

**SECTION 146000 - CRANES AND HOIST****PART 1 GENERAL****1.1 SUMMARY**

## A. Section Includes:

1. **The Owner will provide all materials, for two 5-ton top running single bridge cranes systems. The Subcontractor shall provide all, labor, equipment, and services required to install two 5-ton top riding single bridge crane systems.** The crane system shall include bridge, trolley, hoist, power and control circuit conductors, safety and control mechanisms, and all other parts and services as defined in this specification. The crane system shall be installed on the runway girders provided Metal Building Supplier. In addition to material and equipment specified, the Subcontractor shall provide incidental materials to effect a complete installation.

## B. Related Work not Included in This Section:

1. The Pre-Engineered Metal Building structure complete, up to and including the runway girders on which the crane shall run.

**1.2 REFERENCES**

## A. General:

1. The following documents form part of the Specifications to the extent stated. Where differences exist between codes and standards, the one affording the greatest protection shall apply.
2. Unless otherwise noted, the referenced standard edition is the current one at the time of commencement of the Work.

## B. American National Standards Institute (ANSI):

1. Safety Standard for Mechanical Power Transmission Apparatus
2. Overhead and Gantry Cranes
3. Hooks
4. Cableways
5. Performance Standards for Electric Chain Hoists
6. Performance Standards for Overhead Electric Wire Rope Hoists
7. Rules for Construction of Overhead and Gantry Cranes
8. Rules for Construction of Cranes, Monorails, and Hoists

## C. AWS – American Welding Society:

1. AWS D1.1 - 2007 Structural Welding Code - Steel
2. AWS D14.1 - 2005 Specifications for Welding Industrial and Mill Cranes

## D. NFPA 70-2020 National Electric Code

## E. Crane Manufacturer's Association of America:

1. Specifications for Electric Overhead Traveling Cranes - CMAA Specification Number 70-2020.

## F. 29 CFR 1910, Subpart N, OSHA General Industry Standards, Materials Handling and Storage Subpart.

## G. 29 CFR 1926, Subpart H, OSHA Construction Standards, Materials Handling, Storage, Use, and Disposal Subpart

## H. 29 CFR 1926, Subpart N, OSHA Construction Standards, Cranes, Derricks, Hoists, Elevators, and Conveyors Subpart.

## I. American Institute of Steel Construction, The Manual of Steel Construction, latest edition

**1.3 DEFINITIONS**

- A. Terms used in this specification shall be used as in the Definitions of ANSI/ASME B30.2 - 2016 Overhead and Gantry Cranes.

**1.4 SUBMITTALS**

- A. Pre-Construction Submittals:
1. Detailed design of completed crane system.
  2. Administrative Data: Submit name, address and telephone number of the local representative; a general sales and engineering bulletin covering the full line of products manufactured; a certification that the line of products proposed for this contract have been in continuous and successful use for not less than 5 years; general catalog information covering the characteristics of the systems proposed for this contract; and a statement that the components and the systems proposed will be maintained and supported by the manufacturer for parts and service for not less than 10 years.
  3. Shop Drawings and Calculations: Submit all drawings required for the construction of the system which are in addition to the subcontract drawings. Shop drawings shall be to scale and fully dimensioned and shall provide sufficient detail to clearly indicate the arrangement of equipment and its components. The drawings shall show plan, elevation and sectional views along with all other pertinent data. All drawings prepared by the Subcontractor shall be developed using the AutoCAD™ computer-aided drafting program version 14. All drawings shall be a maximum ANSI size D and use LBNL layering conventions. Submit structural calculations for the bridge. Shop drawings and calculations shall be signed by a Missouri Registered Professional Engineer.
  4. Product Data: Submit technical product specification sheets for each system component and device which include all data needed to prove compliance with this specification. Clearly indicate the exact model of each component to be provided.
  5. Mill Test Reports: Submit mill test reports for the bridge.
  6. Inspection and Rated Load Test Reports: Submit inspection reports and operational and rated load test reports in accordance with ANSI B30.2.
  7. Manufacturer's Installation Instructions: Submit for all components being provided under this section.
  8. Paint: Submit a complete list of manufacturers and products required throughout the work. Submit manufacturer's specifications for each product, including product description, features, composition, specifications, special surface preparation procedures, substrate conditions requiring special attention, and recommended method of application. Include the manufacturer's recommended dry mil thickness for each coat of each scheduled finish.
  9. Manufacturer's Directions: Follow manufacturer's directions covering items not shown on the drawings or specified herein. Manufacturer's directions do not take precedence over the Subcontract drawings and specifications. Where these are in conflict with the drawings and specifications, notify the Project Manager for clarification before installing the work.
- B. Pre-Commissioning Submittals:
1. Operator's manuals: Submit for the specific crane furnished.
  2. Testing Procedure: Submit a testing procedure to be used to verify compliance with this specification.
- C. Project Record Documents:
1. The subcontract drawings shall be submitted with the Subcontractors' markings which record the installed conditions from which the General Contractor will produce the "as-builts". Show actual locations of all system components and affected equipment.
  2. Submit all electronic files developed for this project including shop drawings, operator's manuals, and test procedures.
  3. Submit the crane certification documentation.
- D. Operating and Maintenance Data:

1. Include a project information sheet including project name, building(s), and Subcontractor contact information. Include name, address, and phone number of the service representative to be called in the event of equipment failure. Include a Statement of Guarantee including date of termination.
2. Include operation and maintenance documentation for all equipment and devices, including the bridge, trolley, hoist, power and control circuit conductors, safety and control mechanisms, and all other parts and services as defined in this specification.  
Documentation shall include manufacturer's model number, manufacturer's installation instructions, frequency of inspection, recommended cleaning methods and materials, testing methods, and calibration tolerances. In the event such manuals are not obtainable from the manufacturer, it shall be the responsibility of the Subcontractor to compile and include them. Advertising brochures shall not be used in lieu of the required technical manuals.
3. The maintenance and operating manuals shall include key component breakaway pictures for ease of parts ordering, catalog cut pages, part numbers, and sub-assembly details.
4. Include copies of all testing forms completed for this project.

#### **1.5 QUALITY ASSURANCE**

##### **A. Qualifications:**

1. The manufacturer shall have a minimum of five years documented product development, testing, and manufacturing experience with the products specified in this Section.
2. The installer shall have a minimum of five years documented experience applying the work of this Section.
3. The Subcontractor shall have a service office which has been established for a minimum of five years and is staffed with factory-authorized service technicians capable of servicing all aspects of the crane.

#### **1.6 PROJECT CONDITIONS**

- ##### **A. Examination of Site:** The Subcontractor shall examine the site and become familiar with all conditions that may affect the work covered by the specifications. Failure to do so shall not lessen the subcontractor's responsibility or entitle the Subcontractor to additional compensation for work not included in the bid.

#### **1.7 WARRANTY**

- ##### **A. Free maintenance services shall be provided by the Subcontractor for one (1) year after final system acceptance. These services shall consist of manufacturer's factory-trained representatives providing emergency repair service with on-site response within 24 hours of call, all test equipment and hardware necessary for maintenance and repair work and installation of any hardware modifications designed to improve system performance or eliminate known problems or deficiencies.**

### **PART 2 PRODUCTS**

#### **2.1 CRANE SUMMARY**

- A. Count: Two single girder top running bridge cranes on same runway beam.
- B. Span: Approximately 35'-0" subject to Pre-Engineered Metal Building Engineering of building mainframes.
- C. Capacity: 5 tons each.
- D. Classification: CMAA classification Class C Moderate Service.

#### **2.2 MATERIALS AND SUBSTITUTIONS**

- ##### **A. Materials and Equipment:** Materials and equipment shall be uniform throughout the installation. All materials and equipment shall be new and shall be the standard products of manufacturers regularly engaged in the production of such equipment equal to or superior to the material

specified, and shall be the manufacturer's latest standard design that complies with the specification requirements.

### **2.3 BRIDGE GIRDERS**

- A. The center-to-center dimension of the runway rails shall be approximately 35 feet; 0 inches. This dimension shall be field verified by the Subcontractor prior to manufacturing. This dimension is subject to Pre-Engineered Metal Building Engineering of the mainframes subject to change after engineering.
- B. Bridge girders shall be constructed of A-36 structural steel beams reinforced as necessary or fabricated plate box sections.
- C. The bridge girders track end stops shall be capable of withstanding the impact of a fully loaded trolley or carrier traveling at 50 percent of the full load speed.
- D. End truck assemblies shall comply with paragraph 2.03.

### **2.4 TROLLEYS**

- A. Wheel axles shall be precision machined from high strength steel.
- B. Wheel bearings shall be double row precision ball or taper roller bearings, lubricated and sealed at assembly, and fitted with external grease fittings. Bearings must have minimum B-10 life of 5,000 hours.

### **2.5 CRANE DRIVE**

- A. The crane speed shall be controlled through a variable frequency drive from 2 to 80 feet per minute.

### **2.6 HOIST CARRIER**

- A. The hoist carrier shall be comprised of two end trucks, structural framing, carrier drive, and electrical controls.
- B. The carrier speed shall be controlled through a variable frequency drive from 2 to 40 feet per minute.

### **2.7 HOIST**

- A. The hoist and appurtenances shall be designed to withstand all stresses imposed under safe operating conditions while handling loads within the rated capacity. Load bearing parts shall be designed such that the static stress, calculated for rated load, shall not exceed 20 percent of the ultimate strength of the material.
- B. All bearings shall be heavy duty, anti-friction type with a minimum B10 life of 5,000 hours. Motor bearings shall be lifetime lubricated, sealed ball bearings.
- C. All gearing shall be forged heat treated alloy steel machined for smooth quiet operation. All gearing must meet AGMA quality specifications. No cast gears shall be permitted.
- D. Bottom block shall be completely shrouded for safety and fabricated from steel. Sheaths must be forged or rolled steel, running on anti-friction bearings. Hooks are to be forged steel supported by anti-friction thrust bearings and permit 360 degree rotation. A latch shall be provided to bridge the opening of the hook for the purpose of retaining slings, chains, etc., under slack conditions.
- E. Motors shall be totally enclosed, specifically designed for hoist service capable of starting and operating under any condition within the designed capacity and provided with thermal overload protection.
- F. The hoist shall incorporate an upper plugging type limit switch automatically stopping the hoist motion when the block reaches its highest position. Excessive hook drift shall cause the block to be momentarily reversed.
- G. Electric hoist controls shall comply with N.E.C. requirements for the application being considered and shall include control circuit breakers and contactors mechanically and electrically interlocked.

- H. The hoist speed shall be controlled through a variable frequency drive from 2 to 20 feet per minute.

## 2.8 HEIGHT DIMENSIONS

- A. The top of the shall be 29'-0" above the finished floor. The crane shall have a maximum height of 3 feet, 0 inches from the top of the trolley to the top of the crane rail. The crane lift height shall be long enough to pick loads up off of the floor.

## 2.9 MOTORS

- A. All variable speed motors shall be squirrel cage type, totally enclosed. Motor shall be provided with lifetime lubricated anti-friction bearings, unless otherwise specified.

## 2.10 ELECTRICAL SCOPE OF WORK

- A. Provide all materials, labor, equipment and services necessary to provide a fully functioning and tested crane electrical system, complete with pendant and radio control.

- B. Codes:

1. The electrical equipment shall meet NEMA Classification requirements for crane construction except where higher grade devices are specified and all requirements under Article 1.2 References, and Article 1.6 Quality Assurance.
2. The design and installation shall conform to the requirements of the National Electric Code NFPA 70.

- C. Submittals:

1. Submit under Article 1.5 Submittals the Bill of Materials, Manufacturer's Brochures and Catalog Cuts, Shop Drawings, Erection Drawings, Wiring Diagrams, Schematics, and an Equipment layout.
2. Submit for approval all electrical controls, micro switches, wiring diagrams, schematics, control panels, identification labels, disconnect switches, wire, limit switches, enclosures, contactors, circuit breakers, pendants and buttons, radio control enclosure, master radio transmitter/receiver, hand held transmitter, radio selector switch, collectors and shoes, motors, electric brakes, variable frequency drives (VFD), factory and field default settings for each VFD, and alarm devices.
3. Show location and elevation of all electrical controls and panels which shall be placed so that they are available for servicing when the crane is docked at the maintenance platform.

- D. AC Controls:

1. The AC controls shall be provided with an under voltage device which will disconnect all motors from the line on failure of power or brownout and will not permit any motor to be restarted until a reset switch or push-button is operated.
2. All magnetic contactors shall be fully rated for their horsepower load and sized for continuous duty.
3. All crane components to be designed for a 480V, 3 phase, 3 wire, Delta system. The control voltage shall be 120VAC from a control power transformer with protective circuit breakers.
4. The Color Code for 480 VAC wiring is: AØ = brown, BØ = yellow, CØ = purple, Neutral = slate, insulated equipment ground = green.
5. Bridge and runway conductors shall be Duct-O-Bar, Insul-8 or equal
6. All control wiring shall be 120 VAC, #14 minimum size, MTW or better in conduit or within panels.
7. All wiring to be color coded and all terminal strips and wires to be identified with markings consistent with the drawings.
8. All wiring between enclosures to terminate on field wiring terminal strips at both ends, except where not practical at small field devices. Field terminal strips aren't required for

circuit breakers and large power contactors. Splicing of wires to make connections is forbidden and not acceptable.

9. Limit switches shall be installed at both ends of travel on the trolley and the bridge to prevent the trolley or the bridge from striking the bumpers or existing crane. Location of limit switches to be adjustable. Use Heavy Duty limit switches.
  10. Furnish engraved plastic name plates (to be secured with screws not glue or double back tape) with 1/4" engraved lettering on the exterior of all controller enclosures with the appropriate marking i.e. Main Disconnect, Main Line and Bridge Control, Trolley Control, Hoist Control, etc.. Within the enclosure all components including circuit breakers, contactors, relays, timers, terminal blocks, resistors etc. shall be labeled with 1/8" engraved lettering, firmly attached with metal screws to the equipment.
  11. All enclosures shall be NEMA type 12, with removable hinged doors with neoprene gaskets, shall be in full compliance with the National Electric Code for size, be readily accessible and doors shall be fully openable to 90 degrees.
  12. A 480 VAC lockable crane disconnect switch shall be provided at floor level and shall be the Point of Connection for connection to the LBNL power system. Disconnect switch shall be horsepower and heavy duty rated.
  13. A heavy duty, horsepower rated, fused, disconnect switch shall be provided on the crane at the closest entry point to the crane from a maintenance platform that will shut off all power to the crane.
- E. Brakes:
1. Bridge and trolley shall have electrically operated fail safe magnetic disc type brakes for operation from a dedicated circuit breaker.
  2. Brakes shall be sized for the full load torque of the motor plus a safety factor. Provide bridge and trolley brake sizing calculations.
- F. Pendant:
1. All crane motions shall be controlled independently by a pendant push-button station and by a radio remote control, only one of which may have control at any one time as selected by a master switch.
  2. The pendant push-button station shall have an electrified pendant reel which shall be controllable from the radio remote control, a lockable wall mounted switch located at floor level, or pendant push buttons. The pendant reel shall be capable of holding 30 feet of pendant cable.
  3. Pendant push-button station to include a power on light, twist on & push off switch; three step reversing buttons for infinitely variable bridge, trolley, and hoist VFD control; maintained pressure pendant raise and lower buttons, and a maintained pressure bypass button.
  4. The pendant shall have complete control of all crane functions including turning power on and off, pendant up/down control, and bypass of trolley and bridge runway limit switches.
  5. Pendant shall be of such a length that it may be extended to the same level as the hook.
  6. The pendant cable shall contain 8 spare conductors and be extra flexible. The cable connector connecting the cable to the pendant shall support a minimum of 300 pounds.
- G. Radio Control:
1. Use isolated relay contacts for the outputs of the radio control which shall be compatible with the VFD inputs. Triac or solid state type contacts are not acceptable.
  2. Provide a Master switch to select between radio and pendant control. The master switch contacts are to isolate all radio control input and outputs and all pendant controls from each other, and must be easily accessible from the main maintenance entry point onto the crane

3. The radio remote control shall use rechargeable batteries. A spare battery with battery charger shall be provided.
  4. Radio control to be a pendant type and have the following buttons: key operated power on & off switch, power on/battery monitor light; three step reversing bridge, trolley, and hoist buttons for infinitely variable VFD control; pendant raise and lower buttons; bell button, and bypass button.
  5. Provide a "Bypass" switch in the pendant and the radio controls to allow over riding the bridge and trolley limit switches so that docking as close as possible to a maintenance platform is possible. In "Bypass" the speeds of the trolley and bridge must be limited to a very low speed.
  6. Provide a Blue Light under the crane which will light whenever the crane is being operated by radio control. The light shall be visible from all directions under the crane.
- H. Electrical Power:
1. Electrobar , or equal, inverted V-Bar, fully insulated and supported on insulators and brackets, be CAL OSHA and UL approved. All conductors shall be individually enclosed with spring loaded collector shoes running on the underside. All wire attachments to the collectors shall be fully insulated, protected from harm, and securely attached.
  2. All electrical wiring shall be in accordance with the latest requirements of the National Electric Code (NFPA 70) and OSHA Standards, Title 8. All wiring exterior to enclosures shall be in rigid steel conduit with bushings.
  3. Electrical motor connections to be liquid-tight flexible metal steel conduit with ground wire pulled within and bushings.
  4. All wiring which interfaces with the power system shall meet the requirements of Division 16: Electrical.
- I. Electrical Testing:
1. Test Hoist, Trolley and Bridge VFD's under full load and no load conditions. Verify that temperature within VFD enclosures are still within tolerance after full load tests.
  2. Verify operation of all Pendant and Radio controls. Verify that they operate independently of each other and that they do not interfere with each other.
  3. Verify that Pendant and Radio controls both work from the floor level.
  4. Verify operation of all limit switches. Verify operation of Bypass controls for limit switches.
  5. Verify that electrical maintenance of all control enclosures can be performed from the maintenance platform.
- J. Operating Manuals:
1. Submit manuals which include As-Built schematics and wiring diagrams, Bill of Material, spare parts lists, replacement parts guides, lubricant and adjustment manuals, preventative maintenance guides, VFD programming, Radio Control local representatives names and phone numbers.
- K. Electrical As-Built Drawings:
1. At the completion of the installation and after successful testing, Electrical As-Built drawings are to be provided as well as AutoCAD R14 discs containing all schematic, wiring and layout drawing information for the crane and radio controls.

### **PART 3 EXECUTION**

#### **3.1 PAINTING**

- A. All material shall be cleaned of loose rust, mill scale and foreign matter.
- B. The crane bridge, hoist, trolleys, runways and suspension fittings shall be painted one shop coat of primer and two finish coats of manufacturer's standard enamel finish paint.
- C. Equipment must be adequately protected against damage and rust in shipment.

**3.2 SYSTEM MARKING**

- A. Major components of the system shall be marked at the factory so as to assure prompt and proper field identification.

**3.3 CRANE ASSEMBLY AND TEST**

- A. Cranes shall be factory assembled, and a no-load running test of controls and drive machinery performed to ensure proper operation. The crane shall be disassembled only as necessary for shipment.

**3.4 PROTECTION OF EQUIPMENT**

- A. Care shall be exercised during construction to avoid damage or disfigurement of any kind. All equipment shall be protected from dust and moisture prior to and during construction.
- B. Where required or directed, construct temporary protection for equipment and installations so as to protect same from dust and debris caused by construction.
- C. All protection shall be substantially constructed with the use of clean canvas, heavy plastic, visqueen and plywood as required, and made tight and dust proof as directed.
- D. The Subcontractor shall repair by spray or brush painting, after properly preparing the surface, all scratches or defects in the finish of the equipment. Only identical paint furnished by the equipment manufacturer shall be used for such purposes.
- E. Failure of the Subcontractor to protect the equipment as outlined herein shall be grounds for rejection of the equipment and its installation.

**3.5 EXAMINATION**

- A. Verify that systems are ready to receive work.
- B. Once construction has commenced, the Subcontractor shall be fully responsible for all modifications required to meet the requirements of the Subcontract documents.

**3.6 CRANE INSTALLATION**

- A. Install the crane in accordance with the Subcontract documents, manufacturer's instructions, and approved shop drawings.
- B. The Subcontractor shall touch up of any painted surfaces affected by installation of the crane.

**3.7 TESTING**

- A. The Subcontractor shall provide all labor and equipment necessary to perform a comprehensive acceptance test of the crane prior to the acceptance testing witnessed by the University and defined below. The Subcontractor shall complete the testing forms submitted and approved in the Pre-Commissioning Submittals. The Subcontractor shall submit to the Project Manager digital copies of all test results, certified in writing, witnessed, signed and dated, within 24 hours of completion of work.
- B. Under the supervision of the University, the Subcontractor shall provide all labor and equipment necessary to certify the performance of the crane. The Subcontractor shall contact the University to schedule the certification at least two weeks prior to the date of certification testing.
- C. The crane shall be certified in accordance with ANSI B30.2.0 - 2005; and OSHA Title 29, Chapter 17, Part 1910.
  - 1. Safety: The crane certification testing shall be performed in accordance with the accepted Safety Plan for this project.
  - 2. Crane Inspection: Prior to load testing, the following shall be inspected to verify that they are operative and in like-new condition:
    - a. Hoisting motors and brakes.
    - b. Trolley travel and brakes.
    - c. Bridge travel and brakes.
    - d. hoist limit switch.
    - e. Steel hoisting ropes and hook.
  - 3. Holding Brake Load Test:



- a. Select a location for the load tests where a falling test load will not cause any damage if the brakes do not hold. The location shall also be convenient to make measurements of crane hook movements.
  - b. If there is only one holding brake, the test load shall be 125 percent of the rated capacity of the hoist. If there are two holding brakes, the test load shall be 100 percent of the rated capacity of the hoist. Each holding brake shall be test loaded independently.
  - c. The test load shall first be raised three inches off the load support to check the brake. The test load shall then be raised eighteen inches off the floor, the hoist stopped, and the load checked for downward drift. Record the downward drift of the test load after one minute of the holding brake being set. This test shall be performed twice for each holding brake.
  - d. The test load shall then be raised thirty-six inches off the floor. The test load shall then be lowered eighteen inches at maximum lowering speed, the holding brake set, and the load checked for downward drift. Record the downward drift of the test load after one minute of the holding brake being set. This test shall be performed twice for each holding brake.
  - e. If the test load drifts downward more than 1/4 inch within one minute of the holding brake being set during any of the tests, the holding brake shall be adjusted. The tests shall be repeated until the downward drift is less than 1/4 inch within one minute of the holding brake being set, during all tests of all holding brakes.
4. Mechanical Load Brake Test:
- a. Select a location for the load tests where a falling test load will not cause any damage if the brakes do not hold. The location shall also be convenient to make measurements of crane hook movements.
  - b. The test load for the mechanical load brake shall be 125 percent of the rated capacity of the hoist. Make the holding brake inoperative.
  - c. The test load shall be raised three feet off the floor, the hoist stopped, and the load checked for downward drift. Record the downward drift of the test load after one minute of the hoist being stopped. This test shall be performed twice.
  - d. The test load shall then be raised five feet off the floor. The test load shall then be lowered two feet at maximum lowering speed, the hoist stopped, and the load checked for downward drift. Record the downward drift of the test load after one minute of the hoist being stopped. This test shall be performed twice.
  - e. If the test load drifts downward more than 12 inches within one minute of the hoist being stopped during any of the tests, the mechanical load brake shall be adjusted. The tests shall be repeated until the downward drift is less than 12 inches within one minute of the hoist being stopped, during all tests of the mechanical load brake.
5. Operational Tests:
- a. The test load for these tests shall be 75 percent of the rated capacity of the hoist.
  - b. Raise and lower the test load. Verify the hoisting and lowering speeds of the hoist and verify the proper operation of the limit switch.
  - c. Raise the test load three feet off of the floor and move it transversely from side to side of the building. Verify trolley travel speeds and stops on bridge track rails.
  - d. Raise the test load three feet off of the floor and move it longitudinally from end to end of the building. Verify bridge travel speeds and stops on crane track rails.
- D. The crane will not be accepted until all tests described in this section have been performed to the satisfaction of the Project Manager. Any tests that cannot be performed due to

circumstances beyond the control of the Subcontractor shall be exempt from the system acceptance requirements if stated as such in writing by the Project Manager. Such tests shall be performed as part of the crane warranty.

- E. Any unsatisfactory condition revealed by these test results, or unsatisfactory methods of tests and/or testing apparatus and instruments, shall be corrected by the Subcontractor to the satisfaction of the Project Manager.
- F. The Project Manager reserves the right to require that the Subcontractor perform and repeat any tests that are deemed necessary to complete or check the tests or the certified records of the Subcontractor at any time during the course of the work. The Subcontractor shall correct any unsatisfactory portion of his work that is revealed by the tests or that may be due to progressive deterioration during this period, unless the item in question was a direct specification.

### **3.8 ELECTRICAL TESTING**

- A. Test Hoist, Trolley and Bridge VFDs under full load and no load conditions. Verify that temperature within VFD enclosures are still within tolerance after full load tests.
- B. Verify operation of all Pendant and Radio controls. Verify that they operate independently of each other and that they do not interfere with each other.
- C. Verify that Pendant and Radio controls both work from the pit area floor.
- D. Verify operation of all limit switches. Verify operation of Bypass controls for limit switches.
- E. Verify that electrical maintenance of all control enclosures can be performed from the maintenance platform.

### **3.9 OPERATING MANUALS**

- A. Submit digital As-Built schematics and wiring diagrams, Bill of Material, spare parts lists, replacement parts guides, lubricant and adjustment manuals, preventative maintenance guides, VFD programming, Radio Control local representatives names and phone numbers.

### **3.10 ELECTRICAL AS-BUILT DRAWINGS**

- A. At the completion of the installation and after successful testing, Electrical As-Built drawings are to be provided as well as AutoCAD R14 discs containing all schematic, wiring and layout drawing information.

### **3.11 DRAWINGS**

- A. The Subcontractor shall provide all labor and equipment necessary to perform a comprehensive acceptance inspection of all as-built documentation. The inspection shall be performed under the supervision of the University. The Subcontractor shall contact the University to schedule the inspection at least one week prior to the date requested.

### **3.12 NOISE AND VIBRATION**

- A. Noise levels shall not exceed ASHRAE recommended noise criteria (NC) for a shop.
- B. If noise problems are a result of improper material or installation, or exceeds limits determined by Sections 3.12.A, these conditions shall be corrected by the Subcontractor at no cost to the University.

### **3.13 TRAINING**

- A. The Subcontractor shall provide 8 hours of training developed specifically for this project. The training sessions shall be given at on the jobsite on a mutually-agreed upon schedule. Manuals covering the training subject matter shall be submitted at least two weeks prior to each training session. The instructor conducting the training sessions shall be fully proficient in the subject matter. The training shall be in two sessions as follows:
  1. Session 1 - Four hours of training shall be provided prior to the proof-of-performance testing. The training shall focus on the overall system design, equipment functions, operation, and the Pre-Commissioning Submittal documentation.

2. Session 2 - Four hours of training shall be provided following acceptance of the crane system. The training shall focus on the Project Record Documents and Operating and Maintenance Data.

**END OF SECTION**