****

NASA-14600 (May 2005)

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

NASA

Superseding NASA-14600 (January 2005)

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SECTION TABLE OF CONTENTS

DIVISION 14 - CONVEYING SYSTEMS

SECTION 14600

HOISTS AND CRANES

05/05

PART 1 GENERAL

1.1 REFERENCES
1.2 SUBMITTALS
1.3 DEFINITIONS
1.4 WELDING
1.5 STANDARD PRODUCTS
1.6 PREPRODUCTION DESIGN DATA
1.7 FIELD MEASUREMENTS
1.8 DELIVERY, HANDLING, AND STORAGE
1.9 PERFORMANCE REQUIREMENTS
1.9.1 Design Safety Factor
1.9.2 Design Loads
1.9.3 Allowable Deflection
1.9.4 Operational Requirements
1.9.5 Bearings and Bearing Life
1.10 CRANE CLASSIFICATION
1.10.1 Type, Duty Class, and Capacity
1.10.2 Transfer Bridge
1.11 OPERATING CHARACTERISTICS
1.11.1 Operating Speeds
1.11.2 Hoist Lift
1.11.3 Number of Hoists Per Crane
1.11.4 Noncorroding, Nonsparking Requirements
1.11.5 Hoist Type
1.11.6 Hoist Suspension
1.11.7 Headroom
1.12 CERTIFICATES

PART 2 PRODUCTS

2.1 CRANE BRIDGE MATERIALS
2.1.1 Structural Steel
2.1.2 High-Strength Threaded Fasteners
2.1.3 Standard Fasteners
2.1.4 Crane Bridge Design and Fabrication
2.1.5 Maximum Spans and Bridge Arrangement
2.1.6 Bridge and Trolley Drive
2.1.7 End Trucks
2.2 TROLLEYS

2.2.1 General Trolley Characteristics
2.2.2 Trolley Types
2.3 HOISTS
2.3.1 General
2.3.2 Wiring
2.3.3 Wire Rope
2.3.4 Rope Drum
2.3.5 Load Block and Sheaves
2.3.6 Hook Assembly
2.3.7 Gear Assembly
2.3.8 Bearings
2.3.9 Frame and Housing
2.4 LUBRICATION
2.4.1 General
2.4.2 Factory Lubrication
2.5 MOTORS AND CONTROLS
2.5.1 General
2.5.2 Motor Rating
2.5.3 Voltage Ratings
2.5.4 Bridge and End Truck Motors
2.5.5 Trolley Motor
2.5.6 Hoist Motor
2.5.7 Motor Type
2.5.8 Motor Bearings
2.5.9 Motor Brakes
2.5.10 Hoist Load Brake
2.5.11 Eddy-Current Load Brake
2.5.12 Motor Controller
2.5.13 Motor-Controller Enclosure
2.5.14 Protective Equipment
2.5.15 Pushbutton Control Stations
2.5.16 Limit Switches
2.6 ELECTRIFICATION SYSTEM
2.6.1 General
2.6.2 Safety Contact Conductor System
2.6.3 Bridge and Runway Electrification
2.6.4 Enclosed Safety Type Conductors
2.6.5 Current Collectors
2.6.6 Electric Cable Reel
2.6.7 Disconnect Switch, Conduit, and Wiring
2.6.8 Fungus Resistance
2.6.9 Electromagnetic Interference Characteristics
2.7 PAINT FINISH
2.8 CRANE IDENTIFICATION PLATES

PART 3 EXECUTION

3.1 GENERAL
3.2 CRANE RAILS AND RUNWAYS
3.3 ERECTION PROCEDURE
3.4 FACTORY TESTS BEFORE SHIPMENT
3.5 EXAMINATION
3.6 CRANE TESTS AFTER ERECTION
3.7 MONORAIL HOIST OPERATION TESTS
3.8 CRANE ELECTRIFICATION SYSTEM FACTORY TESTS
3.9 ON-SITE COMPLEX ELECTRIFICATION SYSTEM TESTS
3.10 OPERATION AND MAINTENANCE

-- End of Section Table of Contents --

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SECTION 14600

HOISTS AND CRANES

05/05

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NOTE: Delete, revise, or add to the text in this section to cover project requirements. Notes are for designer information and will not appear in the final project specification.

This section covers single girder-type electric, overhead cranes and electrification system, with capacity from 1 ton to 10 tons 907 kilogram to 9072 kilogram and maximum span of 70 feet 21350 millimeter.

Drawings must indicate crane runway framing, supporting structures, elevation of rail or runway clearances, obstructions, control stations, hook lift, capacity of main hoist and auxiliary hoist, when required.

Drawings must schedule each crane separately and completely by style, type, capacity, and operating characteristics when cranes of different types, capacities, and operating characteristics are required.

Crane rails, runways, and related structural steel framing and bracing is specified in Section 05120, "Structural Steel."

Painting is specified in Section 09970, "Coatings for Steel."

Crane manufacturer's data and specifications must be reviewed to aid in developing specific job requirements and to avoid the possibility of specifying improper combinations.

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: The following references should not be manually edited except to add new references. References not used in the text will automatically be deleted from this section of the project specification.

****

The publications listed below form a part of this section to the extent referenced:

AMERICAN BEARING MANUFACTURERS ASSOCIATION (ABMA)

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

AMERICAN GEAR MANUFACTURERS ASSOCIATION (AGMA)

AGMA 250.04	(1981) Lubrication of Industrial Enclosed Gear Drives

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC 317	(1992) Manual of Steel Construction, Volume II, Connections
AISC S329	(1996) Structural Joints Using ASTM A 325 or ASTM A 490 Bolts

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI B18.22.1	(1975; R 2003) Plain Washers
ANSI B18.22M	(1981; R 2000) Metric Plain Washers
ANSI C80.1	(1994; R 1995) Rigid Steel Conduit - Zinc Coated

AMERICAN WELDING SOCIETY (AWS)

AWS A2.4	(1998) Standard Symbols for Welding, Brazing and Nondestructive Examination
AWS D1.1/D1.1M	(2004) Structural Welding Code-Steel

ASTM INTERNATIONAL (ASTM)

ASTM A 167	(2004) Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
ASTM A 307	(2004) Standard Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength
ASTM A 325	(2004b) Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
ASTM A 325M	(2004b) Standard Specification for Structural Steel Bolts, Steel, Heat Treated 830 Mpa Minimum Tensile Strength (Metric)

ASTM A 36/A 36M	(2004) Standard Specification for Carbon Structural Steel
ASTM A 366/A 366M	(1997e1) Standard Specification for Steel, Sheet, Carbon, Cold-Rolled, Commercial Quality
ASTM A 48/A 48M	(2003) Standard Specification for Gray Iron Castings
ASTM A 490	(2004) Standard Specification for Heat-Treated Steel Structural Bolts, 150 psi Minimum Tensile Strength
ASTM A 490M	(2004) Standard Specification for High-Strength Steel Structural Bolts, Classes 10.9 and 10.9.3, for Structural Steel Joints (Metric)
ASTM B 633	(1998) Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel
ASTM F 568M	(2004) Standard Specification for Carbon and Alloy Steel Externally Threaded Metric Fasteners

CRANE MANUFACTURERS ASSOCIATION OF AMERICA (CMAA)

CMAA 70	(2004) Top Running Bridge and Gantry Type Multiple Girder Electric Overhead Traveling Cranes
CMAA 74	(2004) Specification for Top Running and Under Running Single Girder Electric Traveling Cranes Utilizing Under Running Trolley Hoist

JOINT INDUSTRIAL COUNCIL (JIC)

JIC-01	(1967) Electrical Standards for Mass Production Equipment

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(2003) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA BU 1	(1999) Busways
NEMA ICS 1	(2000) Industrial Control and Systems: General Requirements
NEMA KS 1	(2001) Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum)
NEMA ST 1	(1988) Specialty Transformers (Except General Purpose Type)

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2005) National Electrical Code 2005 Edition

U.S. DEPARTMENT OF DEFENSE (DOD)

MS MIL-C-28546	(Rev A; Am 2) Cranes, Overhead Traveling, Underhung, Electric Powered
MS MIL-V-173	(1999c) Varnish, Moisture-and-Fungus Resistant (for Treatment of Communications, Electronic, and Associated Equipment)

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

FED-STD 595	(1994b) Colors Used in Government Procurement
FS FF-B-171	(Rev A; Am 1) Bearings, Ball, Annular (General Purpose)
FS FF-B-185	(Am 4) Bearings, Roller, Cylindrical; and Bearings, Roller, Self and Aligning
FS RR-C-271	(1995d) Chains and Attachments, Welded and Weldless
FS RR-W-410	(2002e) Wire Rope and Strand

UNDERWRITERS LABORATORIES (UL)

UL 50	(2003) UL Standard for Safety - Enclosures for Electrical Equipment
UL 674	(2003) UL Standard for Safety Electric Motors and Generators for Use in Hazardous (Classified) Locations
UL 857	(2002) UL Standard for Safety Busways and Associated Fittings
UL Elec Const Dir	(2003) Electrical Construction Equipment Directory

1.2 SUBMITTALS

****
NOTE: Review submittal description (SD) definitions in Section 01330, "Submittals," 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. Include a columnar list of appropriate products and tests beneath each submittal description.
****

The following shall be submitted in accordance with Section 01330, "Submittals," in sufficient detail to show full compliance with the specification:

SD-02 Shop Drawings

Fabrication Drawings shall be submitted for electric overhead crane systems in accordance with paragraph entitled, "Preproduction Design Data," of this section.

Installation Drawings shall be submitted for electric overhead crane systems in accordance with the paragraph entitled, "Erection Procedure," of this section.

SD-06 Test Reports

The following test reports shall be submitted for the electric overhead crane systems in accordance with MS MIL-C-28546.

Operation Tests
Temperature Tests
Mechanical Tests
Dielectric Tests
Voltage Drop and Short Circuit Tests
Continuity Tests
Insulation Tests

SD-07 Certificates

Certificates shall be submitted for electric hoist and crane system shall be submitted in accordance with paragraph entitled, "Certificates," of this section.

SD-10 Operation and Maintenance Data

Operation and Maintenance Manuals shall be submitted in accordance with paragraph entitled, "Operation and Maintenance," of this section.

1.3 DEFINITIONS

Capacity shall mean the rated load in pounds (or tons of 2,000 pounds), kilogram (or metric tons of 1,000 kilogram), each specified by the manufacturer for the hoist, shall be legibly marked on the crane hoist and load block. In determining the applied load, handling devices shall be included.

Hoisting speed shall mean the velocity in feet per minute (fpm) meter per second at which the hoisting mechanism will lift the rated load. Actual lifting speed shall be within plus or minus 10 percent of the manufacturer's rating.

Rated lift shall mean the distance between the upper and lower elevations of travel of the load block.

Bridge shall mean the main structural and mechanical portions of the crane, consisting of a structural frame of main and auxiliary girders, braces, and ties that support and carry the trolley and hoisting mechanism; the travel

drive mechanism; the end trucks and related parts; and fabricated to span from one runway to the other and to travel parallel to runway.

Trolley shall mean the unit consisting of a frame, trucks, and trolley drive, moving on bridge rails in a direction at right angles to crane runway.

Hoisting mechanism shall mean a unit consisting of a motor drive, coupling, brakes, gearing, drum, ropes, and load block designed to raise, hold, and lower the maximum rated load.

Unit hoist shall mean a standard-production, monorail hoist of the specified capacity, type, and suspension, mounted on the crane bridge.

Bridge speed shall mean the velocity in fpm meter per second at which a motor-driven bridge with trolley and hoisting mechanism will carry the rated load in horizontal travel along the crane runway.

Trolley speed shall mean the velocity in fpm meter per second at which a motor-driven trolley and hoisting mechanism will carry the rated load in horizontal travel across the crane bridge.

Rated load shall mean the maximum load for which a crane or individual hoist is designed and built by the manufacturer and shown on the equipment identification plate.

L-10 Rating Life of a group of apparently identical ball bearings is defined as the number of hours at some given constant speed that 90 percent of a group of bearings will complete or exceed before the first evidence of fatigue develops.

1.4 WELDING

****

NOTE: If Section 05095, "Welding Steel Construction," is not included in the project specification, applicable requirements therefrom should be inserted and the following paragraph deleted.

****

[Section 05095, "Welding Steel Construction," applies to work specified in this section.]

[Welding procedures shall be in accordance with AWS D1.1/D1.1M.]

1.5 STANDARD PRODUCTS

Crane and its component hoists, electrification system components, parts, attachments, and accessories shall be of size, design, and quality to meet requirements specified herein and shall be the standard, fabricated products of the manufacturer or his supplier, so that prompt and continuing service and the delivery of repair parts and replacement components may be ensured. Parts, assemblies, and components shall be new.

1.6 PREPRODUCTION DESIGN DATA

Contractor shall provide construction drawings and supporting design data before fabrication of each proposed crane assembly.

Fabrication Drawings shall be submitted for electric overhead crane Systems consisting of fabrication and assembly details to be performed in the factory.

1.7 FIELD MEASUREMENTS

Field measurements shall be taken prior to preparation of shop drawings and fabrication to ensure proper fits.

1.8 DELIVERY, HANDLING, AND STORAGE

Crane, crane components, and accessories shall be delivered and unloaded as directed.

Crane bridge assembly shall be stored off the ground on platforms, skids, or other supports and shall be protected from weather.

Materials shall be kept free from dirt and protected from moisture and corrosion.

1.9 PERFORMANCE REQUIREMENTS

1.9.1 Design Safety Factor

Allowable structural design stresses for members of the crane or crane complex shall be limited to a safety factor of 5, based on the ultimate strength of the material used.

1.9.2 Design Loads

Design loads for dead load, horizontal travel load induced by bridge or trolley travel, and impact load shall conform to MS MIL-C-28546.

Wind load for cranes in exterior service shall be not less than 35 pounds per square foot. 1700 pascal.

1.9.3 Allowable Deflection

Bridge girder and runway track deflection in combination with whatever applicable camber that may exist in the girder or beam shall be such that the wheel-running surfaces will not deviate above or below a level line connecting the tops of the ends of the surfaces any more than that allowed in the following table under any combination of empty hook or hooks, fully loaded hook or hooks, trolley or trolleys in any work position, bridges in any work position; and with no impact included:

CRANE DUTY CLASS	MAXIMUM ALLOWABLE DEVIATION, INCLUDING DEFLECTION OF BRIDGE GIRDER OR RUNWAY TRACK BEAMS, IN INCH PER INCHES OF SPAN
A	1 in 450
B	1 in 600
C	1 in 800

CRANE DUTY CLASS	MAXIMUM ALLOWABLE DEVIATION, INCLUDING DEFLECTION OF BRIDGE GIRDER OR RUNWAY TRACK BEAMS, IN MILLIMETER PER MILLIMETER OF SPAN
A	25 in 11430
B	25 in 15240
C	25 in 20320

1.9.4 Operational Requirements

Performance response to controls shall be instantaneous, except where time delay devices and relays are provided. Operation shall be smooth and quiet. Heat rise in motors, brakes, and transistors during maximum capacity operation shall not exceed the design limitation. Cranes shall be capable of continuous maximum load and speed operation without electrical breakdown or overheating of motors, resistors, or brakes as follows:

CRANE DUTY CLASS	MINIMUM CONTINUOUS HOURS
A	2.5
B	4.0
C	9.0

Safety devices and brakes shall be positive in action without slipping, chattering, or jamming and shall have a fail-safe design.

1.9.5 Bearings and Bearing Life

****
NOTE: When possible the use of sealed bearings is encouraged. One of the major causes of bearing failures is over lubrication and lubrication contamination. Using sealed bearings helps to eliminate this failure mode.
****

Bearings, except those subject only to small rocker motion, shall be precision, antifriction type conforming to FS FF-B-171, Grade OO, for ball bearings and to FS FF-B-185 for roller bearings.

Squaring-shaft bearings shall be internally self-aligning or spherically mounted on cranes of Duty Classes A and B and shall be spaced at not over 60 times the shaft diameter nor more than 10 feet 3050 millimeterapart, whichever is less.

Bearings subject to thrust from deflection of bearing supports and bearings for herringbone and double helical gear sets shall include one fixed and one floating bearing.

Housings (including pillow blocks) shall be dusttight, of cast steel or nodular graphitic cast iron, and secured by not less than four bolts. When practical, housings shall be split. Split-bearing housings shall be fastened together with not less than four bolts. One-piece housings shall be designed and located to facilitate shaft and bearing removal.

Bearings shall be shielded, sealed, and lubricated as specified for the application. Bearings in exposed applications and bearings lubricated with an oil bath shall be sealed to prevent leakage.

Antifriction bearings, except hook bearings, shall be designed for dead load, direct reactions of the hook load (applied as a dead load), and torque reactions. Hook bearings shall be of the thrust type, designed on the basis of hours of life and load for the applicable hoist duty class at an arbitrary speed of 10 revolutions per minute. Dead load and hook load shall be reduced to percentage with normal impact, shock, and similar loadings omitted. Antifriction bearings shall be designed for the speeds resulting from operation of the driving motor at its 30-minute rated speed. Percentage of dead load and hook load and the applicable L-10 standard ABMA 9, rating life of bearings in hours, as applicable to the crane duty class, shall be as follows:

CRANE DUTY CLASS	HOIST		TROLLEY		BRIDGE	
	RATING LIFE*	PERCENT LOAD	RATING LIFE*	PERCENT LOAD	RATING LIFE*	PERCENT LOAD
A	7,000	75	5,000	75	5,000	75
B	7,000	85	5,000	75	7,500	75
C	15,000	75	10,000	85	15,000	85

*The L-10, rating life of a group of apparently identical ball bearings is defined as the number of revolutions (or hours at some given constant speed) that 90 percent of a group of bearings will complete or exceed before the first evidence of fatigue develops, ABMA 9.

1.10 CRANE CLASSIFICATION

1.10.1 Type, Duty Class, and Capacity

Crane units shall be overhead traveling and underhung electric powered, conforming to MS MIL-C-28546 and to the type, class, and material requirements specified.

Crane shall be Type I, Class (A1) (A2) (B) (C), single-girder, [underhung bridge and trolley, and single span.] [top-running bridge with underhung trolley.] [underhung bridge and trolley, and multiple span.]

Each crane shall be type, service duty class, and capacity as indicated.

****
NOTE: Refer to MS MIL-C-28546 and to CMAA 70, section 70-2 crane classifications for data on typical uses of various crane classifications.
****

Crane shall be designed and fabricated for [Class A "standby service"] [Class B "light service"] [Class C "moderate service"] duty classification.

****
NOTE: Drawings must indicate required runway span.
****

Total rated capacity of the crane assembly shall be not less than [_____] ton(s) kilogram at the indicated span. Total rated capacity of each transfer crane, or crane complex, shall be as indicated and shall include the dead load and the capacity load of possible combinations of hoist units.

****
NOTE: Following paragraph must be included.
****

Rated capacity shall be shown in tons on not less than two capacity plates, at least one on each side, attached to the crane bridge in fully exposed locations.

1.10.2 Transfer Bridge

[Crane bridge shall be equipped with manually operated, safety interlock transfer devices to effect accurate register of crane bridge with connecting tracks and to provide uninterrupted electrical service through the track connections.]

1.11 OPERATING CHARACTERISTICS

1.11.1 Operating Speeds

Operating speeds shall be as follows:

****
NOTE: Specified speeds are in the low or standard speed category. A bridge speed of 150 fpm 0.76 meter per second approximates normal walking speed.
****

[Bridge - [Single] [Variable]-speed, approximately [100] [125] [150] fpm [maximum]]

[Bridge - [Single] [Variable]-speed, approximately [0.51] [0.64] [0.76] meter per second [maximum]]

[Bridge - Speed characteristics as indicated]

[Bridge - [Hand-operated gear] [Manual push] type]

[Trolley - [Single] [Variable]-speed, approximately [50] [75] [100] fpm]

[Trolley - [Single] [Variable]-speed, approximately [0.25] [0.38] [0.51] meter per second]

[Trolleys - Variable-speed, each trolley speed as indicated]

[Trolley - Manually propelled, as specified hereinafter]

****
NOTE: Select hoist speed.
****

[Hoist - Single-speed, standard-lift, [1-ton and 1-1/2-ton] [2-ton to 6-ton] [7-1/2-ton and 8-ton] [10-ton] capacity, maximum [30] [15] [25] fpm]

[Hoist - Single-speed, standard-lift, [907 kilogram and 1360 kilogram] [1815 kilogram to 5445 kilogram] [6805 kilogram and 7260 kilogram] [9075 kilogram] capacity, maximum [0.15] [0.08] [0.13] meter per second]

[Hoist - 2-speed, standard-lift, [1-ton and 1-1/2-ton] [2-ton to 6-ton] [8-ton and 10-ton] capacity, [10 and 30] [5 and 15] [8 and 24] fpm maximum]

[Hoist - 2-speed, standard-lift, [907 kilogram 1360 kilogram] [1815 kilogram to 5445 kilogram] [7260 kilogram and 9075] capacity, [0.05 and 0.15] [0.03 and 0.08] [0.04 and 0.12] meter per second maximum]

[Hoist - [Single] [2]-speed, high-lift, speeds as indicated]

[Hoists - Each hoist shall be lift and speed as indicated]

[Hoist - Variable-speed and lift as indicated]

1.11.2 Hoist Lift

****
NOTE: Select height of lift. Drawings must indicate special lifting requirements, for example: loads lowered from one elevation into pits or through floor openings to an intermediate or lower level.
****

[Hoist shall be standard lift with a minimum hook lift of [_____] feet. meter.]

[Each hoist shall have minimum height of hook lift as indicated.]

1.11.3 Number of Hoists Per Crane

****
NOTE: Select number of hoists required for each crane bridge. Correlate capacity of each hoist with total rated capacity of crane assembly.
****

[Crane assembly shall have one unit hoist or hoisting mechanism of the specified total rated capacity.]

[Crane assembly shall have two unit hoists or two hoisting mechanisms with a combined capacity not exceeding that specified for the crane assembly.]

1.11.4 Noncorroding, Nonsparking Requirements

[Hoists and trolleys shall be equipped with noncorroding, nonsparking wire rope, hook, and trolley assembly.]

[Hoists and trolleys shall be equipped with the specified wire rope with no noncorroding, nonsparking requirements.]

[Hoist and trolley assembly shall be Form A and Form B with noncorroding, nonsparking requirements as indicated.]

1.11.5 Hoist Type

Unit hoists for Style 1 and 2 cranes shall be monorail-type, electric-motor-driven wire-rope or chain hoists.

1.11.6 Hoist Suspension

****
NOTE: Select type of suspension. Tractor drive must not be used for units of more than 5-ton 4600 kilogram capacity. Drawings must indicate suspension by mark letters.
****

Crane hoists, Mark [IMT] [HGT] [HPT], shall have [integral, motor-driven] [plain, hand-propelled] trolley suspension.

Crane hoists, Mark TEMD, shall be tractor mounted, with electric-motor-driven tractor-trolley unit.

****
NOTE: Select type of suspension mounting.
****

Hoist shall be suspended [parallel to trolley track.] [at right angle to trolley track.] [as indicated.]

1.11.7 Headroom

****
NOTE: Select paragraph to define headroom requirements.
****

[Hoist and suspension shall be [standard-headroom type] [minimum-headroom type].]

[Each hoist shall be standard-headroom or minimum-headroom type as indicated.]

1.12 CERTIFICATES

Certificate that crane and component hoists and controls comply with the requirements specified

Certificate that crane has been factory tested for the tests specified

Certificate that electric crane bridge motors, hoist and trolley motors, wiring, contact conductors, controls, overcurrent protection, and grounding conform to NFPA 70, and to UL standards; the label or listing with reexamination of the UL will be accepted as evidence that the materials conform to this requirement and to NFPA 70.

Manufacturer's warranty

Reports of chemical composition, mechanical, usability, and soundness tests as specified in the particular reference specification for the material for electrodes

Certified copies of previous tests on identical electrification systems under actual conditions shall be submitted for voltage-drop and short-circuit tests.

PART 2 PRODUCTS

2.1 CRANE BRIDGE MATERIALS

2.1.1 Structural Steel

Steel for crane bridges, end truck frames, auxiliary girders, trusses, and reinforcing shall be hot-rolled structural steel I-beam, wide flange beams, channels, and angles and plates not less than ASTM A 36/A 36M. Girders and track beams shall be true, straight, and free of twists with standard mill tolerances for crane use.

Runway track beams that carry rolling loads on the lower flange shall conform to MS MIL-C-28546.

Runway track beams that carry rails shall conform to CMAA 70.

2.1.2 High-Strength Threaded Fasteners

High-strength bolts shall be quenched and tempered medium-carbon-steel bolts for structural joints and shall have suitable nuts and hardened washers. Bolts, nuts, and washers shall conform to ASTM A 325, ASTM A 325M, or to ASTM A 490. ASTM A 490M.

2.1.3 Standard Fasteners

Unfinished, threaded fasteners shall consist of regular hexagon-head carbon steel bolts and nuts and special flathead bolts and nuts conforming to ASTM A 307, Grade A. ASTM F 568M, Class 4.8 or above.Washers shall be plain carbon steel conforming to ANSI B18.22.1, ANSI B18.22M, Type B.

2.1.4 Crane Bridge Design and Fabrication

Crane bridge and end truck assembly, trolley rails, and beam runways shall be designed and fabricated in accordance with AISC 317 and CMAA 70, Section 70-2, "Crane Classifications."

High-strength bolt fasteners shall be installed in accordance with AISC S329.

Bridge assembly shall be all-welded construction, except for removable subassemblies and girder splices required to maintain shop alignment and for shipment. Removable subassemblies and track beam splices shall be fastened with high-strength bolt fasteners. Splices for bridge girders shall be made by means of continuous, complete penetration butt welds.

2.1.5 Maximum Spans and Bridge Arrangement

Styles 1, 1T, and 2 cranes shall not be used for single spans over 50 feet 15240 millimeter or for multiple spans totaling over 70 feet 21340 millimeter and shall consist of main girder, trolley and hoist, an auxiliary bracing girder or outrigger beam laterally braced to the main girder with end trucks for each runway track beam. Auxiliary girder shall be spaced not less than 1/10 the largest bridge span nor less than 4 feet 1220 millimeter from the main girder and shall be of a depth not less than one-half of that of the main girder. Auxiliary girder hall be fully

trussed to top flange of main girder with structural steel shapes.

2.1.6 Bridge and Trolley Drive

Mechanical design of bridge and trolley drive, shafts, axles, gears and gearing, bearings, wheels, couplings, brakes, bumpers, and stops shall conform to MS MIL-C-28546 and to the requirements specified.

2.1.7 End Trucks

End trucks shall be of either the rigid or the articulated type and shall be connected to the bridge girders frame by body-bound bolts in reamed holes, by dowels and bolts, or keys and bolts. Trolleys shall be integral with hoisting mechanism or with hoist.

Each assembly shall have not less than four wheels. Sufficient wheels shall be provided to distribute the load on the track beams. Static wheel loading in pounds kilogram for cylindrical treads shall not exceed 1,200 DW 544 kilogram (1,200 pound) DW for crane Duty Classes A and B and 1,000 DW 454 kilogram (1,000 pound) DW for Duty Class C where "D" equals the diameter of the wheel in inches millimeter and "W" equals the nominal width of bearing on the tread.

Wheels shall be flanged type, manufactured from forged or wrought alloy steel with machined, hardened treads and flanges or high-strength cast or nodular iron with machined flanges and treads, chill hardened not less than 1/16 inch 1.5 millimeter deep. Wheels shall be designed to operate on either sloped or flat flange I-beams or on crane rail as indicated.

Noncorroding, nonsparking end truck wheels shall be AISI Type 304 corrosion-resistant steel or suitable copper alloy.

Wheels shall be carried on sealed, self-aligning, permanently lubricated antifriction bearings designed for axial and thrust loading. Bearings shall be provided with fittings for pressure lubrication.

Wheel gear teeth shall not touch track beams. Wheels shall be readily removable anywhere along the track beams. Provision shall be made for equal bearing of wheels on both sides of bridge girders and the runway track beams.

Side frames shall be fabricated from structural quality rolled-steel shapes or plate, milled or formed to the required profile with integral bosses where necessary to support equalizing pins and fitted with safety hangers and end bumpers.

Wheel base of the end truck assembly for bridges having four pairs of wheels shall be not less than 1/7 of the bridge span; for bridges having eight pairs of wheels, the center-to-center distance of the rocker pins on which the equalizer bar pivots shall be not less than 1/7 of the longest bridge span. Safety lugs shall be provided to limit the drop to not more than 0.5 inch 12.7 millimeter in case of wheel or axle breakage and to maintain the crane or trolley on the track beam.

2.2 TROLLEYS

2.2.1 General Trolley Characteristics

Each trolley assembly shall be a type designed for use with the specified

crane. Trolley shall be fabricated as an integral part of the hoisting mechanism or as an assembly bolted to a unit hoist.

Trolley assembly shall conform to applicable requirements specified and to the type requirements as specified.

****
NOTE: Delete following paragraphs if plain trolley or geared manual drive trolleys are not required.
****

Plain trolley and geared manual drive trolleys shall have suitable quick-acting, steel track clamps. Clamps shall be adjustable for wear and shall not injure track flanges. They shall function satisfactorily on curved and straight track and shall be capable of withstanding a pull equivalent to one-third the rated capacity of the hoist when executed parallel to the track.

Hand chain wheel of geared trolleys shall be manufactured from steel, malleable iron, high-strength cast iron or aluminum alloy, with accurately shaped pockets to receive hand chain and with guides which will permit operation of the hand chain from an angle of 10 degrees from either side of the chain wheel without slipping or jumping the wheel rim.

Hand chain shall be endless coil, welded-link, cadmium-plated, proof-coil steel chain conforming to FS RR-C-271, Type I, Grade C, Class 4.

Noncorroding, nonsparking hand chain shall be endless coil link type fabricated from AISI Type 304 corrosion-resistant steel or suitable bronze or aluminum alloy.

Hand-chain reach distance shall be standard length for specified lift height of hoist and shall reach to a point approximately 30 inches 760 millimeter above the operating floor.

2.2.2 Trolley Types

****
NOTE: Select required trolley type. Electric motor-driven tractor-trolley drives must be limited to duty Class A and B and to a maximum capacity of 5 tons 4536 kilogram.
****

[Trolley shall be an electric-motor drive, geared type conforming to the requirements specified.]

[Trolley shall be an electric-motor-driven-tractor type conforming to the requirements specified. Motor shall drive through a totally enclosed gear train to an adjustable tension, spring-loaded, rubber-tired drive wheel. Trolley wheels shall be flangeless type, carried on the specified type of antifriction bearings. Tractor frame shall include two guide rollers on each side of the frame, carried on sealed, permanently lubricated antifriction bearings.]

[Trolley shall be a [geared, hand-chain operated, manual drive] [plain, manual push] type.]

[Each trolley shall be type as indicated.]

2.3 HOISTS

2.3.1 General

Hoist assembly shall include hook, load block, wire rope and drum, gearing, brakes, motor drive and controls with integral or attached trolley. Electric hoists wiring, contact conductors, controls, overcurrent protection and grounding shall conform to NFPA 70 and to the applicable UL standards and specified requirements. Each unit shall be factory wired and ready for operation.

Electric hoist and trolley unit shall conform to MS MIL-C-28546 and shall be of capacity, lift, type, suspension, headroom, and materials specified.

Each hoist shall be factory lubricated and shall be complete and ready for operation with the specified controls and accessories.

All parts of the hoist shall be designed and constructed for safety of operation and durability of components. Replacement parts shall be interchangeable and readily accessible.

2.3.2 Wiring

Each hoist shall be completely wired by the manufacturer in accordance with NFPA 70 and UL standards. Exposed, flexible wiring from controller housing to hoist and trolley motors shall be Type SO flexible neoprene oil-resistant cable.

2.3.3 Wire Rope

Wire rope for standard applications shall be extra flexible, preformed, improved, plow steel, 6 by 37, fiber-core wire conforming to FS RR-W-410, Type I, Class 3.

Wire rope for single-line application shall be preformed, improved plow steel, 18 by 7, fiber-core, nonrotating wire conforming to FS RR-W-410, Type IV, Class 2.

Wire rope for noncorroding, nonsparking hoist application shall be preformed, AISI Type 304, 18-8 corrosion-resistant steel, 6 by 19, bright finish, conforming to FS RR-W-410, Type I, Class 2.

****
NOTE: Following paragraphs must be included.
****

Wire rope shall be anchored to drum or dead-end. Anchoring shall be of captive type, easily detached for changing and repair.

Wire rope shall have a safety factor of not less than 5, based on the minimum ultimate strength of the material used, for Class A and B cranes, and a safety factor of 6 for Class C cranes.

2.3.4 Rope Drum

Rope drum shall be hardened steel or special-grade cast iron. Drum shall have accurate, machine-cut grooves, cut to full depth of wire-rope radius, with rounded corners of dimension as required for the indicated lift.

Groove diameter and pitch centers shall be not less than 1/32 inch 0.79 millimeter greater than diameter of rope. Drum shall be flanged at each end and shall have enclosed tops and sides to preclude cable binding and jamming.

Drum shall be proportioned to store not more than one layer of rope with the load hook at the upper operating limit and shall have not less than two full turns remaining on the drum in the lowest elevation of the lift. Drum and sheave pitch diameters (in rope diameter units) shall be not less than the following:

CRANE DUTY CLASS	DRUMS	RUNNING SHEAVES	EQUALIZER SHEAVES
A	20	16	12
B	20	18	12
C	24	20	12

2.3.5 Load Block and Sheaves

Cable load block shall be an enclosed steel safety type which will shroud the sheave and protect the operator. Sheave assembly shall be mounted on a steel axle and carried on sealed, prelubricated antifriction bearings.

Wire-rope sheaves shall be machine-grooved, hardened steel or cast iron with chilled groove surfaces.

2.3.6 Hook Assembly

****

NOTE: Select hook material for standard application or for nonsparking, noncorrosive uses.

****

Hooks and hook swivels shall be heat-treated alloy steel forgings. Yokes, crossheads, and bars shall be of suitable strength steel or cast iron.

Load blocks and hook assembly shall be nonsparking, noncorroding type, fabricated of AISI Type 304, 18-8 chrome-nickel, corrosion-resistant steel or a bronze alloy of suitable strength and section for the rated capacity load.

Hook assembly for electric hoists shall be carried on antifriction bearings to permit free swivel under rated-capacity load without twisting load chain or wire.

Each hook assembly shall include a machined and threaded shaft and swivel locknut with an effective locking device to prevent nut from backing off.

Each hook shall have a spring-loaded safety latch.

2.3.7 Gear Assembly

Gears and gearing shall conform to MS MIL-C-28546.

Gear shafts shall be manufactured from high-carbon steel or alloy steel, machined and ground for accurate fit and splined for fitting to the mating

gear.

Gear-train assembly shall be carried on antifriction bearings and enclosed in the hoist frame casting. Assembly shall operate in a sealed oil bath. Frame casting shall be provided with lubrication fittings and inspection ports.

2.3.8 Bearings

Bearings in the hoist mechanism shall be precision manufactured antifriction bearings, either needle-type roller bearings or end and radial thrust ball bearings, operating in an oil bath and conforming to the requirements specified.

Exposed bearings and load block bearings shall be prelubricated and factory sealed.

2.3.9 Frame and Housing

Operating parts of the hoist shall be mounted and enclosed in a sealed, factory painted metal frame of malleable iron, cast steel, welded steel, or aluminum.

Welded or bolted frames shall be designed to carry loads on the fabricated pieces. Welds or bolts shall be used only to hold the fabricated parts in position.

2.4 LUBRICATION

2.4.1 General

Means shall be provided for adequate lubrication of moving parts of the crane bridge hoist and trolley, and for filling, draining, and checking the level of the lubricant.

Lubricant shall be designed for use in an ambient temperature of 0 to 150 degrees F. minus 18 to plus 66 degrees C. Hoist, trolley, bridge, and end truck assemblies shall be conspicuously tagged to identify the lubricants used and their temperature range. Complete crane complexes shall be completely lubricated after installation and prior to acceptance testing.

Fittings shall be located as required for easy accessibility for lubrication. Pressure lubrication fittings shall not be used where lubricating pressure may damage grease seals or other parts.

Vertical gear trains shall be provided with positive lubrication to the upper gears and to oil-lubricated bearings. Enclosed reduction gearing and automatic loadlowering brakes shall be lubricated in an oil bath. Gear reduction at trolley and bridge wheels for cranes of Duty Classes A and B may be of open design and grease lubricated. Trolley and bridge wheel gears on Duty Class C cranes shall run in oil. Cases for oil baths shall have a drain plug, dusttight and weathertight filler opening, and a ready means for determining the oil level. Grease-lubricated bearings shall be lubricated through individual pressure lines to each bearing. Each line shall be equipped with a lubrication fitting.

Bearings shall be provided with a positive oil feed, or shall be grease lubricated, and fitted with shields to prevent entry of grease to gear oil. Worm gear housing shall be integral with that for other gears in the train.

Lubricant shall not be permitted to contact motor windings. Exposed bearings shall be fitted with dusttight seals.

2.4.2 Factory Lubrication

Where practical, moving parts of hoist, trolley, bridge, and end truck assemblies shall be lubricated prior to delivery. Lubricant shall conform to AGMA 250.04, type as recommended by manufacturer.

2.5 MOTORS AND CONTROLS

2.5.1 General

Motors and controls shall conform to MS MIL-C-28546, and to the requirements specified. Motor mounting, shaft, and keyway dimensions shall conform to manufacturer's standards.

Crane, trolley and hoist wiring, conductors, controls, overcurrent protection, and grounding shall conform to NFPA 70 and to the requirements specified.

2.5.2 Motor Rating

Motor ratings shall be determined by either CMAA 70 or CMAA 74. These specifications are developed for the purpose of promoting standardization and to provide a basis for equipment selection.

2.5.3 Voltage Ratings

****

NOTE: Select motor voltage ratings as required.

****

Voltage rating of [single] [3]-phase electric motors 1/2 horsepower 373 watt and larger for connection to [120/240] [120/208] [240] [277/480] [480]-volt, [single] [3]-phase, [3] [4]-wire distribution circuits shall be [115/230] [200] [230/460]-volt, [3-phase] 60-hertz.

2.5.4 Bridge and End Truck Motors

****

NOTE: Select required motor type. Delete paragraph title and all following paragraphs if geared, chain propelled, or push-type, bridge drive is selected.

Single-speed squirrel cage motors are of limited use for crane bridge and trolley drive motors and are normally used only in class a and b cranes of light capacity, with a motor rating of not over 10 hp. 7.46 kilowatt.

****

Bridge and end truck motors shall be single-speed, high-starting-torque, high-slip, squirrel-cage ac motors with motor brake and fluid coupling or other mechanical device to provide smooth and even acceleration and deceleration.

Bridge and end truck motors shall be variable-speed, low-slip, wound-rotor ac motors with motor brake.

2.5.5 Trolley Motor

****
NOTE: Select required type. Delete paragraph title and all following paragraphs if gear hand chain propelled or manual push trolley is selected.
****

[Each trolley motor shall be a single-speed, high-starting-torque, high-slip, squirrel-cage ac motor, with motor brake and fluid coupling or other mechanical device to provide smooth and even acceleration and deceleration.]

[Each trolley motor shall be a variable-speed, low-slip, wound-rotor, ac motor with motor brake.]

[Each trolley motor shall be of the type and speed characteristics as indicated.]

2.5.6 Hoist Motor

****
NOTE: Select required motor type and speed characteristic.
****

[Each hoist motor shall be a [single] [two]-speed, high-starting-torque, high-slip, squirrel-cage ac motor.]

[Each hoist motor shall be a variable-speed, low-slip, wound-rotor ac motor.]

[Each hoist motor shall be of type and speed characteristics as indicated.]

2.5.7 Motor Type

****
NOTE: Select motor type.
****

Motors shall be totally enclosed, nonventilated type, certified for 30-minute time-rated operation at full identification plate power output in an ambient temperature of 104 degrees F 40 degrees C, maximum temperature rise 167 degrees F 75 degrees C, insulation not less than Class B system.

****
NOTE: Verify explosion-proof class and group with the current edition of UL 674 as applicable.
****

Motors where indicated shall be explosionproof, certified for 30-minute time-rated operation at full identification plate power output in an ambient temperature of 104 degrees F 40 degrees C, maximum temperature rise 167 degrees F 75 degrees C, insulation not less than Class B system. Enclosure shall be fitted with a UL-approved drain and breather and shall be certified and labeled in accordance with UL 674, Class 1, Groups C and D.

2.5.8 Motor Bearings

****

NOTE: When possible the use of sealed bearings is encouraged. One of the major causes of bearing failures is over lubrication and lubrication contamination. Using sealed bearings helps to eliminate this failure mode.

****

Motor bearings shall be heavy-duty ball or roller antifriction type with full provision for the type of thrust imposed by the specific duty load and meeting the requirements specified.

Bearings in motors shall be either factory sealed and lubricated for life or prelubricated. Prelubricated bearing shall be equipped with lubrication service fittings and with provision for automatic positive relief of lubrication pressure. This may be accomplished by either built-in relief devices or automatic ball-and-spring relief fittings at the bottom of the bearing housing. Pressure relief shall be to the outside of the housing. Lubrication fittings shall be fitted with color-coded plastic or metal dust caps.

Bearings in any motor that is lubricated at the factory for extended duty periods shall be identified with tags. Tag shall state the lubrication requirements for a given number of operating hours.

2.5.9 Motor Brakes

Motor brakes shall be provided on electric-motor-operated hoists, trolleys, and bridges. Motor brake shall be an externally adjustable, electrically operated shoe or multiple friction electromagnetic disk brake which shall apply automatically when the power is interrupted.

Torque rating of the bridge and trolley brakes shall be not more than 50 percent of the full-load torque of the bridge and trolley motors and shall be adjustable to 25 percent for all duty classes.

Hoist motor brake shall be capable of holding the capacity load of the hoist at any point independent of the load brake and, in addition to stopping and safely holding 125 percent of the rated load from any operating speed, shall hold a static load equal to 150 percent of the rated capacity.

2.5.10 Hoist Load Brake

Each hoisting unit shall be provided with two means of braking. One brake shall be an electric motor brake as specified. The other brake shall be a mechanical load brake, directly applied to the hoist motor shaft or other shaft in the hoist gear reduction.

Load brake shall be a totally enclosed, automatic, mechanical-type, externally adjustable brake with hardened steel, Weston-type ratchet and pawl mechanism that will hold the capacity load of the hoist at any point when the motor is stopped.

2.5.11 Eddy-Current Load Brake

****

NOTE: This control is designed for duty Class A and C for use with reversing, wound-rotor motors and with an electric brake of the eddy-current type. It is adapted to applications requiring accurate speed control in both hoisting and lowering directions and in all conditions of loading.

****

Eddy-current-type brake shall be provided for hoist control of wound-rotor motors. Eddy-current brakes shall provide an adjustable varying artificial load on four lowering speed points and on not less than two hoisting speed points. Provision shall be made to prevent operation of the hoist on any eddy-current-brake-controlled point upon loss of brake excitation. Eddy-current brake shall be excited with reduced voltage when the control is in the off position. There shall be a positive downdrive with the control set on any lowering point. Speed on the first-speed point hoisting shall not exceed 20 percent of full-load hoist speed with no load on the hook and shall be more than zero with 125 percent of the full load. Speed on the second-speed point hoisting shall not exceed 60 percent of the full-load hoist speed with no hook load or 25 percent with full load. Speed on the first point lowering shall not exceed 15 percent of rated hoist speed under full load. On the second point lowering, the speed shall be between 10 percent and 20 percent of the full-load hoist speed with no load and between 30 percent and 40 percent of the full-load hoist speed with full load. Last or fifth lowering speed point shall be a regenerative speed point with the full-load speed not more than 115 percent of the full-load hoist speed. Third and fourth speed points shall be evenly spaced between the second and fifth speed points. When eddy current brakes and motors are not determined from root-mean-square computations, the crane torque rating of the eddy-current brakes shall be not less than 1.2 times the torque rating of the motor.

2.5.12 Motor Controller

****

NOTE: Ability to open and/or remove access covers is required for maintenance activities. In addition, access may be required to inspect this device while circuits are energized (for example, using infrared imaging). Minimum distances to energized circuits is specified in OSHA Standards Part 1910.333 (Electrical - Safety-Related work practices). OSHA Standards are available on the internet.

****

Each motor shall be provided with a full magnetic, electrically operated, reversing-type controller with thermal-overload protection, fused disconnect switch, and control-circuit transformer.

****

NOTE: Class I crane controllers are intended for use with all Crane Manufacturers Association of America (CMAA) crane service classes except A2 and B.

Class II crane controllers are intended for use with CMAA crane service classes A2 and B (infrequent use or light industrial service).

****

Controllers for cranes of Duty Class I shall be in accordance with NEMA ICS 1, Part 3-442 and Part 3-443.

Controllers for cranes of Duty Class II shall be in accordance with NEMA ICS 1, Part 3-442 and Part 3-443, Service Classes A2 and B.

Operating parts of the controllers shall be contained in an enclosure as specified. Enclosure shall be accessible for service. When resistors are mounted in the same enclosure as controllers, air circulation by natural convection shall be provided.

Controller component ratings shall conform or be in proportion to the tabulated ratings of NEMA ICS 1. All contactors shall be provided with arc shields or suppressors or the contacts shall be enclosed in an arc box.

Contactors for starting, stopping, and reversing shall be mechanically and electrically interlocked. A line contactor shall be provided for each motor controller on the crane or crane complex.

An emergency stop button and a reset button shall be provided to operate the main-line contactor.

Controllers for variable speed motors shall be provided with five speed points, not less than three of which shall be hand-controlled points. When provided with three hand-controlled points, points one, two, and five shall be the hand-controlled points, and points three and four shall be automatic. Accelerating relays, adjustable from at least 1/4 second to 2 seconds, shall be provided for points above the second.

Overcurrent protection shall consist of externally operable, manual reset, thermal-overload relays in each pole of the controller. Thermal overload relays shall be melting alloy or bimetallic, nonadjustable type with continuous current ratings and service-limit current ratings in accordance with Section 2, Part 2-321A of NEMA ICS 1.

Magnetic motor controllers shall be capable of interrupting operating overloads up to and including 10 times their normal motor rating. Continuous current ratings shall be based on temperature rise above an ambient temperature of 104 degrees F. 40 degrees C. Core and coil assembly, auxiliary contacts, and other control-circuit devices shall be rated at 120 volts.

Resistors shall have a thermal capacity of not less than Class No. 150 series and shall be rated for continuous duty. Accelerating resistors shall be rated for Duty Classes A and B cranes, hoists, and trolleys: 15 seconds on and 45 seconds off; for Duty Class C: 15 seconds on and 30 seconds off. Resistors for variable-speed bridge motors shall provide not more than 25-percent full-load motor torque for the first speed point of bridge travel.

Resistors for variable speed hoists and trolleys shall provide not more than 50-percent full-load motor torque for the first (slow)-speed point hoisting and not more than 25 percent for the first-speed point of trolley travel. Resistors shall be designed for operation within temperature ratings of 707 degrees F 375 degrees C, ambient plus rise when wires are bare, and 572 degrees F 300 degrees C when embedded. Resistors shall be of the nonbreakable, noncorroding, wound type capable of adjustment by taps and shall be thoroughly ventilated. Resistors shall be mounted in

substantial end frames and shall be enclosed in louvered enclosures for both indoor and outdoor service.

Control-circuit transformers shall be provided within the enclosure of all motor controllers when the line voltage is in excess of 120 volts. Transformer shall be dry-type, single-phase, 60-hertz ac with a 120-volt, isolated, secondary winding in accordance with NEMA ST 1. Controls shall operate at 120 volts or less.

Rated primary voltage of the transformer shall be not less than the rated voltage of the controller. Rated secondary current of the transformer shall be not less than continuous-duty current of the control circuit.

Voltage regulation of the transformer shall be such that with rated primary voltage and frequency, the secondary voltage will be not less than 95 percent nor more than 105 percent of rated secondary voltage.

Source of supply for control-circuit transformers shall be taken from the load side of the main disconnecting device. Secondary winding of the transformer and control-circuit wiring shall be protected against overloads and short circuits by fuses selected in accordance with Tables 4-4 and 4-5 of JIC-01. Secondary winding of the control-circuit transformer shall be grounded in accordance with JIC-01.

2.5.13 Motor-Controller Enclosure

****

NOTE: Drawings must list class and group for NEMA 7 enclosures. Refer to NFPA 70, article 500.

****

Motor-controller enclosure shall be NEMA 250, [Type 1 - general-purpose sheet steel case.] [Type 3 - dusttight, raintight, and sleet(ice)-resistant sheetsteel case.] [Type 4 - watertight and dusttight, cast-iron or corrosion-resistant steel case.] [Type 7 - hazardous; cast-iron case, location, class, and group as indicated.] [Type 12 - industrial use; dusttight and driptight sheet-steel case.]

Cast iron for control enclosures shall conform to ASTM A 48/A 48M.

Sheet steel for control enclosures shall be fabricated from commercial quality uncoated carbon steel conforming to ASTM A 366/A 366M.

Control enclosures shall be fabricated from corrosion-resistant, chromium-nickel, steel sheet conforming to ASTM A 167, 300 series, ASM No. 4 finish.

Box dimensions and thickness of steel shall conform to UL 50.

Sheet steel and cast iron enclosures shall be chemically cleaned, phosphatized, and then painted, both interior and exterior, with the manufacturer's standard finish to a minimum dry-film thickness of 2 mils 0.051 millimeter. Enclosure interiors shall be painted white or light gray.

2.5.14 Protective Equipment

Protective devices shall conform to NEMA ICS 1 and shall include a fused circuit switch for each motor controller, a main-line magnetic contactor incorporating undervoltage protection, main overload protection, and motor

overload protection. Two overload relays shall be provided for each 3-phase motor winding. Operation of any protective device (overload, undervoltage, control circuit fuse, or stop pushbutton) shall stop motions. Fuses shall be of the nonrenewable cartridge type. Each hoist shall be provided with undervoltage and overload protection in accordance with NEMA ICS 1. Overload relays of inverse-time characteristics shall be provided. Undervoltage protection shall be provided for cranes of Duty Class C. Overload relays shall be connected in each phase of a 3-phase, ac circuit. Control circuit shall be fused.

2.5.15 Pushbutton Control Stations

Pushbuttons and pushbutton stations for crane control shall be heavy-duty, oiltight, momentary contact devices rated 600 volts with the number of buttons and the marking of identification plates in accordance with NEMA ICS 1. Color code for pushbuttons shall be in accordance with JIC-01.

[Crane shall be floor controlled with pendant pushbutton, suspended from trolley to provide control at point of loading.]

[Crane shall be floor controlled with pendant pushbutton, suspended from crane bridge where indicated to provide control at the distance indicated from the point of loading.]

****
NOTE: The following paragraphs must be included.
****

Unit shall have a pendant-mounted conductor cable with a permanently attached strain-reliever chain or cable integral with the pendant conductor cable.

Pushbutton station shall be grounded to the hoist and crane bridge. Strain-reliever chain or cable shall not be used as a grounding circuit.

Pushbuttons shall be designed to transmit a distinct notch or step feeling to the operator for each pressure or release action on hand-controlled speed points. Pendant pushbuttons shall be legibly and permanently marked and shall be vertically arranged in the following top to bottom grouped order: TROLLEY FORWARD, TROLLEY REVERSE; BRIDGE FORWARD, BRIDGE REVERSE; UP, DOWN; and RESET, STOP. Stop control shall be a red, plastic-covered, mushroom-head button. A pilot light to indicate that power is available shall be furnished integral with the pushbutton cases.

An emergency stop pushbutton and a reset button shall be provided to operate the main line contactor.

Bottom of the control station shall be approximately 48 inches 1220 millimeter above the operating floor level.

A limit switch shall be provided to prevent power being applied to the crane travel motor when the crane track beam is interlocked to a fixed track beam. Operation of the interlock shall be controlled by means of nylon ropes or chains with suspended, unbreakable, insulated handles having a reach and location as indicated. Handles shall be approximately 54 inches 1370 millimeter above the operating floor level.

2.5.16   Limit Switches

Adjustable upper limit switch shall be provided to prevent overtravel of the hook or load block in the hoisting direction. Limit switches shall be arranged to stop the hoist motor and apply the motor brake before reaching the uppermost safe limit of travel. In case of hook overtravel, the motor shall be automatically and momentarily reversed.

Adjustable lower limit switch to stop the hoist motor shall be provided. Motor brake shall be applied when the load hook reaches a predetermined lower limit.

2.6   ELECTRIFICATION SYSTEM

2.6.1   General

Crane, bridge-trolley and hoist wiring, contact conductors, controls, over-current protection, and grounding shall conform to NFPA 70 and to the requirements specified herein.

2.6.2   Safety Contact Conductor System

****

NOTE: Drawings must indicate runways, transfer points, construction details, track layout, clearances, location of power source, and number of hoists to be used with horsepower wattage and full-load rating of each.

****

Electrification system for power distribution from the source of supply to mobile tapoff devices on crane runway and crane bridge shall consist of an approved, 3-wire safety contact conductor system of a type listed in UL Elec Const Dir for the quality of materials and type of service specified.

System shall be complete with unit length conductors, insulating conductor covers, insulators, splices and splice covers, end caps, support brackets and fasteners, current collectors, expansion, isolation and power-interrupting sections, disconnect switch, and conduit and wiring to power takeoff point.

2.6.3   Bridge and Runway Electrification

Maximum voltage drop from the building power takeoff point for the track electrification system to the hoist motor shall not exceed 4 percent, and the equivalent conductance shall not be less than No. 4 American Wire Gage (AWG) copper wire. Size of bridge conductors shall be proportioned to limit the total voltage drop in the conductors to a maximum of 3 percent of the supply voltage when the current on the individual motors is full load.

Short-circuit current rating of conductors shall be not less than 10,000 amperes.

Continuous-current, thermal rating of conductors shall not exceed 140 degrees F 60 degrees C based on an ambient temperature of 86 degrees F 30 degrees C.

2.6.4 Enclosed Safety Type Conductors

Conductors shall be in accordance with MS MIL-C-28546.

2.6.5 Current Collectors

Current collector assembly shall consist of a shoe-type, current collector case mounted on an articulated trolley arm. Assembly shall be dead-front construction of ample current-carrying capacity for the specified equipment. Exposed parts of current collectors shall be grounded and of corrosion-resistant material.

Shoe collector shall be a spring-loaded, sliding contact type with a shoe of hard copper alloy or sintered copper graphite. Shoe shall be mounted in an insulating case of phenolic or urea compound of suitable temperature and insulation quality. Each collector shall be fitted with the required length of extra-flexible No. 10 AWG copper conductor Type SO neoprene cable.

Current collector assembly shall be designed to operate through gaps, splices, and switches and shall be self-centering. System shall include expansion sections for every 150 feet 45720 millimeter for systems using galvanized steel conductors and every 100 feet 30480 millimeter for systems using copper conductors.

Conductors shall be accurately aligned to ensure positive electrical contact between the collector and the conductor.

2.6.6 Electric Cable Reel

****

NOTE: Delete paragraph if cable reel is not required. Reel should be considered for installations where crane complex does not justify an electric conductor system.

****

Cable reel shall be an automatic rewind assembly with the specified length of 3- or 4-wire No. 14 or No. 12 AWG Type SO cable. Reel shall have a replaceable spring motor with adjustable tension and sufficient takeup for the entire cable length. Main shaft shall be carried on permanently lubricated antifriction bearings. Unit shall include a 4-pole bronze brush and collector ring assembly, wired into a safety terminal block. Unit shall be listed in the UL Elec Const Dir. Each reel shall include a guide-roller cable outlet and cable length as follows:

[Cable length shall be not less than [25] [35] [40] [50] feet.]

[Cable length shall be not less than [7600] [10700] [12200] [15300] millimeter.]

[Cable length shall be length as indicated.]

[Cable reel assembly shall include a swivel mount base that will permit the indicated turn in either direction.]

[Cable reel assembly shall be an explosionproof type, furnished with extra grounding ring and color-coded grounding wire to provide an uninterrupted grounding circuit in accordance with NFPA 70, Article 500.]

2.6.7 Disconnect Switch, Conduit, and Wiring

Feed-in boxes for the attachment of feeder conductor to runway conductor shall consist of bus tap connections for terminal lugs without overcurrent protection in a protective enclosure.

Enclosures shall be formed from cast iron, corrosion-resistant steel, or carbon steel with thickness of metal and box dimensions in accordance with UL 857. Seams and joints shall be closed and reinforced with flanges formed of the same material from which the box is made. Box shall be provided with a screwed-on cover plate. Carbon-steel enclosure shall be zinc coated after fabrication with Type SC3 minimum thickness of coating in accordance with ASTM B 633.

Enclosure shall be the same type material and paint finish of NEMA enclosure as specified herein.

Disconnect switch shall be a surface-mounted, heavy-duty, single-throw, air-break, enclosed type conforming to NEMA KS 1 as indicated and as follows:

Disconnect switch shall be [fused] [nonfused].

****
NOTE: The following subparagraph must be included.
****

Switch box shall be installed with centerline 66 inches 1675 millimeter above the finished floor and at the approximate center of the crane runway length.

Conduit between monorail feeder enclosures and disconnect switches and fixed control stations shall be zinc-coated, rigid-steel conduit, couplings, elbows, bends, and nipples conforming to ANSI C80.1. Zinc coating shall be an electrodeposited coating conforming to ASTM B 633.

Building wire for use in conduits, raceways, and wireways in wet or dry locations shall be single-conductor, 600-volt, heat and moisture resistant, Type RHW or THW with a maximum temperature rating of 167 degrees F 75 degrees C, or cross-linked thermosetting polyethylene insulation with a temperature rating of 194 degrees F 90 degrees C.

Wiring in the vicinity of resistors shall employ insulation Types AVA, A, AA, AI, or AIA, as applicable to heat conditions.

Wiring of control and protective panels shall be Type AVB, AVE, or SIS.

Switchboard wire shall run vertically and horizontally only and in such manner that each wire is accessible and firmly supported.

Bus bars shall be made of hard-drawn rectangular copper with silver-plated contact surfaces. Buses shall be rigidly supported and spaced to provide ample room for connecting cables and to prevent arcing.

Wiring, except panel wiring, shall be protected by drained or moisturetight, zinc-coated, rigid conduit. Flexible leads, where required, shall be enclosed in moistureproof flexible steel conduit. Crane complex wiring and conduit shall be arranged for a minimum of wiring during assembly and construction on site. Junction boxes shall be provided, where

practical.

2.6.8 Fungus Resistance

Electrical connections, including terminal and circuit connections, components, and circuit elements, shall be coated with varnish conforming to MS MIL-V-173, except that:

Components and elements inherently inert to fungi or in hermetically sealed housings need not be treated.

Components and elements whose operation will be adversely affected by the application of varnish shall not be treated.

One percent of copper 8-quinolinolate (by weight based on the nonvolatile content of the varnish) may, at the supplier's option, be substituted for the salicylanilide specified in MS MIL-V-173, provided that the varnish conforms to MS MIL-V-173 in all other respects.

2.6.9 Electromagnetic Interference Characteristics

Equipment shall conform to the electromagnetic characteristic requirements and test limits specified in MS MIL-C-28546.

2.7 PAINT FINISH

Crane bridge assembly, trolley and hoist, and electrical and mechanical equipment shall receive a factory-applied paint finish.

Painting shall be in accordance with Section 09970, "Coatings for Steel," Coating System No. 2.

Finish of the crane bridge and the trolley and hoist assembly shall be inspected after erection. Fasteners, welds, abrasions, and handling marks shall be painted in the finish color; brackets and hangers of electrification system shall be painted in the finish color of the track.

****
NOTE: Select general type of color finish.
****

[Color finish of moving parts of crane and trolley and hoist assembly shall be as selected from manufacturer's standard machinery finish colors. Trolley and hoist assembly and crane bridge shall be in contrasting colors. Other steel work shall be painted to match the color of existing adjacent surfaces.]

[Color finish of all moving parts of crane and trolley and hoist assembly shall be of color selected from FED-STD 595. Other steel work shall be painted to match the color of existing adjacent surfaces.]

****
NOTE: Following paragraph must be included.
****

Hook blocks and pendant pushbutton stations shall be brilliant yellow, Color No. 13538, of FED-STD 595. Other steel work shall be painted to match the color of existing adjacent surfaces.

2.8 CRANE IDENTIFICATION PLATES

Identification plates shall be in accordance with MS MIL-C-28546.

PART 3 EXECUTION

3.1 GENERAL

Crane manufacturer shall provide a qualified erection superintendent to supervise the delivery, unloading, assembly, and erection of the crane; to inspect and approve the installation; and to place the crane in operation.

Crane shall be assembled at the factory, properly wired, tested without load, and disassembled only as required for shipment. Each disassembled part shall be matchmarked for field assembly.

Adequate and safe erection equipment and tackle shall be provided as required to mount crane assembly on crane runway.

3.2 CRANE RAILS AND RUNWAYS

Previously erected runway assembly shall be inspected before erection of crane.

Runways shall be level, in straight alignment, and true to span.

Gage tolerance for span shall be plus or minus 1/8-inch 3 millimeter. Runway shall be held to an alignment and elevation tolerance of plus or minus 1/8-inch 3 millimeter.

Joints shall be smooth, level, and in true alignment to offer no obstruction to end truck movement. Welded joints shall be ground smooth.

3.3 ERECTION PROCEDURE

Crane shall be erected in accordance with the manufacturer's printed instructions and as directed by the manufacturer's erection superintendent and in his presence.

Installation drawings shall consist of the following:

General arrangement drawings showing location, floor plan, runway layout, span, capacities, duty class, speeds, building sections, and details of all of the main features of the crane or crane complex; and shall include clearances, lifts, speeds, hook approaches to sides and ends, hook loads, maximum wheel loads, and other simultaneous wheel loads without impact and weight breakdown. Weights, as applicable, shall be shown for: bridge girders and rails only; end trucks complete with wheels, axles, and gears; bridge-driving machinery; trolley complete with rope and blocks; total net weight of the crane assembly. Each assembled integral overhead traveling crane shall be shown in plan, elevation, and end view.

Specific arrangement drawings of the bridge, bridge drive, trolley, trolley drive, and hoisting machinery shall show in plan, section, and elevation, as applicable: gears, reducers, shafts, bearings, couplings, drums, wheels, blocks, rope reeving, and framing. In addition, these drawings shall show, as applicable, controlling dimensions, the load-operating ranges and speeds for all load-carrying

parts, and a description of motors, controllers, limit switches, couplings, brakes, bearings, and similar parts, with a parts list for hoists, transfer cranes, and trolleys. Description shall include, as applicable, time and power ratings, revolutions per minute, service factors, temperature, torque, current characteristics, and manufacturer's model designations. Details shall be provided as required to show dimensions with tolerances at track beams, supports, and girders; surface finishes; hardness-material specification designations; and welding symbols. Welding symbols and instructions for their use shall be in accordance with AWS A2.4.

Drawings indicating the complete electrification system, including: a general drawing of the electrical equipment, raceway conductors, wiring and conduit, showing and identifying electrical equipment, manufacturer's name, model numbers, ratings, ohmic values or resistor segments, wire types and sizes, conduit types and sizes, and diagrams showing connections including manufacturer's panel wiring diagrams with schematics and interconnections of panels, hook-speed and hook-load curves (hoisting and lowering) of controllers for hoist motors, and motor-speed and motor-torque curves for controllers for trolley and bridge travel, all carried to 200 percent of the full rated load.

3.4 FACTORY TESTS BEFORE SHIPMENT

Crane manufacturer shall assemble, wire, and test each overhead crane assembly at the point of manufacture in accordance with the requirements of MS MIL-C-28546.

3.5 EXAMINATION

Examination shall be in accordance with MS MIL-C-28546.

3.6 CRANE TESTS AFTER ERECTION

Completed crane complex, erected, adjusted, lubricated, and made ready for operation, shall be tested by the Contractor in the presence of the Contracting Officer in accordance with MS MIL-C-28546.

3.7 MONORAIL HOIST OPERATION TESTS

Operation tests shall be performed in accordance with MS MIL-C-28546.

3.8 CRANE ELECTRIFICATION SYSTEM FACTORY TESTS

Factory tests on crane electrification systems and associated fittings shall be made in accordance with the applicable provisions of the referenced standards.

Temperature tests, mechanical tests, and dielectric tests shall be in accordance with UL 857. Voltage-drop and short-circuit tests shall be in accordance with "Testing Standards" of NEMA BU 1.

Routine tests shall include dielectric tests on crane electrification system. Certification of dielectric tests shall be submitted and shall show compliance with the referenced standard. Certification test reports shall be provided to the Contracting Officer. Reports shall have a cover letter/sheet clearly marked with the System name, date, and the words "Final Test Reports - Forward to the Systems Engineer/Condition Monitoring Office/Predictive Testing Group for inclusion in the Maintenance Database."

3.9 ON-SITE COMPLEX ELECTRIFICATION SYSTEM TESTS

Crane complex electrification system shall be given continuity tests and insulation tests after the installation has been completed but before equipment is energized.

Contractor shall provide necessary test equipment, labor, and personnel to perform the tests as herein specified. Insulation testing instruments shall consist essentially of a direct-reading ohmmeter and a motor-driven dc generator. Continuity tests shall be conducted using a dc device with bell or buzzer.

Electrification-system equipment shall be completely isolated from all extraneous electrical connections. Substation and switchboard feeder breakers, circuit breakers in panelboards, and other disconnecting devices shall be used to isolate the equipment under test.

Insulation tests on 480-volt equipment shall be conducted using a 1,000-volt, insulation-testing instrument. Readings shall be recorded every minute and until three equal and consecutive readings are obtained. Resistance between phase conductors and between phase conductors and ground shall be not less than 50 megohms.

Insulation tests on equipment, 300 volts or less, shall be conducted using a 500-volt, insulation-testing instrument. Readings shall be recorded after 1 minute or until the reading is constant for 15 seconds. Resistance between phase conductors and between phase conductors and ground shall be not less than 25 megohms.

Test data shall be recorded and shall include location and identification of busway and megohm readings versus time. Final acceptance shall depend upon satisfactory performance under test. No electrification system shall be energized until recorded test data are approved.

Final test reports shall be provided to the Contracting Officer. Reports shall have a cover letter/sheet clearly marked with the System name, Date, and the words "Final Test Reports - Forward to the Systems Engineer/Condition Monitoring Office/Predictive Testing Group for inclusion in the Maintenance Database."

3.10 OPERATION AND MAINTENANCE

Contractor shall submit [6] [_____] copies of the Operation and Maintenance Manuals 30 calendar days prior to testing the electric overhead crane system. Data shall be updated and resubmitted for final approval no later than 30 calendar days prior to contract completion.

-- End of Section --