
USACE / NAVFAC / AFCEA UFGS-14630A (November 2003)

Preparing Activity: USACE

Superseding
UFGS-14630A (May 1993)
UFGS-14601A (April 1994)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated 22 December 2004

Revised throughout - changes not indicated by CHG tags

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SECTION 14630A

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SECTION 14630A

OVERHEAD ELECTRIC CRANES 11/03

NOTE: This guide specification covers the requirements for electric overhead traveling cranes with capacities of 27 metric tons (30 tons) or less, suitable for indoor or outdoor use in hazardous or non-hazardous environments.

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

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

Use of electronic communication is encouraged.

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

PART 1 GENERAL

NOTE: Types of crane covered include (1) top-running bridge and trolley, multiple-girder, with CMAA 70 service class of A through E, (2) top-running bridge/gantry, underhung trolley, single girder, with CMAA 74 service class of moderate, and (3) underhung bridge/gantry and trolley, single-girder, with CMAA 74 service class of moderate. Control types and systems may be specified as follows:

1. Cab or Pendant Crane Controls or a combination of the two can be provided.

2. Alternating current or dc control systems can be specified.

Crane Terminology:

a. Top-running [bridge][gantry] is a [bridge][gantry] which travels on the top surface of rails of a fixed runway structure.

b. Top-running Trolley is a trolley which travels on the top surfaces of rails of the [bridge][gantry] girder(s).

Overhead or Gantry: Throughout the guide specification is the following: "[bridge][gantry]". For an overhead crane, select "bridge" and for a gantry crane, select "gantry".

1.1 REFERENCES

NOTE: Issue (date) of references included in project specifications need not be more current than provided by the latest guide specification. Use of SpecsIntact automated reference checking is recommended for projects based on older guide specifications.

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

AMERICAN GEAR MANUFACTURERS ASSOCIATION (AGMA)

AGMA 2000	(1988; Rev A) Gear Classification and Inspection Handbook Tolerances and Measuring Methods for Unassembled Spur and Helical Gears (Including Metric Equivalents)
AGMA 2001	(1995; Rev C) Fundamental Rating Factors and Calculation Methods for Involute Spur and Helical Gear Teeth
AGMA 390.03A	(1980; Errata 1983; R 1988) Gear Handbook Gear Classification, Materials and Measuring Methods for Bevel, Hypoid, Fine Pitch Wormgearing and Racks Only as Unassembled Gears (Partially replaced by AGMA 2000-A)
AGMA 6010	(1997; Rev F) Standard for Spur, Helical, Herringbone, and Bevel Enclosed Drives
AGMA 6019	(1989; Rev E) Gearmotors Using Spur, Helical, Herringbone, Straight Bevel, or

Spiral Bevel Gears

AGMA 6021 (1989; Rev G) Shaft Mounted and Screw Conveyor Drives Using Spur, Helical and Herringbone Gears

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC 316 (1989) ASD Manual of Steel Construction

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 90.1 (2001; various Errata) Energy Standard for Buildings Except Low-Rise Residential Buildings

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M (2004) Structural Welding Code - Steel

AWS D14.1 (1997) Welding Industrial and Mill Cranes and Other Material Handling Equipment

ASME INTERNATIONAL (ASME)

ASME B30.16 (2003) Overhead Hoists (Underhung)

ASME B30.17 (2003) Overhead and Gantry Cranes (Top Running Bridge, Single Girder, Underhung Hoists)

ASME B30.2 (2002) Overhead and Gantry Cranes (Top Running Bridge, Single or Multiple Girder, Top Running Trolley Hoist)

ASME HST-1 (1999; R 2004) Electric Chain Hoists

ASME HST-2 (1999; R 2004) Hand Chain Manually Operated Chain Hoists

ASME HST-3 (1999; R 2004) Manually Lever Operated Chain Hoists

ASME HST-4 (1999; R 2004) Overhead Electric Wire Rope Hoists

ASME HST-5 (1999; R 2004) Air Chain Hoists

ASME HST-6 (1999) Air Wire Rope Hoists

ASME NOG-1 (2002) Rules for Construction of Overhead and Gantry Cranes (Top Running Bridge, Multiple Girder)

ASTM INTERNATIONAL (ASTM)

ASTM A 159 (1983; R 2001) Automotive Gray Iron Castings

ASTM A 325	(2004b) Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
ASTM A 325M	(2004b) Structural Bolts, Steel, Heat Treated, 830 Mpa Minimum Tensile Strength (Metric)
ASTM A 490	(2004a) Structural Bolts, Alloy Steel, Heat Treated, 150 ksi Minimum Tensile Strength
ASTM A 490M	(2004a) High-Strength Steel Bolts, Classes 10.9 and 10.9.3, for Structural Steel Joints (Metric)
ASTM A 668/A 668M	(2004) Steel Forgings, Carbon and Alloy, for General Industrial Use
ASTM B 438	(1995a ¹) Sintered Bronze Bearings (Oil-Impregnated)
ASTM B 439	(2000e ¹) Iron-Base Sintered Bearings (Oil-Impregnated)
ASTM B 612	(2000) Iron Bronze Sintered Bearings (Oil-Impregnated)
ASTM B 633	(1998e ¹) Electrodeposited Coatings of Zinc on Iron and Steel
ASTM E 125	(1963; R 2003) Photographs for Magnetic Particle Indications on Ferrous Castings

CRANE MANUFACTURERS ASSOCIATION OF AMERICA (CMAA)

CMAA 70	(2004) EnviroTop Running and Bridge and Gantry Type Multiple Girder Electric Overhead Traveling Cranes, No. 70
CMAA 74	(2004) Top Running and Under Running Single Girder Electric Overhead Cranes Utilizing Under Running Trolley Hoist, No. 74

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ICS 2	(2000) Industrial Controls and Systems: Controllers, Contactors, and Overload Relays Rated Not More than 2000 Volts AC or 750 Volts DC
NEMA ICS 6	(1993; R 2001) Industrial Control and Systems: Enclosures
NEMA MG 1	(2003) Motors and Generators

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70 (2005) National Electrical Code

UNDERWRITERS LABORATORIES (UL)

UL 1004 (1994; Rev thru Feb 2001) Electric Motors

UL 1449 (1996; Rev thru Jul 2002) Transient
Voltage Surge Suppressors

UL 489 (2002; Rev thru May 2003) Molded-Case
Circuit Breakers, Molded-Case Switches,
and Circuit-Breaker Enclosures

UL 50 (1995; Rev thru Sep 2003) Enclosures for
Electrical Equipment

UL 943 (1993; Rev thru Feb 2004) Ground-Fault
Circuit-Interrupters

1.2 SUBMITTALS

NOTE: Submittals must be limited to those necessary for adequate quality control. The importance of an item in the project should be one of the primary factors in determining if a submittal for the item should be required.

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

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

Submittal items not designated with a "G" are considered as being for information only for Army projects and for Contractor Quality Control approval for Navy projects.

Government approval is required for submittals with a "G" designation;

submittals not having a "G" designation are [for Contractor Quality Control approval.][for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government.] The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Electric Overhead Cranes[; G][; G, [____]]

Detail drawings containing complete wiring and schematic diagrams. Diagrams shall indicate each numbered wire, where wire initiates, where wire terminates, and any other details required to demonstrate that the system has been coordinated and will properly function as a unit. Drawings shall show layout and anchorage of equipment and appurtenances, and equipment relationship to other parts of the work including clearances for maintenance and operation.

SD-03 Product Data

Crane Design Criteria

A complete list of equipment and materials, including manufacturer's descriptive data and technical literature, performance charts and curves, catalog cuts, and installation instructions.

Hooks

Hook material and any heat treatment performed, stamped on the hook shank or documented in certification papers furnished with the hooks. Crane test data recorded on appropriate test record forms suitable for retention for the life of the crane.

Electric Overhead Cranes

A complete list of equipment and materials, including manufacturer's descriptive data and technical literature, performance charts and curves, catalog cuts, and installation instructions.

Spare Parts

Spare parts data for each different item of material and equipment specified, after approval of the detail drawings and not later than [____] months prior to the date of beneficial occupancy. The data shall include a complete list of parts and supplies, with current unit prices and source of supply.

Framed Instructions

Diagrams, instructions and safety requirements.

SD-06 Test Reports

Acceptance Testing

Test reports in booklet form showing all field tests performed

to adjust each component and all field tests performed to prove compliance with the specified performance criteria, upon completion and testing of the installed system. The report shall include the information as required by paragraph ACCEPTANCE TESTING.

SD-10 Operation and Maintenance Data

Electric Overhead Cranes[; G][; G, [____]]

[Six] [____] copies of operation and [six] [____] copies of maintenance manuals for the equipment furnished. One complete set prior to performance testing and the remainder upon acceptance. Operation manuals shall detail the step-by-step procedures required for system startup, operation and shutdown. Operation manuals shall include the manufacturer's name, model number, parts list, and brief description of all equipment and basic operating features. Maintenance manuals shall list routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guides. Maintenance manuals shall include piping and equipment layout and simplified wiring and control diagrams of the system as installed. Operation and maintenance manuals shall be approved prior to the field training course.

1.3 QUALIFICATION

Electric overhead cranes shall be designed and manufactured by a company with a minimum of 10 years of specialized experience in designing and manufacturing the type of overhead crane required to meet requirements of the Contract Documents.

1.4 TESTING AND INSPECTIONS

1.4.1 Pre-Delivery Inspections

Contractor shall be responsible for performance of quality control inspections, testing and documentation of steel castings, hook assembly and nuclear safety as follows.

1.4.2 Inspection of Steel Castings

Load-carrying steel castings shall be visually inspected and tested using the magnetic-particle inspection method. Allowable degree of discontinuities shall be referenced to ASTM E 125, and shall be related to service loads and stresses, critical configuration, location and type. Methods of repairing the discontinuities shall be subject to review by the Contracting Officer.

1.4.3 Inspection of Hook Assembly

Hook and nut shall be inspected by a magnetic-particle type inspection or X-rayed prior to delivery. Documentation of hook inspection shall be furnished to Contracting Officer at the field operational testing. As part of the acceptance standard, linear indications will not be allowed. Welding repairs of hook will not be permitted. A hook showing linear indications, damage or deformation will not be accepted, and shall be replaced.

1.4.4 Nuclear Safety Analysis

NOTE: Certification is required for cranes handling nuclear materials. Results from the Safety Analysis will be utilized by the Using Agency as a basis for bridge crane certification. Delete this paragraph if the crane is not required to handle nuclear materials.

Nuclear certification, testing, and rules of construction shall be in accordance with ASME NOG-1. Contractor shall submit analysis and test reports to Contracting Officer for approval.

1.5 DESIGN CRITERIA

NOTE: The area of hook coverage, runway dimensions, rail size, hook vertical travel, clear hook height and lifting capacity will be clearly shown on drawings.

Cranes shall operate in the given spaces and shall match the runway dimensions and rails indicated. Hook coverage, hook vertical travel, clear hook height, lifting capacity, and load test weight shall not be less than that indicated.

1.5.1 General

NOTE: Add number of cranes, building name and crane rated load capacity (tonnage). The last sentence may be deleted if only 1 hoist system is in project.

The hoisting equipment shall include the following: Number of cranes [____], located in building name [____], with a number of [____] metric tons tons, electric overhead traveling crane. The Contractor shall assure that the manufacturer supplying the hoist equipment in Section [____] is also the manufacturer supplying the hoist equipment in this section.

1.5.1.1 Welding

Welding shall be in accordance with qualified procedures using AWS D14.1 as modified. Written welding procedures shall specify the Contractor's standard dimensional tolerances for deviation from camber and sweep and such tolerances shall not exceed those specified in AWS D14.1. All welding shall be performed indoors. Welders and welding operators shall be qualified in accordance with AWS D1.1/D1.1M or AWS D14.1. Allowable stress values shall be in accordance with CMAA 70.

1.5.1.2 Crane Design Criteria

The cranes shall be designed to operate in the spaces and match the runway dimensions and rails indicated. The hook coverage and hook vertical travel shall not be less than that indicated.

1.5.2 Classification

NOTE: The CMAA 74 specification covers a service classification of moderate industrial service equivalent to CMAA 70 Class C service. Select a moderate service for girder cranes. Refer to NFPA 70 for environmental requirements. Make a selection from the following CMAA 70 service classifications:

1. Class A (Standby or Infrequent Service): This service covers cranes which may be used in installations such as powerhouses, public utilities, turbine rooms, motor rooms and transformer stations where precise handling of equipment at slow speeds with long, idle periods between lifts are required. Capacity loads may be handled for initial installation of equipment and for infrequent maintenance.
2. Class B (Light Service): This service covers cranes which may be used in repair shops, light assembly operations, service buildings, light warehousing, etc., where service requirements are light and the speed is slow. Loads may vary from no load to occasional full rated loads with 2 to 5 lifts per hour, averaging 3 m (10 feet) per lift.
3. Class C (Moderate Service): This service covers cranes which may be used in machine shops of paper mill machine rooms, etc., where service requirements are moderate. In this type of service the crane will handle loads which average 50 percent of the rated capacity with 5 to 10 lifts per hour, averaging 4.5 m (15 feet), not over 50 percent of the lift at rated capacity.
4. Class D (Heavy-Duty): This service covers cranes which may be used in heavy machine shop, foundries, fabricating plants, steel warehouses, container yards, lumber mills, etc., and standard duty bucket and magnet operations where heavy-duty production is required. In this type of service, loads approaching 50 percent of the rated capacity will be handled constantly during the working period. High speeds are desirable for this type of service with 10 to 20 lifts per hour averaging 4.5 m (15 feet), not over 65 percent of the lifts at rated capacity.
5. Class E (Severe Service): This type of service requires a crane capable of handling loads approaching rated capacity throughout its life. Applications may include magnet, bucket, magnet/bucket combination cranes for scrap yards, cement mills, lumber mills, fertilizer plants, container handling, etc., with 20 or more lifts per hour at or near the rated capacity.

6. Class F (Continuous Severe Service): This type of service requires a crane capable of handling loads approaching rated capacity continuously under severe service conditions throughout its life. Applications may include custom designed specialty cranes essential to performing the critical work tasks affecting the total production facility. These cranes must provide the highest reliability with special attention to ease of maintenance features.

Crane shall be designed and constructed to [CMAA 70 Class [____], [____] service] [CMAA 74 moderate service] requirements for operation in [indoor] [outdoor] [hazardous] [non-hazardous] environment with hoist in accordance with [ASME HST-1] [ASME HST-2] [ASME HST-3] [ASME HST-4] [ASME HST-5] [and] [ASME HST-6].

1.5.3 Rated Capacity and Speeds

NOTE: Select rated speed under full load for the main hoist, auxiliary hoist (if specified) [bridge] [gantry] and trolley from the following: (Speeds are in meters per second (feet per minute)). In the following tabulations, the slow speeds apply to Class A and B service, the medium speeds to Class C and D service, and the fast speeds to Class E service. Speeds are in millimeters per second or feet per minute.

1. FLOOR OPERATED INDUSTRIAL CRANES (meters per second)

RATED		HOIST			TROLLEY			[BRIDGE] [GANTRY]	
LOAD	Slow	Medium	Fast	Slow	Medium	Fast	Slow	Medium	Fast
4.5	0.10	0.15	0.25	0.25	0.38	0.51	0.51	0.76	0.89
9	0.08	0.13	0.18	0.25	0.38	0.51	0.52	0.76	0.89
14	0.08	0.10	0.13	0.25	0.38	0.51	0.51	0.76	0.89
18	0.08	0.10	0.13	0.25	0.38	0.51	0.51	0.76	0.89
23	0.05	0.10	0.13	0.25	0.38	0.51	0.38	0.51	0.76
27	0.05	0.08	0.13	0.25	0.38	0.51	0.38	0.51	0.76

1. FLOOR OPERATED INDUSTRIAL CRANES (feet per minute)

RATED		HOIST			TROLLEY			[BRIDGE] [GANTRY]	
LOAD	Slow	Medium	Fast	Slow	Medium	Fast	Slow	Medium	Fast
5	20	30	50	50	75	100	100	150	175
10	15	25	35	50	75	100	100	150	175
15	15	20	25	50	75	100	100	150	175
20	15	20	25	50	75	100	100	150	175
25	10	20	25	50	75	100	75	100	150

1. FLOOR OPERATED INDUSTRIAL CRANES
(feet per minute)

RATED	HOIST			TROLLEY			[BRIDGE]		[GANTRY]
LOAD	Slow	Medium	Fast	Slow	Medium	Fast	Slow	Medium	Fast
30	10	15	25	50	75	100	75	100	150

2. CAB OPERATED INDUSTRIAL CRANES
(meters per second)

RATED	HOIST			TROLLEY			[BRIDGE]		[GANTRY]
LOAD	Slow	Medium	Fast	Slow	Medium	Fast	Slow	Medium	Fast
9	0.15	0.30	0.46	0.64	0.76	1.02	1.02	1.52	2.03
14	0.15	0.23	0.30	0.64	0.76	1.02	1.02	1.52	2.03
18	0.10	0.15	0.20	0.84	0.76	1.02	1.02	1.52	2.03
23	0.08	0.13	0.15	0.51	0.76	1.02	1.02	1.52	2.03
27	0.08	0.13	0.15	0.51	0.76	1.02	1.02	1.52	1.78

2. CAB OPERATED INDUSTRIAL CRANES
(feet per minute)

RATED	HOIST			TROLLEY			[BRIDGE]		[GANTRY]
LOAD	Slow	Medium	Fast	Slow	Medium	Fast	Slow	Medium	Fast
10	30	60	90	125	150	200	200	300	400
15	30	45	60	125	150	200	200	300	400
20	20	30	40	125	150	200	200	300	400
25	15	25	30	100	150	200	200	300	400
30	15	25	30	100	150	200	200	250	350

3. Auxiliary hoist may be specified for handling light loads (typically 10 to 30 percent of main hoist rated load) at 2 to 4 times the main hoist speed. Micro-drive should be specified if precise handling and position are required. Micro-drive is a single speed drive normally driving the crane at 5 mm/s (1 fpm) or less. Delete reference to micro-drive and auxiliary hoist if not applicable.

Rated capacity of crane shall be [_____] metric tons ([_____] tons). [_____] tons. Auxiliary hoist capacity shall be [_____] metric tons ([_____] tons). [_____] tons. Lower load block or assembly of hook, swivel bearing sheaves, pins and frame suspended by the hoisting ropes shall not be considered part of the rated capacity. Rated speeds (in meters per second (feet per minute) feet per minute) for the hoist, hoist micro-drive, bridge micro-drive, trolley micro-drive, [bridge] [gantry] and trolley at the rated load shall be as follows:

Description	Rated Speeds		
	[meters per second]	[feet per minute]	
	Minimum	Maximum	Micro-drive
Main Hoist	[_____]	[_____]	[_____].
[Auxiliary Hoist]	[_____]	[_____]	[_____].
Trolley	[_____]	[_____]	[_____].
[Bridge] [Gantry]	[_____]	[_____]	[_____].

1.6 DELIVERY AND STORAGE

Equipment delivered and placed in storage shall be stored with protection from the weather, humidity and temperature variations, dirt and dust, and other contaminants.

1.7 FIELD MEASUREMENTS

Before performing any work, Contractor shall become familiar with all details of the work, verify all dimensions in the field, and submit a letter describing the results of this verification including discrepancies to the Contracting Officer and crane manufacturer.

1.8 STABILITY

**NOTE: Applicable only if the crane is a gantry,
otherwise delete paragraph.**

The gantry crane shall have a minimum factor of safety of 1.25 against overturning under each condition of loading stated in paragraph 3.3.2.4 of CMAA 70. Counterweights shall be provided if necessary to obtain the required stability.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 General

Materials and equipment shall be standard products of manufacturers regularly engaged in the fabrication of complete and totally functional cranes including necessary ancillary equipment.

2.1.2 Nameplates

**NOTE: Delete identification plates if only one
bridge crane/gantry is required.**

Nameplates shall be secured to each major component of equipment with the manufacturer's name, address, type or style, model or catalog number, and serial number. Two bridge identification plates shall be provided, one for each side of bridge. Identified plates shall be noncorrosive metal with letters which are easily read from the floor, showing a separate number such as BC-1, BC-2, for each bridge crane.

2.1.3 Use of Asbestos Products

Materials and products required for designing and manufacturing cranes shall not contain asbestos.

2.1.4 Capacity Plates

Two capacity plates indicating the crane capacity in metric tons and tons are required, one secured to each side of bridge. Each capacity plate shall be fabricated of a steel backing plate and exterior quality/fade-resistant stick-on labels with letters large enough to be easily read from the floor. Capacity plates shall be placed in a location visible to pendant operator's position after the crane has been installed.

2.1.5 Safety Warnings

Readable warning labels shall be affixed to each lift block or control pendant in a readable position in accordance with ASME B30.16, ASME B30.2 and ASME B30.17. The word "WARNING" or other legend shall be designed to bring the label to the attention of the operator. Warning labels shall be durable type and display the following information concerning safe-operating procedures: Cautionary language against lifting more than the rated load; operating the hoist when the hook is not centered under the hoist; operating hoist with twisted, kinked or damaged rope; operating damaged or malfunctioning hoist; operating a rope hoist with a rope that is not properly seated in its hoist drum groove; lifting people; lifting loads over people; and removing or obscuring the warning label. The Contractor shall submit these safety warnings, diagrams and other framed instructions for display as indicated by the Contractin Officer.

2.1.5.1 Directional Arrows

To avoid operation of crane in the wrong direction, the words "FORWARD" and "REVERSE" and accompanying directional arrows shall be affixed in a location on the trolley and bridge which are visible and readable to the operator from pendant station. The words "FORWARD" and "REVERSE" shall agree with the markings on control pendant. Directional arrows shall not be indicated on control pendant.

2.2 STRUCTURAL MATERIALS

2.2.1 Bolts, Nuts and Washers

High-strength bolted connections shall utilize SAE Grade 5 bolts with corresponding lockwashers, nuts, etc., conforming to requirements of AISC 316 bolts. Bolts, nuts and washers shall conform to ASTM A 325M ASTM A 325 bolts. Galvanized bolts are not acceptable. ASTM A 490M ASTM A 490 bolts shall not be used.

2.2.2 [Bridge] [Gantry] Girder or Girders

NOTE: Specify welded structural steel box sections
for multiple girder cranes Class C, D, or E with a
capacity greater than 18 metric tons (20 tons) or a
span greater than 12 m (40 feet).

Bridge girders shall be [welded structural steel box sections] [wide flange beams, standard I-Beams, reinforced beams or sections fabricated from rolled plates and shapes].

2.2.3 Bridge Rails or Bars

**NOTE: Remove this paragraph for underhung cranes
and cranes having a capacity less than 18 metric
tons (20 tons) (many crane manufacturers do not need
or want rails or bars).**

Trolley runway rails, crane girders and other sections shall be straight and true. When loaded with motor driven cranes the deflection of rails shall not exceed 1/800 of the span. The deflection shall be calculated with the worst case of two loaded bridge cranes located adjacent each other. Rail joints shall be flush and true without misalignment of running tread and shall be designed to minimize vibration. The gap between adjacent rail ends and the vertical misalignment of running treads shall not exceed 1.588 mm 0.0625 inch. The bridge rail shall be leveled to a plus-or-minus 3 mm 1/8 inch at all rail support joints. Bridge rail shall be fastened to [top cover plate] [wide flange] or centered on flange or offset near web plate for welded box sections, complete with welded clips. Bridge rail joints shall be bolted using standard joint bars. Rail joints shall be staggered. A positive stop shall be provided at bridge rail ends to prevent creep.

2.2.4 End Ties and [Bridge] [Gantry] Girder End Connections

**NOTE: Specify end ties for cranes with more than 4
wheels. Specify welded structural steel box
sections for multiple-girder cranes Class C, D, or E
with a capacity greater than 18 metric tons (20
tons) or a span greater than 12 m (40 feet).**

Welded steel box sections shall be used for end ties, full depth diaphragms shall be provided at girder connections and jacking points. Horizontal gusset plates shall be provided at the elevation of top and bottom end tie flanges for connection to girder ends. End connections shall be made with high-strength bolts. Body-bound bolts fitted in drilled and reamed holes shall be used to maintain the crane square.

2.2.5 Bridge End Trucks

End trucks shall be the rotating or fixed axle type fabricated of structural tubes or from structural steel to provide a rigid box section structure. Jacking pads shall be provided for removal of wheel assemblies.

2.2.6 Trolley Frame

**NOTE: Trolley frame is applicable only to multiple
girder cranes.**

Trolley frame shall consist of two structural steel side frames or trucks

welded together with one or more structural steel load girts to form a one-piece unit. Pads shall be provided for the use of jacks or wedges when changing truck wheels. All trolley yokes and load bars shall be of drop forged, cast or rolled steel.

2.2.7 Stops and Bumpers

NOTE: Rubber bumpers dry out with time. Hydraulic type bumpers are more expensive. Using the words shock-absorbing allows the manufacturer to choose. Rubberlike materials are not acceptable as an option.

Crane runways and bridge girders shall be fitted with structural steel end stops. Bridge end trucks and trolley frames shall be fitted with shock-absorbing, [spring] [or] [hydraulic] type bumpers capable of decelerating and stopping the bridge and/or trolley within the limits stated by OSHA and MHI CMAA. Trolley end stops shall be of sufficient strength to withstand the impact of a fully loaded trolley moving at 50 percent of maximum rated travel speed. When two bridge cranes are on the same runway, one crane shall be fitted with shock-absorbing bumpers on each end of each end-truck, and the other crane shall have shock-absorbing bumpers as per above on one end only of each end-truck which is the opposite end of the adjacent crane. The other end of the end-truck shall be fitted with a structural steel stop to engage the bumpers of the adjacent crane. Bridge bumper stops shall be provided as specified in Section 05120 STRUCTURAL STEEL. Stops shall be located to permit maximum [bridge] [gantry] and trolley travel.

2.2.8 Footwalks

NOTE: Delete the following paragraph if double-girder cranes are not required. Footwalk fall protection shall be provided with guard rails or static line with safety belts.

The location and construction of footwalks shall be in accordance with ASME B30.2. A full-length structural platform is required on the driver's side of the bridge. The platform shall be checkered steel flooring, double member handrail and a suitable toe-guard, with 760 mm 30 inch clearance in front of control equipment. Minimum 380 mm 15 inch clearance is required in front of bridge machinery. [To give access to the opposite side of the trolley, [bridge] [gantry] conductors, or other equipment, a footwalk twice the length of the trolley, shall be mounted on the opposite side of the crane. A cross-over footwalk shall be provided over an end tie between the two girder footwalks.] The drive side footwalk shall mate with the crane access platform. The length of the drive side footwalk shall be [adequate to provide access to the trolley and provide sufficient room for mounting control cabinets] [along the entire length of the [bridge] [gantry]]. Safety handrails shall be provided for footwalks.

2.2.9 Runway Rails

The runway rail size shall be as recommended by crane manufacturer.

2.2.10 Operator's Cab

NOTE: Applicable if a cab is specified, otherwise delete paragraph. Specify enclosed cab for outdoor use. Open cab may be used indoors. Enclosed cabs can be provided with a heating and/or air conditioning unit according to environmental conditions. Specify the location of cab and the direction the operator should face.

2.2.10.1 Design

Operator's cab shall be designed and constructed in accordance with [CMAA 70] [CMAA 74] and ASME B30.2. Location of cab access shall be easily accessed by crane operator. Cab shall have space near cab entrance for storage of a carbon-dioxide, dry chemical, or equivalent hand fire extinguisher.

2.2.10.2 Cab Construction

Cab shall be [fixed cab mounted on bridge] [trolley mounted cab] of the [enclosed] [open] type for [outdoor] [indoor] use, and designed to provide a clear view of the operating floor and hook for operator. Cab shall be provided with a suitable [heating] [heating and air conditioning] unit. Cab shall be located on the [_____] of the [bridge] [trolley] with the operator facing [_____].

2.2.11 Additional Provisions for Outside Service

NOTE: This paragraph is applicable for outdoor cranes only.

Welded structural members on outdoor cranes shall be seal welded. Crane bridges shall be provided with parking brakes which will sufficiently hold the crane against a wind pressure of 244 Pa 5 psf for in-service conditions. Crane bridges shall be provided with manually-operated pin locks at each rail, designed to securely anchor the crane against a wind pressure of 1.5 kPa 30 psf for out-of-service conditions.

2.3 MECHANICAL EQUIPMENT

2.3.1 Drives

2.3.1.1 [Bridge] [Gantry] Drives

NOTE: If the span is less than 12 m (40 feet) and the application is MHI CMAA Class "A" or "B", then A-1 drive may be included as an option.

[Bridge] [Gantry] drives shall be [either the A-1 or] [A-4] drive arrangement as specified in CMAA 70 or CMAA 74. Bridge drive shall consist of a single electric motor mechanically connected through gear reduction and drive shafts to the drive wheels or separate drive motors at each end

of bridge. Acceleration and deceleration shall meet the requirements specified in this section. Gears shall conform to applicable AGMA standards. Gear reducers shall be oil tight and fully enclosed with pressure or splash type lubrication. Bridge-travel limit-switches are optional.

2.3.1.2 Trolley Drives

Trolley shall be complete with a drive arrangement with a minimum of two wheels driven by an integral electric motor. Drive mechanism shall run in totally enclosed oil bath. Limit switches are optional for drive mechanism. Acceleration and deceleration controls shall meet requirements specified in this section.

2.3.1.3 Micro-Drives

NOTE: Include those motions where a micro-drive is required. If micro-drive is not specified, delete these paragraphs. Micro-drives are generally required when slow speeds are required for an extended amount of time. If precision movement is required for limited time for final positioning of loads, use adjustable frequency or dc variable voltage crane controls instead of micro-drives.

The following crane motions shall be provided with a separate micro-drive: [main hoist], [auxiliary hoist], [trolley drive] [and] [bridge drive]. The micro-drives shall be used to precisely position loads. Each micro-drive shall consist of an electric motor, gear reducer, magnetic coupling clutch and necessary controls. The output shaft of the reducer shall be connected to an extension of the primary drive high-speed shafting with a magnetic coupling clutch. Coupling shall normally be disengaged and shall be engaged only if the micro-drive is required. Electrical clutch components required for proper operation shall conform to the requirements specified in paragraph ELECTRICAL COMPONENTS. Clutches shall be the magnetic coupling type, and shall engage and disengage the micro-drives from the high speed shafts of the main drive arrangement. The clutch shall be engaged by electromagnet and released by springs. Clutch ratings shall be not less than 150 percent of the micro-motor rated torque as amplified by the intervening gearing. Clutch enclosures shall facilitate easy access for wear inspection of the friction elements and visual examination of the clutch assemblies.

2.3.2 Load Blocks

2.3.2.1 Main and Auxiliary Hoist Load Blocks

Load blocks shall be of welded steel construction. Load blocks shall be provided with hot-rolled or forged steel fixed crosshead separate from the sheave pin with swivel mounting for forged steel hook. Each lubrication fitting for sheave pins shall be an independent type recessed within the sheave pin or adequately guarded to prevent damage. The pitch diameter of the sheaves shall be not less than 16 times the rope diameter. Sheaves shall be supported by roller type bearings on steel sheave pins. Provisions for external lubrication shall be provided to allow pressure relief and purging of old grease. Sheave blocks shall be constructed to provide maximum personnel safety and to prevent the hoist rope from leaving

the sheaves under normal operating condition.

2.3.2.2 Hook Assembly

NOTE: If specific hook dimensions are provided in
the drawings, include the appropriate sentence;
otherwise manufacturer's standard hook will be
provided. If hooks are required to be disassembled
and inspected, include appropriate sentence.

Hooks shall be single barbed and shall be made of forged steel complying with ASTM A 668/A 668M Hook dimensions shall be as shown. Hooks shall be fitted with safety latches designed to preclude inadvertent displacement of slings from the hook saddle. Painting or welding shall not be performed on the hook. Hook nut shall be secured with a removable type set screw or other similar fastener, but shall not be welded. Hooks shall be designed and commercially rated with safety factors in accordance with MHI CMAA. The hook shall be free to rotate through 360 degrees when supporting the rated load.

2.3.3 Hoisting Ropes

Hoisting ropes shall be regular lay, preformed, uncoated, improved plow steel, 6 by 37 construction, with independent wire rope core. Ropes shall be suited to meet the service requirements. Rope socketing or U-bolt clip connections shall be made in accordance with clip or rope manufacturer's recommendation, and shall be equal to or greater than the rope strength. Hoisting ropes shall be the rated capacity load plus the load block weight divided by the number of rope parts, and shall not exceed 20 percent of the certified breaking strength of rope. Hoisting ropes shall be secured to hoist drum so that no less than two wraps of rope remain at each anchorage of hoist drum at the extreme low position (limit switch stop).

2.3.4 Sheaves

NOTE: Sheaves are used in the reaving similar to
pulleys and are not required on single reaved hoist.

Sheaves shall be of cast, forged, rolled, or welded structural steel. Sheave grooves shall be accurately machined, smoothly finished and free of surface defects.

2.3.5 Hoist Drums

Hoist drums shall be of welded rolled structural steel, cast steel, or seamless steel pipe. Drums shall be machined and provided with right-hand and left-hand grooves to take the full run of cable for the required lift without overlapping, plus a minimum of two full wraps of cable when load is on floor. At least one groove shall remain unused when hook is at the highest position. Drum grooves shall be cut from solid stock and have sufficient depth for size of cable required. Drum flanges shall be guarded so that the cable cannot wedge between drum flange and hoist frame.

2.3.6 Gearing

Gearing shall be of the enclosed gear reducers type. Gears and pinions shall be spur, helical, or herringbone type only, and shall be forged, cast or rolled steel; open-type gearing is not acceptable. Gears and pinions shall have adequate strength and durability for the crane service class and shall be manufactured to AGMA 2001 Quality Class 6 or better precision per [AGMA 390.03A] [AGMA 2000].

2.3.6.1 Gear Reducers

Gear reducers shall be standard items of manufacturers regularly engaged in the design and manufacture of gear reducers for Class D and G cranes or shall be integral components of standard hoists or hoist/trolley units of manufacturers regularly engaged in the design and manufacture of hoists or hoist/trolley units for Class A, B or C cranes. Gear reducers shall be designed, manufactured and rated in accordance with AGMA 6010, AGMA 6019, or AGMA 6021 (for trolley drives only), as applicable. Except for final reduction, the gear reduction units shall be fully enclosed in oil-tight housing. Gearing shall be designed to AGMA standards and shall operate in an oil bath. Operation shall be smooth and quiet.

2.3.6.2 Open Gearing

All gears and pinions shall have adequate strength and durability for the crane service class and manufactured to AGMA 2001 quality class 6 or better precision per [AGMA 390.03A] [AGMA 2000]. Open gears shall be enclosed with safety guards provided with openings with covers for inspection and access for grease lubrication.

2.3.7 Brakes

Brakes shall be of the shoe, disc, or conical type with thermal capacity suitable for class and service specified in this section. Shoe, disc, and conical brakes shall be spring-set and electrically-released by a continuously rated direct acting magnet. Brakes shall be self-aligning and provide for easy adjustment for torque setting and lining wear. Brake lining material shall be asbestos free. Brake wheels shall be cast iron conforming to ASTM A 159 or shall be the manufacturer's standard high-strength ductile cast-iron, provided that the material exhibits wear characteristics in the form of powdered wear particles and is resistant to heat-checking. Disc brakes shall be totally enclosed and have multiple discs with stationary releasing magnets. Brake torque shall be easily adjustable over a 2:1 torque range.

2.3.7.1 Hoist Holding Brakes

NOTE: If non-critical loads are handled, one hoist holding brake with a torque rating of 150 percent of motor full load torque should be specified. If critical or hazardous loads are handled, two holding brakes with a torque rating of 125 percent of motor full load torque should be specified. Specify two holding brakes for DC control systems.

Each hoist shall be equipped with at least [1] [2] holding brakes. Holding brake shall be disc, shoe, or conical design, applied to one of the

following: motor shaft or gear reducer shaft or rope drum. Braking system shall be designed to have zero hook lowering motion when a raise motion is initiated. Primary brake shall be a spring-set, electrically-released, disc, shoe, or conical type brake. Brake shall have a minimum torque rating of 150 percent of motor torque. Brake shall be capable of holding the rated load with zero hook drift. Primary brake shall be automatically set when controls are released or when power is interrupted. Provisions shall be made to facilitate easy brake adjustment. Hoists shall be furnished with mechanical-control braking or a power-control braking system. Typical power means include dynamic lowering, eddy-current braking, counter-torque, regenerative braking, variable frequency, and adjustable or variable voltage.

2.3.7.2 Hoist Control Brake

NOTE: Mechanical load brake shall be allowed only in MHI CMAA Class "A", "B" or "C" applications with less than 6 m (20 foot) maximum lift height. Mechanical load brakes provide poor control characteristics under light loads relative to rated load. Electrically controlled system breaking will be used in MHI CMAA Class "D" and "E" applications.

[Each hoist shall be equipped with an integral mechanical load brake of the "Weston" type or multiple-disc type. Multiple disc-type brake shall be provided with external adjustment for wear.] [Each hoist shall be provided with electrically-controlled braking system to prevent overspeeding.]

2.3.7.3 Trolley Brake

NOTE: 1. Coordinate selection of motor type with selection of control type.

2. Select applicable ac or dc control system.

3. Include micro-drive motors if micro-drive motors are specified; otherwise delete.

4. If micro-drive is specified include clutches; otherwise delete.

5. If dc control system specified, include sentence concerning control rectifiers.

6. Include thyristors if dc variable specified; otherwise delete.

7. Delete requirement for rectifier bridge if ac control systems are used.

8. Select protective enclosure type. Enclosures containing devices that produce excessive heat (resistors) or ozone or devices that require cooling for proper operation may require ventilation. Types 1, 2 and 3R may be ventilated or non-ventilated. Type 12 enclosures are non-ventilated, but may

include sections and compartments that are ventilated. Type 1 enclosures are normally specified for indoor cranes. Type 3R enclosures are normally specified for outdoor cranes. Type 12 enclosures are specified for exceptionally dirty environments.

[Trolley braking system shall be provided with spring-applied and electrically-released shoe, disc, or conical brakes.] [Trolley braking system shall be provided with electrically-operated and hydraulically-operated shoe, disc, or conical brakes. Hydraulic portion of braking system shall be designed so that the shoes will become disengaged by spring pressure and set by hydraulic pressure. Electrical portion of the braking system shall be designed such that the shoes will be spring-applied and electrically-released.] Braking system shall be automatically set when controls are released or power is interrupted. Provisions shall be made to facilitate easy brake adjustment. Brakes shall have a torque rating of at least 50 percent of trolley drive motor rated torque.

2.3.7.4 [Bridge] [Gantry] Brakes

[[Bridge] [Gantry] braking system shall be provided with a spring-applied and electrically-released single shoe, disc, or conical brake for each bridge drive motor.] [[Bridge] [Gantry] braking system shall be provided with electrically-operated and hydraulically-operated shoe, disc, or conical brakes. Hydraulic portion of braking system shall be designed so that the shoes will be disengaged with spring pressure and set with hydraulic pressure. Electrical portion of braking system shall be designed so that the shoes will be spring-applied and electrically-released.] Braking system shall be automatically set when controls are released or power is interrupted. Provisions shall be made to facilitate easy brake adjustment. Brakes shall have a torque rating of at least 50 percent of bridge drive motor rated torque.

2.3.8 Wheels

NOTE: Include the second sentence for CMAA 70 class D and E, cranes; otherwise delete. Include the requirement for trolley wheels only for multiple girder cranes.

Wheels shall be manufactured of rolled or forged steel. Wheel treads and flanges shall be rim toughened to between 320 and 370 Brinell hardness number. [Bridge] [Bridge and trolley] wheels shall be double-flanged. Trolley wheels shall have straight treads. Bridge wheels shall have straight treads. Wheels shall be equipped with self-aligning double-row spherical roller-bearings of capacity as recommended by bearing manufacturer for design load of trolley or bridge.

2.3.9 Bearings

NOTE: Equalizer sheaves compensate for unequal length, stretch of the hoisting, and swinging of the

load block.

Bearings shall be antifriction type, except bearings which are subject only to small rocker motion. Equalizer sheaves shall be equipped with sintered oil-impregnated type bushings in accordance with ASTM B 438, ASTM B 439, or ASTM B 612.

2.3.10 Anti-Drip Provisions

NOTE: Delete this paragraph if lubricant leaks are acceptable on the operating floor.

Cranes shall be designed to preclude leakage of lubricants onto the lifted loads or the floor. Equipment and components which cannot be made leak-proof shall be fitted with suitable drip pans. Drip pans shall be manufactured of steel and designed to permit removal of collected lubricant.

2.3.11 Lubrication System

Splash-type oil lubrication system shall be provided for hoist, trolley and [bridge] [gantry] gear cases; an oil pump shall be used on vertical-mounted gear cases exceeding two reductions. Oil pumps shall be the reversible type capable of maintaining the same oil flow direction and volume while being driven in either direction. Electric motor-driven pumps may be used when input shaft speed is too low at any operating condition to ensure adequate oil flow. In such applications, pump shall be energized whenever drive mechanism brakes are released.

2.3.12 Electrically Driven Oil Pump Alarm

If an electric-driven lubricating pump is used, an audible alarm and red indicating light shall be provided and shall be energized in the event of pump malfunction.

2.4 ELECTRICAL COMPONENTS

2.4.1 Explosion Proof Requirements

NOTE: Delete this paragraph if explosion proofing is not part of design criteria. Define hazardous classification and evaluate Contractor's proposal for electrical equipment. Show location of the hazardous areas.

Equipment and wiring in locations indicated shall conform to NFPA 70 for Class [I] [II] [III], Division [1] [2] hazardous locations. Equipment shall be suitable for [Group [____]] [operating temperature of [____] degrees C degrees F]. Wiring and equipment in locations indicated shall be of the classes, groups, divisions, and suitable for the operating temperature as indicated.

2.4.2 Control Systems

A separate controller shall be provided for each motor; however, a duplex

controller shall be used for two motor [bridge][gantry] drives. Overload protection shall be in conformance with the requirements of NEMA ICS 2. Contactors that are used for starting, stopping, and reversing shall be mechanically and electrically interlocked.

2.4.2.1 Hoist Control System

NOTE: Select the appropriate paragraph for system desired. Delete auxiliary hoist when not required.

Selection of the desired control system must be coordinated with the appropriate motor selection. Different control systems may be selected for hoists and travel in order to obtain the desired control characteristics. The following are options for the various control/motor combinations:

1. Alternating current Magnetic Control, ac Squirrel Cage Motors: Squirrel cage motors have only limited usefulness on cranes. Application is limited to light-duty weight handling service requiring not more than about 15 kW (20 HP) motors. These motors are used where hook or travel speed is slow, operation is by unskilled personnel, and elaborate speed control and accurate positioning of the load is not required. The main advantage of selection of this control and motor arrangement is low cost and simple maintenance for light capacity cranes.
2. Alternating Current Magnetic Control, ac Wound Rotor Type Motors: ac wound rotor type motors with ac magnetic controls are well suited for high capacity weight handling service (heavy duty crane with large motors). Alternating current magnetic control with ac wound rotor motors is generally used when there is a restricted range of speed and load, and there are no requirements for precision handling.
3. Alternating current Stepless Secondary Saturable Reactor Control, ac Wound Rotor Type Motors: Control of the system is essentially stepless and fine control is provided. Speed is determined by the master switch setting independent of the load weight. Static stepless control is not suited for extended low speed operation. Static control is suitable for all crane services and is normally specified when good regulated speed control is required.
4. Alternating current Adjustable Frequency Control, ac Squirrel Cage Motors: ac adjustable frequency control uses ac squirrel cage motors and a sine-coded pulse width modulated voltage to develop a sinusoidal current waveform from a rectified filtered ac power source. This type of control system will provide stepless speed control with smooth acceleration and deceleration, precise

regulated speed control, and fine minimum speed capability.

5. Direct current Magnetic Control, dc Series Wound Motors: dc series wound motors with dc magnetic control are usually used in existing applications where dc mainlines are present.

6. Direct current Variable Voltage Control, dc Shunt Wound Motors: dc variable voltage control uses dc shunt wound motors and a static conversion unit to convert ac power to dc for the motor. This type of control system will provide stepless speed control with smooth acceleration and deceleration, precise regulated speed control, and fine minimum speed capability.

7. Alternating current Magnetic Hoist Control Selection:

a. An ac wound rotor motor with ac magnetic control, reversing, with mechanical load brake. This type of control is the least expensive control. Good positioning and landing speeds are inherently available for only a fraction of the loads, and jogging must be heavily relied on. This type of control should be used only for rough (nonprecision) handling situations.

b. An ac wound rotor motor with ac magnetic control, reversing, with automatically controlled eddy-current brake. The eddy-current brake provides a load on the motor permitting unregulated speed control. This control is suitable for applications that do not require accurate positioning of loads, and where there are no requirements for precision handling.

c. An ac wound rotor motor with ac magnetic control, reversing, countertorque control braking means. This control system is commonly used for bracket and magnet handling cranes. The control is only suited to those applications where at least 50 percent rated load is on the ropes at all times. If the hoist is operated in lower mode without a substantial load, the load may actually go up.

8. Alternating current Magnetic Travel Control Selection: An ac wound rotor motor with ac magnetic control, 5 speed, reversing, plugging type. This type of control provides rough acceleration under rated load. The [bridge] [gantry] or trolley will accelerate almost to full speed regardless of control point selected.

Main hoist [and auxiliary hoist] motion control system shall be [[single] [two] speed, with ac magnetic control of ac squirrel cage motor] [[single] [two] speed, with ac magnetic control of ac wound rotor motor]. Control

shall provide for reversing, and for [a mechanical load brake] [an automatically controlled eddy-current brake] [a countertorque control brake] [ac stepless secondary saturable reactor control of an ac wound rotor type motor] [ac adjustable frequency control of an ac squirrel cage motor] [dc magnetic control of a dc series wound motor] [dc variable voltage control of a dc shunt wound motor].

2.4.2.2 Travel Motion Control System

Bridge and trolley motion control system shall be [[single] [two] speed with ac magnetic control of squirrel cage motors] [five-speed with dc magnetic control of ac wound rotor motors] [ac static stepless secondary saturable reactor control] [ac adjustable frequency control] [five-speed dc magnetic constant potential control].

2.4.2.3 Drive Control System

NOTE: Select dc micro-drive control for ac mainline power control systems and dc micro-drive control for dc mainline power control systems.

The [main hoist], [trolley] [and bridge] micro-drive control systems shall be [ac] [dc] magnetic, single speed, reversing.

2.4.3 Power Sources

2.4.3.1 System Supply Voltage

Cranes shall be designed to be operated from a [_____] volt, [three-phase, 60 Hz, alternating current] [direct current] system power source. Energy isolating devices for such machine or equipment shall be designed to accept a lockout device in accordance with NFPA 70.

2.4.3.2 Transformers

NOTE: This paragraph is applicable to ac power supplies only.

Transformers shall be dry type and shall carry full load continuously at rated voltage and frequency without exceeding an average temperature rise of 115 degrees C above an ambient temperature of 40 degrees C. The transformer shall have a totally enclosed case which shall be finished with manufacturer's standard coating system. Transformers shall be fully encapsulated, except for those specifically designed for use as an isolation transformer for static power conversion units.

2.4.3.3 Power Rectifiers

NOTE: This paragraph is applicable to dc power supplies only.

Applicable rectifier requirements must be coordinated for each specific job. Select totally enclosed non-ventilated enclosure for indoor and

outdoor usage. Select totally enclosed fan cooled enclosure for motors operating at rated speed for long periods. Select forced ventilated air over frame enclosure for motors operating at slow speed for long periods or for severe-duty cycle service.

Select protective enclosure type. Enclosures containing devices that produce excessive heat (resistors) or ozone or devices that require cooling for proper operation may require ventilation. Types 1, 2, 3R, 9 and 12 may be ventilated or nonventilated. Type 1 enclosures are normally specified for indoor cranes. Type 3R enclosures are normally specified for outdoor cranes. Type 12 enclosures are specified for exceptionally dirty environments.

Power rectifiers shall be provided where required to convert ac to dc. Active semiconductor devices shall be silicon type. Rectifiers for motor control system shall be three-phase full wave rectifiers. Rectifiers for brakes shall be single-phase full-wave or three-phase full-wave rectifiers. A single rectifier may be used in lieu of several smaller rectifiers; brakes shall be supplied from a different rectifier than the other equipment. Protective enclosures shall conform to the requirements of NEMA ICS 6 Type [____]. Rectifying elements shall be hermetically-sealed and mounted on heat sinks cooled by natural convection or by mechanical means. Minimum protection for rectifiers shall consist of transient surge suppressors, and 100,000 AIC current-limiting 700V rectifier type fuses in the ac line. Minimum protection for main power rectifiers shall include a line isolation transformer of the type specifically designed for use with static conversion units. Individual diode sets and thyristors shall be protected by fuses on the ac side. Each rectifier bridge used in brake circuits (including overload protection) shall be rated for continuous-duty at a minimum of 150 percent of load rating, and for 1 minute at a minimum of 300 percent of load rating. Each rectifier or SCR bridge used in the [dc constant potential control system] [or in] [dc variable voltage] shall be rated for continuous-duty at a minimum of 100 percent of the load rating, and for one minute at a minimum of 200 percent of load rating following 8 hours at 100 percent load. The dc rated output voltage shall not exceed 460 volts.

2.4.4 Motors

NOTE: Specify hoist motor temperature sensors for hoists subject to low speeds for long periods (greater than 3 minutes) and hoists carrying critical loads; edit paragraphs as required. Motor heaters are desirable for outdoor cranes, unheated warehouse service cranes, or any other condensing high-humidity application. Select a motor from the following types and coordinate with the desired control type.

Select industrial motors for CMAA 70, Class A, B, C and D cranes, as follows:

- a. For critical load handling, self-excited

alternator with electrical load brakes or emergency dynamic braking is preferred.

b. Select crane type motors for ac motors.

c. Select 800 Series dc mill type motors or dc industrial motors for dc motors.

d. If crane and/or industrial type motors are specified, select NEMA MG 1.

Select mill motors for CMAA 70, Class E cranes, as follows:

a. If 800 Series dc mill type motors are specified, select AISE Std No. 1.

b. Select dc motor type (squirrel cage, wound rotor) for the appropriate control system.

c. Select dc series wound motors for dc constant potential control.

d. Select dc shunt wound for dc variable voltage control.

e. Select ac motor (squirrel cage, wound rotor) for the appropriate control system.

2.4.4.1 General Requirements

Motors shall be designed specifically for crane and hoist duty. Drain holes shall be provided at low points near each end. Inspection and service covers shall be provided with gaskets. Hardware shall be corrosion-resistant. Motors shall conform to the requirements of NFPA 70, [NEMA MG 1] and UL 1004. Motor heaters shall be energized when mainline contactor is de-energized, and water heaters shall be de-energized when mainline contactor is de-energized. Motors 15 kW (20 hp) 20 HP and larger shall be provided with a suitable heater to prevent condensation during long periods of inactivity. One thermal sensitive device embedded in hoist motor windings shall be provided. Device and associated circuitry shall serve as an alarm activating an amber signal or pilot light visible to control stations when motor temperatures become excessive. Set point shall be set below the Class B insulation temperature limit. Thermal-sensitive device and associated circuits shall be self-restoring (automatic reset). Two-speed, two-winding motors with a solid-state control will not be allowed for creep-speed use.

2.4.4.2 Main [and Auxiliary Hoist] Motor

Hoist motor shall be [dc crane type] [dc industrial type] [800 Series dc mill type] [[single-speed; single-winding] [two-speed; two-winding]] [NEMA design D squirrel cage ac type] [wound-rotor type ac type] [ac squirrel cage type for use in ac adjustable frequency control systems] [dc series wound type] [dc shunt-wound type].

2.4.4.3 [Bridge] [Gantry] and Trolley Drive Motors

[Bridge] [Gantry] and trolley drive motors shall be [ac crane type] [dc industrial type] [800 Series dc mill type] [[single-speed; single-winding] [two-speed; two-winding]] [NEMA design B squirrel cage ac type rated] [wound rotor ac induction type] [ac type designed for ac adjustable frequency operation] [dc series wound type] [dc shunt-wound type].

2.4.4.4 Motor Enclosures

NOTE: Applicable to 1 or 2 speed ac magnetic control of ac squirrel cage motor. If it is not desirable to have the motor immediately reverse direction, include sentence on plugging to allow the motor to stop prior to reversing direction. If excessive load swing cannot be tolerated during the start of the bridge or trolley, include sentence on reduced voltage starting.

a. Select drip-proof enclosure for indoor usage, except in a hazardous atmosphere.

b. Select totally enclosed nonventilated enclosure for outdoor use and indoor use in a hazardous atmosphere.

c. Select totally enclosed fan cooled enclosure for motors operating at rated speed for long periods.

d. Select forced ventilated enclosure for Class E service.

Motor enclosures shall be [totally enclosed, non-ventilated (TENV)] [totally enclosed, fan cooled (TEFC)] [totally enclosed, air-over frame (TEAO)] [drip-proof] [drip-proof forced ventilation].

2.4.4.5 Hoist Motor Insulation and Time Rating

NOTE: For hoist motors, select Class F insulation based on a rated temperature rise of 105 degrees C by resistance above a 40 degree C ambient for CMAA 70 Class A, B, C cranes and CMAA 74 cranes with ac or dc magnetic control and a mechanical load brake.

CMAA 70 cranes include top running bridge and gantry type multiple girder electric overhead traveling cranes. CMAA 74 cranes include top running and under running single girder electric traveling cranes utilizing an under running trolley hoist.

For hoist motors, select Class F or H insulation based on a rated temperature rise of 105 (Class F)/125 (Class H) degrees C by resistance above a 40 degree C ambient for CMAA 70 Class A, B, C cranes and CMAA 74 cranes with ac or dc magnetic control and electrical control braking.

For bridge and trolley motors, select Class F insulation for MHI CMAA 70 Class A, B, C cranes and CMAA 74 cranes with ac or dc magnetic control.

For all motors, select Class F or H insulation with a rated temperature rise of 105 (Class F)/125 (Class H) degrees C by resistance above a 40 degree C ambient for CMAA 70 Class A, B, C and CMAA 74 cranes with ac or dc static controls.

For all motors, select Class F or H insulation based on a rated temperature rise of 105 (Class F)/125 (Class H) degrees C by resistance above a 40 degree C ambient for CMAA 70 Class D and E cranes.

Delete frame size selection if not needed for the project.

Hoist motors shall be provided with insulation which has a [Class F] [Class H] rating based on an [105] [125] degree C motor temperature rise above 40 degrees C ambient, with frame size selection based on continuous ratings.

2.4.4.6 Bridge and Trolley Motor Insulation and Time Rating

Bridge and trolley drive motors shall be provided with an insulation which has a [Class F] [Class H] rating based on [105] [125] degrees C motor temperature rise above 40 degree C ambient with frame size selection based on continuous rating.

2.4.4.7 Micro-Motors

Micro-motors for [main hoist] [auxiliary hoist] [bridge] [and trolley] drives shall be [direct current industrial type, shunt wound motors] [industrial type, single-speed; single-winding; ac squirrel cage motor] operation and shall conform to the requirements of NEMA MG 1. Micro-motor shall be totally enclosed, fan cooled (TEFC), with Class F or H insulation. Motor voltage rating shall comply with system supply voltage rating specified.

2.4.5 Electric Brakes

2.4.5.1 Brakes

NOTE: Delete this paragraph if hydraulic braking system is not required.

If electric brakes are used, a drift point may be provided so the brakes will release after the motor is de-energized, thereby allowing the motion to coast and reducing swing of the load. A drift point can also allow the trolley to center itself over the load before actually starting to lift.

For pendant control cranes and cab controlled cranes where hydraulic braking is not desired, select spring-applied electrically-released brakes. For

cab operated cranes, electric-hydraulic brakes should be specified for bridge or trolley brakes except in the case of constant speed/speed regulated (at a particular controller setting) type controls.

Electric-hydraulic brakes should be limited to ac magnetic or secondary saturable reactor and dc magnetic controls for ac wound rotor motors and dc series/compound wound motors respectively. Electric-hydraulic brakes should be limited to bridge brakes on bridge mounted cabs and trolley brakes for trolley mounted cabs.

Electric-hydraulic brakes should not be specified for the following:

- a. Single and multi-speed magnetic control of squirrel cage motors.
- b. Alternating current adjustable frequency control of squirrel cage motors.
- c. Direct current variable voltage control of shunt wound ac motors.

Electric-hydraulic [bridge] [trolley] brakes shall be dc shunt magnet type equipped with hydraulic actuators manually-operated with a foot-operated master control unit in the operator's cab, and electrically released with the operation of the mainline contactor POWER-OFF pushbutton or power failure. Remote control bleeders operable by pushbutton and foot pedal shall be provided except for power-assisted brake systems. Remote control bleeders shall be complete with pushbutton clearly labeled and located in operator's cab where the operator can easily depress the pushbutton and pump the brake simultaneously. In lieu of the combination electric-hydraulic brakes, separate hydraulic and electric brakes may be provided. Hydraulic brake system shall be designed to ensure equal pressure at each brake cylinder.

2.4.5.2 Hoist Brake Time Delay

NOTE: Delete this paragraph if one brake is specified.

One of the hoist holding brakes shall be provided with a time-delay setting (from 1 to 3 seconds). The time-delay shall be initiated upon releasing the control pushbutton or returning the master switch to OFF. Operation of mainline POWER-OFF pushbutton or power failure shall result in each hoist brake's setting without any time-delay.

2.4.5.3 Automatic Stop System

Electrically-controlled brakes shall be fail-safe spring set when power is interrupted. Brakes shall be released with a mainline contactor POWER-OFF pushbutton or a master switch for the associated drive. Brakes shall automatically stop when there is a power failure. Electric shall be designed to be mechanically released. Enclosures for electrical-controlled

brake components shall be NEMA ICS 6 Type [____]. Direct current shunt magnetic shoe brakes shall be provided with an electrical forcing circuit for rapid release of brake. Each shunt coil brake shall be circuited for both conductors to open simultaneously when the brake is de-energized.

2.4.6 Control System

A separate controller shall be provided for each motor; a duplex type for 2-motor bridge drives and a quadraplex type for 4-motor bridge drives on ac central cranes. When 2-motor bridge drives are furnished and dc magnetic control is required, dc series-connected motors shall be provided. When 4-motor bridge drives are furnished and dc magnetic control is required, dc series-parallel connected motors shall be provided. Overload protection shall be in conformance with requirements of NEMA ICS 2 and NFPA 70. When contactors are used for starting, stopping and reversing, contactors shall be mechanically and electrically interlocked.

2.4.6.1 Control Panels

NOTE: Control panel heaters are desirable for outdoor cranes, unheated warehouse service cranes or any other condensing high-humidity application. Alternating current or dc static crane control for outdoor cranes need thermostatically-controlled panel heaters for outdoor panels or any other application which is colder than 0 degrees C. Alternating current or dc static crane control may need both thermostatic control and mainline contactor control.

Control panels shall be fabricated of solid sheet steel designed and constructed to conform to requirements of NEMA ICS 6 Type [____]. [Thermostatically-controlled heaters to keep control enclosure temperatures at or above 0 degrees C shall be provided in each static crane control panel.] [Control panel heaters shall be energized when mainline contactor is de-energized, and shall be de-energized when mainline contactor is energized to prevent anti-condensation.] Control panel doors shall be hinged, equipped with gaskets and fitted with key-lock handle design, complete with a single key to open all locks.

2.4.6.2 Main and Auxiliary Hoist Control

NOTE: Select a hoist control from the following paragraphs a through i and coordinate with paragraph Motors.

- a. Hoist motor control system shall provide one speed in each direction with an electrically-operated, full-magnetic, across-the-line reversing type starter. Speed contactors shall be used to prevent the operation of high speeds and low speeds.
- b. Hoist motor control system shall provide two speeds in each direction with of an electrically-operated, full-magnetic, across-the-line reversing type starter. Electrical and mechanical interlocks shall be used to prevent the operation of high speeds

and low speeds.

- c. Hoist motor control shall provide five-speed dc magnetic control of ac wound rotor motor with eddy-current braking. Eddy-current brake shall provide an adjustable varying artificial loading of wound rotor hoist motor on at least two hoisting points and four lowering points. Operation of hoist shall be prevented upon loss of eddy-current brake excitation. Eddy-current brake shall be excited with reduced voltage when hoist control is in the OFF position. Positive-drive down is required on all lowering points. On first speed-point hoisting, hook shall not lower with 100 percent of rated load, and the no-load hook speed shall not exceed 30 percent of rated speed. On first speed-point lowering, the full-load hook speed shall not exceed 15 percent of synchronous motor speed. A self-excited alternator shall be mounted on the electric load brake housing to excite load brake if power supply and holding brakes fail.
- d. Hoist motor control shall provide five-speed dc magnetic control of ac wound rotor motor with a mechanical load brake. First point for hoisting shall provide not more than 40 percent of full-load motor torque. First point lowering speed with any load up to rated load shall not exceed more than 80 percent of full-load hoisting speed. Second point lowering shall cause 75 percent of rated load to lower at not more than 50 percent of full-load hoisting speed.
- e. Hoist motor control shall provide five-speed, countertorque control for wound rotor motors. When the control handle is in the fourth and fifth point lowering position there shall be a positive drive down of the hook or load to not less than synchronous speed nor more than 25 percent of synchronous speed with full-rated load. This fourth and fifth point for lowering shall provide regenerative braking. All other lowering points shall provide speed retardation by the application of countertorque. Countertorque shall increase as the control handle is moved toward the NEUTRAL or OFF position. Countertorque secondary-resistance control shall provide for not less than five manually held and one automatic speed point in each direction of motion.
- f. Hoist motor control shall provide ac static stepless secondary saturable reactor control. Control shall provide continuously-adjustable speeds throughout the range from minimum speed to maximum speed. Eddy-current braking shall provide a retarding torque for control of light loads in the hoisting direction and all loads in the lower direction of subsynchronous speed. To reduce holding brake wear, control shall be arranged so that the electric load brake is effective in slowing the motion when the control is in OFF position. Minimum hoist position of control shall not allow hook to lower with full-rated load on the hook. Minimum lowering speed at rated hook-load shall not exceed 15 percent of synchronous motor speed. Minimum speed hoisting with an empty hook shall not exceed 20 percent of synchronous motor speed. Loads up to 100 percent rated capacity shall raise on minimum speed point of master. A self-excited alternator shall be mounted on electric load brake housing to excite the load brake, if power supply and holding brakes were to fail.
- g. Hoist control system shall provide reversing, constant potential

dc, five-speed, dynamic lowering, variable-resistance, dc magnetic control of dc series wound hoist drive motors. Full-load lowering speed shall not exceed the following percentages of rated full-load hoisting speeds: 30 percent on first point; 205 percent on fifth speed point. First point hoisting shall provide not more than 30 percent of rated-motor speed at no-load motor torque, and zero speed (plus 5 percent, minus 0 percent of rated speed) at not less than 60 percent of rated-motor torque. Emergency dynamic speed at no-load motor torque. Emergency dynamic braking circuits shall be established when the motion control switch is in the OFF position and when power supply is disrupted.

- h. [Hoist motor speed control shall provide dc stepless, speed regulated, adjustable-voltage control of dc shunt-wound motors. Control shall provide continuously adjustable speed from minimum speed to full speed. Minimum hoist position of control shall not allow hook to lower with 125 percent of full-rated design load on hook, and the minimum lower position of control shall provide a full-rated design-load lowering speed at not more than 2 percent of rated speed. Control shall provide automatic regenerative or dynamic braking for speed reduction and slow down before brake setting.] [Emergency dynamic braking shall be provided when control is in the OFF position and in case of power failure.] [Control shall provide a 50-to-1 speed range.]
- i. [Hoist motor speed control shall provide ac adjustable frequency-regulated, control of ac squirrel cage motors. Control speed shall provide continuously-adjustable speed from minimum speed to full speed. Minimum hoist position of the control shall not allow hook to lower with 100 percent of full-rated design load on hook, and the minimum lower position of control shall provide a full-rated design-load lowering speed at not more than 3.3 percent of rated speed. Control shall provide automatic regenerative or dynamic braking for speed reduction and slow down before brake setting.] [Emergency dynamic braking shall be provided when control is in the OFF position and in case of power failure, or a self-excited alternator shall be mounted on the electric load brake housing to excite the load brake if power supply and holding brakes fail.] [Control shall provide a minimum 30-to-1 speed range.]

2.4.6.3 Bridge and Trolley Control

**NOTE: Select a bridge and trolley control from
following paragraph a through f and coordinate with
paragraph Motor Enclosures.**

- a. [Bridge and trolley main control systems shall provide [one] [two] speeds in each direction with an electrically-operated, full-magnetic, across-the-line reversing type starter.] [Centrifugal switches shall be used in control circuit to prevent the plugging of trolley or bridge drive motors; each switch shall be arranged to set the associated drive's brake while attempts are made to plug.] [The [bridge] [and] [trolley] main control system shall be provided with reduced voltage starting for all speed points.]

- b. Bridge and trolley main control systems shall be ac magnetic control, five-speed, reversing, plugging type.
- c. Bridge and trolley main control systems shall be ac static stepless secondary saturable reactor. Control shall provide continuously-adjustable speed from minimum to full speed. Minimum speed with zero hook load shall not exceed 15 percent of full-rated speed. Control shall provide speed regulation of 15 percent or less from no-load to full-load at all speed settings.
- d. Bridge and trolley main control systems shall be dc magnetic control type, five-speed, reversing, plugging type.
- e. Bridge and trolley main control systems shall employ dc stepless, speed-regulated, adjustable-voltage control of dc shunt-wound motors. Control shall provide continuous-speed adjustment from minimum speed (2 percent at no hook load) to full speed. Control shall provide automatic-regenerative braking for speed reduction and slow down before brake setting. Control shall provide a minimum 50-to-1 speed range.
- f. Bridge and trolley main central systems shall employ ac adjustable-frequency, speed-regulated, control of ac squirrel cage motors. Control shall provide continuous-speed adjustment from minimum speed (2.5 percent at no-hook load) to full-speed. Control shall provide automatic regenerative or dynamic braking for speed reduction and slow down before brake setting. Control shall provide a minimum 40-to-1 speed range with constant torque acceleration, for base and subbase speeds.

2.4.6.4 Drift Point

NOTE: Provide bridge and trolley directions normally oriented to main compass headings.

Select method of festoon suspension. For multiple girder cranes select underneath footwalk and for single girder cranes select auxiliary girder. If a hoist thermal sensor is specified, include requirement for yellow pilot light. If a micro-drive is specified, include the sentence, "A 2-position [____]."

Pendant handles are required only if pendant is in an explosion area. Monorail cranes do not require an independent track for pendants.

Trolley and bridge main control systems shall have a drift point between OFF and first speed control point in each direction or shall have a separate pushbutton.

2.4.6.5 Micro-Drive Motor and Clutch Control

Micro-drive system shall be designed such that when micro-drive is selected at control station, all main motors shall be disconnected, and all micro-drive clutches shall be energized. Operation of micro-drive motors shall be from crane control station. Micro-motor control systems shall

provide single-speed in each direction by means of an electrically-operated, full-magnetic, [reduced] [full] voltage type starter. Power shall not be applied to any micro-motor unless all clutches are fully engaged. If a clutch disengages during operation of micro-motors, the mainline contactors shall open and all brakes shall set. Application of power to any main motor shall be prevented with any clutch engaged. A transfer switch shall be provided at crane control station to allow transfer from either mode of operation to the other only when all brakes have been set for not less than 5 seconds. A single CLUTCH-ENGAGED green pilot light shall be provided [at the pendant station] [in the cab] when all clutches are energized; individual CLUTCH ENGAGED pilot lights shall be provided on drive control panels.

2.4.7 Cab Control Station

2.4.7.1 General

NOTE: Provide bridge and trolley directions normally oriented to main compass headings. If stepped speeds and/or drift point are specified, include the applicable requirements in this paragraph. Delete aux hoist switch if not necessary for the project.

Crane control shall be accomplished by a [bridge-mounted] [trolley-mounted] cab control. Master switch operating handles shall be spring-returned to OFF, [shall have distinct drift point detents,] [shall have distinct speed-point intents] and shall have OFF position latching. Master switch enclosures shall be NEMA Type 1. POWER-OFF pushbutton shall have a red mushroom head. POWER-ON pushbutton shall be green or black. Cab master switches shall be as follows:

- a. Main Hoist - up/down.
- b. Aux Hoist - up/down.
- c. Bridge - [_____] [_____].
- d. Trolley - [_____] [_____].
- e. POWER-OFF.
- f. POWER-ON.

2.4.7.2 Cab Indications

NOTE: If hoist thermal sensor is specified, include requirement for amber light. Voltmeter applicable to dc control systems only. If rail clamps are specified, include sentence regarding rail clamp operation and indication. If flood lighting is specified, include requirement for toggle switch.

Amber pilot lights to indicate excessive hoist motor temperature shall be provided. A white pilot light to indicate that power is available on load side of crane disconnect switch shall be provided. A blue pilot light shall be provided to indicate that the main contactor is energized. [A minus 300 to plus 300 Vdc voltmeter shall be supplied to monitor the main rectifier output voltage, a selector switch shall be provided to select the voltage to be monitored.] [A red pilot light shall be provided to indicate

the rail clamps are set.] [A single-toggle switch shall be provided to operate crane floodlights.] [A single green pilot shall be provided to indicate all micro-drive clutches are engaged.]

2.4.7.3 Cab Controls

NOTE: Delete this paragraph if combination controls (cab and pendant or cab and radio control) are not used. If it is desirable to raise the pendant out of the way, include the last sentence. Otherwise, delete.

Cab shall be provided with a 2-position key-operated switch to allow transfer of control from cab to [pendant] [radio control] station and a red pilot light mounted in cab shall be provided to indicate that the control has been transferred to other station. Selection of one operating station shall lock out the controls of other stations. A 2-position switch shall be provided to raise and lower the pendant station.

2.4.8 Pendant Control Station

NOTE: Delete the following paragraphs if pendant control is not specified.

If pendant control is not specified, delete paragraphs. If the crane is higher than 18 m (60 feet) above the operating floor and the span is greater than 15 m (50 feet), consider including a pendant drive for ease of movement of the pendant if it is not towed by the trolley; otherwise delete this paragraph. Pendant drive speed should be the same as the trolley.

2.4.8.1 General

Pendant control station enclosure shall be NEMA Type [1] [3R] [7] [9] [12]. Physical size of pendant shall be held to a minimum. A separate cable of corrosion-resistant chain consisting of minimum 6.4 mm 1/4 inch wire shall be provided. Pendant station shall be attached to [underside of crane bridge footwalk] [an auxiliary girder] and shall hang vertically with bottom of pendant at 1 m 40 inches above floor. Weight of pendant shall not be supported by control cable.

2.4.8.2 Operating Pushbuttons

NOTE: Delete requirement for auxiliary hoist pushbutton when no auxiliary hoist is used.

Provide [bridge] [gantry] and trolley directions normally oriented to main compass headings. Select method of festoon suspension: For multiple girder cranes select underneath footwalk and for single-girder cranes select auxiliary girder. If a hoist thermal sensor is specified, include

requirement for yellow pilot light.

Operating pushbuttons shall be heavy-duty, dust-and-oil-tight type with distinctly-felt operating positions which meet requirements of NEMA ICS 2. Pendant control buttons shall be momentary pushbuttons. Pushbuttons (except the POWER-OFF button) shall be the recessed type to avoid accidental operation. Diameter of buttons shall be a size which will make operation possible with a thumb while holding the pendant with same hand. Nameplates shall be provided adjacent to each pushbutton. Barriers shall be provided on pendant between various pushbutton functions, except on elements mounted in junction box. In a multi-speed application, dual-position pushbuttons shall have a definite click-detent position for each speed. Pushbuttons shall be designed and manufactured not to hang up in control case. Pendant shall include a separate set of pushbuttons for each motion and for POWER-ON POWER-OFF. Pushbuttons shall be as follows:

POWER-OFF.

POWER-ON.

Hoist-up.

Hoist-down.

[Gantry]-[____].

[Gantry]-[____].

Trolley-[____].

Trolley-[____].

[Auxiliary Hoist-up.]

[Auxiliary Hoist-down.]

2.4.8.3 Light Indicators

NOTE: Coordinate requirement for pilot lights and selector switches.

Pilot lights shall meet heavy-duty requirements of NEMA ICS 2. One amber pilot light to indicate excessive hoist motor temperature shall be provided on pendant station. A blue pilot light shall be provided to indicate that the main contactor is energized, and a white pilot light to indicate that power is available on the load side of crane disconnect switch. A bright red mushroom head shall be provided with the POWER-OFF pushbutton. A 2-position selector switch shall be provided to select between normal and micro-drive. A single green pilot light shall be provided to indicate all micro-drive clutches are engaged.

2.4.8.4 Pendant Drive Control

NOTE: If the crane is higher than 18 meters (60 feet) above the operating floor and the span is greater than 15 meters (50 feet), consider including a pendant drive for ease of movement of the pendant if it is not towed by the trolley; otherwise delete this paragraph. Pendant drive speed should be the same as the trolley.

A 3-position momentary contact spring-return to OFF toggle switch shall be provided to control the motorized trolley for pendant.

2.4.8.5 Transfer of Control Stations

Pendant shall be provided with a green pilot light to indicate that control has been transferred to pendant station from cab with key lock-out.

2.4.9 Radio Remote Control, Infrared Remote Control

NOTE: Include this paragraph if radio remote control or infrared remote control is desired; otherwise delete.

2.4.9.1 General

Crane shall be equipped with a complete digital radio remote-control system to permit full control of crane from a portable wireless transmitter. System shall be the use-proven product of a manufacturer regularly engaged in design and manufacture of crane radio remote-control systems. System shall be of a "fail-safe" design so that the failure of any component or loss of signal will cause all crane motors to stop. The system shall permit complete, independent and simultaneous operation of all crane functions. System frequency shall be in the 72MHz-76MHz band. Receiver shall include transfer relays if crane is also cab or pendant controlled.

2.4.9.2 Transmitter

NOTE: Provide bridge and trolley directions normally oriented to main compass headings. Delete requirement for auxiliary hoist control when no auxiliary hoist is used.

Transmitter shall be portable and complete with an adjustable belt or harness. Crane motion switches shall be spring-return to OFF. Transmitter shall be provided with two spare batteries and battery charger to permit continuous operation. A key-lock with the key removable in the OFF position only shall be provided to control transmitter operation. A blue signal light mounted on crane visible from floor shall be provided to indicate the main contactor is energized. POWER-OFF toggle-switch shall be bright red. Transmitter shall be provided with the following controls:

Hoist-up/down.
Bridge-[____].
Trolley-[____].
POWER-ON.
POWER-OFF.
Auxiliary Hoist-up/down.

2.4.10 Protection

2.4.10.1 Main Line Disconnect

A main line disconnect consisting of a combination circuit breaker (50,000 AIC) and non-reversing starter, starter without overloads (mainline contactor) in NEMA Type [____] enclosure shall be provided. Mainline disconnect shall be controlled by a control circuit so that all crane

motions will be stopped upon mainline undervoltage, overload, control circuit fuse failure, or operation of POWER OFF pushbutton. Mainline disconnect shall be equipped with energy isolating devices designed to accept lockout devices.

2.4.10.2 Isolation Transformer

NOTE: Specify an isolation transformer and surge protection to protect electronics from external faults. Recommended for dc static control systems. Applicable to ac power supplied systems only.

The isolation transformer shall be an SCR drive type specifically designed for cranes, with a continuous rating which will exceed that required of the sum of rated full-load full-speed KVA of hoist plus 50 percent of rated full-load full-speed KVA of trolley and bridge motors plus the rated KVA of controls. Total KVA is then multiplied by 1.05 (efficiency factor). The isolation transformer shall be connected to load side of mainline disconnect of the transformer. Crane dc static control electric power distributed on the crane shall be supplied through this isolation transformer.

2.4.10.3 Surge Protection

Surge suppressors shall meet the requirements of UL 1449. Three metal oxide varistors shall be provided on the line side of each SCR drive isolation transformer to provide transient over-voltage protection.

2.4.10.4 Circuit Breakers

Circuit breakers shall meet the requirements of UL 489.

2.4.10.5 Overloads

NOTE: Select applicable overload protection based on control circuit type.

[Alternating current circuit overload relays shall be of the ambient compensated, automatic reset, inverse time type located in all phases individual motor circuits. Overload relays shall be arranged to de-energize the associated motor on an overload condition.] [An automatically reset inverse time-trip running overload relay shall be provided for each dc motor circuit. An automatically reset instantaneous trip overload relay shall be provided in each dc motor circuit or for a pair of series-connected motors. Overload relays shall be arranged to de-energize the associated motor on an overload condition.] [Alternating current adjustable frequency-control motor overload-protection shall be electronic and shall protect by inverse time and current versus output frequency which will allow less current for a given amount of running time when frequency (speed) is lower than rated.] [Direct current variable voltage control motor overload-protection shall be electronic.]

2.4.11 Limit-Switches

NOTE: Delete reference to micro-drive control system if not applicable.

Geared limit-switches shall be heavy-duty quick-break double-pole double-throw type conforming to NEMA ICS 2. The geared limit-switch interruption of a motion in one direction shall not prevent the opposite motion. Geared limit-switches shall reset automatically. Limit-switch housings shall be NEMA Type [1] [4]. Limit-switches shall interrupt power to the primary and micro-drive control systems.

2.4.11.1 Hoist Upper Limit-Switches

Two limit-switches shall be provided for each hoist. A rotating-type adjustable geared-control circuit interrupt limit-switch shall provide hoist-up limiting. A secondary hoist-upper-limit shall be provided with a weight-operated power circuit limit-switch to prevent the hoist from raising beyond the safe limit. The secondary limit-switch shall operate to interrupt power to all hoist motor conductors, set the hoist holding brakes and directly open all "raise" power circuits. [A power bypass contactor and operator button to permit backing out and resetting of power limit-switch shall be provided for ac adjustable frequency control.] [A power bypass contactor and operator button to permit backing out and resetting of power limit-switch shall be provided for dc variable-voltage control.]

2.4.11.2 Hoist Lower Limit-Switches

Hoists shall be provided with a rotating-type adjustable geared-control circuit interrupt limit-switch for hoist-down travel limiting. The hook downward vertical travel of the hook shall be field-adjustable to approximately 150 mm 6 inches above working surface.

2.4.11.3 Bridge and Trolley Travel Limit-Switches

Runway (track-type) limit-switches shall be provided for crane bridge and trolley motions to stop the bridge and trolley motions, respectively. Limit-switch actuators shall be installed on building and trolley frame to actuate the limit-switches and stop the crane bridge or trolley prior to contacting the trolley frame bumpers. Trip mechanism for trolley motion shall be located on crane runway to trip the switch before the bumper contacts the stop. Trip mechanism for bridge motion shall be located on crane runway to trip switch before bumper contacts the stop. When the switch is tripped, the switch shall permit opposite travel in the direction of stop and then automatically reset.

2.4.11.4 Rail Clamp Limit-Switches

NOTE: Include paragraph for outdoor cranes; otherwise delete. Delete reference to micro-drive when not applicable.

When rail clamps are set, each rail clamp shall be furnished with a limit-switch designed to interrupt the primary and micro-drive control circuits to bridge drive. A red pilot light shall be provided at control station to indicate the rail clamps are set.

2.4.12 Wiring

Wiring shall comply with Article 610 of NFPA 70. Wires shall be numbered or tagged at connection points. Splices shall be made in boxes or panels on terminals boards or standoff insulators. Motor loop, branch circuit and brake conductor selection shall be based on NFPA 70 for 90 degree C conductor rating on indoor cranes, and for 75 degree C conductor rating on outdoor cranes. Conductors in the vicinity of resistors and conductors connected to resistors shall be Type 5RML.

2.4.13 Electrification

2.4.13.1 Main Power Electrification

Main power electrification system shall provide power to crane starter/disconnect circuit breaker.

2.4.13.2 Crane Runway Conductors

NOTE: Select covered conductor bar system for:

- a. Indoor non-hazardous service
- b. Outdoor non-corrosive environment

Select festoon system for:

- a. Indoor - hazardous service
- b. Outdoor - corrosive (marine) environment

[Crane runway conductor system shall be the covered conductor bar system type designed and manufactured to meet UL requirements. Protective covers shall be the rigid or flexible self-closing type designed to cover all live conductors and shall be shaped to prevent accidental contact with conductors. Collectors shall be heavy-duty sliding shoe type compatible with the electrification system. Two tandem designed collector heads shall be provided for each conductor rail to provide redundancy.] [Crane runway conductor system shall be the festooned type consisting of a support rail, cables, junction boxes, cable cars and accessories. Hardware shall be corrosion-resistant or protected against corrosion. Festoon storage area shall not restrict the crane travel at the ends of runway.]

2.4.13.3 Bridge Span Conductors

Bridge span conductor system shall be the [festooned type consisting of a support rail, electrical cables, junction boxes, cable cars and accessories] [rigid conductor/collector type located within enclosure]. Cable loops shall not drop below the hook high position. Outdoor crane bridge festoon system hardware shall be corrosion resistant.

2.4.13.4 Pendant Festoon System

NOTE: The pendant festoon system is an option to the Designer.

Pendant festoon system shall consist of a support rail, cables, junction boxes, cable cars and accessories. Cable loops shall not drop below the hook high position. Pendant control car shall be provided with NEMA Type [1] [3R] [12] junction box. Pendant festoon shall be [towed by trolley] [independent of trolley motion]. Outdoor crane pendant festoon system hardware shall be corrosion resistant.

2.4.13.5 Pendant Drive System

Pendant festoon system shall be provided with a motor-drive system capable of driving the pendant control car at [_____] m/s fpm. Pendant motor drive shall be controlled from the pendant.

2.4.13.6 Pendant Retraction System

NOTE: Select method of pendant retraction if specified; otherwise delete paragraph.

[Pendant control car shall be provided with an electric-powered cable reel so that the pendant station will retract fully.] [A wire-rope hoist shall be provided to hoist the pendant station. Pendant and pendant drop-cable shall be retractable to approximately 1/3 of drop cable length.] Retraction system shall be controlled from cab.

2.4.14 Special Requirements

2.4.14.1 Warning Horn

NOTE: Delete last sentence if not applicable to project.

A solid-state electronic warning horn shall be provided on the crane. Any bridge or trolley motion shall be accompanied by a continuous series of alternating tones. The warning horn shall not sound when the crane is in the micro-drive mode.

2.4.14.2 Accessory Power

NOTE: If lighting, motor or control cabinet heaters or receptacles are specified, include the following paragraph if 460 volt ac is the power source. Select the components requiring power.

Three-phase 208Y/120 volt ac power supplied via a circuit breaker and isolation transformer from the line side of the main line disconnect shall be used for [lighting,] [heaters,] [and accessory circuits] on the crane. The circuit breaker shall have a NEMA Type [1] [3R] [12] enclosure. The enclosure shall have provisions to lock the breaker in the OFF position. Each circuit breaker pole shall have individual thermal and magnetic trip elements, and the enclosure cover shall be complete with a button for mechanically tripping the circuit breaker. A three-phase 480 volt delta primary and 208Y/120 volt wye secondary general lighting transformer shall

be supplied from the accessory circuit breaker and shall feed a 208Y/120 volt UL listed circuit breaker panelboard and a heater circuit breaker/combination starter. The panelboard shall supply branch circuits for utilization of various accessories such as [receptacles,] [lighting] [panel internal lighting] [motor heaters and control enclosure which meets NEMA requirements]. Transformer and panelboard shall have the same NEMA classification as the circuit breaker.

2.4.14.3 Receptacles

NOTE: Specify receptacles for multiple girder cranes. Specify ground fault protection for outside cranes. Delete requirement for receptacle in cab when not applicable.

Receptacles shall be single-phase, 120-volt 15-amp, grounded, duplex types complete with metal weather-proof enclosure with self-closing weatherproof receptacle cover. A receptacle shall be provided on the trolley at each end of the front bridge walkway in the vicinity of bridge travel drive motors and in the cab. Several receptacles shall be provided in the vicinity of the control equipment equally spaced every 3 m 10 feet. Breakers used to protect circuits supplying the receptacles for outside cranes shall incorporate ground fault current interruption feature and meet the requirements of UL 943.

2.4.14.4 Lighting

NOTE: Specify lighting for outdoor cranes or in dimly lighted areas.

Control panels shall be provided with a 120-volt lamp fixture with an unbreakable lens and switch. Floodlights shall be provided to illuminate the work area under the crane and drum area on crane and shall be controlled from crane control station. Floodlights shall be metal halide industrial luminaries. Each floodlight shall be totally enclosed, vapor-tight design, gasketed and shall be provided with a heat-resistant and impact-resistant glass lens. Floodlights shall be spaced and attached to underside of crane to provide uniform lighting.

2.4.14.5 Anti-Condensation Heaters

NOTE: Motor heaters recommended for outdoor cranes, unheated warehouse service cranes or any other condensing high-humidity application; if not desired delete this paragraph. Thermostatically-controlled heaters is a designer option.

Motor and control panels shall be equipped with anti-condensation heaters. Thermostatically-controlled heaters shall be provided in each static-control panel to keep control enclosure temperatures at or above 0 degrees C. Circuit breaker combination magnetic starter shall be NEMA Type [1] [3R] [12] enclosure. Magnetic starter shall be equipped with manually-reset overload relays and interlocked with the mainline disconnect

so that anti-condensation heaters are de-energized when the mainline contactor is energized and the magnetic starter is energized when the mainline contactor is de-energized.

2.4.14.6 Wind Indication and Alarm

NOTE: Specify location of wind alarm station for outdoor cranes, normally mounted near center of the bridge. Provide location of cutout. Delete paragraph if not applicable.

A wind-indicating device with an adjustable alarm trip point shall be provided. Alarm trip shall have time-delay for wind gusts. Adjustable trip shall actuate an oscillating blue light and bell mounted near [____]. Bell shall have the ability to be cut from the [pendant station] [cab].

2.4.14.7 Electrically-Driven Oil Pump Alarm

Electrically-driven lubricating pump shall be complete with an audible alarm and red light for indication of pump malfunction. Location of alarm shall be the factory standard location.

2.4.15 Load-Limit System

NOTE: Specify load sensing if loads approaching the capacity of the crane are to be lifted routinely.

A load-limit visual/audible system shall be provided for the main hoist to inform the operator that the preset load has been exceeded. The load-limit system shall consist of a load-cell, load-sensing electronics, overload indicator lights, overload alarm bell and alarm cut-out switch. Load cell shall be mounted to receive the load from equalizing sheave pin or upper block sheave pin. The alarm setpoint shall be adjustable.

2.4.15.1 Load-Sensing Electronics

Load-sensing electronics shall be NEMA Type [1] [3R] [12] enclosures. Alarm setpoint shall be adjustable.

2.4.15.2 Alarm and Indicator Light

An overload alarm light shall be provided to indicate a load greater than the preset maximum. Overload alarm shall be indicated with a red light and clearly labeled "OVERLOAD". A bell shall be provided to indicate when an overload condition exists. Provision shall be made to turn off the bell.

2.4.16 Cab Heating and Ventilating [and Air-Conditioning]

NOTE: If heating or air conditioning of the cab is required, edit this paragraph to specify design requirements; otherwise delete this paragraph. Refer to TM-5-785 or AFM 88-29 ambient temperatures for cab heating and air conditioning.

Cab shall be thermally-insulated and shall be provided with air-conditioner and electric heater. A filter unit shall pressurize the cab with filtered outside air. Air filter shall be a standard commercial type capable of removing airborne dust and shall be located where it can be readily cleaned or changed. Air conditioner with heater shall be controlled with an adjustable thermostat. The unit shall meet the Energy Efficient requirements of ASHRAE 90.1. The cab interior shall be maintained at 18 degrees C 65 degrees F in winter with [] degrees C F ambient temperature and [] degrees C F in summer with [] degrees C F dry bulb and [] degrees C F wet-bulb ambient temperatures. All other hardware and components shall be of corrosion-resistant material or protected against corrosion. Motor compressor assembly shall be mounted on vibration isolators.

2.4.17 Fungus Resistance

**NOTE: Specify fungus resistance for cranes in
marine or humid environments.**

Electrical connections such as terminal connections, circuit connections, components and circuit elements shall be coated with fungus-resistant varnish. Components and elements inherently inert to fungi or hermetically sealed shall not be treated. Elements whose operation will be adversely affected with the application of varnish shall not be treated.

2.5 ELECTROMAGNETIC INTERFERENCE SUPPRESSION

**NOTE: Specify EMI suppression if electro-magnetic
interference from the crane may be a problem to
sensitive electronics in the work area.**

2.5.1 Shielded Cable

Pendant and festooned cables shall be the shielded type of braided tinned-copper. Each cable shielding shall be grounded with a single connection to equipment grounding conductor.

2.5.2 EMI/RFI Shielded Boxes

2.5.2.1 General

Boxes designed to house electronic and electrical control equipment, instruments, metering equipment, etc., in installations where electromagnetic compatibility and/or system security is required shall protect interior components from stray radio frequency (RF) fields and shall contain RF signals produced by interior components.

2.5.2.2 Construction

Electromagnetic Interference/Radio Frequency Interference (EMI/RFI) shielded boxes shall be designed to meet UL 50 Type 12 and Type 13. The shielded boxes shall be constructed of [1.519] [1.897] mm [16] [14] gauge steel with seams continuously welded and ground smooth, without holes and knockouts. Cover gasket shall be a combination of woven plated steel mesh

and oil-resistant gasket which will provide an EMI/RFI seal as well as an oil-tight, dust-tight and water-tight seal between cover and body. Gasket shall be attached to cover with oil-resistant adhesive. Stainless steel cover clamps and screws which are quick and easy to operate shall be provided on three sides of hinged cover for positive clamping.

2.5.2.3 Attenuation

EMI/RFI shielded boxes shall be designed to provide maximum shielding of electric and magnetic components of radiated RF energy. RF filters shall be provided to suppress conducted radio frequency in cables and conductors. Shielded boxes shall provide attenuation greater than 60 db at 14.5 KHz to greater than 100 db at 1 MHz for magnetic fields and greater than 100 db from 14.5 KHz to 430 MHz for electric fields.

2.5.2.4 Finish

EMI/RFI shielded boxes shall be zinc-plated in accordance with ASTM B 633 SC3/Type II to provide corrosion-resistant conductive surfaces for gasket contact area and conduit entries. The finish coat shall match the crane finish.

2.5.3 Drum Grounding

**NOTE: A grounding drum is required for non-sparking
environment only (general nuclear or explosive).**

A copper ring/collector assembly shall be provided to ground each drum. Ring shall be electrically-bonded to drum. Collector shall be stationary and connected to equipment grounding conductor system with a No. 8 AWG copper wire.

PART 3 EXECUTION

3.1 ERECTION

The entire crane erection shall be performed in accordance with manufacturer's instructions under the full-time supervision of the manufacturer's representative. Contractor shall provide a written certificate from crane manufacturer indicating the crane is erected in accordance with manufacturer's recommendations before testing the completed installation.

3.1.1 Shop Assembly

Major crane components shall be shop assembled as completely as possible. Disassembled parts shall be match marked and electrical connections tagged after complete no-load shop testing. Parts and equipment at site shall be protected from weather, damage, abuse and loss of identification. Erection procedures shall ensure that the crane is erected without initial stresses, forced or improvised fits, misalignments, nicks of high-strength structural steel components, stress-raising welds and rough burrs. Damaged painted surfaces shall be cleaned and repainted after crane is erected. All necessary grease and oil of approved quality and grade for the initial servicing and field test shall be provided by the Contractor.

3.1.2 Mechanical Alignment

Motors, couplings, brakes, gear boxes and drive components shall be aligned when reinstalled in accordance with manufacturer's instructions.

3.1.3 Electrical Alignment

Control system shall be aligned in accordance with manufacturer's instructions. A copy of the final alignment data shall be stored in control panel door and shall include but not be limited to timer settings, resistor tap settings, potentiometer settings, test-point voltages, supply voltages, motor voltages, motor currents and test conditions such as ambient temperature, motor load, date performed and person performing the alignment.

3.1.4 Welding

Welders, welding operations and welding procedures shall be qualified or prequalified in accordance with AWS D14.1. Welding shall be performed indoors and the surface of parts to be welded shall be free from rust, scale, paint, grease or other foreign matter. Minimum preheat and interpass temperatures shall conform to the requirements of AWS D14.1. Welding shall be performed in accordance with written procedures which specify the Contractor's standard dimensional tolerances for deviation from camber and sweep. Such tolerances shall not exceed those specified in accordance with AWS D14.1. Allowable stress ranges shall be in accordance with CMAA 70. Welding of girders and beams shall conform with AWS D14.1.

3.1.5 Field Painting

**NOTE: The last sentence will only be required if
the bridge crane is in an explosion proof area.**

Painting required for surfaces not otherwise specified, and finish painting of items only primed at the facility, shall be as specified in Section 09900 PAINTS AND COATINGS. Bridge crane including bridge, trolley, hoist and all attached items shall be painted in accordance with the manufacturer's standard practice. The complete crane shall be of one color. Bridge rail, supports and bracing shall be painted in accordance with Section 09900 PAINTS AND COATINGS. Items such as surfaces in contact with the rail wheels, wheel tread, hooks, wire rope, surfaces on the electrical collector bars in contact with the collector shoes and nameplates shall not be painted. The requirements of explosion proof cables shall be coordinated with cable manufacturer.

3.2 ACCEPTANCE TESTING

3.2.1 General

**NOTE: This paragraph applies to new construction
only. Specify the test weights required. The
weights normally required are the rated load, 125
percent of the rated load and 10 percent of the
rated load (for the grounding and the
acceleration/deceleration test).**

Contractor shall provide all personnel necessary to conduct the required testing which shall include but not be limited to crane operators, riggers, rigging gear and test weights. Testing shall be performed in the presence of Contracting Officer or his designated representative. Contractor shall notify Contracting Officer [_____] days prior to testing operations. Contractor shall operate all equipment and make all necessary corrections and adjustments prior to the testing operations witnessed by Contracting Officer. A representative of the Contractor responsible for procuring and installing hoist equipment shall be present to direct the field testing. Test loads shall be compact and permit a minimum of 50 percent of vertical lift. Test loads shall be minus 0 percent to plus 5 percent of the required weight, and shall be verified prior to testing. Test weights required are [_____] kg, [_____] kg and [_____] kg [_____] pounds, [_____] pounds and [_____] pounds. Operational testing shall not be performed until after building interior has been painted. [Three] [_____] copies of all test reports shall be furnished to Contracting Officer.

3.2.1.1 Test Sequence

Crane shall be tested in accordance with applicable paragraphs of this procedure in the sequence provided.

3.2.1.2 Test Data

Operating and startup current measurements shall be recorded for coils, hoist, trolley, and bridge motors using the appropriate instrumentation. Speed measurements shall be recorded as required by facility evaluation tests (normally at 100 percent load). Recorded values shall be compared with design specifications or manufacturer's recommended values and the abnormal differences shall be justified in the remarks or appropriate adjustments performed. The high temperatures or abnormal operation of any equipment or machinery shall be noted, investigated and corrected. Hoist, trolley and bridge speeds shall be recorded during each test cycle.

3.2.1.3 Equipment Monitoring

Improper operation or poor condition of safety devices, electrical components, mechanical equipment and structural assemblies shall be monitored during the load test. Defects observed to be critical during the testing period shall be reported immediately to the Contracting Officer and the testing operations shall be suspended until the defects are corrected. During each load test and immediately following each load test, the following inspections shall be made:

- a. Inspect for evidence of bending, warping, permanent deformation, cracking or malfunction of structural components.
- b. Inspect for evidence of slippage in wire rope sockets and fittings.
- c. Check for overheating in brake operation; check for proper stopping. All safety devices including emergency stop switches and POWER-OFF pushbuttons shall be tested and inspected separately to verify proper operation of the brakes. When provided, safety accessories including warning horn, lighting, gauges, warning lights and accuracy of wind indicating device and alarm shall be inspected.
- d. Check for abnormal noise or vibration and overheating in machinery

drive components.

- e. Check wire rope sheaves and drum spooling for proper reeving and operation, freedom of movement, abnormal noise or vibration.
- f. Check electrical drive components for proper operation, freedom from chatter, noise, overheating, and lockout/tagout devices for energy isolation.
- g. Inspect gears for abnormal wear patterns, damage, or inadequate lubrication.
- h. Verify that locations of crane capacity plates are visible from pendant operator's position.

3.2.1.4 Hooks

Hooks shall be measured for hook throat spread before and after load test. A throat dimension base measurement shall be established by installing two tram points and measuring the distance between the tram points to within 0.4 mm/164 inch. This base dimension shall be recorded. Distance between tram points shall be measured before and after load test. An increase in throat opening by more than 1 percent from base measurement shall be cause for rejection.

3.2.2 No-Load Testing

NOTE: Delete references to micro-drive when not applicable.

3.2.2.1 Hoist Operating and Limit Switch Test

Load hook shall be raised and lowered through the full range of normal travel at rated speed and other crane speeds. Load hook shall be stopped below the geared limit-switch upper setting. In slow speed only, proper operation of upper and lower limit-switches for primary and micro-drive motions shall be verified. The test shall be repeated a sufficient number of times (minimum of 3) to demonstrate proper operation. Brake action shall be tested in each direction. Proper time-delay shall be verified between the actuation of dual brakes.

3.2.2.2 Trolley Travel

NOTE: Delete references to micro-drive when not applicable.

Trolley shall be operated the full distance of bridge rails exercising all primary drive and micro-drive speed controls in each direction. Brake operation shall be verified in each direction. In slow speed or micro-drive, trolley bumpers shall contact trolley stops located on the bridge girders. In slow speed the proper operation (interrupt power, automatic reset) of the trolley limit-switches at both limits of trolley motion shall be tested.

3.2.2.3 [Bridge] [Gantry] Travel

NOTE: Delete references to micro-drive when not applicable.

[Bridge] [Gantry] shall be operated in each direction the full distance of runway exercising all primary drive and micro-drive speed controls. Brake operation shall be verified in each direction. [In slow speed the proper operation (interrupt power, automatic reset) of the [bridge] [gantry] limit-switches at both limits of [bridge] [gantry] motion shall be tested.] In slow speed or micro-drive the crane [bridge] [gantry] bumpers shall contact the runway rail stops.

3.2.2.4 Hoist Loss of Power No-Load Test

Using the primary drive, hooks shall be raised to a height of approximately 3.5 m 12 feet or less. While slowly lowering the hook the main power source shall be disconnected, verifying that the hook will not lower and that both brakes will set. Test shall be repeated using micro-drive controls.

3.2.2.5 Travel Loss of Power No-Load Test

With the hook raised to clear obstructions and trolley traveling in slow speed, the main power source shall be disconnected, verifying that the trolley will stop and the brake will set. Test shall be repeated for trolley using micro-drive speed. Test shall be repeated for [bridge] [gantry] micro-drive and slow speed primary drive controls.

3.2.3 Load Test

NOTE: Delete references to micro-drive when not applicable.

3.2.3.1 Hoist

Unless otherwise indicated, the following tests shall be performed using a test load of 125 percent (plus 5 percent, minus 0 percent) of rated load.

- a. Hoist Static Load Test: Holding brakes and hoisting components shall be tested by raising the test load approximately 300 mm 1 foot and manually releasing one of the holding brakes. Load shall be held for 10 minutes. First holding brake shall be reapplied and second holding brake released. Load shall be held for 10 minutes. Any lowering that may occur indicates a malfunction of brakes or lowering components.
- b. Dynamic Load Test: Test load shall be raised and lowered through the full range operating in each speed. Machinery shall be completely stopped at least once in each direction to ensure proper brake operation.
- c. Hoist Mechanical Load Brake: With test load raised approximately 1.5 m 5 feet and with the hoist controller in the neutral position, holding brake shall be released. Mechanical load brake

shall be capable of holding the test load. With holding brake in released position, test load shall be lowered (first point) and the controller shall be returned to OFF position as the test load lowers. Mechanical load brake shall prevent the test load from accelerating.

- d. Hoist Loss of Power Test: After raising test load to approximately 2.5 m 8 feet, slowly lowering the test load, the main power source and control pushbutton shall be released verifying that the test load will not lower and that both brakes will set. Test shall be repeated using micro-drive controls.
- e. Trolley Dynamic Load Test: While operating the trolley the full distance of bridge rails in each direction with test load on the hook (one cycle), proper functioning of all primary drive and micro-drive speed control points and proper brake action shall be tested.
- f. [Bridge] [Gantry] Dynamic Load Test: With test load on hook, bridge shall be operated for the full length of runway in both directions with trolley at each extreme end of [bridge] [gantry]. Proper functioning of all primary drive and micro-drive speed control points and brake action shall be verified. Binding of the [bridge] [gantry] end trucks shall indicate malfunction.

3.2.3.2 Trolley and Bridge Loss of Power Test

A test load of 100 to 105 percent of rated load shall be raised clear of any obstructions on operating floor. Starting at a safe distance from walls or other obstructions, a slow speed shall be selected using the trolley and [bridge] [gantry] primary drive. While maintaining a safe distance to obstructions, the main power source shall be disconnected and brakes shall be verified to have set and that the equipment stops within the distance recommended by manufacturer.

3.2.4 Overload Tests

After the operational tests, bridge crane system and all functions of bridge crane shall be tested at 125 percent of rated load.

3.2.5 Acceleration and Deceleration Tests

The acceleration and deceleration of bridge and trolley shall be tested with approximately 10 percent of rated load at lowest possible location of hook. Bridge and trolley shall be operated to run up to high speed and then stopped without jarring or swinging the load.

3.2.6 Grounding Test

Hoist shall be tested to determine that the hoist, including hook and pendant, are grounded to building during all phases of hoist operation. The grounding of bridge and trolley shall be tested with approximately 10 percent of rated load on hook. Grounding shall be tested between hoist hook and the structure's grounding system.

3.2.7 Adjustments and Repairs

Adjustments and repairs shall be performed by Contractor under the direction of the Contracting Officer at no additional cost to the

Government, until satisfactory conditions are maintained, and contract compliance is affected. After adjustments are made to assure correct functioning of the components, pertinent testing shall be repeated.

3.3 SCHEMATIC DIAGRAMS

Schematic diagrams for equipment shall be stored where indicated on drawings.

3.4 MANUFACTURER'S FIELD SERVICE REPRESENTATIVE

Contractor shall furnish a qualified experienced manufacturer's field service representative to supervise the crane installation, assist in the performance of the on site testing, and instruct personnel in the operational and maintenance features of the equipment.

3.5 FIELD TRAINING

Contractor shall conduct a training course for the operating staff. Training period shall consist of a total of [_____] hours of normal working time and shall start after the system is functionally completed but prior to final acceptance. Course instructions shall cover pertinent points involved in operating, starting, stopping, and servicing the equipment, including all major elements of operation and maintenance manual. Course instructions shall demonstrate all routine maintenance operations such as lubrication, general inspection, and [_____]. Contracting Officer shall be given at least 2 weeks advance notice of field training.

3.6 SPARE PARTS

One set of manufacturer's recommended spare parts shall be furnished and delivered to the site. The spare parts shall be suitably packaged for long-term protection and storage. The packaging shall be legibly labeled to identify the spare parts. A list of the furnished spare parts shall be included in the Maintenance manual.

3.7 ACCEPTANCE

NOTE: This paragraph should be used as written for projects where the crane is the principal construction element, or represents a very significant portion of the Contract cost. However, if the crane is part of a new facility or renovation, the acceptance paragraph should be deleted from this section. Warranty period and operating and maintenance processes should not be started before the actual beneficial occupancy of the entire facility.

Final acceptance of crane system will not be given until Contractor has successfully completed all testing operations, corrected all material and equipment defects, made all proper operation adjustments, and removed paint or overspray on wire rope, hook and electrical collector bars.

-- End of Section --