ADDENDUM 1
28 JULY 2026

SECTION 41 22 13.15

BRIDGE CRANES, OVERHEAD ELECTRIC, UNDER RUNNING TROLLEY
11/22, CHG 1: 02/23

PART 1 GENERAL

1.1 REFERENCES

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 908	(1989B; R 1999) Information Sheet: Geometry Factors for Determining the Pitting Resistance and Bending Strength of Spur, Helical and Herringbone Gear Teeth
ANSI/AGMA 2001	(2004D; R 2010) Fundamental Rating Factors and Calculation Methods for Involute Spur and Helical Gear Teeth
ANSI/AGMA 2015-1	(2001A; R 2014) Accuracy Classification System - Tangential Measurements for Cylindrical Gears
ANSI/AGMA 6013	(2006A; R 2016) Standard for Industrial Enclosed Gear Drives

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC 360	(2016) Specification for Structural Steel Buildings

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B1.1	(2024) Unified Inch Screw Threads (UN, UNR, and UNJ Thread Form)
ASME B30.10	(2019) Hooks
ASME B30.16	(2022) Overhead Underhung and Stationary Hoists
ASME B30.17	(2020) Overhead and Gantry Cranes (Top Running Bridge, Single Girder, Underhung Hoists)
ASME B30.30	(2019) Ropes
ASME HST-1	(2023) Performance Standard for Electric Chain Hoists
ASME HST-4	(2021) Performance Standard for Overhead Electric Wire Rope Hoists

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2020; Errata 1 2021) Structural Welding Code - Steel
AWS D14.1/D14.1M	(2019) Specification for Welding of Industrial and Mill Cranes and Other Material Handling Equipment

ASTM INTERNATIONAL (ASTM)

ASTM A275/A275M	(2023) Standard Practice for Magnetic Particle Examination of Steel Forgings
ASTM A1023/A1023M	(2021) Standard Specification for Stranded Carbon Steel Wire Ropes for General Purposes
ASTM E543	(2021) Standard Specification for Agencies Performing Non-Destructive Testing
ASTM F436/F436M	(2024) Standard Specification for Hardened Steel Washers Inch and Metric Dimensions
ASTM F3125/F3125M	(2019) Standard Specification for High Strength Structural Bolts and Assemblies, Steel and Alloy Steel, Heat Treated, Inch Dimensions 120 ksi and 150 ksi Minimum Tensile Strength, and Metric Dimensions 830 MPa and 1040 MPa Minimum Tensile Strength

BRITISH STANDARDS INSTITUTION (BSI)

BS ISO 4309	(2017) Cranes - Wire Ropes - Care and Maintenance, Inspection and Discard

CRANE MANUFACTURERS ASSOCIATION OF AMERICA (CMAA)

CMAA 70	(2020) Specification for Top Running Bridge and Gantry Type Multiple Girder Electric Overhead Traveling Cranes
CMAA 74	(2020) Specifications for Single Girder Cranes

INTERNATIONAL ELECTROTECHNICAL COMMISSION (IEC)

IEC ISO 15408	(2022) Information Technology-Security Techniques-Evaluation Criteria for IT Security

MATERIAL HANDLING INDUSTRY OF AMERICA (MHI)

MHI MH27.1	(2016) Specifications for Underhung Cranes and Monorail Systems

NATIONAL ELECTRICAL CONTRACTORS ASSOCIATION (NECA)

NECA NEIS 1	(2015) Standard for Good Workmanship in Electrical Construction

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(2020) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA ICS 3	(2005; R 2010) Medium-Voltage Controllers Rated 2001 to 7200 V AC
NEMA ICS 5	(2017) Industrial Control and Systems: Control Circuit and Pilot Devices
NEMA ICS 6	(1993; R 2016) Industrial Control and Systems: Enclosures
NEMA ICS 8	(2011) Crane and Hoist Controllers
NEMA MG 1	(2021) Motors and Generators

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

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

RESEARCH COUNCIL ON STRUCTURAL CONNECTIONS (RCSC)

RCSC A348	(2020) RCSC Specification for Structural Joints Using High-strength Bolts

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC SP 6/NACE No.3	(2007) Commercial Blast Cleaning

SOCIETY OF AUTOMOTIVE ENGINEERS INTERNATIONAL (SAE)

SAE J429	(2014) Mechanical and Material Requirements for Externally Threaded Fasteners
SAE J995	(2017) Mechanical and Material Requirements for Steel Nuts

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

FS RR-W-410	(2022; Rev J) Wire Rope and Strand

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910	Occupational Safety and Health Standards
29 CFR 1910.147	The Control of Hazardous Energy (Lock Out/Tag Out)
29 CFR 1910.179	Overhead and Gantry Cranes

29 CFR 1910.306	Specific Purpose Equipment and Installations

U.S. NAVAL SEA SYSTEMS COMMAND (NAVSEA)

NAVSEA T9074-AS-GIB-010/271	(2014; Revision 1) Requirements for Nondestructive Testing Methods

UL SOLUTIONS (UL)

UL 943	(2016; Reprint Sep 2023) UL Standard for Safety Ground-Fault Circuit-Interrupters
UL 1004-1	(2012; Reprint Nov 2020) UL Standard for Safety Rotating Electrical Machines - General Requirements

U. S. NAVY FACILITIES ENGINEERING AND SYSYEMS COMMAND (NAVFAC)

NAVCRANECEN INSTRUCTION 11450.2A (2018) DESGIN OF WEIGHT HANDLING EQUIPMENT

1.2 DEFINITIONS

a. Crane Bridge: That part of an overhead crane system consisting of a girder, end trucks, walkway, and drive mechanism which carries the trolley(s) and travels along the runway rails parallel to the runway.

b. Crane Runway: The track system along which the crane operates horizontally, including track hangar rods, track connection devices, and runway structural supports.

c. Dead Loads: The weight of all effective parts of the bridge structure, the machinery parts, and the fixed equipment supported by the structure.

d. Crane Bridge Girder: The principal horizontal beam of the crane bridge structure. It is supported by the crane end trucks. Typically for single girder cranes the trolley mounted hoist is suspended from the girder below the crane. For double girder cranes, the trolley is typically run on top of the bridge girder and the hoist is mounted on top of the trolley.

e. Insulated Link: A component normally installed between the hook and the lifting wire rope or lower load block, or below the hook to prevent the flow of electrical energy. Insulated links are primarily used when there is the possibility radio frequency energy collecting on the weight handling equipment structure. Insulated links are used extensively in the handling of ordnance.

f. Lifted Load: The load consisting of the rated load and the weight of lifting devices attached to the crane such as the load block, bucket, or other supplemental devices.

g. Original Equipment Manufacturer (OEM): the Company that produced the part or original equipment.

h. Packaged Hoist: A commercially designed and mass produced hoist characterized by the motor, gearing, brake(s), and drum contained in a

single package often connected by the use of c, d, or p-face flanges.

i. Patented Track: A generic term referring to track built in accordance with MHI MH27.1 utilizing a composite track section incorporating a proprietary bottom flange shape. For this crane system, it is provided for the crane bridge girder and also the crane runway track, if under running.

j. Pendant: A control for a hoist and a crane. The pendant hangs from the hoist or the crane by a cable at a height that is easy for the operator to reach.

k. Rated Load: The maximum working load suspended under the load hook.

l. Standard Commercial Cataloged Product: A product which is currently being sold, or previously has been sold, in substantial quantities to the general public, industry or Government in the course of normal business operations. Models, samples, prototypes or experimental units do not meet this definition. The term "cataloged" as specified in this section is defined as "appearing on the manufacturer's published product data sheets. These data sheets must have been published or copyrighted prior to the issue date of this solicitation and have a document identification number or bulletin number.

m. Top Running Crane: An overhead electric traveling crane that is supported by end trucks which run on top of supporting rails.

n. Trolley Load: The weight of the trolley and its associated equipment carried by the trolley wheels.

o. Under running (Underhung) Crane: An electric overhead traveling crane that is supported by crane end trucks suspended below the crane runway. The load is supported by hanging from the lower flange of a beam or patented track.

1.3 SYSTEM DESCRIPTION

The requirements for the structures supporting the crane runway are specified in Section 05 12 00 STRUCTURAL STEEL, and must conform to AISC 360.

1.3.1 Crane Design Criteria

Cranes will operate in the given spaces and match the runway dimensions and rails indicated. Hook coverage, hook lift, clearances, lifting capacity, and load test weight must not be less than that indicated. Provide loaded hook coverage to the maximum extent possible.

1.3.1.1 General

Include the following: Number of cranes: Two (2) , located in building identified as building 114, high bay area with the capacity expressed as 6,000 pounds, for each of the two overhead electric traveling (OET) cranes. Also clearly locate and identify each hoist and system components.

1.3.1.2 Classification

Provide top running single girder electric bridge crane(s), with under running trolley mounted hoist, conforming to MHI MH27.1, CMAA 70, and

CMAA 74 service class C , as applicable. The crane(s) must be designed for operation in an indoor environment, general purpose service, meeting the requirements of ASME B30.16 and ASME B30.17, with an ambient temperature range of 30 to 120 degrees Fahrenheit. The total crane span must be 21'-0" +/- with a minimum vertical hook lift of 16'-1 1/2" +/- and as specified herein.

The cranes must be pendant controlled and operate in the spaces and within the loading conditions indicated. Provide a crane, including hooks and hoisting rope , that is able to clear permanent obstructions in all operating configurations. The pendant controller must be mounted on a separate festooned cable system from the trolley power supply. The crane must operate on 460-volts AC, three phase power source. Maximum loading on the facility (without impact) due to dead loads, trolley loads, and lifted loads, with the trolley in any position, must not exceed the allowable wheel loading and wheel spacing of the facility (or not exceed maximum hanger loading for under running cranes).

Each crane shall be equipped with an electronic anti-collision system that will keep the two cranes a minimum distance from each other while operating on the same rail system. The anti-collision system will be active over the entire crane rail length to ensure there is a minimum distance maintained between the cranes. The minimum distance maintained shall be determined in accordance with requirements outlined on the accompanying drawings. The minimum distance is dependent on the bridge end truck wheel base spacing and the maximum runway rail beam support bracket spacing.

1.3.1.3 Rated Speeds

Provide the crane with rated (maximum) speeds within plus or minus 10 percent (in feet/min) for the main hoist, bridge, and trolley at the rated load as specified in the table below. The minimum speed must not exceed the values listed.

Rated Speeds feet/min		
Description	Minimum	Maximum
Main Hoist	14	35
Trolley	45	45
Bridge	50	100

The hook lift capacity and speed must be the manufacturer's standard within the limits specified.

1.4 VERIFICATION OF DIMENSIONS

The Contractor is responsible for the coordination and proper relation of their work to the building structure and to the work of all trades. Coordinate with the crane support structure design, where applicable, to provide the desired crane operating envelope (i.e., hook envelope and hook height). Verify all dimensions of the building that relate to fabrication of the crane and notify the Contracting Officer of any discrepancy before finalizing the crane order.

The existing crane rail beam and crane rails are of an unknown size and grade but have successfully served the existing single 3-ton crane. Existing W12x crane rail beam to remain for re-use. The existing crane rail and existing conductors shall be replaced with new and shall be included in the bid.

The existing crane system was installed incrementally in phases spanning many years. See plans for demarcation of each high bay addition phase and the approximate dates. The existing supporting structure are cold formed lightweight steel building systems that are proprietary. The building system manufacturers are unknown. Each of the systems uses a different structural support bracket for the crane rail beam and crane rail.

1.5 SUBMITTALS

Government approval is required for submittals with a "G" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Overhead Electric Crane System; G

Complete Schematic Wiring Diagram; G

Control System and Network Drawings; G

SD-03 Product Data

Hoist Brakes; G

Travel Brakes; G

Load Block and Hook; G

Hoist and Trolley Units; G

Hoisting Rope; G

Travel Reducer; G

Wheels; G

Bridge End Trucks; G

Crane Bridge Girder; G

End Stops; G

Bumpers; G

Crane Runway System; G

Motors; G

Enclosures; G

Circuit Breakers; G

Disconnect Switch; G

Contactors and Relays; G

Fuses; G

Variable Frequency Drives; G

Limit Switches; G

Resistors; G

Pendant Push-Button Station; G

Pendant Conductor System; G

Crane Controllers; G

Control Parameter Settings; G

Pilot Devices; G

Warning Devices; G

Floodlights; G

Runway Conductor System; G

Bridge Conductor System; G

Overload Protection; G

Painting System; G

Control System and Network; G

SD-05 Design Data

Load and Sizing Calculations bearing the seal and signature of a professional engineer; G

SD-06 Test Reports

Hook Proof Test; G

Hook Non-Destructive Test (NDT); G

Post-Erection Inspection; G

Operational Tests; G

Hook Tram Measurement; G

Load Tests; G

SD-07 Certificates

Wire Rope; G

Crane Runway Rail; G

Hazardous Material; G

Loss of Power Test; G

Overload Test; G

Brake Adjustment Record; G

Public Domain Software; G

Software and Services; G

SD-10 Operation and Maintenance Data

Operation and Maintenance Manuals, Data Package 3; G

SD-11 Closeout Submittals

Final Load Testing and Certification, Including Naval Crane Center Crane Alteration Request (CAR)

1.6 QUALITY ASSURANCE

1.6.1 Manufacturer Qualification

Overhead Electric Crane System, including sub-system components manufactured by vendors, must be designed by, or directly supervised by, a registered professional engineer (PE). PE licensing must be by a board or agency authorized to license and register professional engineers. The PE may be a Contractor's regular employee or a consultant. The PE's review and attestation of specification compliance and professional responsibility must be signified by their PE original seal and dated signature on the final drawings. The professional engineers must only undertake and perform work under this contract in the branch(s) of engineering in which they are licensed.

1.6.2 Pre-Delivery Inspections

Contractor is responsible for performance of quality control inspections, testing, and documentation.

1.6.2.1 Hook Proof Test

Proof test load hooks per ASME B30.10. Perform the proof test prior to Hook NDT.

1.6.2.2 Inspection of Hook Assembly

Inspect hook by a magnetic particle type inspection prior to delivery. Furnish documentation of hook inspection from a certified materials testing labto Contracting Officer prior to field operational testing.

Acceptance standard is no defects. A defect is defined as a linear indication for which the largest dimension is greater than 1/16 inch long. Welding repairs of hooks are not permitted. A hook showing linear indications, damage, or deformation is not acceptable.

1.6.2.2.1 Hook Non-Destructive Test (NDT)

For hooks of ferromagnetic materials, magnetic-particle inspect the hook over the entire area in accordance with NAVSEA T9074-AS-GIB-010/271 or ASTM A275/A275M.

Inspect each hook and shank over the entire surface area. If NDT cannot be performed on surfaces inside small holes (e.g., hook/nut captivation roll pin holes), visually inspect those surfaces to the maximum extent practical.

a. Procedure for magnetic particle inspection: Conduct magnetic particle inspection in accordance with NAVSEA T9074-AS-GIB-010/271. ASTM A275/A275M may be used with the following restrictions: Do not use DC yokes (including switchable AC/DC yokes used in the DC mode) or permanent magnet yokes. Do not use automatic powder blowers or any other form of forced air other than from a hand-held bulb for the application or removal of dry magnetic particles. Remove arc strikes. Equipment ammeters must have an accuracy of plus or minus 5 percent of full scale (equipment ammeter accuracy other than that stated is acceptable provided the MT procedure states that a magnetic field indicator is used to establish and verify adequate field strength for all aspects of the inspection.)

b. Acceptance Criteria: Defects found on the hook will result in rejection of defective items for use on furnished hoist.

c. Test Report: Submit a test report of the inspection of each hook to the Contracting Officer for approval prior to final acceptance of hoist installation. Certify test reports by the testing organization. The performing organization must provide a written statement of certification to ASTM E543, current within one year of the date the NDT was performed. The NDT procedures including technique sheets specific to the types, shapes, and size of the parts being examined must adequately describe the orientation of the hooks within the magnetizing equipment, as applicable. The performing organization must have the NDT procedures and its technique sheet used for testing of the hook reviewed and approved by an independent Level III examiner. Submit the (Level III examiner) approved procedures, technique sheets, and certification to the Contracting Officer with the test report.

1.6.3 Drawings: Overhead Electric Crane System

a. Submit drawings showing the general arrangement of all components in plan, elevation, and end views to demonstrate proper interface with the facility and relation to other cranes on the same rail system, if applicable. Show all major features of the crane including: hook approaches on all four sides, clearances and principal dimensions, hoist, trolley and bridge drives, motor nameplate data, overcurrent protective device ratings, and electrical schematic drawings. Include weights and centers of gravity of major components (e.g., bridge girder(s), trolley/hoist).

b. Submit shop drawings of all fabricated components. Shop drawing quality must be equivalent to the contract drawings accompanying this solicitation. Drawings must be reviewed, signed and sealed by a licensed professional engineer.

c. Provide Bill of Materials for crane components on each drawing. The schedule must provide a cross reference between manufacturer data and shop drawings. Components listed on the schedule of crane components must include total quantity, description, original manufacturer, and part number. Distributing agents will not be acceptable in lieu of the original manufacturer.

d. Provide control system drawings. Network diagram must show equipment locations, names, models, and equipment.

1.6.4 Design Data: Load and Sizing Calculations

Submit complete list of equipment and materials, including manufacturer's descriptive data, technical literature, and performance charts and curves. Submit calculations reviewed, signed, and sealed by a registered professional engineer verifying the load cases, sizing of the bridge girder(s), end trucks, travel drives, motors, overcurrent protection, and conduit. Provide a list of all codes and standards, design assumptions, equations, specified efficiencies, limits, factors of safety, component ratings, and sources of values used. Include free body diagrams or sketches of each load case.

1.6.5 Certificates

All certifications must be dated and bear the original signature (above the printed name) of the authorized representative of the Contractor or the manufacturer of the items or equipment being certified. Submit certifications that clearly identify the crane, the drives, components, and location (as applicable) to which it applies:

a. Wire Rope Certification with the wire rope manufacturer's certification that the rope meets the published breaking force, including a testing certification of the actual breaking force of a sample taken from the reel and tested. Show the published breaking force on the wire rope certificate; the actual wire rope breaking force must meet or exceed the published value. Certification must be traceable to the hoist, crane, and reel.

a. Crane Runway Certificate stating that the new crane will operate properly on the runway. Include statement certifying runway has been aligned in accordance with CMAA 74 or MHI MH27.1, as applicable. The existing crane rail support beams shall be adjusted to meet these requirements. A crane rail alignment survey shall be performed and documented by a liscensed registered surveyor.

b. Hazardous Material Certificate that the crane does not contain hazardous material including asbestos, lead, cadmium, chromium, PCBs, or elemental mercury. Products required for the designing and manufacturing of cranes must not contain the prohibited materials.

c. Loss of Power Test Certificate stating that a test may be performed in which power is removed during operation without any detrimental effects to the crane.

d. Overload Test Certificate stating that the crane can be periodically load tested to 125 percent (plus 0 minus 5 percent) of rated load.

e. Certificate of the Brake Adjustment Record. Provide a brake adjustment record and installation/maintenance manuals for each brake on the crane. Each brake measurement must have a tolerance traceable to the associated brake manual or documentation provided by the brake manufacturer, location of measurements, and the actual brake setting. Changes made to settings of the brake, at any time, will void the record.

1.6.6 Welding Qualifications and Procedure

Welding must be in accordance with qualified procedures using AWS D14.1/D14.1M as modified. Written welding procedures must specify the Contractor's standard dimensional tolerances for deviation from camber and sweep and not exceed those specified in AWS D14.1/D14.1M, MHI MH27.1 and CMAA 74. Welders and welding operators must be qualified in accordance with AWS D1.1/D1.1M or AWS D14.1/D14.1M.

1.7 CRANE SAFETY

Comply with the mandatory and advisory safety requirements of ASME B30.10, ASME B30.16, ASME B30.17, ASME HST-4 or ASME HST-1, 29 CFR 1910.147, 29 CFR 1910.179, 29 CFR 1910.306, and all applicable provisions of 29 CFR 1910 and NFPA 70.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 General

Provide materials and equipment which are standard products of manufacturers regularly engaged in the fabrication of complete and totally functional cranes including necessary ancillary equipment. Material will be free from defects and imperfections that might affect the serviceability and appearance of the finished product. All material must be new and unused.

2.1.2 Nameplates

Secure nameplates to each major component of equipment with the manufacturer's name, address, type or style, model or catalog number, and serial number. Provide two bridge identification plates, one for each side of the bridge. Provide noncorrosive metal identification plates 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 Capacity Marking

Mark the rated capacity in pound units on each side of the crane on the bridge girder. Capacity marks must be large enough to be clearly visible from the floor. Individual hoist units must have their rated capacity clearly marked on their lower block, and additionally labeled on the hoist body.

2.1.4 Safety Warnings

Affix labels in a readable position to each lift block or control station in accordance with ASME B30.16 and ASME B30.17. Submit safety warnings, diagrams and other instructions suitably framed and protected for display as indicated by the Contracting Officer as follows:

Design and locate the word "WARNING" or other legend to bring the label to the attention of the operator. Provide durable type warning labels 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.

2.2 STRUCTURAL REQUIREMENTS

Structural requirements must be in accordance with CMAA 74 and MHI MH27.1, as applicable. Structural steel materials must conform to the standards permitted in CMAA 74, MHI MH27.1, and AISC 360. Skewing and other applicable lateral loads must be considered in the design.

2.2.1 Structural Connections

High-strength bolted structural connections must be designed and installed in accordance with RCSC A348. Bolts must be of ASTM F3125/F3125M Grade A325/A325M or Grade A490/A490M material. Galvanized bolts are not acceptable.

Welded connections for the crane must be performed in accordance with AWS D14.1/D14.1M. Welded connections to the building must be performed in accordance with AWS D1.1/D1.1M. Allowable stress values must comply with CMAA 74 or MHI MH27.1, as applicable.

2.2.2 Crane Bridge Girder

a. Provide crane bridge girder(s) of rolled steel shape conforming to CMAA 74 or patented track conforming to MHI MH27.1. Intermittent ("skip") welds on bridge girder elements (e.g., web and flange interfaces) are prohibited. If the girder is notched to fit over the end trucks, reinforce the girder ends with vertical and horizontal stiffeners. Splices in the unsupported length of the girder are prohibited.

b. For patented track girder(s), submit manufacturer's standard published tables that verify the crane bridge girder is sized in compliance with all specification requirements. When standard published tables are not available, provide calculations for the strength design and deflection of the bridge. Patented track girder must be of welded steel construction and fabricated by a manufacturer regularly engaged in the production of this type of beam.

c. Keep splices in the bridge girder(s) to a minimum and splices in high stress locations must be avoided. Make splices with complete joint penetration welds. Field (on-site) welded splices are prohibited.

2.2.3 Bridge End Trucks

Provide bridge end trucks conforming to ASME B30.17 and CMAA 74 or MHI MH27.1, as applicable. Configure end trucks with a feature that limits end truck movement to one inch in the event of wheel or shaft failure.

2.2.4 End Stops

Fit the crane bridge girder(s) with structural steel end stops. Locate stops to permit maximum trolley travel. Design end stops in accordance with MHI MH27.1 and ASME B30.17. Provide a system in which the travel wheels do not contact the end stops. End stops must be designed to absorb the maximum kinetic energy and impact force developed by the bumper contact. Provide end stops compatible with trolley bumpers and designed to bolt to the crane bridge girder.

2.2.5 Bumpers

Fit bridge end trucks and trolley frames with shock-absorbing bumpers capable of decelerating and stopping the bridge and trolley within the limits stated by ASME B30.17. Ensure bumpers conform to ASME B30.17. Bumpers must fully engage end stops. Mount bumpers so that there is no direct shear on mounting bolts (if any) upon impact. Bumpers must provide adequate clearance between the crane and surrounding structure when compressed to preclude damaging equipment (clearance requirements are defined in MHI MH27.1 or CMAA 74, as applicable, and ASME B30.17). When more than one crane is located and operated on the same runway, bumpers must be provided on their adjacent ends or on one end of one crane. Fit the other end of the end-truck with a structural steel stop to engage the bumpers of the adjacent crane. Ensure bridge bumpers are properly aligned with runway end stops.

2.2.6 Crane Runway System

a. The existing crane rail support girder is a 12 inch deep wide flange steel beam with an 8 inch wide flange. Beam weight is unknown. This beam has successfully supported the existing single 3-ton crane operation and shall remain in place. The crane rail support girder shall conform to CMAA 74 Section 1.4 installation tolerance requirements and AISC 303 for the new crane installation.

The existing crane rail shall be replaced with a new ASCE standard crane rail shape of the crane installers choice that is suitable for the bridge wheels and imposed loading.

b. Crane runway girders shall be rolled steel shapes consiting of plate stock, channels, and wide flange beam sections. Crane runway girders shall be straight and true with a top flange surface of sufficient width and thikness to support a standard ASCE crane rail shape. Design of crane runway shall conform to CMAA 74 subsection 1.4 requirements.

Center the crane rail on the top flange and position directly over the girder web. Fasten rail to girder with welded clips. Position rail clips in pairs and locate not more than 36 inches on center. Stagger and position rail joints directly over the girder web. Make all rail

joints flush and true without misalignment. The horizontal gap between adjacent rail ends shall not exceed 1/16 inch and vertical misalignment must not exceed 1/32 inch.

c. For top running crane runways, design, fabricate, and install new runway end stops in accordance with ASME B30.17, CMAA 70, CMAA 74 or MHI MH27.1, as applicable. End stops must be designed to absorb the maximum kinetic energy and impact force developed by the bumper contact. Provide end stops compatible with end truck bumpers, designed to bolt to the runway support girders, and maximize bridge travel.

2.3 MECHANICAL REQUIREMENTS

a. Provide steel shafts, gears, and keys, with the exception of worm gears which may be bronze. No three or more bearing shaft configurations are allowed.

b. Cast iron and aluminum used to support components of the hoist power transmission train must be ductile. For the purposes of this specification, "ductile" is defined as having a minimum elongation of 5 percent in 2.00 inches.

c. Provide steel or ductile/malleable cast iron brake housings of motor mounted disc brakes, brake lining backing plates, shoes and shoe holders. Provide spring-set brake shoe or pad linings of a non-asbestos material.

d. All mechanical components must be accurately aligned and positively secured to maintain the alignment. Parts must not be forced into position to obtain apparent alignment.

e. Provide minimum bearing life in accordance with ASME hoist performance standards and MHI MH27.1 or CMAA 74, as applicable.

f. All "should" statements in CMAA 74, MHI MH27.1, and ASME B30 are considered to be "shall" statements.

2.3.1 Threaded Fasteners

Fasten mechanical connections that are not part of a commercial packaged assembly with SAE J429 Grade 5 fasteners, ASTM F436/F436M washers, and SAE J995 Grade 5 nuts. Lubricate all mechanical fasteners unless otherwise specified by the original component manufacturer.

2.3.2 Hoist

Provide hoist conforming to ASME B30.16, except as modified and supplemented in this section. Packaged hoist and trolley units (packaged hoists) must be double reeved electric wire rope hoist conforming to ASME HST-4 Duty Class H3 or better and be rated for the operating environment.

Configure trolley such that the trolley frame contacts the trolley stops and prevents the trolley from dropping more than one inch in the event of an axle or wheel failure.

2.3.2.1 Hoist Brakes

a. Equip the hoist with two holding brakes, each with a minimum torque rating of 125 percent of the rated load hoisting torque. Provide a brake configuration with one electro-mechanical spring set brake and one mechanical load brake, or self-locking worm gear, that stops and holds 125 percent of the hoist's rated load and does not require the load to be raised before being lowered.

b. Electro-mechanical brakes must have an externally accessible means of manual release. Provide manual-adjusting brakes designed to permit inspection and adjustment without disassembly of the brake. The brakes must be equipped with a manual self-return to ON brake release; maintained brake releases must reset when power is applied. Double face-mounted brakes are not permitted.

2.3.2.2 Load Block and Hook

a. Provide a load block constructed of steel. The load block must be designed to prevent metal-to-metal contact of moving parts. The block must be fully enclosed, concealing the sheaves and wire ropes, except for wire rope slots and drain holes. The design must preclude the wire rope from being cut, pinched, crushed, or chafed in case of two-blocking. Standard commercial blocks may be used at their published ratings when their published design factors are 5.0 or greater.

b. Provide an unpainted and unplated forged carbon steel single barbed hook with a minimum material longitudinal elongation of 16 percent in 2 inches. Hooks must conform to the requirements of ASME B30.10. The hook must be a standard commercial product with a published design factor of 5.0 or greater. Fit hook with a safety latch designed to preclude inadvertent displacement of slings from the hook saddle. The hook and hook nut must be removable without unreeving of the hoist. Provide hook nut secured to the hook with a commercial standard removable and reusable means. Do not weld hook nut. When provided, provide shank and nut threads with a Class 1 or 2 fit, per ASME B1.1. Uniquely mark the hook in a permanent fashion that is traceable to the NDT certification. The nut must be marked to match the hook. Marking shall be the crane number assigned by the weight handling program office. Hook must be free to rotate through 360 degrees when supporting the test load up to 125 percent of the rated capacity.

2.3.2.3 Hoisting Rope

a. Wire rope must comply with ASME B30.30 and FS RR-W-410, ASTM A1023/A1023M, or BS ISO 4309 and have a rope classification appropriate for the usage. Wire ropes must be handled and sized in accordance with ASME B30.30. The wire rope must be in a double reeved configuration equalized with a sheave. Select wire rope minimum design factor in accordance with ASME B30.16. Provide proof of Wire Rope breaking force by means of physical testing reports prepared by a certified materials laboratory..

b. Provide hoist wire ropes with improved, extra-improved, or extra-extra-improved plow steel (or appropriate ISO grades), pre-formed, regular lay, bright, and uncoated, with an independent wire rope, wire strand, or otherwise, steel core. Hot-dipped galvanized wire rope is not permitted.

2.3.2.4 Drum

Provide grooved drum made of steel. Design drum in accordance with ASME B30.16. All hoisting rope is to be wound in a single layer and provided with no less than two dead wraps of hoisting rope remaining at each anchorage when the hook is in its extreme low position.

2.3.2.5 Sheaves

Provide steel sheaves. Size sheaves in accordance with ASME B30.16 for the minimum pitch diameters of running and equalizer sheaves.

2.3.3 Travel Drives

Provide under running travel assemblies with a minimum of one driven wheel on each side of the web and at least one quarter of all wheels driven.

The travel drive arrangement must consist of motor(s) driving through self-contained gear reduction units located at each driven wheel assembly. Gear reducers must be fully enclosed in an oil-tight housing and provided with a convenient means of lubricant level indication and draining. Open-type gearing is not acceptable, except for final drives.

2.3.3.1 Trolley Drives

Provide a motor-driven trolley arrangement. Acceleration and deceleration must meet the requirements specified in CMAA 70. Provide trolley travel limit switches.

2.3.3.2 Bridge Drives

Provide a motor-driven bridge arrangement. Acceleration and deceleration must meet the requirements specified in CMAA 74. Provide bridge travel limit switches.

2.3.3.2.1 Bridge Travel Gearing

Gearing must conform to ANSI/AGMA 2001 and AGMA 908, with internal and external gear dimensional tolerances conforming to the applicable AGMA standard for tooth geometry and tolerances.

2.3.3.2.1.1 Bridge Travel Reducer

Gear reducers must be standard commercial products designed, manufactured, and rated in accordance with ANSI/AGMA 6013. Provide cranes with a CMAA service class "C" or higher with the corresponding "Industrial Duty" service factors. The speed reducer input (high speed) gear set must use helical (including double helical and herringbone), spiral bevel, or worm gear tooth forms. Provide torque arms that are not of the threaded rod type. Operation must be smooth and quiet.

2.3.3.2.1.2 Bridge Open Gearing

Provide all gears and pinions with adequate strength and durability for the crane service class and manufactured to ANSI/AGMA 2015-1 Accuracy Grade A8 or better. Wherever feasible, open gears must be enclosed with safety guards provided with openings with covers for inspection and access for grease lubrication.

2.3.4 Travel Brakes

Provide travel drives with an end-mounted electro-mechanical spring set brake conforming to the requirements of CMAA 74 or non-freecoasting mechanical drive capable of stopping the motion of the travel function within a distance in feet equal to 10 percent of the full load speed in feet per minute when traveling at full speed with a full load.

Spring set brakes must be provided with an externally accessible means to manually release the brake. Provide manual-adjusting brakes designed to permit inspection and adjustment without disassembly of the brake. The brakes must be equipped with a manual self-return to ON brake release; maintained brake releases must reset when power is applied. Double face-mounted brakes are not permitted.

2.3.4.1 Trolley Brake

Provide brakes for underrunning trolleys/carriers sized in accordance with ASME B30.17, but not sized larger than 150 percent of the drive motor rated torque.

2.3.4.2 Bridge Brake

Provide brakes with a minimum torque rating per CMAA 74 according to the applicable environment, but not sized larger than 150 percent of the drive motor rated torque.

2.3.5 Wheels

a. Top running wheels are to be straight tread, double flanged, and sized in accordance with CMAA 74 recommendations for wheel sizing and flange to rail head clearances. Wheel material must be forged steel. Hollow stamped and gray cast iron wheels may not be used; the use of plate steel is prohibited. Provide steel wheels with a minimum tread hardness of 320 BHN.

b. Provide under running wheel sizing and flange-to-rail head clearances in accordance with MHI MH27.1 and CMAA 74 recommendations, as applicable. The wheels must be compatible with their respective runway profile. Wheel material is to be cast or forged steel, or ductile or malleable cast iron. Hollow stamped and gray cast iron wheels may not be used; the use of plate steel is prohibited. Minimum tread hardness for underhung wheels that run on patented track is 375 BHN. Minimum tread hardness for wheels running on structural shapes is 320 BHN.

2.3.6 Drip Pans

a. The crane must be designed to preclude leakage of lubricants onto the lifted loads or the floor. Equipment or components, which cannot be made leak-proof, must be fitted with unpainted corrosion resistant steel drip pans or must have the foundations seal welded to create a dam. Drip pans that utilize liquid sealant to prevent leakage of lubricants are not permitted.

b. The drip pans must be sized to hold the entire gear case fluid capacity, installed under all drive machinery, designed to permit easy removal of collected lubricant. A trolley floor designed to contain

any lubricant drips may be used as fluid containment for any equipment that is mounted on it.

2.4 ELECTRICAL REQUIREMENTS

a. The design, selection, rating, and installation of the electrical portions of the crane and its accessories must conform to the requirements of NEMA ICS 3,NEMA ICS 8, the applicable ASME HST standard, and NFPA 70, and other requirements specified herein.

b. All electrical components must be industrial grade, commercially available and comply with established national or internationally recognized approving organizations such as Underwriters Laboratories (UL) and Canadian Standards Association (CSA).

c. All electrical components must be located so they are easily accessible for inspection and maintenance without removing other parts, doors, or door center posts. Electrical equipment and panel wiring must be installed in a neat and workmanlike manner in accordance with Electrical Construction Standard NECA NEIS 1. Each motion of the crane must be provided with a separate control system or drive. The loss of any one function must not prevent the operation of other unaffected functions. Two independent relays, contactors, drive inputs, or other equivalent components/logic must be utilized for each function to provide directional control such that the failure of a single relay/contactor/component cannot result in motion in an unintended direction.

d. Disconnecting means for cranes must be in accordance with NFPA 70 Article 610.32. A permanent placard must be installed on the face of the main line disconnect that states "WARNING – THIS DOES NOT ISOLATE POWER TO LIGHTING, RECEPTACLES, AND ANCILLARY EQUIPMENT". Additionally, a lighting (ancillary equipment) disconnect must be provided, with lockout feature, as the isolation means for the lighting transformer and lighting circuit breaker panel, which must power the crane's ancillary equipment. It must feed 480 VAC to the primary side of the transformer directly from the runway conductors via tapping the line side of the main power disconnect. Provide individual disconnects, with lockout feature, capable of being locked in the open position for bridge lights and receptacles.

e. Unless otherwise specified, interconnecting wiring must be of copper stranded construction complying with Table 310.104(A) of NFPA 70. Interconnecting wiring containing asbestos in the insulation or outer covering are prohibited. Aluminum conductors must not be used. Aluminum connectors are allowed if they are rated for use with copper conductors (marked "AL/CU"). All conductors connected to or routed above resistors must have insulation shown in NFPA 70 Table 610.14(a) for 257 degrees F. For packaged hoists and hoist/trolleys, provide wiring sizes in accordance with NFPA 70 Table 610.14(a). Motor branch circuit conductors not part of a packaged hoist and hoist/trolley must be sized as to have an ampacity not less than 150 percent of the motor full load current rating and to be no smaller than 12 AWG. Conductors must be selected and de-rated based on maximum ambient temperature. Continuous loads such as utility, heating, lighting, and air conditioning must be multiplied by 2.25 to determine ampacity in order to permit application of NFPA 70 610.14 (A) for crane supply

conductors. Wire-nuts are not permitted on splices. However, connections for lighting ballasts may be made using wire-nuts (if applicable).

f. Excluding conduit directly connected to dynamic breaking resistors, raceways must maintain a 12-inch clearance between the raceway and dynamic braking resistors. A separate grounding wire, sized in accordance with Section 250.122 of NFPA 70, must be routed with all ungrounded conductors. Only one equipment grounding conductor must be run in each conduit and be the largest size required for any circuit routed in that conduit. All wiring must be numbered or tagged at all connection points. Power conductors which are shielded such that their wire size cannot be easily determined must be labeled as to the conductor size. All unused conduit openings must be plugged.

g. When fiber optic cable is utilized, inspections and performance checks must be accomplished upon completion of on-site installation to ensure cable cleanliness and proper signal integrity. Testing and verification must be conducted by a knowledgeable fiber optics technician using specialized, calibrated equipment. Cables must be tested for signal loss/attenuation. The fiber optic system must also be tested using an Optical Time Domain Reflectometer (OTDR). Final attenuation and OTDR readings from each fiber optic cable run, including spares, must be documented as a baseline for future reference. All spare fiber optic cables must have protective covers over their ends to maintain cleanliness while not in use. When fiber optic cable is utilized the drive OEM's recommendations for encoders and optical to digital converters must be followed. All system components utilized for this purpose must have known compatibility prior to integration.

h. Power cables and low voltage signal cables may not be mixed in the same conduit.

i. The crane manufacturer must furnish and install all electrical equipment on the crane conforming to NEMA ICS 6, including motors, conforming to NEMA MG 1, electrically released brakes, switches, crane controllers, panels, operating station, wiring system, cables, and crane electrification.

2.4.1 Motors

Motors must meet all applicable requirements of NEMA MG 1 and UL 1004-1. Use CMAA 70 calculations for motor horsepower in selecting bridge, trolley, and hoist drive motors. All motors must have a minimum of a 60 minute duty rating and be Totally Enclosed Non Ventilated (TENV), Totally Enclosed Fan Cooled (TEFC), or Totally Enclosed Blower Cooled (TEBC). Provide inverter duty motors for Open Loop Variable Frequency Drives (VFD). Provide motors with a minimum of Class F insulation. Provide motor overload protection utilizing a thermal sensitive device embedded in its windings.

2.4.2 Controls

a. Provide static reversing, variable frequency drives (VFD) for the bridge, trolley and hoist electric controls. VFD controllers must meet NEMA ICS 8, Part 8 and at a minimum, provide under-voltage protection, electronic instantaneous over current protection, DC bus over voltage protection, and be able to withstand output line to line

shorts without component failure. Select bridge and trolley drives such that the continuous rating of the controller is not less than the calculated motor full load current based on CMAA 70 paragraph 5.2.9.1.1.1 and NFPA 70 Table 430.250. Select hoist drives such that the continuous rating of the controller is not less than 125 percent of the calculated motor full load current based on CMAA 70 paragraph 5.2.9.1.1.1 and NFPA 70 Table 430.250. All hoist drives must have a motor over-torque limit to lock out the hoist and prevent gross overload of the associated hoist. Provide dynamic braking for each electric drive that is sized per VFD manufacturer's requirements. Submit VFD Control Parameter Settings.

b. Provide speed control which is infinitely variable for each function, controlled via pendant pushbutton station. Provide controls designed such that the maximum speed of each function will be limited to 25 percent of rated speed when a slow speed switch is actuated on the controllers. Energize a yellow/amber light/indicator while in slow speed mode.

c. The hoist, trolley, and bridge brakes must set after the associated controller decelerates the drive motor to a controlled stop. The hoist, trolley, and bridge, controllers must be sized to provide sufficient starting torque to initiate motion of that crane drive mechanism from standstill with 0 to 125 percent of rated load on the hook. The hoist controller must prove torque before release of the brakes and enable the drive motor to develop full torque continuously at zero speed. Motors must operate smoothly at all speeds without torque pulsations and must only be energized within the frequency range of 50-60 Hz at rated speed.

d. The use of definite purpose contactors is prohibited. If IEC contactors are used, the application cannot exceed the contactor manufacturer's AC3 ratings for the contactor at a minimum.

e. On hoist function roll-up must be less than 1/8 inch measured at the hook block and roll-back must not occur over the entire load range.

f. Use of Uninterruptible Power Supplies (UPS) is prohibited. Feed control circuits from a single phase, air cooled, double wound transformer with a grounded metal screen between the primary and secondary windings of the transformer.

g. Provide a main line contactor. Energization of the main line contactor must be controlled by the POWER-OFF/POWER-ON switch/pushbutton on all controllers. Upon actuation of the POWER-OFF pushbutton; power to all drive motors, brakes, and controls must be removed. The mainline contactor must not be able to be energize while the POWER-OFF pushbutton is actuated. The POWER-OFF pushbutton circuitry must be independent of all controls or any other electronic devices.

h. Provide a spring returned brake bypass keyswitch for each hoist. The switch allows for actuation of the electro-mechanical brake for independent testing of the mechanical load brake. The normal position allows both brakes to work in their normal operating configuration. Label the keyswitch positions as "NORMAL" and "LOAD BRAKE TEST".

2.4.3 Protection

Protection must not be less than that required by NEMA ICS 3, NEMA ICS 8, CMAA 74, NFPA 70, UL 1004-1, UL 943, 29 CFR 1910.147, 29 CFR 1910.179, 29 CFR 1910.306 and all applicable provisions of 29 CFR 1910. All protection must be by circuit breakers or fuses. Provide a disconnect switch or enclosed type circuit breaker readily accessible to the crane operator for the crane disconnect. Motor branch circuits must be individually protected by inverse time circuit breakers capable of being locked in the open position. The means for locking must remain in place with or without the lock installed. Motor full load current from NFPA 70 Article 430, Part XIV (Tables) must be used to calculate the circuit breaker size.

Provide disconnecting means on the crane in accordance with NFPA 70 Article 610.32. Provide for lockout/tagout of all hazardous energy sources. Provide product data for all circuit breakers and fuses.

2.4.3.1 Conductors

a. The crane contractor is responsible for ensuring that all conductors from the load side of the existing floor level disconnect to the motor branch circuits have adequate overcurrent protection complying with one of the following:

   (1) Not be greater than the largest rating or setting of any branch circuit protective device plus the sum of the nameplate rating of all other loads per NFPA 70 Article 610.41(A).

   (2) Not be greater than the ampacity of all feeder conductors after all ampacity correction factors have been applied.

b. Conductors for brake coils must be protected by fuses or other protective devices. The device must be chosen to protect the brake circuit conductors from ground faults or short circuits.

2.4.4 Resistors

Provide resistors with natural convection cooling sized as recommended by the VFD OEM and fabricated of corrosion resistant metal; the use of "wire wound" type resistors is prohibited for segments of 8 ohms or less. Mount resistors in substantial, ventilated enclosures constructed entirely of non-combustible materials. Provide resistors with terminals fitted in the coolest position in the enclosure.

2.4.5 Transients and Harmonics Protection

a. Provide contactors and relays with appropriate Metal Oxide Varistors (MOV) or resistor-capacitor (R-C) surge absorbers installed across the respective coil.

b. Provide transient protection for electronic drive controllers that is either internal to the drive or via an MOV connected line-to-ground close to the line terminals of the drive.

c. Provide line reactors rated for continuous duty operation based upon the motor nameplate amperes. With motors of 50 horsepower or greater, harmonics protection must be provided by an isolations transformer or as recommended by the VFD OEM. For a drive motor branch circuit that

exceeds 150 feet in length, a reactor must also be connected in series with the controller load (output) terminals to provide standing wave protection or as otherwise recommended by the VFD or motor OEM.

2.4.6 Limit Switches

a. Provide primary upper and lower geared limit switches. Geared limits must allow reversing direction to back out of the limit without resetting. The lower limit switch must be set such that there are a minimum of two wraps of rope on the hoist drum.

b. Provide a backup mechanical hook block activated upper limit switch wired independent of the directional controllers and the primary upper limit switch that removes power from the hoist motor, hoist brake and hoist controls conforming to NEMA ICS 5. The backup limit must require hoist resetting prior to operation of the hoist in any direction.

c. For chain hoists, the upper hoist limit switch must be wired to remove all power from the hoist drive motor and brake(s) independent of the microprocessor drive. A two-position spring-returned bypass switch must be provided that allows for resetting of the final limit switch prior to resuming operation. During resetting of the final limit, the hoist must operate in the lowering direction only.

d. Travel limit switches must be provided for the bridge and trolley motion to slow the crane to 25 percent of its rated speed 10 feet before the bridge end stops and 5 feet from the trolley end stops. Limit switches must be mounted rigidly in a manner so as to protect the switch from misalignment or damage. The target/trip arm must be large enough to provide interception given a misalignment were to occur.

2.4.7 Operator Controls

a. Provide crane equipped with a pendant pushbutton station.

b. If VFD controls are not provided, provide directional contactors with both mechanical and electrical interlocks.

2.4.7.1 Pendant Pushbutton Station

The cranes must be controlled from a pendant pushbutton station suspended from an independent festooned messenger track system, operating the length of the bridge Provide multiconductor flexible cords for pendant pushbutton stations with No. 16 AWG minimum conductors. Provide a method of strain relief to protect the electrical conductors from damage. Locate the pendant pushbutton station 4 feet above the finished floor. Pushbutton pendant station must have its elements legibly marked and arranged vertically, in order, in accordance with CMAA 74. Provide 3-step infinitely variable pendant pushbuttons for control of the hoist, trolley, and bridge. Provide pendant pushbuttons for control that spring return to the OFF position. Voltage in the pendant pushbutton station must not exceed 150 Volts AC or 300 Volts DC. Provide a maintained two-position selector switch for slow speed selection.

2.4.7.1.1 Pendant Conductor System

Provide a festoon type pendant conductor system. The festoon cables must

be flat cables suspended from carriers riding on an I-beam or C-track. The pendant controller must be capable of traveling the entire length of the bridge and move independently of the trolley. Festoon loops must not extend below the high hook position.

2.4.8 Electrification Systems

2.4.8.1 Runway Conductor System

a. Provide a rigid runway Conductor Bar System for the runway conductor system, including all necessary cables and hardware to the crane from a wall or column mounted disconnect switch. Provide electrification system with three power conductors and an equipment grounding conductor. The crane must be grounded through the runway electrification system. Provide runway conductors sized for simultaneous motions of the hoist, bridge, trolley mechanisms and any ancillary loads. If there is any way the hook block or wire rope can swing into the runway electrification, provide a guard installed to prevent contact.

b. Provide two Collector Shoes (tandem design) for each conductor; each collector shoe must be rated for not less than the runway conductor sizing, so as to provide redundancy.

2.4.8.2 Bridge Conductor System

a. Provide Festoon System for the bridge conductor system utilizing cables suspended from carriers riding on an I-beam or C-track. Conductors must be fabricated from copper. A minimum of 20 percent of the festoon control circuit conductors for each electrification system must be spares at the time of crane acceptance. The trolley is required to be grounded through this conductor system. Festooned cable loops must not extend low enough to come into contact with any obstructions.

2.4.9 Overload Protection

a. Provide a capacity overload protective device for all hoist systems using VFD drive capacity overload protection (separate from torque limiting feature of the VFD). Set hoist capacity overload protection at 100 percent of rated capacity. Hoist capacity overload protection must be adjustable between 80 and 150 percent of hoist capacity. Provide a keyed override or other means to disable the hoist capacity overload protection when performing a load test. If a slip clutch is used as the overload limiting device, it must comply with all ASME B30.16 requirements. Provide adjustable slip clutches set at or less than the cranes maximum test load. If the slip clutch is non-adjustable, the OEM factory setting is acceptable and must be identified with the Product Data sheets and O&M manual.

b. Initially, set the torque limiting capability of the VFD (that is separate from the capacity overload protective device) to 150 percent of the motor torque (amperage) necessary to hoist 100 percent load. It may be adjusted up only to avoid nuisance trips and adjusted down if possible while still avoiding nuisance trips.

2.4.10 Enclosures

a. Provide enclosures for control panels, controls, and brakes in

accordance with NEMA 250 and NEMA ICS 6, Classification Type 12 indoor without knockouts, general purpose.

b. Provide a non-resettable hour meter, connected across the main line contactor, readable from the exterior of the main control panel, to indicate the elapsed number of hours the crane is energized.

2.4.11 Warning Devices

Provide a warning horn that is operable from a push button at the pendant pushbutton station. Provide a warning strobe light that is illuminated at all times during movement of the hoist, trolley, or bridge function, but may be deactivated on the operator control station.

2.4.12 Floodlights

Provide evenly spaced floodlights along the bridge. Select floodlights to provide an illumination level of 40 foot-candles at three feet above the finished floor. All lights must be vibration resistant and designed to prevent any material from falling from the fixture. Switch the floodlights from the pendant pushbutton station.

2.4.13 Pilot Devices

Provide Indicator Lights mounted in an enclosure on the bottom of the bridge with lights sized and positioned to be visible from the ground. The lights must be the dual-lamp type. Provide a white light to indicate that power is available to the crane and a blue light to indicate that the main contactor is energized. Light voltage must be 115 VAC. Provide nameplates that are legible from ground level. The nameplates must read, in their respective order, "POWER AVAILABLE" and "CRANE ENERGIZED". The POWER AVAILABLE light must be supplied by a separate, fused transformer for its energization.

2.4.14 Cyber Security of Control Systems

a. Provide the following for PLC, RTU, Supervisory Controller, or other network-capable (whether networked or not upon delivery) control devices as applicable:

(1) Hardware list (Hardware list must include the following for each device):

(a) Manufacturer

(b) Model

(c) Location

(d) Key technical ratings (e.g., memory)

(e) Serial number

(f) MAC addresses

(g) IP addresses

(2) Software List (Software list must include the following for each device):

(a) Manufacturer

(b) Version/subversion

(c) Location/device

(d) Used network ports/protocols/services

(3) List and discussion of all security features of Contractor hardware and software.

b. For every PLC, RTU, Supervisory Controller, or other network-capable control devices (whether networked or not upon delivery), deliver the following on CD/DVD:

(1) Original firmware

(2) Original firmware hash

(3) SOP for application of firmware updates/patches

(4) POC or website for firmware updates/patches

(5) Count of interfaces and types

(6) Protocols in use, per interface

(7) Configuration file

(8) SOP for configuration

2.4.14.1 Control System and Network

a. Provide one rugged laptop type workstation (computer) complete with all compatible software (including software licenses), redundant physical back-up copies on CD/DVD of the installed software, and all necessary cables and special connectors to allow crane software to be troubleshot, checked and upgraded, and for the data recorder to be accessed and information retrieved. Equip the workstation with a CD/DVD drive and the associated CD/DVD burning software. The workstation must also be equipped with USB ports (2.0 and 3.0), an Ethernet port, and a serial port. Delivering the software on a USB (flash drive) device is prohibited.

b. The laptop must be designed for an industrial environment and must be shock resistant and weatherproof as a minimum. Provide the laptop with a built-in CD/DVD reader with the capability to burn CDs and DVDs including associated software to burn CDs and DVDs.

c. The Contractor must provide all equipment, including software and hardware, necessary for testing, installation, and communicating/troubleshooting all systems provided with the crane (e.g., engine/generator, control system, LID, etc.). The Contractor must provide all crane specific operational software files (e.g., ladder logic, functional block programming, etc.) for their associated systems (e.g., control systems, LID, engine generator, etc.).

d. A single common networked design must not be used for the control

systems. A network for an individual function may be used as long as a failure of the network does not affect any other function/network except as defined for specific safety interlocks (e.g., LMI system). A common crane network may be used in a monitoring mode for recording faults and trending and is encouraged. Failure of the monitoring system must not affect crane functions.

e. All provided hardware and software must be currently marketed products, not currently scheduled for end of life or obsolescence, to ensure system sustainability.

f. The control system engineering workstation hardware and operating system must be in conformance to the Common Criteria for IT Security Evaluation (IEC ISO 15408, visit https://www.niap-ccevs.org for more information).

g. Ensure there is no remote access capability enabled as remote access capabilities are prohibited. Physically disable or remove all modem/network devices not required for operational purposes.

2.4.14.2 Software and Services

a. Remove all Software and Services not required for operation and/or maintenance of the product. If removal is not technically feasible, then disable software not required for the operation and/or maintenance of the product. Configure the product to allow the ability to re-enable ports and/or services if they are disabled by software. The removal of software or services may not impede the primary function of the product. If software that is not required cannot be removed or disabled, document a specific explanation and provide risk mitigating recommendations and/or specific technical justification. The software/service to be removed and/or disabled includes, but is not limited to:

(1) Cameras

(2) Games

(3) Device drivers for product components not procured/delivered

(4) Messaging services (e.g., email, instant messenger, peer-to-peer file sharing)

(5) Source code

(6) Software compilers in user workstations and servers

(7) Software compilers for programming languages that are not used in the control system

(8) Unused networking and communications protocols

(9) Unused administrative utilities, diagnostics, network management, and system management functions

(10) Backups of files, databases, and programs used only during system development

(11) All unused data and configuration files

(12) Remove and/or disable, through software, physical disconnection, or engineered barriers, all services and/or ports in the procured product not required for normal operation, emergency operations, or troubleshooting. This includes communication ports and physical input/output ports (e.g., USB docking ports, video ports, and serial ports).

b. Provide documentation showing all disabled ports, connectors, and interfaces for all network-capable devices. In addition, provide summary documentation of the procured product's security features and security-focused instructions on product maintenance, support, and reconfiguration of default settings.

c. For the evaluation status of hardware and software, the Contractor must provide information on Common Criteria (IEC ISO 15408) or National Information Assurance Partnership (NIAP) or Federal Information Processing Standards (FIPS) evaluation status of hardware and software.

2.4.14.3 Access Control

a. The Contractor must configure each component of the procured product to operate using the principle of least privilege. This includes operating system permissions, file access, user accounts, application-to-application communications, and energy delivery system services.

b. Provide user accounts with configurable access and permissions associated with one or more organizationally defined user role(s), where roles are used.

c. Provide a system administration mechanism for changing user(s') role (e.g., group) associations.

d. The Contractor must document control system access control options by defining access and security permissions, user accounts, and applications with associated roles.

e. Provide recommended methods for the Acquirer to prevent unauthorized changes to the Basic Input/Output System (BIOS) and other firmware. If it is not technically feasible to protect the BIOS to reduce the risk of unauthorized changes, the Contractor must document this case and provide mitigation recommendations.

2.4.14.4 Control System Account Management

The Contractor must document all accounts (including, but not limited to, generic and/or default) that need to be active for proper operation of the procured product.

Remove or disable any accounts that are not needed for normal or maintenance operations, emergency, or troubleshooting of the energy delivery system.

2.4.14.5 Session Management

The Contractor may not allow multiple concurrent logins using the same authentication credentials, allow applications to retain login information

between sessions, provide any auto-fill functionality during login, or allow anonymous logins.

Provide account-based and group-based configurable session-based logout and timeout settings (e.g., alarms and human-machine interfaces).

2.4.14.6 Authentication/Password Policy and Management

Provide a configurable account password management system that allows for, but is not limited to, the following:

a. Changes to passwords (including default passwords)

b. Selection of password length

c. Frequency of change

d. Setting of required password complexity

e. Number of login attempts prior to lockout

f. Inactive session logout

g. Screen lock by application

h. Comparison to a library of forbidden strings

i. Derivative use of the user name

j. Denial of repeated or recycled use of the same password

The Contractor must time stamp log files.

2.4.14.7 Logging and Auditing

Provide logging capabilities that cover the following events, at a minimum (as appropriate to their function):

a. Information requests and server responses

b. Successful and unsuccessful authentication and access attempts

c. Account changes

d. Privileged use

e. Application start-up and shutdown

f. Application failures

g. Major application configuration changes

2.4.14.8 Heartbeat Signals

The Contractor must identify heartbeat signals or protocols and recommend which should be included in network monitoring. At a minimum, include a last gasp report from a dying component or equivalent.

The Supplier must provide packet definitions of the heartbeat signals and

examples of the heartbeat traffic if the signals are included in network monitoring.

2.4.14.9 Patch Management and Updates

The Contractor must verify that procured products (including third-party hardware, software, firmware, and services) have appropriate updates and patches installed prior to delivery.

Provide documentation of the patch management program and update process (including third-party hardware, software, and firmware). This documentation must include resources and technical capabilities to sustain this program and process. Provide the Contractor's method or a recommendation for how the integrity of the patch is validated by the Acquirer as well as the Supplier's approach and capability to remediate newly reported zero-day vulnerabilities.

2.4.14.10 Malware Detection and Protection

a. The Contractor is required to implement at least one of the following:

(1) Provide a host-based malware detection capability that quarantines (instead of automatically deleting) suspected infected files. Provide an updating scheme for malware signatures. The Contractor must test and confirm compatibility of malware detection application patches and upgrades.

(2) If the Contractor is not providing the host-based malware detection capability, the Contractor must suggest malware detection products to be used and provide guidance on malware detection and configuration settings that will work with Contractor products.

b. The Contractor must validate that cybersecurity services running on the procured product (e.g., virus checking and malware detection) do not conflict with other such services running on the procured product.

c. For malware detection and protection, the Contractor must provide, or specify how to implement, the capability to automatically scan any removable media that is introduced to the product being acquired.

2.4.14.11 Physical Security

Provide lockable or locking enclosures or rooms for energy delivery systems and system components (e.g., servers, clients, and networking hardware) and for the systems used to manage and control physical access (e.g., servers, lock controllers, and alarm control panels). Provide a method for tamper detection on lockable or locking enclosures. If a physical security and monitoring system is used, tamper detection must be compatible. The Contractor must ensure that physical security features do not hamper the crane system operations. Provide the tools and instructions for making changes to locks, locking codes, keycards, and any other keyed entrances.

2.4.14.12 Wireless Technology

For wireless technology provisions, the Contractor must document:

a. Specific protocols and other detailed information required for

wireless devices to communicate with the control network, including other wireless equipment that can communicate with the Contractor-supplied devices.

b. Use, capabilities, and limits for the wireless devices.

c. Power and frequency requirements of the wireless devices (e.g., microwave devices meet the frequency requirements of Generic Requirements GR-63 Network Equipment Building System (NEBS) and GR-1089.

d. Range of the wireless devices and verify that the range of communications is minimized to both meet the needs of the Acquirer's proposed deployment and reduce the possibility of signal interception from outside the designated security perimeter.

e. Wireless technology and associated devices compliance with standard operational and security requirements specified in applicable wireless standard(s) or specification(s) (e.g., applicable IEEE standards, such as 802.11).

f. Configuration control options that enable varying of the security level of the devices.

2.4.14.13 Control System Inventory

Provide the complete control system inventory. The Control System Inventory must include the following attributes, in tabular format, as applicable:

General Information	Location Information	Hardware Details	Operating System and Platform	Network Information (Actual Function, not potential function)
Unique ID	Facility Name	Device Type	Embedded OS (Yes/No)	MAC Address(es)
Barcode or Identifier	NFAID	Device Sub-Type	OS Contractor	IP Address(es)
Region	Commodity	Device Function	Operating System (O/S)	Upstream Device
Installation	Floor	Manufacturer	O/S Version	Protocols In Use
Special Area (Option DNA1)	Room	Product Line	Platform Contractor	Host Name
	Location	Model No.	Platform Product Line	
	System Type	Serial No.	Platform	
	Functional System or Equipment Control	Remote Connectivity: (Wired / Wireless / None)	Platform Version	

		Network Type Used: (Serial / Ethernet / Both / None)		

2.5 PAINTING SYSTEM

a. Remove all grease, oil, and surface debris by solvent wiping or detergent/water scrubbing, prior to blast cleaning. Prepare surfaces to be coated by abrasive blasting to SSPC SP 6/NACE No.3, Commercial Blast Cleaning, or in accordance with the coating manufacturer's requirements, whichever is more stringent.

b. Use a painting system appropriate for the conditions provided in the Crane Design Criteria section of this specification. Paint exposed portions of the crane and crane runway system using a three -coat system as follows: zinc-rich primer consisting of a minimum of 77 percent zinc by weight in the dry film, an anticorrosive epoxy intermediate coat, and an aliphatic polyurethane top coat. All paint products must be supplied by a single manufacturer and free of chromates, lead, and mercury. Apply each coat in accordance with manufacturer's instructions and requirements. Ensure each coat is smooth, even, and free of runs, sags, orange peel, and other defects. Desired color of finish coat is brilliant yellow . Submit product data for painting system.

c. Coat faying surfaces of bolted connections per RCSC A348, but do not apply finish paint.

d. Paint the load block brilliant yellow with black diagonal striping.

e. Paint, coatings, or galvanizing on the following items or areas is not acceptable: hoist wire rope or load chain, hooks, hook nuts, sheave and drum grooves, sprockets, wheel treads, lubrication fittings, nameplates, flange mounting faces, corrosion resistant steel, bronze, or other items not normally painted.

f. Factory paint electrical and mechanical equipment in accordance with the manufacturer's best standard practice for the specified environment.

2.6 IDENTIFICATION PLATES

Furnish and install identification plates. Provide non-corrosive metal identification plates with clearly legible permanent lettering giving the manufacturer's name, model number, serial number, capacity in pound units, and other essential information or identification.

2.6.1 Markings on Crane, Trolley, and Hook

To avoid operation of the crane in the wrong direction, affix the appropriate directions (NORTH, SOUTH, EAST, and WEST) with arrows on both sides of the bridge and both sides of trolley, as applicable. Markings must be visible by the operator and from the loading point. Labels on the controls must have corresponding directional (NORTH, SOUTH, EAST, and WEST) markings. Markings must agree with the markings on controller. Do not indicate directional arrows on controller.

Mark the hook rated capacity in pound units on both sides of the hoist load block.

2.7 ELECTRICAL ASSEMBLY

Installation of all electrical wiring, conduit, and components must be performed in accordance with the requirements of NFPA 70. As a minimum, items a. through g. below must be followed:

a. All electrical connections must be installed in accordance with NFPA 70 Articles 110.14 or 430.9, as applicable, or as recommended by the device manufacturer.

b. Crimped terminal lugs, if used, must be properly sized for the wire and installed using the device(s) – e.g., crimping tool and indenter – recommended by the terminal lug manufacturer.

c. All spare conductors must be identified as spare conductors, and must have their ends insulated to preclude accidental contact with energized equipment.

d. Bonding straps and equipment grounding conductors must be connected to engineered ground points, have all paint removed from their termination points, or have tooth lockwashers (star lockwashers) installed, to insure proper grounding of the equipment.

e. Rigid Polyvinyl Chloride conduit may be used to protect festoon cable from physical damage when the cable is run along the footwalk of the crane, provided that only sections of conduit are used.

f. Festoon cable must be installed with suitable strain relief and protected from physical damage in accordance NFPA 70 Article 610.11(E)(1). This includes damage from chafing against the crane structure and any other type of damage that may be incurred.

g. Fiber optic cable must be installed in accordance with the manufacturer's installation guidelines. However, at a minimum the following guidelines must be adhered to: no sharp bends (bend radii must be greater than 1 inch or as prescribed by the manufacturer), avoid tight loops, no zip ties, and no stretching of cable.

PART 3 EXECUTION

3.1 EXAMINATION

After becoming familiar with all details of the work, and before performing any work, verify all dimensions in the field. The Contractor is responsible for the coordination and proper relation of the contracted work to the building structure and to the work of all trades. Verify all dimensions of the building that relate to fabrication of the crane and notify the Contracting Officer of any discrepancy before finalizing the crane order.

3.2 SHOP ASSEMBLY AND TESTS

Shop assemble major components as completely as possible. Reeving of drums and sheaves is not advisable for shop testing, however it is acceptable for packaged hoists. Functionally test the crane system at the construction facility prior to shipment. The Government reserves the

right to inspect the crane for compliance with this specification and to witness the functionality tests. Notify the Contracting Officer 21 days prior to starting testing operations.

3.3 ERECTION AND INSTALLATION

Perform the entire crane system erection in accordance with manufacturer's instructions under the full-time supervision of the manufacturer's representative.

3.3.1 Mechanical Alignment

Align motors, couplings, brakes, gear boxes, and drive components in accordance with manufacturer's instructions.

3.3.2 Electrical Adjustments

Adjust control system in accordance with manufacturer's instructions. Store a copy of all Control Parameter Settings (PLC, VFD). Provide the final settings and configurations data on the Complete Schematic Wiring Diagram, including but not limited to, timer settings, resistor tap settings, potentiometer settings, test-point voltages, supply voltages, motor voltages, motor currents. Provide the test conditions such as ambient temperature, motor load, date performed and person performing the adjustments as part of the Operational Tests report.

3.3.3 Field Welding

Perform welding indoors, where possible. Surface of parts to be welded must be free from rust, scale, paint, grease, and other foreign matter. Minimum preheat and interpass temperatures must conform to the requirements of AWS D14.1/D14.1M.

3.3.4 Field Painting

Perform painting indoors, where possible. Field painting (including touch-up) must conform to the requirements of the coating manufacturer and as specified in paragraph PAINTING SYSTEM.

3.4 FIELD QUALITY CONTROL

3.4.1 Post-Erection Inspection

After erection, the Contractor, the Activity Crane Inspector/Test Director, and the Contracting Officer must jointly inspect the crane bridge and hoist systems and components to verify compliance with specifications and approved submittals. Notify the Contracting Officer 21 days before the inspection. Provide for approval a report of the inspection indicating the crane is considered ready for operational tests.

Document the results of this inspection and outstanding punch list items that require correction by the Contractor. Submit the post-erection inspection report to the Contracting Officer for approval.

3.4.2 Operational Tests

Check the clearance envelope of the entire crane prior to picking or traversing any load to ensure there are no obstructions. Test the systems in service to determine that each component of the system operates as

specified, is properly installed and adjusted, and is free from defects in material, manufacture, installation, and workmanship. Rectify all deficiencies disclosed by testing and retest the system or component to prove the crane is operational.

3.4.2.1 No-Load Test

Raise and lower each hook through the full range of normal travel at rated speed for three complete cycles. Raise and lower each hook, testing other speeds of the crane. Verify proper operation of hoist limit switches. Operate the bridge and trolley in each direction the full distance between end stops and bring bumpers into contact with the end stops. Operate through the entire speed range and verify proper brake operation. Verify correct operation of all indication and ancillary devices.

3.4.3 Test Data

Submit all crane test data recorded on appropriate test record forms suitable for retention for the life of the crane. Record operating and startup current measurements for hoist, trolley, and bridge motors using appropriate instrumentation (i.e., clamp-on ammeters). Compare recorded values with design specifications or manufacturer's recommended values; abnormal differences (i.e., greater than 10 percent from manufacturer's or design values) must be justified or appropriate adjustments performed. In addition, note, investigate, and correct any high temperatures or abnormal operation of any equipment or machinery. Record hoist, trolley, and bridge speeds during each test cycle.

3.4.4 Hook Tram Measurement

Establish a throat dimension base measurement by installing two tram points and measuring the distance between these tram points (plus or minus 1/64 inch). Record this base dimension. Measure the distance between tram points before and after load test. An increase in the throat opening from the base measurement is cause for rejection.

3.4.5 Load Tests

a. Perform the following tests, as specified below.

b. Test loads used in this section are defined as the following:

Wire rope run-in load (when applicable): 25 - 50 percent of rated load.

Rated load test: 100 percent (plus 0 minus 10) of rated load.

Overload test: 125 percent (plus 0 minus 5) of rated load.

c. Testing of cranes must be done with the use of test weights. The use of dynamometers in lieu of lifting test weights is not permitted. Each test weight for crane tests must be marked with a unique identification number and the weight in pounds. The weight marked must be the actual weight taken from the scale or other measuring device. Solid weights must be measured using calibrated equipment traceable to the National Institute of Standards and Technology (NIST), with a minimum accuracy of plus or minus two percent (i.e., indicated weight must be within plus or minus two percent of actual weight). A list of test weights, with identification numbers and

weights, must be retained. The list must include the type and serial number (or other identifier) of the weighing device(s) used to weigh the test weights. Where a lifting attachment supports multiple test weights (e.g., stacked weights or multiple weights suspended from a padeye), the total capacity must be marked on the attachment. All rigging gear must meet OSHA and ASME requirements.

3.4.5.1 Wire Rope Run-In

The primary purpose of this procedure is to exercise the newly installed wire rope.

Place the load on the hook. Start at ground level and hoist up to one foot below upper limit at slow speed. Hoist down to lower limit at slow speed. Repeat hoisting and lowering of the load for approximately 10 hoisting cycles, increasing the speed for each cycle. During this test, the capacity overload lockout should not activate.

3.4.5.2 Rated Load Test

3.4.5.2.1 Hoist

a. Static Load Test: With the trolley in the center of the bridge span, raise the test load approximately one foot. Hold the load for 10 minutes. Rotate the load and hook 360 degrees clockwise and counterclockwise to check bearing operation with no binding. Observe for lowering of the load, which may indicate a malfunction of hoisting components or brakes. Verify that maximum beam and girder deflections do not exceed CMAA 74 and MHI MH27.1 design limits, as applicable.

b. Dynamic Load Test: Raise and lower test load through the full lift range and visually observe smooth control and acceleration between points. Completely stop the machinery at least once in each direction to ensure proper brake operation.

c. Hoist Mechanical Load Brake (or Self-locking Worm Gear): Raise test load approximately 5 feet. With the hoist controller in the neutral position, release (by hand) the holding brake. Document the method used to release the holding brake. The load brake must hold the test load. Again, with the holding brake in the released position start the test load down at slow speed and return the controller to the "off" position as the test load lowers. The load brake must stop and hold the test load.

d. Hoist Loss of Power Test: Raise the test load to approximately 8 feet. While slowly lowering the test load, disconnect the crane's power source. Verify that the test load does not lower and that the brake is set.

3.4.5.2.2 Trolley

Operate the trolley (if space is available) the full distance of the bridge rails in each direction with a test load on the hook. Check proper functioning through the range of speeds. Verify proper brake action and stopping distance.

3.4.5.2.3 Bridge

With a test load on the hook, operate the bridge for the full length of

the runway (if space is available) in one direction with the trolley at the far end of the bridge, and in the opposite direction with the trolley at the opposite end of the bridge. Use extreme caution. Check proper functioning through the range of speeds. Check for any binding of the bridge end trucks. Verify proper brake action and stopping distance. Record deficiencies. Secure from testing if deficiencies are found.

3.4.5.2.4 Trolley Loss of Power Test

Raise the test load approximately midway between the trolley and any permanent obstruction on the operating floor. Starting at a safe distance from walls or other obstructions, attain a slow speed of trolley travel. While maintaining a safe distance from obstructions, disconnect the main power source at the wall mounted safety switch (disconnect) to simulate a power failure. Verify that the trolley stops and that the brake sets properly. Measure the distance required for the trolley to stop.

3.4.5.2.5 Bridge Loss of Power Test

Raise the test load approximately midway between the trolley and any permanent obstruction on the operating floor. Starting at a safe distance from walls or other obstructions, attain a slow speed of bridge travel. While maintaining a safe distance from obstructions, disconnect the main power source at the wall mounted safety switch (disconnect) to simulate a power failure. Verify that the bridge stops and that the brake sets properly. Measure the distance required for the bridge to stop.

3.4.5.3 Overload Test

3.4.5.3.1 Hoist

Disconnect or adjust the overload limit device to allow the hoist to lift the test load. Verify proper operation of the overload limit device after it is reconnected.

a. Static Load Test: With the trolley in the center of the bridge span, raise the test load approximately one foot. Hold the load for 10 minutes. Rotate the load and hook 360 degrees clockwise and counterclockwise to check bearing operation with no binding. Observe for lowering of the load, which may indicate a malfunction of hoisting components or brakes.

b. Dynamic Load Test: Raise and lower test load and visually observe smooth control. Stop the load during raising and lowering to verify that the brakes holds the load.

c. Hoist Mechanical Load Brake (or Self-locking Worm Gear): Raise test load approximately 5 feet. With the hoist controller in the neutral position, release (by hand) the holding brake. Document the method used to release the holding brake. The load brake must hold the test load. Again, with the holding brake in the released position start the test load down at slow speed and return the controller to the "off" position as the test load lowers. The load brake must stop and hold the test load.

d. Hoist Loss of Power Test: Raise the test load to approximately 8 feet. While slowly lowering the test load, disconnect the crane's power source. Verify that the test load does not lower and that the brake is set.

3.4.5.3.2 Trolley

Operate the trolley the full distance of the bridge rails in each direction with a test load on the hook (one cycle) through the range of speeds. Verify proper brake action.

3.4.5.3.3 Bridge

With a test load on the hook, operate the bridge for the full length of the runway in one direction with the trolley at the extreme end of the bridge, and in the opposite direction with the trolley at the opposite extreme end of the bridge (one cycle). Check proper functioning through the range of speeds. Check for any binding of the bridge end trucks and verify proper brake action. Record deficiencies. Secure from testing if deficiencies are found.

3.5 MANUFACTURER'S FIELD SERVICE REPRESENTATIVE

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.

3.6 OPERATION AND MAINTENANCE MANUALS

Provide three (3) hard copies of operation and three (3) hard copies of maintenance manuals for the equipment furnished along with an electronic copy (PDF) of each on a Compact Disc. Provide one complete set prior to performance testing and final copies upon acceptance. Provide operation manuals that detail the step-by-step procedures required for system startup, operation, and shutdown. Include the manufacturer's name, model number, parts list, and brief description of all equipment and basic operating features. List in the maintenance manuals routine maintenance procedures, including weekly, monthly, semi-annual, and annual required maintenance items, possible breakdowns and repairs, and troubleshooting guides. Also include as-built drawings, piping and equipment layout, design calculations, Control Parameter Settings and printouts of any software, and simplified wiring and control diagrams of the system as installed. Secure approval of operation and maintenance manuals prior to the field training course (as applicable).

3.7 FIELD TRAINING

Conduct a training course for ten (10) operating and maintenance staff and provide a copy of the training material to each participant. Provide a training period consisting of a total of eight hours of normal working time and starting after the system is functionally completed but prior to final acceptance. Cover all pertinent points involved in operating, starting, stopping, and servicing the equipment, including all major elements of the Operation and Maintenance Manuals. Demonstrate in course instructions all routine maintenance operations such as lubrication, general inspection, and basic troubleshooting.

Provide a minimum of two separate four(4) hour training sessions on the Variable Frequency Drives (VFDs) discussing maintenance, troubleshooting of fault codes, theory of operation, and adjustment of crane parameters. This training session will be for an audience of approximately eight people.

3.8 FINAL ACCEPTANCE

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 --