that will adhere to and not be injurious to the protective painting provided under these specifications.

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A minimum of two coats of paint shall be applied to all equipment in accordance with the manufacturer's standard process for the conditions specified.

1.3 SUBMITTALS

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NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification

technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy, Air Force, and NASA projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

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

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

SD-02 Shop Drawings

Controller

Limit Switch

Hoist Motor

Control Station[s]

Brake Enclosing Case

SD-03 Product Data

Hoist Motor

Brake

Limit Switch

Overload Relays

Controller

Control Station[s]

Wiring

Conductors

Terminal Leads

Terminal Blocks

Motor nameplates

Equipment and Door Nameplates

SD-06 Test Reports

Tests

PART 2 PRODUCTS

2.1 HOIST MOTOR

Submit [6] [_____] copies of motor characteristics, curves or tabulated data (tested or calculated), indicating the speed, power factor, efficiency, current and kilowatt input, all plotted or tabulated against torque or percent of rated motor load.

a. Submit [6] [_____] copies of calculations to determine the required horsepower rating of each motor.

b. Submit [6] [_____] copies of detailed descriptive specifications of the motor, with necessary cuts, photographs, and drawings to clearly indicate the construction of the machine. Place special emphasis on describing and illustrating features of "Insulated Windings," "Winding Heaters," "Bearings and Lubrication," and "Terminal Leads."

2.1.1 Motor Type

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NOTE: When a single-speed motor or two single-speed motors in lieu of a two-speed motor is acceptable for the application, the designer will specify NEMA MG 1 standard design letter. The torque requirements listed in paragraph MOTOR LIMITS must be met, and the designer will verify that the design specified is sufficient. Design "C" and "B" have a 5 percent or less slip limit and are used where load inertia is lower. Design "D" has a 5 percent or greater slip and must be used where inertia is high. Designs "B," "C," and "D" provide progressively higher torques and get progressively more expensive. Design "B" will generally apply to motors from 745 to 2240 W 1 to 3 hp, design "C" to motors between 2.24 to 11 kW 3 and 15 hp, and design "D" for motors larger than 11 kW 15 hp. This a general guide according to NEMA minimum standards

and may vary with manufacturer's specific equipment.

At reduced cost, dripproof encapsulated construction may be used in protected locations. Consult manufacturer's data for information on application of this type motor to specific environmental conditions.

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Provide a motor of the horizontal-shaft, squirrel-cage induction type [two-speed, two-winding, constant [torque] [horsepower]] [NEMA design [B] [C] [D]], designed for full-voltage starting, [of water-proof, totally enclosed, fan-cooled or nonventilated frame construction],[dripproof, encapsulated frame construction] and shall conform to the applicable requirements of NEMA MG 1.

2.1.2 Motor Rating

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NOTE: For a two-speed motor, use single-voltage rating. Specify load conditions when Contractor designed. (Second Option) This specification covers three-phase motors which are suitable for most applications and shall be used whenever possible. When utility three-phase power is unavailable and forces use of single-phase motors, this specification may be modified accordingly. Generally, single-phase motors used for this application should be below19 kW 25 horsepower. The torque limits should be carefully evaluated, and the testing requirements should be changed. Please consult Engineering Manual (EM) 1110-2-2703 for further guidance.

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[The motor shall be rated [_____] horsepower, [_____] rpm synchronous speed for the machinery design shown on the drawings or, if the design is changed as permitted by [_____], shall have a horsepower rating as required by performance requirements specified to [_____].] [The motor shall have a horsepower rating as required by the load conditions specified in [_____].] The motor shall be rated for continuous full-load operation without exceeding the standard temperature rise for the class of insulation and frame construction used, and it shall be wound for [_____] [230/460] [460] volts, three-phase, 60-Hz.

2.1.3 Motor Torque

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NOTE: The torque values are those required by design guidance given in EM-1110-2-2702 and EM-1110-2-2703. The gate design must be coordinated with the requirements of these documents to ensure that torque limits are met. Reducing the upper limit or raising the lower limit will result in significant cost increase and should be avoided where ever possible.

****

2.1.3.1 Motor Limits

The torque limits for each individual winding shall be as follows:

a. Upper Limit: The upper limit of the torque between locked-rotor and breakdown shall be not more than 280 percent of the rated full-load torque of the motor.

b. Lower Limit: The lower limit of the torque between locked-rotor and breakdown shall be as high as possible consistent with good design but not less than 150 percent of the rated full-load torque of the motor.

c. When the characteristics of a motor or the winding of a motor results in a speed torque curve without a definite value of breakdown torque, the limitations on the minimum value of torque shall apply between locked-rotor and 75 percent of synchronous speed.

2.1.3.2 [Single-Speed Motor Limits

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NOTE: Permit the use of two single-speed motors in lieu of a single two-speed motor where space is not a concern, and a two-speed motor cannot meet the specifications requirements.
****

Two single-speed motors may be used in lieu of a two-speed motor, providing the synchronous speed of the high-speed motor is not more than 1,800 rpm's and the low-speed motor will conform to the 50 percent over-speed requirements of the high-speed motor.]

2.1.4 Frames and Shafts

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NOTE: Shafts of stainless steel may be specified in lieu of manufacturer's standard treatment where extremely corrosive atmospheres exist. The use of stainless steel will change the motor design and increase the shaft diameter at a significant cost. Manufacturer's should be consulted before specifying stainless steel in a given application.
****

Size and dimensions of frames shall conform to NEMA MG 1 and shaft extension shall be as required. Eye bolts shall be provided on all motors. Each motor shall be provided with a drain-breather which shall be so located to prevent accumulation of water inside the motor. Frames shall have corrosion prevention in accordance with the requirements of paragraph CORROSION PREVENTION AND FINISH PAINTING. Exposed portions of shafts shall be treated with manufacturer's standard primer and two coats of moisture proof varnish in accordance with the manufacturer's recommendation.

2.1.5 Windings and Insulation

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NOTE: Select insulation class based on NEMA temperature requirements as follows:

CLASS	LIMITING TEMPERATURE (in degrees Celsius)
B	130
F	155
H	180

Selection of insulation class should be left to the Contractor when he is also responsible for motor design, but in no case should it be less than Class B. Class F is typical.

Designer will provide ambient temperature values where possible.

****

Insulation shall be Class [B] [F] [H] [B or better as required for design conditions] with special moisture, [fungus], and oil proof treatment. Motors shall be designed and constructed to withstand the environmental conditions specified. The following specifications describe the minimum requirements for acceptable insulation and are not intended to restrict or prohibit the use of materials or methods which will give equal or better performance.

2.1.5.1 Insulated Windings

Insulated windings, unless otherwise approved, shall be completely assembled in the motor core before impregnating with the insulating compound. Insulating compound shall be 100 percent solid. Impregnation of the windings with the insulating compound shall be by vacuum impregnation method followed by baking. The procedure shall be repeated as often as necessary to fill in and seal over the interstices of the winding, but in no case shall the number of dips and bakes be less than two dips and bakes when the vacuum method of impregnation is used.

2.1.5.2 Magnet Wire

The magnet wire shall have an insulation or combination of insulations with an insulation thickness not less than that required for the environment specified and the temperature rating as required by the hot-spot temperature of the motor.

2.1.6 Winding Heaters

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NOTE: Delete this paragraph and the requirement for "Winding Heaters," if dripproof encapsulated motor is used. Additionally, the designer should consider elimination of winding heaters if possible in other situations, i.e. where the probability of condensation is low. In the past, heaters have been a maintenance problem and have been disconnected by project personnel.

****

A heater or heaters shall be installed in the motor frame or end bells or

wrapped around the winding end turns. Heaters shall meet the requirements of paragraph HEATERS-GENERAL. Heaters installed around the winding end turns shall consist of the required turns of heating cable wrapped around the end turns and secured in place before the motor windings are impregnated.

2.1.7 Bearings and Lubrication

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NOTE: The use of sealed bearings should be limited to special applications. Sealed bearings do not require as much maintenance but reduce the overall life of the motor.

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The motors shall be provided with antifriction bearings, and the design of the housing and method of assembly shall permit ready removal of the end brackets and prevent escape of lubricant and entrance of foreign materials. 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. Bearings [shall be of an approved prelubricated type requiring no addition or change of lubrication for a period of at least 5 years] [shall have fitted openings located on the top and bottom of the bearing housing. The openings shall be readily accessible for applying and draining the lubricant]. Pressure lubrication fittings may be used provided the housings are properly vented to prevent damage to the seals. When the brake housing or other equipment is to be assembled adjacent to or bolted to the motor end bell, suitable filler and drain pipe extensions, with the ends properly fitted and easily accessible, shall be provided. For those applications where the brake wheel is mounted on a shaft extension on the front end of the motor, the bearing housing, or a suitable flange, shall be furnished to provide a suitable surface and connecting means to allow the fastening of the brake enclosure to the bearing housing (see paragraph BRAKE ENCLOSING CASE).

2.1.8 Terminal Leads

Terminals leads shall extend outside the frame; shall have insulation equivalent to that of the motor winding; shall be terminated in a two-piece, watertight terminal box secured rigidly to the motor frame; and shall be suitably identified. Leads shall be positioned and sealed where they pass through the frame with a water-resistant seal of a synthetic rubber material or a synthetic rubber gasket. Terminal box shall have threaded conduit entrances on a minimum of four sides.

2.1.9 Machine Work

Machine work shall be accurate, of high quality, and in conformity with approved standard practice. Threads shall be in accordance with ASME B1.1. Thread fittings shall be Class 2. Threads on all body-bound bolts shall be chased a sufficient length so that when the nut is tightened there will be approximately one and one-half full threads under the nut. All bolts and cap screws shall be provided with lock washers.

2.1.10 Designation and Markings

Motor nameplates of a suitable corrosion-resisting material shall be attached to the frame of each motor and shall indicate clearly the motor NEMA temperature and insulation class, continuous amperage rating, voltage

rating, operating frequency, rated RPM, horsepower rating, nominal efficiency, NEMA locked rotor code letter and serial number. In addition, the nameplate shall show a lead connection diagram. Identification or serial numbers shall be die stamped on the frame.

2.2 BRAKE

Submit [6] [_____] copies of detailed descriptive data covering the brake, with necessary cuts, photographs, and drawings to indicate clearly the construction of the brake and the materials used. Releasing device specifications and characteristics, including input current minimum voltage required for brake release.

2.2.1 Brake Type

The brakes shall be of the shoe type, spring set, with AC or DC magnet operated release and shall be completely enclosed in a watertight and dusttight enclosing case arranged for [floor mounting] [motor mounting].

2.2.2 Brake Rating

****
NOTE: Delete paragraph b. if constant torque two-speed motor or a single-speed motor is specified.
****

a. The brake shall have a torque rating not less than 150 percent of the full load torque of the motor when referred to the shaft on which the brake wheel is mounted, efficiency of speed reducer not being considered. The torque rating shall be based on open construction, [1-hour] [continuous] duty.

b. [The brake shall have a torque rating of [_____] pound-feet as shown on the plans, or if the design is changed as permitted by [_____], the brake shall have a torque rating not less than 150 percent of the full-load torque of the motor when referred to the shaft on which the brake wheel is mounted, efficiency of speed reducer not being considered.] [For a two-speed motor, the rating shall be computed from the full-load torque of the low-speed winding of the motor.]

2.2.3 Adjustment

Means shall be provided for varying torque required for holding. Additionally, the brake shall have means of adjusting the position of the shoes to compensate for wear, unless the design is such that compensation for shoe wear is automatic.

2.2.4 Release

2.2.4.1 Releasing Magnets and Rectifier

****
NOTE: Coordinate voltage requirements with paragraph MOTOR RATING.
****

The releasing magnets shall be of the DC or AC shunt type and of standard stock design, suitable for operation on [_____] [230] [460]-volt, 60-Hz, AC electrical power. Direct current shall be supplied by means of a

self-contained rectifier unit of proper rating. The complete unit shall be suitable for connection to the control circuit or the power circuit of the motor with which the brake is used so that the brake will set or release when the motor is deenergized or energized, respectively. The brake releasing magnet shall be rated in accordance with the brake rating requirements of paragraph MOTOR RATING, 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. The rectifier, when required, shall be mounted in the motor controller enclosing case unless otherwise noted.

2.2.4.2 Hand Release

Hand release shall be provided. It shall be operable only when the enclosing case cover is removed and shall be self-resetting.

2.2.5 Terminal Leads

Connecting leads from the releasing magnet shall be extended outside the enclosing case and shall be terminated on a terminal block located in a watertight terminal box, which shall be rigidly bolted or equally secured to and on the outside of the lower or fixed half of the enclosing case. The terminal box shall provide for conduit entrances on four sides. All conduit entrances to the brake terminal box shall be threaded. The leads inside the brake enclosing case shall be suitably protected. Enclosing case space heater leads shall be terminated in the same manner in separate terminal boxes.

2.2.6 Brake Enclosing Case

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NOTE: Manufacturers do not generally weld enclosures. Welding required only where conditions require substantial construction and costs may be justified.

****

Submit [6] [_____] copies of dimensioned outline drawings showing specific relationships and clearances between equipment and their component parts. The outdoor NEMA Type 4-watertight enclosing case shall be [welded type] [in accordance with the manufacturer's standard practice for the conditions indicated]. In order that the brake mechanism will be accessible from above, when the upper half or cover of the enclosing case is removed, the enclosing case shall be constructed to give equal accessibility to all portions of the brake. The joint between the two halves shall be made with a synthetic rubber gasket, not less than 6 mm 1/4 inch in width, and held in place by embedding in a groove or by other equally effective means. For those applications where the brake wheel is mounted on a shaft extension on the front end of the motor, the enclosing case shall be arranged to permit bolting to the bearing housing of the motor, the joint being made watertight with a gasket. For those applications where the brake wheel is mounted on a shaft of the operating machine or on a flange and shaft extension on the front end of the motor, suitable watertight seals shall be provided on each part of the housing. The shaft seals shall be arranged for pressure lubrication and shall be adjustable for alignment relative to the shaft. An automatic drain breather, located in a protected location, shall be provided in the lower part of the enclosing case. If the drain breather cannot be located in a protected location, the tapped hole shall be plugged and the drain

furnished separately for installation in the field. Enclosing case space heaters conforming to the applicable part of paragraph HEATERS-GENERAL, shall be provided. The enclosing case shall be treated to render the steel resistant to corrosion as required by paragraph CORROSION PREVENTION AND FINISH PAINTING.

2.2.7 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 or shall be treated to render them corrosion-resistant as required by paragraph CORROSION PREVENTION AND FINISH PAINTING. 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 prelubricated type. The machine work shall conform to the requirements for the motor with which the brake is used.

2.2.8 Designation and Markings

A nameplate of suitable corrosion-resisting material shall be provided and attached to a part of the brake which ordinarily will not be renewed during its service life. The nameplate shall conform to standard practice and clearly indicate the manufacturer's name, identification symbols, serial number, and salient design features such as type, frame, torque, rating, voltage, phase, and frequency. If adjustment is required, pertinent information for making the adjustments is necessary.

2.3 CONTROL SYSTEM

****

NOTE: The scheme of control shown on the applicable plate at the end of this document should be retained where possible.

The Plates listed below, containing the related control sequences, are attached at the end of this spec.

PLATE NO. SUBJECT

1. Crest Gate, Electrical Control System (With Approximately 300 mm 1.0 Foot Increments)

2. Crest Gate, Electrical Control System (With Approximately 150 mm 0.5 Foot Increments)

3. Crest Gate, Electrical Control System (With Remote Control and Approximately 300 mm 1.0 Foot Increments)

4. Crest Gate, Electrical Control System (With Remote Control and Approximately 150 mm 0.5 Foot Increments)

5. Outlet Control Gate, Electrical Control System

(Single-Speed Motor)

6. Outlet Control Gate, Electrical Control System (Multispeed Motor)

7. Intake Gate, Electrical Control System.

In some instances, where control for a penstock intake gate hoist where the emergency lower control switch is to be located in the powerhouse, the length of the connecting circuit may be such that its mutual inductance may render the circuit susceptible to false operation. In such cases, it will be necessary to use direct current and interpose an additional control relay. The direct current can be provided from a rectifier located in the control cabinet or from a circuit on the power house control battery.

****

The scheme of operation of the [outlet control gate] [tainter gate] [intake gate] hoist motor control system shall be as described and indicated. The control system shall include the controller, limit switch, master control station[s], and such other items as may be required to accomplish the operating features specified. Each item shall be [installed and] tested as specified and shall be complete and ready for operation [, when installed under another contract,] in accordance with the scheme of operation.

2.4 CONTROLLER

****

NOTE: Separate mounting of the controller is usually the preferred practice. When mounting the controller on the hoist frame is desired, the Contractor will be required to submit a drawing showing the arrangement of the controller and other electrical equipment on the hoist frame. In this case, the electrical equipment should be wired in the shop complete and ready for operation upon bringing the power connection to the line side of the controller disconnect switch.

****

Submit [6] [_____] copies of a description of the operation scheme, if other than herein specified or shown on the drawings; a dimensioned outline drawings showing specific relationships and clearances between equipment and their component parts, detailed panel layouts, schematic wiring diagrams, and a panel wiring diagram dimensioned outline drawings showing specific relationships and clearances between equipment and their component parts. Submit [6] [_____] copies of detailed descriptive data covering all component parts of the controller.

2.4.1 Controller Type

The hoist motor controller shall be of the full magnetic type initiated by the push-button control station and controlled automatically by a limit switch or limit switches. Limit switch[es] shall be driven by the hoist mechanism or other auxiliary operating devices as indicated or required to

provide the sequence of operation specified or indicated on the plans.

2.4.2 Protection

The controller shall provide [under-voltage protection,] inverse-time-limit overload protection, or other protection as indicated or specified. [In addition, the controller shall provide protection from single-phase faults.] The protection shall be accomplished by suitable relays conforming to the requirements of paragraph RELAYS. Overload relays shall provide protection during both the starting and running condition, and approved means shall be provided to manually reset the relays without opening the enclosing case of the controller. All forward and reversing contactors shall be electrically interlocked. Controller disconnecting circuit breaker[s] shall be interlocked with the controller enclosing case access door to permit opening or closing the access door only when the disconnect is in the "OPEN" position.

2.4.3 Enclosure

****

NOTE: When controller is mounted in a dry room or gallery adjacent to the hoist equipment adjacent to the hoist equipment, a NEMA Type 12, industrial-use enclosure should be specified and the drawings and specifications revised accordingly. Hubs shall be specified for all conduit entrances.

Wall mounting is generally the least costly alternative and should be used whenever practical.

Designer shall coordinate padlock requirements with local standards.

****

Enclosing cabinet shall be of the NEMA Type [3R [stainless steel]] [4 watertight [stainless steel] and moisture-resisting] [12 industrial use] construction with interior dead-front panel meeting the requirements of NEMA ICS 6. Enclosing cabinet shall be designed for [floor mounting] [mounting on the hoist frame] [wall mounting]. Suitable padlock eyes shall be provided to allow locking the exterior door in the closed position. Padlocks, conforming to [_____], shall be provided with each controller and chained to the enclosing case. The chain shall be of a nonferrous material resistant to corrosion. Only front-connected devices shall be used, and clearances shall be in accordance with NEMA ICS 1 requirements. Threaded hubs for conduit entrance of the welded-in type shall be provided as indicated on the drawings or as required to make the wiring connections. An automatic breather-drain, not less than 3/8-inch size and located in a protected location and at the lowest point of the enclosure, shall be provided.

2.4.4 Air Circuit Breakers

Air circuit breakers as shown on the drawings or specified shall be provided and assembled in the housing of each controller.

2.4.4.1 Circuit Breakers - General

Each air circuit breaker shall conform to the applicable requirements of UL 489. The circuit breakers shall be manually operated and shall be of

the instantaneous trip type, unless otherwise specified or indicated on the drawings. All poles of each breaker shall be operated simultaneously by means of a common handle and shall be enclosed in a common molded plastic case. The contacts of multipole breakers shall open simultaneously when the breaker is tripped manually or automatically. The operating handles shall clearly indicate whether the breakers are in "ON," "OFF," or "TRIPPED" position. Each circuit breaker shall be externally operated [and interlocked] as specified in paragraph PROTECTION. Approved means shall be provided for padlocking the breaker[s] operating handle in either the "ON" or "OFF" position. A padlock of the same type as specified in paragraph ENCLOSURE, shall be provided for each breaker and shall be chained to the enclosing case. The circuit breakers shall be products of only one manufacturer and shall be interchangeable when of the same frame size.

2.4.4.2 Trip Units

Except as otherwise indicated on the drawings, the circuit breakers shall be provided with combination thermal and instantaneous magnetic trip units. The minimum frame sizes and the trip unit ratings shall also be as required for the equipment controlled. Nonadjustable instantaneous magnetic trip unit shall be set as approximately 10 times the continuous current ratings of the circuit breakers.

2.4.4.3 480-Volt AC Circuits

Air circuit breakers for 480-volt AC circuits shall be rated 600 volts AC and shall have a minimum NEMA interrupting capacity of 14,000 symmetrical amperes at 600 volts AC.

2.4.4.4 120-Volt AC Circuits

Air circuit breakers for 120-volt AC circuits shall be rated not less than 120/240 or 240 volts AC and shall have a minimum NEMA interrupting capacity of 10,000 symmetrical amperes.

2.4.4.5 125-Volt DC Circuits

Air circuit breakers for 125-volt DC circuits shall be two-pole rated 125/250 or 250 volts DC and shall have a minimum NEMA interrupting capacity of [5,000] [10,000] amperes DC.

2.4.5 Assembly of Controller

Furnish all necessary air circuit breakers, contactors, relays, resistors, interlocks, master switches, limit switches, or other devices required by the scheme of operation. The panel for mounting the relays and contactors shall be sheet steel of sufficient thickness to provide rigid support for the equipment mounted thereon. The steel panel shall be given a corrosion resisting treatment in accordance with the requirements of paragraph CORROSION PREVENTION AND FINISH PAINTING.

2.4.5.1 Wiring

Submit [6] [_____] copies of data sufficient to demonstrate that the proposed wire and cable conform to these specifications. Insulated wire shall conform to the requirements of paragraph CONDUCTORS. All wiring shall be securely held in place and arranged in a neat and orderly manner in horizontal and vertical runs. All wiring passing through steel gutters

shall be protected by grommets, unless the openings in the steel gutter are formed to protect the wiring from damage. [All controllers shall be wired in like manner as to location of parts and phase sequence.] The wire and terminal numbers shall be neatly and legibly identified in an approved manner. Terminal blocks shall be used for making all external connections.

2.4.5.2 Terminal Blocks

Submit method of identifying conductors, terminal leads, and terminal blocks. Terminal blocks for control wiring shall be molded type with barriers, rated not less than 600 volts, and they shall be provided with covers. The terminals shall be removable, screw type, or of the stud type with contact and locking nuts. The terminals shall be not less than No. 10 AWG in size and shall have sufficient length and space for connecting at least two indented terminals on No. 10 AWG conductors to each terminal. The terminal arrangement shall be subject to the approval of the Contracting Officer.

a. Not less than 10 percent, but in no case less than 2 percent, spare terminals shall be provided on each block. Terminal blocks for conductors larger than No. 10 AWG or with a capacity of more than 30 amperes shall be adequate for the purpose intended, having length and space for at least two indented terminals of the size required on the conductors to be terminated.

b. For conductors rated more than 50 amperes, all screws shall have hexagonal heads. For conductors rated 50 to 99 amperes, the minimum screw size shall be 8 mm 5/16 inch. Conducting parts between connected terminals shall have adequate contact surface and cross section to operate without overheating.

c. White or other light-colored marking strips, fastened by screws to the molded sections at each block, shall be provided for circuit designation. Each connected terminal of each block shall have the circuit designation or wire number placed on the marking strip with permanent marking fluid. One reversible or one spare marking strip shall be furnished with each block.

2.4.6 Magnetic Contactors

2.4.6.1 Contactor Ratings

All heavy-duty magnetic contactors shall be of the voltage rating indicated on the drawings or otherwise required. They shall have a horsepower rating not less than the horsepower rating of the motor with which the controller is to be used, but in no case shall the contactor used be smaller than NEMA, Size 1. The contactors shall meet the requirements of NEMA ICS 2and have continuous current ratings for the duty indicated. Contactors shall be suitable for at least 200,000 complete operations under rated load without more than routine maintenance. They shall operate successfully on 10 percent over-voltage and 15 percent under-voltage. The interrupting capacity shall conform to NEMA standards. Mechanical interlocking between contactors shall be provided as indicated or required and shall be accomplished without any mechanical attachment between the interlocking mechanism and the moving parts of the contactor, unless otherwise approved by the Contracting Officer.

2.4.6.2 Arcing Protection

For each pole, the interruption arc and flame shall be minimized by suitable arc chutes or other means so that no damage will be done to other portions of the device. The arc chutes, if provided, shall be easily removed without removing or dismantling other parts.

2.4.6.3 Contactors

All current carrying surfaces shall be of a silver alloy or of copper faced with a silver alloy and shall be easily accessible and removable for replacement. Contactor shall operate without chatter or perceptible noise while energized. Coils shall be suitable for continuous operation on the voltage specified.

2.4.6.4 Construction

Each contactor shall be provided with a minimum of three auxiliary contacts, which many be easily changed from normally open to normally closed. Contactor construction shall be such as to prevent corrosion in accordance with paragraph CORROSION PREVENTION AND FINISH PAINTING.

2.4.7 Relays

2.4.7.1 Control

Control relay devices shall meet applicable requirements of NEMA ICS 2for Class A600 contacts. All contacts shall be of a silver alloy or of copper faced with a silver alloy.

2.4.7.2 Overload

Submit [6] [_____] copies of curves showing the overload relay tripping time versus current characteristics of the overload relays for the controller. Overload relays shall be the adjustable thermal type with normally closed control circuit contacts having a pilot and control circuit contact rating of A600, in accordance with NEMA ICS 2, and shall have combination manual and automatic-type reset. They shall have inverse-time tripping characteristics simulating the heating characteristics of the motor, shall protect the motor with which used against exceeding its specified temperature rise under any overload, stalled rotor, or single-phase condition, and shall be self-protecting under all conditions, except short circuit. A relay consisting of an assembly of individual-phase thermal elements actuating a common tripping bar shall be used. The means of adjustment shall provide a range from 90 percent to 110 percent of the heater rating and shall be sufficiently accurate to allow setting the relay at the full-load current value of the motor with which used. Reset mechanism shall be trip free and arranged for manual reset in accordance with paragraph PROTECTION, unless automatic reset is indicated. Reset mechanism shall be of design that will permit changing from manual to automatic reset or vice versa without the use of special tools.

2.4.8 Control Transformer

The control transformer shall be a standard, single-phase, 60-Hz, dry-type, [_____] [480]/120 volts, and with kVA rating sufficient to supply the control [and heater] circuits.

2.4.9 Control Circuit Breakers

The control circuit breakers shall conform to the requirements of paragraph AIR CIRCUIT BREAKERS, except that an external operating mechanism is not required. Breakers shall be two-pole, 100-ampere frame, and 20-ampere continuous current rating.

2.4.10 Indicating Lights

Indicating lights shall be complete with low-voltage lamps, self-contained resistor or transformer units, and lens or color caps. Lens and lamp shall be removable from the front. They shall operate on 120 volts AC and be suitable for flush or semiflush mounting to the exterior cabinet door. Exterior mounting of the indication lights shall meet the requirement for the enclosure NEMA type. Hinge wire shall be used for connections between the indicator lights and the terminal block.

2.4.11 [Plug Receptacle for Inching Pendant Control Switch

****

NOTE: Inching pendant control switch in paragraph INCHING STATION, and receptacle is not required on crest gates. Omit requirement for receptacle on controller enclosure and mount receptacle on wall of gate inspection room if inspection room is above maximum flood.

****

The receptacle body shall be weather resistant with threaded cap and gasket complete with polarized female contact unit, four-wire, five-pole, grounded through shell and extra pole, and rated 30A, 460 volts.]

2.4.12 Equipment and Door Nameplates

Submit schedule of nameplates. Nameplates shall be provided for the front of the cabinet door and for each item of equipment within the enclosure. Anodized aluminum, stainless steel, or a laminated plastic sheet with black surface layer and a white bottom layer not less than 1/16 inch thick shall be used for the nameplate material. Equipment within the enclosure shall be identified by nameplates or other suitable marking on the equipment unit base or on the panel.

2.4.13 Heater

The heater shall be strip type and meet the requirements of paragraph HEATERS-GENERAL.

2.4.14 Grounding

The ground connection for the controller enclosing cabinet shall be made by a threaded post fitting which extends through the enclosure wall and which is provided with fittings to connect No. 6 AWG stranded copper ground wire both inside and outside the enclosure. Inside the enclosure, the ground circuit shall be extended with No. 6 AWG stranded copper wire from the connector to the panel.

2.5 CONTROL STATION[S]

Submit [6] [_____] copies of detailed descriptive data covering the

control station[s]. Control station[s] shall be of the rocker handle push-button type and shall provide the number of indicating lights and individual switches of the type or types required by the scheme of operation. Enclosure shall be NEMA-Type [3R] [4 watertight [stainless steel]] [12R industrial use] construction. All contacts shall be of the double-break bridging type and shall have a pilot and control circuit rating designation of A600 in accordance with NEMA ICS 2. Switch cases shall be provided with threaded bosses for conduit or cable connection and shall provide ample wiring space for conductors of the size and insulation specified.

2.5.1 Master Station

****

NOTE: Use padlocked stop switch on all hoists except intake gate hoists provided with remote lowering. Intake gate hoists may use either padlock or "substantial metal cover" alternate. If metal cover alternate is used, the emergency lower contact "ELS" in parallel with the stop switch contact should be deleted.

****

The master station shall be arranged with the elements stacked vertically and with [_____]-inch conduit entrance from the bottom. The station shall provide [a red indicating light and] [3] [4] operating rocker handle-type push buttons. The station shall be arranged starting at top with [a red light followed by] the "RAISE," ["CONDUIT OPEN,"] "LOWER," and "STOP" push buttons. The station switch elements shall have nameplates with the above designations. [The "STOP" switch shall be provided with means of padlocking the switch in the stop or in the open position.] [The station shall be provided with a substantial removable or hinged metal cover which can be locked in the closed position to prevent operation of the switch elements.] The padlock shall be chained to the enclosing case with a chain made of nonferrous material.

2.5.2 [Inching Station

The inching station shall be arranged with the elements stacked vertically and with conduit entrance on the top for a cable clamp. The cable shall be [_____] feet of five-conductor, No. 12 AWG portable cable with extra flexible conductors, heat and moisture resistant insulation, and outer Neoprene jacket. The station shall have two rocker handle-type push buttons. The switch elements shall be designated "INCH UP" and "INCH DOWN" from top to bottom, respectively.]

2.6 LIMIT SWITCH

Submit [6] [_____] copies of dimensioned outline drawing of the limit switch. Show on the Drawings specific relationships and clearances between equipment and their component parts.

a. Submit [6] [_____] copies of all limit switch computations used to determine the selection of gear ratios and calibration for gate travel.

b. Submit [6] [_____] copies of complete descriptive data covering the limit switch with necessary cuts, photographs, and drawings to indicate clearly the construction, materials used in the parts, rating, accuracy of tripping and reset, method of adjustment, and

safeguards.

2.6.1 Normal Operation

The limit switch shall be the linear solid-state programmable type with digital display and shall operate on 120 volts AC. It shall contain all the contacts required for making and breaking all control and interlocking circuits necessary for the proper control and operation in the manner specified or required.

2.6.2 Construction

The limit switch shall be of compact and rugged construction, totally enclosed in a NEMA Type 13 case, and housed within the controller enclosure. The digital display shall be visible without opening the enclosure door. This viewing port in the door shall have a replaceable gasketed piece of clear plastic mounted to maintain the NEMA rating of the enclosure. The cover shall be provided with cap screws or other approved means for readily breaking the cover free for removal unless the gasket is so designed that it will not stick. All parts shall be of corrosion-resisting metal or treated in an approved manner to render it resistant to corrosion. The switch shall permit final adjustment in the field. Tapped bosses shall be provided for making all conduit connections to the switch. A clamp-type connector bolted to the outside of the case shall be provided for making ground connections.

2.6.3 Switches

Switches shall be solid state with current rating as required and shall be assembled or combined into operating units as indicated on the plans. They shall be provided with suitable terminals for connecting the external conductors and shall provide for one remote digital readout. Each terminal shall be suitably marked or tagged with the wire number shown on the contract drawings. The tripping mechanism shall be designed for fail-safe operation and shall reset the contacts when moving in the reverse direction. The switch shall have an operator lockout feature which permits programming only by authorized personnel.

2.6.4 Transducer

The electromagnetic position sensor shall be single-turn, heavy-duty enclosed in a outdoor NEMA 4 watertight enclosure. A cable [chain] connector used for the enclosure shall be provided and be suitable for No. 16 AWG shield twisted pair.

2.6.5 Accuracy of Trip and Reset

****

NOTE: For installations where water control requires gate travel of over 9 m 30 feet, measurement of gate travel may become nonlinear. This is due to stretching of the wire rope. The attachment point for measurement of travel should be as near the switch as possible and need not be at the top of the gate. The designer shall investigate possible options, including use of chain and additional limit switches.

****

The design of the switch elements and operating mechanism of the limit switch shall provide for uniform and accurate setting. Switch shall be single turn with 1,000 counts per turn and a minimum of 16 set points. The switch shall accurately transmit position within + 75 mm 3 inches and shall reset gate for drift exceeding 150 mm 6 inches.

2.7 WIRE AND CONDUIT

2.7.1 Conductors

Conductors shall be of annealed copper wire. Copper conductors shall be insulated with polyethylene. Conductors shall be Class B or Class C stranding, except for hinge wire which shall be Class D or K stranding. Unless otherwise specified, all wire and cable for power and control shall be single conductor. Insulation thickness shall be that required for a rated circuit voltage of 0 to 600 volts. Insulation shall be a cross-linked thermosetting polyethylene insulation type. Over the insulated conductor there shall be applied a moisture resisting thermoplastic jacket. The method of accomplishment shall be in accordance with the current practice of the industry. Wire for power and motor circuits shall have a current carrying capacity corresponding to the ampere rating of the circuit's air circuit breaker and not less than No. 10 AWG and the full-load current of the motor or the circuit. Wire for control circuits shall not be smaller than No. 12 AWG.

2.7.2 Control Wire

All control wire shall be type SIS switchboard wire meeting the requirements of UL 44.

2.7.3 Conduit

Rigid steel conduit shall conform to ANSI C80.1 and shall, in addition, be zinc-coated (galvanized) both inside and outside by the hot-dip method.

2.7.4 Fittings

Conduit fittings shall conform to the requirements of NEMA FB 1 and CID A-A-50553.

2.7.5 Assembly

****

NOTE: For contracts where all conduit and wiring are furnished and installed by others, use paragraph 'a.'

For contracts where all conduit and wiring are on the hoist and are furnished and installed under this contract, use paragraph 'b.'

For contracts where the conduit and wiring on the hoist are furnished and installed under this contract and the connections to remotely located items are made under a subsequent contract, use paragraph 'c.'

****

The hoist motor, motor brake, controller, limit switch, and master control

station shall be installed on the [hoist frame] [as shown on contract drawings].

[a. The conduit and wiring connections external to the items of electrical equipment previously mentioned will not be furnished or installed under this contract.]

[b. The conduit and wiring connections external to these previously mentioned items of electrical equipment shall be furnished, installed, and connected complete and ready for operation. The conduit, wiring, and connections for the incoming power will be made by others under a subsequent contract.]

[c. The conduit and wiring connections external to these previously mentioned items of electrical equipment which are installed on the hoist frame shall be furnished, installed, and connected complete and ready for operation. The conduit and wiring connections to the remotely located control equipment and the incoming power connections will be made by others under a subsequent contract.]

d. All wiring shall be installed in rigid hot-dip galvanized metal conduit with threaded-type fittings (Condulets) and zinc-coated watertight outlet and pull boxes. The conduit shall be securely mounted and fastened to the hoist framework and shall be installed in a neat and workmanlike manner. Change of direction of a conduit run shall be made by means of threaded-type fittings (Condulets) or factory fabricated bends, and the conduit shall be installed to fit close to the hoist framework. Conduit unions shall be used whenever it is necessary to join conduits that are to be turned right and left. No running threads will be permitted. Ends of conduits shall be carefully reamed. All threaded connections shall be made up with electrically conductive colloidal copper rust-inhibiting compound or other suitable compound. Separate conduit systems shall be provided for power and control circuits. The entire conduit system shall be grounded and shall be installed so that any moisture will be drained away from terminal boxes and equipment. All conduit connections to equipment enclosures shall be of the watertight threaded type. Suitable "drain-breather" devices shall be provided at all low points of the conduit system to prevent an accumulation of water. All conductors shall be terminated in an approved manner. Indented terminals shall be used on No. 12 AWG and larger conductors and shall be terminated on screw or stud terminals. Toothed lock washers shall be used on all screw terminals and locking nuts or lock washers shall be used on all stud terminals.

2.8 HEATERS - GENERAL

Enclosure heaters shall be strip type constructed with a chrome-nickel heating element embedded in a refractory insulating material and encased in an approved watertight, corrosion-resisting, nonoxidizing metal sheath. The rate of heat dissipation shall be uniform throughout the effective length. Watt density shall not exceed 20 watts per square inch for chrome-nickel type.

2.8.1 Heater Ratings

Heaters shall be of such rating that, when energized, the temperature of the windings or enclosure will be held approximately 10C above ambient. They shall be designed for 120 volts AC and for continuous operation under

the conditions of installation. The rate of heat dissipation shall be uniform throughout their effective length.

2.8.2 Insulation

Insulation for the heating cable (winding wrap around type) heaters shall be suitable for a conductor temperature of 180C.

2.8.3 Heater Terminals

The terminals of the heater, including the leads, shall be watertight. The leads shall be terminated and sealed in a watertight terminal box located as selected by the motor manufacturer. The method of sealing shall be as specified for the motor winding leads.

2.9 TESTS

****
NOTE: If designer elects to do operational tests of the gate hoist equipment, in conjunction with testing of the hoist itself, the hoist specification number must be included.
****

Each item of equipment furnished, one of each rating and type and selected at random by the Contracting Officer, shall be given a complete test. The remaining items of equipment shall be given a routine test. All complete tests required herein shall be witnessed by the Contracting Officer, unless waived in writing, and no equipment shall be shipped until it has been approved for shipment by the Contracting Officer. Notify the Contracting Officer sufficiently in advance of the date of the tests, so that arrangements can be made for the Contracting Officer to be present at the tests. The test equipment and the test methods used shall conform to the applicable requirements of ANSI, IEEE, and NEMA standards and shall be subject to the approval of the Contracting Officer. Submit [6] [_____] certified copies of the reports of all complete and routine tests, including complete test data. Certified copies of the results of a complete test for duplicate equipment will be accepted in lieu of the requirement of the complete test specified. Reports shall include analysis and interpretation of test results and shall be properly identified with the test systems and materials. Provide test reports for "complete tests" on the motor, brake, and controller. Certified copies of "Complete Tests" on duplicate equipment may be accepted with the approval of the Contracting Officer. No substitute will be accepted for the routine test. The cost of performing all tests shall be borne by the Contractor and shall be included in the price bid. [Operational tests shall be made on the equipment in conjunction with the tests specified in [_____] for the assembled hoist.] [Operational tests shall be made on equipment after it is installed.] Performance curves indicating the results of the motor tests shall be furnished as follows:

a. Excitation Tests. Volts or percent of rated voltage as abscissa vs. amperes and watts as ordinates.

b. Impedance Tests. Volts or percent of rated voltage as abscissa vs. amperes and watts as ordinates.

c. Performance Test. Torque or percent of rated horsepower output as abscissa vs. efficiency, power factor, amperes watts, and rpm or

percent slip as ordinates.

d. Speed-Torque Test. Torque in foot-pounds as abscissa vs. speed in rpm or percent of synchronous speed as ordinates.

e. Temperature Test. Time in minutes as abscissa vs. temperature rise in degrees C as ordinate.

f. Insulation Resistance Test. Test result values shall be plotted on semilogarithmic graphs, the insulation resistance values as logarithmic ordinates, and the temperature values as uniform abscissa.

g. Routine test reports shall include analysis and interpretation of test results and shall be properly identified with the test systems and materials. No substitute will be accepted for the routine test. Provide test reports for "routine tests" on the motor, brake, controller, limit switch, [interrupter,] and wiring.

h. Submit [6] [_____] copies of description of "Interrupter" drive including copies of dimensioned outline drawing of the interrupter. Show on the Drawings specific relationships and clearances between equipment and their component parts.

2.9.1 Motor Tests

All tests shall be performed in accordance with the requirements of IEEE 112 for three-phase induction motors.

2.9.1.1 Complete Motor Tests

The complete tests shall include the following:

a. Excitation test.

b. Impedance test.

c. Performance and speed-torque test (Prony brake or other approved method).

d. Temperature test.

e. Insulation resistance tests. Measurements shall be taken following temperature test with readings taken at approximately 10C intervals. Temperature shall be determined by the resistance method.

f. Dielectric test.

g. Cold and hot resistance measurement.

h. Effectiveness of enclosure.

i. Motor winding heater test.

(1) Successful operation.

(2) Dielectric.

2.9.1.2 Routine Motor Tests

The routine tests shall include the following:

a. Excitation test: (One point - no load, volts, amperes, and watts.)

b. Impedance test: (One point - half-voltage amperes and watts.)

c. General operation.

d. Insulation resistance - temperature test (one point).

e. Resistance measurements.

f. Dielectric.

g. Motor winding heater test.

(1) Successful operation.

(2) Dielectric.

[h. Interrupter.
]

2.9.2 Brake Tests

2.9.2.1 Complete Brake Tests

The complete tests shall include the following:

a. Check operation of brake release at the specified rated brake torque for rated and 85 percent terminal voltage.

b. Heat run on release magnet at the specified rated brake torque and voltage.

c. Insulation resistance of release magnet including leads and terminal block.

d. Resistance measurements of release.

e. Dielectric test of release magnet including leads and terminal block.

f. Brake space heater test.

(1) Successful operation.

(2) Dielectric.

2.9.2.2 Routine Brake Tests

The routine tests of the brake shall be the same as specified in paragraph COMPLETE BRAKE TESTS, except that the heat run tests shall be omitted.

2.9.3 Controller Tests

2.9.3.1 Complete Controller Tests

The complete tests shall include all tests listed in paragraph ROUTINE

CONTROLLER TESTS, and the following:

a. Effect of voltage and frequency variation.

b. Temperature Test.

2.9.3.2 Routine Controller Tests

The routine tests shall include the following:

a. Adjustment, fit, and material.

b. Successful operation.

c. Resistance.

d. Dielectric.

e. Insulation Resistance.

f. Enclosure space heater test.

(1) Successful operation.

(2) Dielectric.

2.9.4 Limit-Switch Tests

Each drive shall be tested in the manufacturers shop by suitable means, simulating service conditions, to ascertain that it will transmit the correct information for the control sequence specified. In addition, the routine tests shall include the following:

a. Adjustment, fit, and material.

b. Accuracy of trip and reset.

c. Successful operation.

d. Dielectric.

e. Insulation resistance.

2.9.5 Wiring Tests

All wiring shall be given a dielectric test following installation by applying, for 5 minutes, a voltage test of 1,500 volts to each circuit and ground and between each conductor and all other conductors in the same conduit.

PART 3 EXECUTION [(Not Applicable)]

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NOTE: Designer should place any requirements for field installation in this section.

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[_____].

Plate No. 1

CREST GATE
ELECTRICAL CONTROL SYSTEM
(With Approximately 1.0 Foot Increments)
DESCRIPTION OF CONTROL SYSTEM

1. SCHEME OF OPERATION

a. General. The control system for the gate shall be as indicated by the schematic control wiring diagram, and as specified below.

b. Control Points. The operation of the hoist motor shall be controlled by:

(1) A push button station located on the gate hoist with momentary contacts designated "RAISE, "LOWER," and "STOP."

(2) A push button station located on the door of the controller cabinet with momentary contacts designated "BACKOUT FROM RAISE OVER TRAVEL" and "BACKOUT FROM LOWER OVER TRAVEL."

c. Operating Features

(1) Actuation of the "RAISE" and LOWER" contacts shall provide seal-in operation.

(2) A limit switch geared or directly connected to the hoist machine, shall control the incremental and stopping operations initiated manually from the control station as described under sequence of operation.

(3) Actuation of the "STOP" contact during any operation shall stop the hoist motor and set the brake.

2. SEQUENCE OF OPERATION

a. Raising

(1) When the gate is between the closed and the intermediate position, each actuation of the "RAISE" contact will cause the gate to raise approximately 1 foot and stop.

(2) When the gate is at or above the intermediate position, actuation of the "RAISE" contact will cause the gate to raise continuously to the raised position.

b. Lowering

(1) When the gate is between the over travel raised position and the intermediate position, actuation of the "LOWER" contact will cause the gate to lower continuously to the intermediate position and stop.

(2) When the gate is at or below the intermediate position and is above the closed position, each actuation of the "LOWER" contact will cause the gate to lower approximately 1 foot and stop.

c. Over Travel. If during normal operation, the gate motor should fail to stop when the gate reaches the raised or closed positions, the over travel limit switch contacts shall stop the hoist motor after over travel by de-energizing the "main" or "line" contactor of the controller. To operate the gate after an over travel, the appropriate backout switch contact shall be held closed to permit operation of the gate only in the direction away from the over travel position after operation of either the "RAISE" or "LOWER" contact on the master control station.

Plate No. 2

CREST GATE
ELECTRICAL CONTROL SYSTEM
(With Approximately 0.5 Foot Increments)
DESCRIPTION OF CONTROL SYSTEM

1. SCHEME OF OPERATION

a. General. The control system for the gate shall be as indicated by the schematic control wiring diagram, and as specified below.

b. Control Points. The operation of the hoist motor shall be controlled by:

(1) A push button station located on the gate hoist with momentary contacts designated "RAISE," "LOWER" and "STOP."

(2) A push button station located on the door of the controller cabinet with momentary contacts designated "BACKOUT FROM RAISE OVER TRAVEL" and "BACKOUT FROM LOWER OVER TRAVEL."

c. Operating Features

(1) Actuation of the "RAISE" and "LOWER" contacts shall provide seal-in operation.

(2) A limit switch geared or directly connect to the hoist machine, shall control the incremental and stopping operations initiated manually from the control station as described under sequence of operation.

(3) Actuation of the "STOP" contact during any operation shall stop the hoist motor and set the brake.

2. SEQUENCE OF OPERATION

a. Raising

(1) When the gate is between the closed position and the first intermediate position, each actuation of the "RAISE" contact will cause the gate to raise approximately 0.5 foot and stop.

(2) When the gate is at or above the first intermediate position and is below the second intermediate position, each actuation of the "RAISE" contact will cause the gate to raise approximately 1 foot and stop.

(3) When the gate is at or above the second intermediate position, actuation of the "RAISE" contact will cause the gate to raise continuously to the raised position.

b. Lowering

(1) When the gate is between the over travel raised position and the second intermediate position, actuation of the "LOWER" contact will cause the gate to lower continuously to the second intermediate position and stop.

(2) When the gate is at or below the second intermediate position and above the first intermediate position, each actuation of the "LOWER" contact will cause the gate to lower approximately 1 foot and stop.

(3) When the gate is at or below the first intermediate position and is above the closed position, each actuation of the "LOWER" contact will cause the gate to lower approximately 0.5 foot and stop.

c. Over Travel. If during normal operation, the gate motor should fail to stop when the gate reaches the raised or closed positions, the over travel limit switch contacts shall stop the hoist motor after over travel by de-energizing the "main" or "line" contactor of the controller. To operate gate after an over travel, the appropriate backout switch contact shall be held closed to permit operation of the gate only in the direction away from the over travel position after operation of either the "RAISE" or "LOWER" contact on the master control station.

Plate No. 3

CREST GATE
ELECTRICAL CONTROL SYSTEM
DESCRIPTION OF CONTROL SYSTEM
(With Remote Control and Approximately 1.0 Foot Increments)

1. SCHEME OF OPERATION

a. General. The control system for the gate shall be as indicated by the schematic control wiring diagram, and as specified below.

b. Control Points. The operation of the hoist motor shall be controlled by:

(1) A push button selector switch station located on the gate hoist with momentary push button contacts designated "RAISE", "LOWER", and "STOP" and selector switch contacts designated "LOCAL" and "REMOTE."

(2) A push button station located on the door of the controller cabinet with momentary contacts designated "BACKOUT FROM RAISE OVER TRAVEL" and "BACKOUT FROM LOWER OVER TRAVEL."

(3) A push button station, located on the spillway gate remote control board with momentary contacts designated "RAISE", "LOWER", and "STOP."

(4) A synchronous type indicator, located on the spillway gate remote control board to show the gate position.

c. Operating Features

(1) Actuation of the "RAISE" and "LOWER" contacts of the remote or local control station shall provide seal-in operation.

(2) The position of the "REMOTE-LOCAL" control switch will determine which station is operative.

(3) The remote control shall utilize direct current interposing relays.

(4) A limit switch geared or directly connected to the hoist machine, shall control the incremental and stopping operations initiated manually from the control station as described under sequence of operation.

(5) Actuation of the "STOP" contact during any operation shall stop the hoist motor and set the brake.

2. SEQUENCE OF OPERATION

a. Raising

(1) When the gate is between the closed position and the intermediate position, each actuation of the "RAISE" contact will cause the gate to raise approximately 1 foot and stop.

(2) When the gate is at or above the intermediate position, actuation of the "RAISE" contact will cause the gate to raise continuously to the raised position.

b. Lowering

(1) When the gate is between the over travel raised position and the intermediate position, actuation of the "LOWER" contact will cause the gate to lower continuously to the intermediate position and stop.

(2) When the gate is at or below the intermediate position and is above the closed position, each actuation of the "LOWER" contact will cause the gate to lower approximately 1 foot and stop.

c. Over Travel. If during normal operation, the gate motor should fail to stop when the gate reaches the raised or closed positions, the over travel limit switch contacts shall stop the hoist motor after over travel by de-energizing the "main" or "line" contactor of the controller. To operate the gate after an over travel, the appropriate backout switch contact shall be held closed to permit operation of the gate only in the direction away from the over travel position after operation of either the "RAISE" or "LOWER"contact on the master control station.

Plate No. 4

CREST GATE
ELECTRICAL CONTROL SYSTEM
DESCRIPTION OF CONTROL SYSTEM
(With Remote Control and Approximately 0.5 Foot Increments)

1. SCHEME OF OPERATION

a. General. The control system for the gate shall be as indicated by the schematic control wiring diagram, and as specified below.

b. Control Points. The operation of the hoist motor shall be controlled by:

(1) A push button selector switch station located on the gate hoist with momentary push button contacts designated "RAISE", "LOWER", and "STOP" and selector switch contacts designated "LOCAL" and "REMOTE."

(2) A push button station located on the door of the controller cabinet with momentary contacts designated "BACKOUT FROM RAISE OVER TRAVEL" and "BACKOUT FROM LOWER OVER TRAVEL."

(3) A push button station, located on the spillway gate remote control board with momentary contacts designated "RAISE", "LOWER", and "STOP."

(4) A synchronous type indicator, located on the spillway gate remote control board to show the gate position.

c. Operating Features

(1) Actuation of the "RAISE" and "LOWER" contacts of the remote or local control station shall provide seal-in operation.

(2) The position of the "REMOTE-LOCAL" control switch will determine which station is operative.

(3) The remote control shall utilize direct current interposing relays.

(4) A limit switch geared or directly connected to the hoist machine, shall control the incremental and stopping operations initiated manually from the control station as described under sequence of operation.

(5) Actuation of the "STOP" contact during any operation shall stop the hoist motor and set the brake.

2. SEQUENCE OF OPERATION

a. Raising

(1) When the gate is between the closed position and the first intermediate position, each actuation of the "RAISE " contact will cause the gate to raise approximately 0.5 foot and stop.

(2) When the gate is at or above the first intermediate position and is below the second intermediate position, each actuation of the "RAISE" contact will cause the gate to raise approximately 1 foot and stop.

(3) When the gate is at or above the second intermediate position, actuation of the "RAISE" contact will cause the gate to raise continuously to the raised position.

b. Lowering

(1) When the gate is between the over travel raised position and the second intermediate position, actuation of the "LOWER" contact will cause the gate to lower continuously to the second intermediate position and stop.

(2) When the gate is at or below the second intermediate position and above the first intermediate position, each actuation of the "LOWER" contact will cause the gate to lower approximately 1 foot and stop.

(3) When the gate is at or below the first intermediate position and is above the closed position, each actuation of the "LOWER" contact will cause the gate to lower approximately 0.5 foot and stop.

c. Over Travel. If during normal operation, the gate motor should fail to stop when the gate reaches the raised or closed positions, the over travel limit switch contacts shall stop the hoist motor after over travel by de-energizing the "main" or "line" contactor of the controller. To operate the gate after an over travel, the appropriate backout switch contact shall be held closed to permit operation of the gate only in the direction away from the over travel position after operation of either the "RAISE" or "LOWER" contact on the master control station.

Plate No. 5

OUTLET CONTROL DATE
ELECTRICAL CONTROL SYSTEM
DESCRIPTION OF CONTROL SYSTEM
(Single-speed Motor)

1. SCHEME OF OPERATION

a. General. The control system for the gate shall be as indicated by schematic control wiring diagram, and as specified below.

b. Control Points. The operation of the hoist motor shall be controlled by:

(1) A push button station located on the gate hoist with contacts designated "RAISE," "CONDUIT OPEN," "LOWER," and "STOP."

(2) A push button station located on the gate hoist with momentary contacts designated "BACKOUT FROM LOWER OVER TRAVEL" and "BACKOUT FROM RAISE OVER TRAVEL."

(3) A pendant push button station with momentary contacts designated "INCH UP" and "INCH DOWN," provided with a portable cable of suitable length to permit operation from the inspection room. The cable shall terminate in a polarized plug matching receptacle located on motor controller cabinet or other suitable place.

c. Operating Features

(1) Actuation of the "RAISE", "CONDUIT OPEN", and "LOWER" contacts of the push button station shall provide seal-in operation.

(2) Actuation of the "INCH UP" and "INCH DOWN" contacts of the pedant push button station shall not provide seal-in operation.

(3) Actuation of the "STOP" contact during any operation shall stop the hoist motor and set the brake.

(4) A limit switch geared to directly connected to the hoist machine shall control the incremental and stopping operations initiated manually from the control station as described under sequence of operation.

2. SEQUENCE OF OPERATION

a. Raising

(1) When the gate is between the closed position and the raised position, actuation of the "RAISE" contact will cause the gate to open continuously to the raised position.

(2) When the gate is between the closed position and the conduit open position, actuation of the "CONDUIT OPEN" contact will cause the gate to open continuously to the conduit open position.

b. Lowering. When the gate is between the over travel raised position and the closed position, actuation of the "LOWER" contact will cause

the gate to lower continuously to the closed position.

c. Inching

(1) To raise the gate above the raised position the "INCH UP" contact shall be held closed. The gate will be stopped at upper inch position by the limit switch.

(2) To lower the gate when it is above the raised position the "INCH DOWN" contact shall be held closed. The gate will be stopped at the raised position by the limit switch.

d. Over Travel

(1) Over travel limit switches shall stop the driving motor if it fails to stop at the raised or closed position on the gate.

(2) The "BACKOUT FROM LOWER OVER TRAVEL" or "BACKOUT FROM RAISE OVER TRAVEL" contact shall be held closed to operate the gate from over travel closed and over travel raised, respectively.

Plate No. 6

OUTLET CONTROL GATE
ELECTRICAL CONTROL SYSTEM
DESCRIPTION OF CONTROL SYSTEM
(Multispeed Motor)

1. SCHEME OF OPERATION

a. General. The control system for the gate shall be as indicated by the schematic control wiring diagram, and as specified below.

b. Control Points. The operation of the hoist motor shall be controlled by:

(1) A push button station located on the gate hoist with momentary contacts designated "RAISE", "CONDUIT OPEN", "LOWER", and "STOP."

(2) A push button station located on the gate hoist with momentary contacts designated "BACKOUT FROM LOWER OVER TRAVEL" and "BACKOUT FROM RAISE OVER TRAVEL."

(3) A pendant push button station with momentary contacts designated "INCH UP" and "INCH DOWN", provided with a portable cable of suitable length to permit operation from the inspection room. The cable shall terminate in a polarized plug matching receptacle located on motor controller cabinet or other suitable place.

c. Operating Features

(1) Actuation of the "RAISE", "CONDUIT OPEN", and "LOWER" contacts of the push button station shall provide seal-in operation.

(2) Actuation of the "INCH UP" and "INCH DOWN" contacts of the pedant push button station shall not provide seal-in operation.

(3) Actuation of the "STOP" contact during any operation shall stop the hoist motor and set the brake.

(4) A limit switch geared to be directly connected to the hoist machine shall control the incremental and stopping operations initiated manually from the control station as described under sequence of operation.

2. SEQUENCE OF OPERATION

a. Raising

(1) When the gate is between the closed position and the raised position, actuation of the "RAISE" contact will cause the gate to open continuously at low speed to the conduit open position.

(2) When the gate is between the closed position and the conduit open position, actuation of the "CONDUIT OPEN" contact will cause the gate to open continuously at low speed to the conduit open position where the limit switch shall cause the gate to open continuously at high speed to the raised position. (3) When the gate is between the conduit open position and the raised position, actuation of the "RAISED" contact will cause the gate to open

continuously at high speed to the raised position.

b. Lowering

(1) When the gate is between the over travel raised position and conduit open position, actuation of the "LOWER" contact will cause the gate to lower continuously at high speed to the conduit open position where the limit switch shall cause the gate to close continuously at low speed to the closed position.

(2) When the gate is between the conduit open position and the closed position, actuation of the "LOWER" contact will cause the gate to lower continuously at low speed to the closed position.

c. Inching

(1) To raise the gate above the raised position the "INCH UP" contact shall be held closed. The gate will be stopped at upper inch position by the limit switch.

(2) To lower the gate when it is above the raised position the "INCH DOWN" contact shall be held closed.

(3) The gate will be stopped at the raised position by the limit switch.

d. Over Travel

(1) Over travel limit switches shall stop the driving motor if it fails to stop at the raised or closed position or the gate.

(2) The "BACKOUT FROM LOWER OVER TRAVEL" or "BACKOUT FROM RAISE OVER TRAVEL" contact shall be held closed to operate the gate from over travel closed and over travel raised, respectively.

Plate No. 7

INTAKE GATE
ELECTRICAL CONTROL SYSTEM
DESCRIPTION OF CONTROL SYSTEM

1. SCHEME OF OPERATION

a. General. The control system for the gate shall be as indicated by the schematic control wiring diagram, and as specified below.

b. Control Points. The operation of the hoist motor shall be controlled by:

(1) A push button station located on the gate hoist with momentary contacts designated "RAISE," "LOWER," and "STOP."

(2) A push button station located on the door of the controller with momentary contacts designated "BACKOUT FROM LOWER OVER TRAVEL" and "BACKOUT FROM RAISE OVER TRAVEL."

(3) A pendant push button station with momentary contacts designate "INCH UP" and "INCH DOWN," provided with a portable cable of suitable length to permit operation from the inspection room. The cable shall terminate in a polarized plug matching receptacle located on motor controller cabinet or other suitable place.

c. Operating Features

(1) Actuation of the "RAISE" and "LOWER" contacts of the push button station shall provide seal-in operation.

(2) Actuation of the "INCH UP" and "INCH DOWN" contacts of the pendant push button station shall not provide seal-in operation.

(3) Actuation of the "CLOSE" contact of the emergency lower switch shall provide seal-in operation.

(4) Actuation of the "STOP" contact during any operation shall stop the hoist motor and set the brake.

(5) A "balanced-pressure switch" with normally closed contact.

(6) A limit switch geared or directly connected to the hoist machine shall control the incremental and stopping operations initiated manually from the control station as described under sequence of operation.

(7) Gate position indicating lights as follows:

(a) A red light on push button station and with emergency lower switch indicating gate is in normal operating position.

(b) A green and blue light with emergency lower switch indicating gate is in closed and raised position, respectively.

(c) Am amber light with emergency lower switch indicating gate is closing.

2. SEQUENCE OF OPERATION

a. Raising. When the gate is between the closed position and the raised position, actuation of the "RAISE" contact will cause the gate to open continuously to the raised position. If there is a pressure difference between the two sides of the gate, the gate will stop at the cracked position. After pressure is balanced actuation of the "RAISE" contact will cause the gate to open to the raised position.

b. Lowering. When the gate is between the over travel raised position and the closed position, actuation of the "LOWER" contact will cause the gate to lower continuously to the closed position.

c. Normal Operating Position

(1) The gate is placed in the normal operating position by either the raising or lowering operation described above.

(2) The red light indicates the gate is in normal position.

(3) Actuation of the "STOP" contact of the push button station stops the gate.

d. Emergency Closing. When the gate is between the normal position and the closed position, actuation of the "CLOSE" contact of the emergency lower switch will cause the gate to lower continuously to the closed position.

e. Inching

(1) To raise the gate above the raised position the "INCH UP" contact shall be held closed. Gate will be stopped at upper inch position by the limit switch.

(2) To lower the gate when it is above the raised position the "INCH DOWN" contacts shall be held closed. Gate will be stopped at the raised position by the limit switch.

f. Over Travel

(1) over travel limit switches shall stop the driving motor if it fails to stop at the raised or closed position of the gate.

(2) The "BACKOUT FROM LOWER OVER TRAVEL" or "BACKOUT FROM RAISE OVER TRAVEL" contact shall be held closed to operate the gate from over travel closed and over travel raised, respectively.

-- End of Section --