Section 116100 - Performance Machinery General Requirements

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Division 1 Specification Sections apply to this Section.
B. This section applies to the following sections:

1. 116133 Performance Manual Rigging.

2. 116137 Proscenium Fire Safety Curtain.

1.2 DEFINITIONS

A. Manual Rigging refers to mechanical devices that are powered using human effort, power, or energy, to locate elements in horizontal or vertical planes.
B. Powered Rigging refers to mechanical devices that are operated via electro-mechanical devices to locate elements in horizontal or vertical planes.
C. Where measurements are provided, they are stated in Imperial units followed by SI units. Conversions are generally performed as soft conversions, unless a hard equivalent is readily available.

1.3 QUALIFICATIONS:

A. The Contractor shall have been an authorized representative of the manufacturer of not less than one of the specified equipment systems for a minimum of five (5) years.
B. Contractors shall have been involved in the type of work of that section for a period of ten (10) years or more and shall have successfully completed at least twenty (20) installations in the country in which the work is being performed of this type and scope, which have been in service successfully for not less than two (2) years. Project scope requirements include, but are not limited to, project complexity, project construction cost, and equipment contractor's construction costs.
C. The right is reserved to inspect previous equipment or systems as furnished or installed by this Contractor. In addition, the right is reserved to reject a Contractor who has failed in any respect to comply with the provisions of previous contracts.
D. No sub-contracting work is permissible, unless the Sub-Contractor is named and included as part of the bid. All terms and requirements herein apply to the Sub-Contractor. The right is reserved to reject the proposed Sub-Contractor based on the terms stated herein.
E. Regardless of whether a Sub-Contractor is accepted and used for installation, the Contractor shall have a person under the Contractor's Company's direct employ supervising the installation at all times.
F. Upon request, the contractor shall submit a list of projects of similar size and scope. The College is the final judge of suitability of experience.

G. Where overhead rigging is part of the Work, it shall be supervised on site at all times through the entirety of installation and system commissioning by an Entertainment Technician Certification Program (ETCP) Certified Rigger – Theatre, or a licensee of authority having jurisdiction.

1.4 SUBMITTALS

A. Coordination Drawings: Prepare and submit coordination Drawings where close and careful coordination is required for installation of products and materials fabricated off-site by separate entities.

1. Show the interrelationship of components shown on separate Shop Drawings.
2. Indicate required installation sequences.
3. Refer to Division 1, Division 23 and Division 26 documentation for specific coordination requirements for mechanical and electrical installations.

B. Make changes in the submittals as required, consistent with the Contract Documents. When resubmitting, notify the Architect in writing of any revisions other than those required.

1. Action indicated is subject to the requirements of the Contract Documents.
2. Adjustments made on shop drawings are not intended to change the Contract Price. If adjustments affect the value of the Work, state such in writing prior to proceeding with the Work.

C. Shop Drawings

1. Submit drawings depicting components, systems and assemblies, subject to static, dynamic or electrical loads affecting their safety and operational integrity, or as otherwise required by legislation, signed and sealed for the intended application, by a licensed Professional Engineer experienced in work of similar nature and scope and licensed in the State of installation.
2. Note and maintain one of the prints returned as a "Record Document".
3. Do not use Shop Drawings without an appropriate final stamp by the Architect indicating action taken in connection with construction.
4. Shop Drawings shall establish the actual detail of the Work, indicate proper relation to adjoining work, amplify design details of mechanical and electrical equipment in proper relation to physical spaces in the structure, and incorporate minor changes of design or construction to suit actual conditions.
5. Submit newly prepared information, drawn to accurate scale.
6. Highlight, encircle, or otherwise indicate deviations from the Contract Documents.
7. Do not reproduce Contract Documents or copy standard information as the basis of Shop Drawings. Standard information prepared without specific reference to the Project is not considered Shop Drawings.
8. Shop Drawings include fabrication and installation drawings, setting diagrams, schedules, patterns, templates and similar drawings.
9. Lettering on Shop Drawings is considered part of the Drawings.
10. Shop Drawings include the following plates and schedules:

    a. Assembly, installation and erection plans and diagrams depicting relative locations of various members and overall dimensions with reference to the preliminary drawings including auxiliary structure.

b. Block schematics of all equipment internal wiring and system element interconnection.
c. Component equipment drawings from Manufacturer's approved drawings or catalog cuts showing weight, dimensions, and capacities of mechanical components.
d. Component Equipment Drawings.
e. Details and assembly drawings.
f. Dimensions.
g. Erection Plans and diagrams.
h. Finishes.
i. Signage and identification systems.
j. Identification of products and materials included.
k. Layout of control consoles, racks and other associated equipment.
l. Mechanical Assembly Drawings.
m. Mechanical Detail Drawings.
n. Miscellaneous details and assembly drawings depicting lengths, widths, and sizes of all members, connection details, location, type and size of bolts, rivets, welds, and other connections together with materials to be used.
o. Notation of coordination requirements.
p. Notation of dimensions established by field measurement.
q. Program logic and relationship to input / output points, either in logic diagrams or ladder logic diagram, or other appropriate format.
r. Riser diagrams showing quantities, coding and sizes of all interconnections between system components.
s. System assemblies, major sub assemblies, components, cabinets and enclosures, including notation of type and manufacturer of switches, relays, locks and hardware.
t. Templates and installation details.
u. Test data on materials components and systems as available for the items specified herein.
v. Wiring Diagrams showing system layout.
w. LCD Screening for motor control systems.

D. Record Document Submittals (As Built Drawings)

1. General: Do not use record documents for construction purposes; protect from deterioration and loss in a secure, fire-resistive location; provide access to record documents for the Architect's reference during normal working hours.
2. On completion of Work and prior to final review, neatly transfer as-built notations to set of transparencies, stamp drawings in set "Certified As-Built Drawings" and submit record documents to the Architect.
3. Record Documents: Maintain a clean, undamaged set of Contract Documents, Shop Drawings and Product Data. Mark the set to show the actual installation where the installation varies substantially from the Work as originally shown. Mark whichever drawing is most capable of showing conditions fully and accurately; where Shop Drawings are used, record a cross-reference at the corresponding location on the Contract Drawings. Give particular attention to concealed elements that are concealed or cannot otherwise be readily discerned later by direct observation.
4. Include details on internal setting of components.
5. Mark record sets with red erasable pencil; use other colors to distinguish between variations in separate categories of the Work.

6. Mark new information that is important to the Owner, but was not shown on Contract Drawings or Shop Drawings.
7. Note related Change Order numbers where applicable.
8. Organize record drawing sheets into manageable sets, bind with durable paper cover sheets, and print suitable titles, dates and other identification on the cover of each set.
9. Testing Data - Include in record submittal documentation of performance tests as required in the contract documents.
10. Upon completion of the Work, submit Record Documents to the Architect for the Owner's records.
11. Record Sample Submitted: Immediately prior to the date or dates of Substantial Completion, the Contractor will meet at the site with the Architect and the Owner's personnel to determine which of the submitted Samples that have been maintained during progress of the Work are to be transmitted to the Owner for record purposes. Comply with delivery to the Owner's Sample storage area.
12. Miscellaneous Record Submittals: Refer to other Specification Sections for requirements of miscellaneous record-keeping and submittals in connection with actual performance of the Work. Immediately prior to the date or dates of Substantial Completion, complete miscellaneous records and place in good order, properly identified and bound or filed, ready for continued use and reference. Submit to the Architect for the Owner's records.

E. Maintenance Manuals

1. Organize operating and maintenance data into suitable sets of manageable size. Bind properly indexed data in individual heavy-duty 2-inch, 3-ring vinyl covered binders, with pocket folders for folded sheet information. Mark appropriate identification on front and spine of each binder.
2. Operating and Maintenance Instructions: Provide instruction manuals describing proper operation and maintenance. Include a detailed review of the following items:

    a. Maintenance and operation manuals for individual components.
    b. Cleaning.
    c. Control sequences.
    d. Copies of warranties.
    e. Emergency instructions.
    f. Fixture lamping schedule.
    g. Fuse list.
    h. Hazards.
    i. Identification systems.
    j. Inspection procedures.
    k. Lubricants.
    l. Recommended "turn around" cycles.
    m. Spare parts list.
    n. Specifications for expendables.
    o. Tools.
    p. Warranties and bonds.
    q. Wiring diagrams reflecting actual labeling in the field.
    r. Maintenance agreements and similar continuing commitments.
    s. Product Data.
    t. As Built drawings depicting actual locations and conditions of the system design, construction and arrangement.

3. As part of instruction for operating equipment, describe the following procedures:

a. Start-up.
b. Operation.
c. Shutdown.
d. Emergency operations.
e. Noise and vibration adjustments.
f. Safety procedures.
g. Economy and efficiency adjustments.
h. Effective energy use.
i. Complete Subcontractor List including names and telephone numbers of persons to contact.

4. Provide copies of documentation as required under Division 1.
5. Unless specified otherwise under Division 1, provide copies of the documentation distributed as follows:

    a. Digital copy to the Architect in portable document format (pdf) prior to general distribution for review of conformance to intent of the Contract Documents.
    b. Following modifications and corrections based on the review, distribute two (2) corrected hard copies and a digital copy to the Owner.

6. In addition to requirements under Division 1, provide a plan and section of performance machinery device locations in CAD format. Drawings should be saved in Drawing Interchange Format (DXF).

1.5 INTERFACE WITH ADJACENT SYSTEMS

A. Systems described shall in no way damage or adversely affect architectural, mechanical, electrical or structural systems, components or construction.
B. Coordinate the system installation with the requirements of adjacent and intersecting Work.
C. Electrical Interface.

1. Perform electrical work in accordance with governing legislation. Coordinate Work with other trades.
2. Products furnished for installation by Division 26 contractor.

    a. Faceplate Back Boxes: Gang back boxes, as outlined in the Documents, are not included and are provided under Division 26.
    b. Devices with 100v and above terminations including receptacles, power raceways, faceplates and back boxes.
    c. Power and control raceways
    d. Motor control panels
    e. Control voltage wire and cable, including, but not limited to, specialty cable and standard wire. Control wiring is terminated by Division 11 contractor.

3. Wire, cable and terminations for 100v and above devices are provided by Division 26.
4. Conduit connecting control systems in this section with other systems is provided by Division 26.
5. Power and Control Distribution

    a. See Division 26 documents for base power and control infrastructure locations.

b. Where manufacturer's standard system requirements differ from those in the Division 11 & Division 26 documents, coordinate those requirements with the Division 26 contractor without further cost to the project.
c. It is incumbent on the Division 11 contractor to ensure a properly coordinated and operational system. Discrepancies in requirements should be noted prior to bid.

6. Delivery

a. Deliver materials within this contract to the project site.

D. Follow Drawings in laying out work and checking drawings of other trades to verify spaces in which work is installed. Maintain maximum headroom and space conditions at all locations. Before proceeding with the work, notify Architect where conditions appear inadequate.
E. If directed by the Architect, without extra charge, execute reasonable modifications in the layout needed to prevent conflict with work of other trades or for proper execution of the work.

1.6 SYSTEM DESIGN AND PERFORMANCE REQUIREMENTS

A. Design Requirements:

1. The Contractor's engineer shall perform detailed analysis and design of each element as required to meet the performance and safety requirement expressed by regulation, standards and in the Contract Documents.
2. Operating Mechanisms: Provide operating devices, mechanisms and hardware in connection with this Work to operate smoothly, freely and without excessive noise or friction.
3. Built-In Work: Provide anchor bolts, inserts, plates and any other anchorage devices and all other items specified herein to be built into concrete, masonry or work of other trades, with necessary templates and instructions. Provide such devices in ample time to facilitate proper placing and installation.
4. Supplementary Parts: Provide as necessary to complete each item of work, even in the event that such supplementary parts are not specifically mentioned in the Contract Documents.
5. Design and perform the mechanical installations to possess the necessary properties to withstand stresses of tension, compression, flexure, shear, and torsion which may be anticipated being imposed on one or more of the components. Conform to the following priorities of installation: 1) safety, 2) ease of operation, 3) quietness of operation and 4) service life. The standards of quality and design covering the equipment and fabrication plus the installation technique required are established on this basis. The decision of the Architect in determining the acceptability of equipment items, installation technique and workmanship is final.
6. Systems provided in the Work shall in no way damage or adversely affect architectural, mechanical, electrical or structural systems, components or construction.
7. Where dimensions and loading capacities have been omitted from the Contract Documents, determine in accordance with the requirements and intent set forth in the Contract Documents.
8. Design, fabricate and erect steel structural components and fastenings shall be in accordance with the Specifications for Design, Fabrication and Erection of Structural Steel for Buildings, latest edition, by the AISC. Perform welding in accordance with the appropriate standards of the AWS.

B. Performance Requirements:

1. Materials, components, processes and workmanship for moveable systems shall comply to the current issues or revisions of the applicable legislation, references and standards.
2. Noise and Vibration:

a. Equipment shall operate quietly and without undue vibration. Provide isolation and damping as required to eliminate mechanical rattles, gearbox and coupling chatter and motor noise.
b. Unless otherwise specified, noise and vibration producing equipment shall not exceed the following noise criteria at any point between the floor and 6'-0" (2m) above finished floor level.

1. On Stage: RC 25
2. In Auditorium: RC 20.
3. Control Rooms: RC 25

c. The noise produced in any area by any item shall not exceed the RC criteria referenced above, in any given octave band. Where the noise level of any 1/3 octave band is more than 3dB greater than the levels of both of its adjacent 1/3 octave bands, the criteria shall be taken to be 5 units lower. Where the noise is intermittent, the criteria shall be taken to be 5 units lower.
d. Noise levels for critical areas are specified elsewhere in the Contract Documents. Provide sound proofing where required; ensure that acoustical treatment does not cause overheating or inhibit the operation of systems.
e. The stiffness of all structures forming a part of the stage or acting surface shall provide a satisfactory natural frequency for setting scenery and acting. Configure such structures to prevent the vibration of moved elements. Unless specifically stated, the natural frequency shall be less than 12 HZ under full loading.

C. Provide systems designed to reflect safeguards and precautions related not only to normal use of the equipment under ideal operating and loading conditions but, additionally, to anticipate equipment misuse, human error, and misjudgment. Design and intent parameters set forth herein in no way relieve this Contractor from responsibility or liability arising from the Work.

1.7 PERFORMANCE EQUIPMENT BASIC ELECTRICAL REQUIREMENTS

A. This section includes general requirements for the provision of electrical wiring methods and materials for the systems described in Division 11 of these documents. Supplementary requirements are specified in specific sections relative to particular systems. Work in this section requires detailed coordination with the base building portion of the projects; particularly Division 26.
B. System Description

1. Design and Performance Requirements:

a. Provide wiring devices complete with mounting devices and other appurtenances where required. Provide wiring devices that are the product of a single manufacturer except as specifically stated otherwise

b. Wiring and elementary diagrams for equipment are based on the product of the specified equipment manufacturer(s) and are shown for convenience to aid in estimating the extent of the work involved. Install the equipment actually provided in accordance with the equipment manufacturer's recommendations and details in approved wiring diagrams furnished by the equipment manufacturer. Provide equipment so connected to operate in a safe, proper and efficient manner. Note that not all control circuitry is necessarily shown on the drawings but shall be installed in conduit between the points and devices indicated on the diagrams.
c. Wiring devices, components and electrical systems shall be in compliance with the standards promulgated by NEMA and listed by Underwriters Laboratory or similar certified testing agency.

2. Equipment Connections:

a. Unless otherwise shown on the drawings or specified herein, the intent is to provide electrical connections required to protect, properly operate, and control motors, appliances, electrical devices, and equipment furnished and installed under the Division 11 sections of these Specifications or shown on the Drawings.
b. Refer to other sections of these specifications and to the drawings of other trades, if necessary, to determine the extent of work included under this division of these specifications.
c. Secure equipment, except portable equipment, firmly in place. Mount components rigidly, except where resilient isolation is required. Design and provide fastenings adequate to support their loads with a safety factor of at least three.
d. Clearly mark switches, jacks, outlets, cables, connectors, etc. logically and permanently during fabrication and installation.
e. Where many cables are run in close proximity, color code by function in a logical manner. Detail coding in instruction and operation manuals as well as signage.
f. Take necessary precautions to prevent and guard against electromagnetic, electrostatic and radio frequency interference.
g. Provide control system wiring which is continuous from the faceplates to the racks. Employ no splices for entire cable length.
h. Exercise care in wiring, so as to avoid damage to the cables and to the equipment. Between racks, cabinets, consoles or modules insure cables are well-supported, neatly laced and dressed. Make joints and connections with mechanical connectors approved by the Consultant.
i. Group terminals by signal type.
j. When cable is surface mounted and crossing through fire walls, use the equivalent Belden fire rated plenum cable to the specified cable type.
k. Label terminal strips, punch blocks, wire and cables in a permanent and logical manner with a unique number on each end of cable runs.
l. Terminate all connections with rack with mating connectors, punch blocks, or terminal strips.
m. Final location of equipment is as shown on the Drawings, located in the field by the Architect or as shown on supplementary drawings prepared by the Consultant.

1.8 IDENTIFICATION SYSTEMS

A. Design Requirements

1. Provide identification not related to the work area conforming to the Americans With Disabilities Act (ADA).
2. Based on a risk analysis performed by the Contractor's designated qualified analyst, provide equipment and systems with appropriate markings, warnings and instructions consistent with the manufacturer's and Contractor's duty to warn.
3. Provide signage and identification marking affecting safety in accordance with ANSI Z535.2 Environmental And Facility Safety Signs including annexes and 29 CFR 1910.144 Safety Color Code For Marking Physical Hazards, 29 CFR 1910.145 Specifications For Accident Prevention Signs And Tags.

    a. Where required and as otherwise feasible, provide pictorial signs in addition to text. Pictographs shall always be accompanied with appropriate explanatory text. Pictorial symbols shall conform with international standards and the ADA.
    b. Design signage to account for unfavorable viewing conditions.
    c. Where wire rope is employed, locate at operating locations and at entry to maintenance points Wire Rope Technical Board Form Number 193 warning signs.

4. Mounting Location and Height:

    a. Mount signage as required to provide effective direction and instruction.
    b. Mount signage with center of the sign no higher than 60" (1500mm) above the finished floor, unless specifically required. Mounting location shall be so that a person may approach within 3" of the sign without encountering protruding objects or standing within the swing path of a door.
    c. Mount hazard communication signage as to be plainly visible from a distance not less that 5'-0" (1500mm).

B. Equipment Identification

1. Nameplates: Except for required labels and operating data, do not attach or imprint manufacturer's or producer's nameplates or trademarks on exposed surfaces of products which will be exposed to view in occupied spaces or on the exterior.
2. Labels: Locate required product labels and stamps on a concealed surface or, where required for observation after installation, on an accessible surface that is not conspicuous.
3. Equipment Nameplates: Provide a permanent nameplate on each item of power-operated equipment. Locate on an easily accessible surface which is inconspicuous in occupied spaces. The nameplate shall contain the following information and other essential operating data:

    a. Name of product and manufacturer.
    b. Model and serial number.
    c. Capacity.
    d. Ratings.

4. Designate items fabricated by the system Manufacturer with the Manufacturer's name, model number and serial number on the chassis or a name plate securely attached to the item.

C. Electrical Component Identification:

1. Wiring devices, components and electrical systems shall be labeled and/or identified in compliance with the standards promulgated by NEMA and listed by Underwriters Laboratory or similar certified testing agency.

PART 2 - PRODUCTS

2.1 GENERAL

A. Commodities provided by the Contractor and the manners of installation shall comply with standards required pursuant to the provisions of the Federal Occupational Safety and Health Act, as amended.
B. General Product Requirements: Provide products that comply with the Contract Documents, that are undamaged and, unless otherwise indicated, unused at the time of installation.
C. Provide products complete with all accessories, trim, finish, safety guards and other devices and details needed for a complete installation and for the intended use and effect.
D. Standard Products: Where available, provide standard products of types that have been produced and used successfully in similar situations on other projects.
E. Product Selection Procedures: Product selection is governed by the Contract Documents and governing regulations, not by previous project experience. Procedures governing product selection include the following:

1. Where products or manufacturers are specified by name, accompanied by the term "or equal," or "or approved equal" comply with the Contract Document provisions concerning "substitutions" to obtain approval for use of an unnamed product.
2. Compliance with Standards, Codes and Regulations: Where the Specifications only require compliance with an imposed code, standard or regulation, select a product that complies with the most current and stringent standards, codes or regulations applicable.

F. Where no product available within the specified category matches satisfactorily and also complies with other specified requirements, comply with provisions of the Contract Documents concerning "substitutions" for selection of a matching product in another product category, or for noncompliance with specified requirements.
G. Visual Selection: Where specified product requirements include the phrase "...as selected from manufacturer's standard colors, patterns, textures..." or a similar phrase, select a product and manufacturer that complies with other specified requirements. The Architect will select the color, pattern and texture from the product line selected.
H. Visual Matching: Where Specifications require matching an established Sample, the Architect's decision will be final on whether a proposed product matches satisfactorily.

2.2 MATERIALS

A. Employ materials that are free of defects impairing strength, durability or appearance and of best commercial quality for the purpose specified. Employ materials with structural proportions to safely sustain and withstand stresses and strains to which they will be subjected. Fabricate true to detail, clean, straight with sharply defined profiles and, unless otherwise noted, with smooth finished surfaces.
B. Material Specifications:

1. Do not employ brittle materials or materials with unknown or unproven structural behavior in critical system components.
2. Steel items incorporated in the Work shall be produced or made in whole or substantial part in the United States, its territories or possessions.
3. Structural steel, plates and bars: A-36.
4. Malleable iron casting: A-47.
5. Steel pipe: A-53 Grade B (schedule as specified herein).
6. Galvanizing: A-153.
7. AISC Code of Standard Practice.
8. SSPC Steel Structures Painting Manual.

C. Allowable Stresses:

1. The following describes allowable stressed for normal design loads:

   a. In employing structural steel members and elements, do not exceed the stress values established in the Manual of Steel Construction, latest edition, as published by the AISC.
   b. In employing structural aluminum components, do not exceed the values established in the Specification of Aluminum Structures, latest edition, as published by the Aluminum Association.
   c. In employing structural elements made of miscellaneous metals, plastics and composite materials, do not exceed the stress values established by the manufacturer's engineers for these specific materials, based on codes, standards and proven design practices for these materials.

2. Determine allowable stresses for normal design loads combined with special design loads as follows:

   a. Allowable stresses shall not exceed the values, which would cause permanent distortion of structural or machinery components. Under certain circumstances as determined by the engineer, limited plastic distortion of moved object or moved support is permissible, provided that such distortion is intentionally designed to relieve the stresses without creating a dangerous condition.

2.3 MINIMUM STANDARDS OF SAFETY:

A. Minimum factor of safety for lifted loads: 10.
B. Increase the factor of safety for ropes where normal operating loads include cyclic dynamic loads, as determined by the Contractor's engineer, to suit the system operational requirements for required service life.
C. Minimum factor of safety for static loads: 8.
D. The factor of safety may be lowered, at the discretion and responsibility of the Contractor's engineer, if the static design loads are higher than the maximum lifted load.
E. Threaded Fasteners: ASTM Fastener Specifications as applicable to loading. Structural fasteners shall be traceable to materials, dimensions, processing and testing.
F. Cable and Cable Connections

1. Unless exceeded by other regulation or standard, select, inspect and employ wire rope, wire rope pulley, drums and connections in accordance with the current edition of the Wire Rope Users Manual published by the Wire Rope Technical Board.

2. Bending ratio: As identified by the Wire Rope Users Manual, no more than one reverse bend in six wire rope lays shall be permitted.
3. Connections shall be capable of developing at least 80 percent of the rated breaking strength of the wire rope. Compression sleeves shall comply with MS-51844
4. Each suspension rope shall have a "Design Factor" of at least 10. The "Design Factor" is the ratio of the rated strength of the suspension wire rope to the rated working load, and shall be calculated using the following formula: F=S(N)/W. Where: F = Design factor, S = Manufacturer's rated strength of one suspension rope, N = Number of suspension ropes under load and W = Rated working load on all ropes at any point of travel.
5. Manufacturers of wire rope, also identified as aircraft cable, employed in overhead lifting or suspension are required to be QPL certified pursuant to QPL-83420 as current. Provide preformed, galvanized unlubricated wire rope conforming to RRW-410 of the Type and Class commensurate with the diameter and construction determined appropriate by the Contractor's engineer. Where the Contractor determines to substitute a non-QPL Certified manufacturer, the Contractor, at no additional cost to the Project, shall provide testing of each spool employed in accordance with ASTM A 931 as current. Certificates of conformance are not substitutions for certificates of testing.
6. Maximum Fleet Angle Typical: 1.5 Degrees.

G. Supplementary Parts: Provide as necessary to complete each item of work, even in the event that such supplementary parts are not specifically mentioned in the Contract Documents.

2.4 PERFORMANCE MANUAL AND POWERED MACHINERY COMPONENTS

A. Clips, Wire Rope: Size "U"-bolt wire rope clips (Crosby Clips) appropriately for the cable construction, diameter and lay of the cable with which they are employed.

1. Saddle material: Drop forged steel
2. "U" bolt and nut material: Steel
3. Finish: Hot dip galvanized
4. Federal Specification: FF-C-450 Type 1 Class 1

B. Compression Sleeves: Size compression sleeves appropriately for the cable construction and diameter of the cable with which they are employed.

1. Material: Copper
2. Cable connection sleeves: Oval pattern
3. Cable stop sleeves: Cylindrical pattern
4. Military Specification MIL-51844

C. Eyebolts: Size eyebolts for the intended application. Employ dropped forged steel shoulder pattern eyebolts.

D. Shackles: Size shackles appropriately for the intended application. Execute chain connections with chain shackles; other connections may employ anchor shackles.

1. Shackle Material: Forged Steel
2. Pin Material: Alloy Steel
3. Treatments: Heat Treat and Temper
4. Pin Type: Safety type bolt type pin or safety type round pin.
5. Federal Specification: RR-C-271D Type IV or IVB, Grade A or greater, Class 1.

6. Size the screw pin to ensure that the threads are not included in the bearing surface of the bolt.

E. Thimbles, Wire Rope: Size wire rope thimbles appropriately for the cable construction and diameter of the cable with which they are employed.

1. Material: Hot dipped galvanized carbon steel.
2. Finishing: Free of characteristics detrimental to the rope or adjacent elements.
3. Federal Specification: FF-T-276b., Type III.

F. Thimbles, Manila/Fibrous and Synthetic Rope: Size appropriately for the rope construction and diameter of the rope with which they are employed.

1. Material: Hot dipped galvanized carbon steel.
2. Finishing: Free of characteristics detrimental to the rope or adjacent elements.

G. Turnbuckles: Size turnbuckles appropriately for the cable construction and diameter of the cable with which they are employed.

1. Material: Drop forged carbon steel
2. Finish: Galvanized
3. Type: Employ Jaw - jaw type unless otherwise noted.
4. Pins: Round pins and cotter keys.
5. Designation: F 1145 – 92 (Reapproved 2001) An American National Standard Standard Specification for Turnbuckles, Swaged, Welded, Forged. Type 1, Class G.

H. Guide Systems:

1. Provide guide systems, as required, for guiding, stabilizing, stopping and holding the moved elements. Where guide systems are employed, provide continuous guiding throughout the entire length of travel.
2. Provide guide rails and shoes, including their supports, to support applied forces, including stabilizing forces, and braking forces if stabilizing, braking and holding functions as performed by the guide system.
3. Provide guide systems so as not to cause accidental jamming or binding.

I. Blocks:

1. Provide blocks with the appropriate sheave for the intended cable and rope.
2. Configure blocks to prevent the hoisting rope from leaving the sheave groove. Provide block design to prevent the hoisting rope to leave the housing in event of sheave shaft failure. Configure blocks to support sheave in event of sheave shaft failure. Provide blocks ensuring sheaves are centered in the housing and run plumb without rubbing or interference with the block housing. Distance between outer face of sheave and inner face of cheek plate shall be less than one cable diameter.
3. Center Pins: Unless otherwise specified, provide sheave center pins designed to transmit the sheave load to the block housing without rotating.

4. Provide side plates (cheeks) of materials and dimensions required for the anticipated load. Provide side plates enclosing the sheave sides. Secure side plates to each other with spacer assemblies to ensure parallel alignment. Arrange spacer assemblies in a configuration to permit anticipated movement of rigging while restraining running lines from escaping sheave grooves. Provide spacers with appropriate tapers and finishes to prevent damage to running lines. Arrange spacer assemblies to provide redundant support for the running lines and sheaves in the event of sheave center pin failure. Arrange side plates to result in a rigid parallel housing for the sheave. Align each sheave within the block so that the center and sides of the groove rotate in the same axis perpendicular to the axle and parallel to the side plates.
5. Provide block assembly with attachment systems designed and fabricated to transmit the block load to the mounting structure, while permitting adjustment, alignment and maintenance of the block. Unless specifically approved by the Architect, welded connections or connections employing cut side plates with draw bolts are not acceptable.
6. Configure the block so the cable is supported according to wire rope manufacturer's recommendations.
7. Provide blocks to be suitable for anticipated loading and required mounting.

J. Sheaves:

1. Provide sheaves designed and fabricated in to meet or exceed the current edition of ANSI A10.5 American National Standard Safety Requirements for Material Hoists, Section 14.5 and the Wire Rope Technical Board's Wire Rope User's Manual, except where exceeded herein.
2. Configure the depth of flare of the groove so that the hoisting rope does not rub against the flange of the sheave when entering and leaving the groove.
3. Provide bearings designed to operate under the anticipated loading conditions for the lifespan of the system. Bore the hub within the close tolerances established by manufacturers engineering data for proper press fit without need of further cup clamping devices. Boring tolerances of sheaves selected at random are subject to inspection. Provide bearings rated for the load and speed derived from the calculated batten load.
4. Properly lubricate bearings according to manufacturers' recommendation.
5. Machine grooves to be smooth and free of irregularities, tool marks and imperfections. Machine hubs to assure proper bearing alignment.
6. Metal Sheaves: Provide from machined cast blanks.
7. Synthetic Sheaves: Provide from either machined extrusion or injection molded shapes. Where applicable, machine sheave grooves and hubs according to wire rope manufacturers' recommendations.
8. The minimum sheave tread diameter for wire rope head blocks is the rope diameter x 48.
9. Provide Multiple grooved blocks, including head blocks, with grooves of equal pitch diameter. Where purchase lines are employed, provide the purchase line groove at the center of the block.
10. Finish metal sheaves as required to prevent rust without wear on wire rope.
11. Acceptable Loft Block Materials (Wire Rope)

    a. Machine grooved molybdenum disulphide filled nylon.
    b. Machine grooved steel

12. Acceptable Loft Block Materials (Natural or Synthetic Fiber)

    a. Machine grooved molybdenum disulphide filled nylon
    b. Machine grooved steel

c. ASTM A48 Class 40 Grey Iron w/ Machined Grooves

13. Acceptable Head Block Materials

a. Machine grooved molybdenum disulphide filled nylon
b. Machine grooved steel
c. ASTM A48 Class 40 Grey Iron w/ Machined Grooves

14. Acceptable Floor Block Materials

a. ASTM A48 Class 40 Grey Iron w/ Machined Grooves

K. Guards:

1. Provide guarding and marking pursuant to OSHA 29 CFR 1910.219 Machinery and Machine Guarding, 1910.144 - Safety color code for marking physical hazards, 1910.145 - Specifications for accident prevention signs and tags and ASME B15.1 Safety Standard For Mechanical Power Transmission Apparatus.
2. Provide guards which do not interfere with the operation or of the machinery and which do not restrict proper ventilation. Configure guards to avoid generation or transmission of audible noise.

L. Control of hazardous energy (lockout/tagout).

1. Provide systems and components to permit the control of hazardous energy during servicing and maintenance of machines and equipment in which the unexpected energization or start up of the machines or equipment, or release of stored energy could cause injury to employees in accordance with 29 CFR 1910.147 The control of hazardous energy (lockout/tagout). This requirement applies, but is not limited to potential energy stored in counterweights.

M. Lubrication Provisions:

1. Provide each component with adequate means of lubrication to ensure moving parts are lubricated. Self-sealed, self-lubricating, or dry bearings of a suitable design are acceptable. Provide oil lubricated gearboxes with a means of determining that the proper quantity of lubricant is contained in the gearbox.
2. Provide for proper lubrication of the system components. Self sealed, self lubricating and dry bearings of suitable design may be used at the discretion of the Contractor's engineer, unless specifically required otherwise.

2.5 FABRICATION

A. Shop Assembly:

1. Workmanship: Work shall be performed by an experienced fabricator or manufacturer and installed by experienced tradesmen. Materials, methods of fabrication, fitting, assembly, bracing, supporting, fastening, operating devices and erection shall be in accordance with the Contract Documents, reviewed shop drawings and best practices of the industry, using new and clean materials specified, having structural properties sufficient to safely sustain or withstand stresses and strains to which materials and assembled work will be subjected. Assemble, fabricate and erect all work in a neat and accurate fashion.
2. Employ materials that are free of defects impairing strength, durability or appearance and of best commercial quality for the purpose specified. Employ materials with structural proportions to safely sustain and withstand stresses and strains to which they will be subjected. Fabricate true to detail, clean, straight with sharply defined profiles and, unless otherwise noted, with smooth finished surfaces.
3. Built-In Work: Provide anchor bolts, inserts, plates, other anchorage devices and other items specified herein to be built into concrete, masonry or work of other trades, with necessary templates and instructions. Provide such devices in ample time to facilitate proper placing and installation.
4. Supplementary Parts: Provide as necessary to complete each item of work, even in the event that such supplementary parts are not specifically mentioned in the Contract Documents.
5. Coordination: Accurately cut, fit, drill and tap Work herein to accommodate and fit work of other trades. Provide or obtain templates and drawings to or from applicable trades for proper coordination of this Work.
6. Connections:

    a. Make connections with tight joints, capable of developing full strength of the members and flush unless indicated otherwise. Locate joints where least conspicuous. Unless indicated otherwise, weld or bolt shop connections; bolt or screw field connections. Provide control joints as required to accommodate environmental variations.
    b. Employ fastening systems of appropriates sizes, ratings and quantities for the application. Where rated fasteners are employed, Provide domestically manufactured fasteners rated for anticipated loads and with approved markings indicating their rating. Provide fastener system's components of the same manufacture and equal ratings.
    c. Holes: Drill or cleanly punch holes, do not burn.
    d. Clean and leave unpainted the contact surfaces of bolted and welded connections. Fabricate built-ups and joints from components that are straight and close fitting, free from twists, bends or open joints in the finished assembly.
    e. Provide and assume responsibility for the location and maintenance in proper position of sleeves, inserts and anchor bolts required for the work. In the event that failure to do so requires cutting and patching of finished work, perform the work without additional cost to the Owner.
    f. Bolted connections: Drive bolts accurately into the holes without damaging the thread. Set bolt heads and nuts to rest squarely against metal. Protect bolt heads from damage during driving. Where members having sloping flange faces, provide bolted connections with appropriate beveled washers to afford square seating of heads and nuts. Do not locate holes in steel members less than 5 bolt diameters from an edge.
    g. Tighten fasteners to the torque specified by the AISC, SAE or applicable standard.
    h. Size bolts to extend not less than 1/4" (6mm) beyond the nuts. Do not employ fasteners that may interfere with the operation or safety of the Work.

i. Employ high strength steel bolts in friction only.
j. In addition to all other requirements, install a hardened washer between bolt heads, nuts and materials having elongated holes.
k. Unless specifically noted, and excepting graded, rated or otherwise certified fasteners, use nylon locking type nuts in locations subject to vibration and loosening.
l. Unless otherwise noted, exposed bolt and screw heads shall be flat and countersunk.

7. Welded Connections:

a. Prior to welding pay particular attention to surface preparation, fit up and cleanliness of surfaces being welded.
b. Follow the American Welding Society Standard for Welding.
c. Perform welding in accordance with the American Welding Society's approved methods.

8. Insofar as practicable, perform fitting and assembly of the Work in the shop. Shop assemble the Work in the largest practical sizes to minimize field work. It is the responsibility of this Contractor to assure himself that shop fabricated items properly fit the field condition. In the event that shop fabricated items do not fit the field condition, return the item to the shop for correction.
9. Cutting:

a. Cut metal by sawing, shearing or blanking. Flame cutting is permitted only when edges are ground back to clean, smooth edges and no deformation or damage is caused to the metal by the process. Make cuts accurate, clean, sharp and free of burrs, without deforming adjacent surfaces or metals.

10. Where dimensions and characteristics have been omitted, furnish based on criteria set forth herein.

B. Shop / Factory Finishing:

1. Environmental Standards: Finish materials shall comply with the following:

a. Environmental Protection Agency (EPA) requirements for less than 350 grams per liter of Volatile Organic Compounds (VOC) for finishes applied to components.

2. General:

a. Clean and shop paint, with one coat of primer, all ferrous metals. No shop primer paint is required on galvanized materials, copper, brass, bronze or aluminum materials.
b. Protective Coatings: Whenever dissimilar metals are in contact and aluminum metals are in contact with or imbedded in concrete, cement, mortar, plaster or masonry, separate contact surfaces by coating each contact surface, prior to assembly or installation with one coat of protective coating in addition to the shop paint prime coat described herein. Mask off those surfaces not required to receive protective coatings.

3. Preparation:

    a. Clean steel in accordance with SSPC-SP2 Hand Tool Cleaning.
    b. Protect sheave grooves, bolt threads, and moving parts prior to painting.

4. After fabrication, all steel; apply a shop coat of paint except the following:

    a. Areas within 2" of field welds.
    b. Contact surfaces of high strength bolted friction connections.
    c. Milled surfaces.
    d. Sheave Grooves.

5. Application:

    a. Apply shop prime coat immediately after cleaning metal. Apply paint in dry weather or under cover. Metal surfaces shall be free from frost or moisture when painted. Paint all metal surfaces including edges, joints, holes and corners. Prior to assembly, paint surfaces that will be concealed after such assembly. Apply paint in accordance with approved paint manufacturer's printed instructions and use thinners, adulterants or admixtures only as stated in said instructions. Paint materials uniformly to completely cover the metal surfaces.
    b. Apply paint to dry surfaces, when temperatures are above dew point, thoroughly and evenly, strict accordance with manufacturer's, to provide dry film thickness of 0 -5 mils. Allow paint to dry before handling or loading steel for shipment.
    c. Apply a second coat of shop paint to surfaces inaccessible after assembly or erection.
    d. Protect machined surfaces by an accepted, neutral, rust inhibitive coating of a type not requiring removal and resistant to wear.
    e. Include painting details in the shop drawings.
    f. Sequence finishing of materials requiring anodized finishes to ensure that finished surface is not damaged during fabrication.

6. Field Touch-Up:

    a. After erection, clean all damaged areas in the shop coat, loosened scale, rust, exposed surfaces of bolts, nuts, and washers, all field welds and unpainted areas (except as mentioned) to the same standard as the shop coat and paint with the same paint used for the shop coat, at the same film thickness.
    b. Shop prime ferrous metals with fast-curing, lead and chromate free universal modified-alkyd primer complying with the performance requirements of FS TT-P-664, selected for good resistance to normal atmospheric corrosion, compatibility with finish systems indicated and capability to provide a sound foundation for field-applied topcoats despite prolonged exposure.
    c. Do not paint moving parts acting as bearing surfaces or subject to friction wear.

C. Factory Finishing Colors:

1. Finish ferrous metals visible from the audience chamber in flat black.
2. Finish grid or floor mounted blocks, loft blocks and headblocks yellow in accordance with OSHA 29 CFR 1910.144 and ANSI Z535.1
3. Do not paint sheave grooves, fasteners, aluminum or galvanized materials and products.
4. Treat timber products with clear penetrating stain.

2.6 SIGNAGE:

A. Provide signage in English.
B. Employ printed or stenciled characters. Handwritten characters are not acceptable.
C. Wall mount diagrams depicting the system layout and maximum load limitations (drawn not less than 1/4"=1'-0" – 1:50) in a protective transparent faced frame on the stage wall near the locking rail and near the loading gallery entrance as to be plainly visible, and as not to interfere with the operation of the system.
D. Clearly display the rated load capacity on each moved element together with restrictions for maximum load concentrations and load locations on the moved element and associated control.
E. The stroke "width-to-height" ratio shall be between 1:6 -1:8 Separate lines of by leading that is approximately 120% of the type point size. Unless specified by regulation or standard, calculate text height in inches based on unfavorable viewing conditions based on the viewing distance in feet multiplied by 0.084 (in mm based on meters x .0045).
F. Numbers and Labels: Employ UL listed, indelible adhesive backed coated polyester printed labels with adhesives designed for the surface energy of the mounting surface.
G. Manual and Powered Linesets

1. Number each arbor with characters located on the back bar or plate of the arbor 6" below the arbor top. Locate double digit numbers with one digit on either side of the tie rod, as to be clearly visible, or centered on the rear plate. Apply white characters on dark backgrounds Minimum height viewing distance: 5'-0" (1500mm).

2. Clearly mark each lineset number on the kick plate at the loading gallery. Coordinate specific label locations with Architect.
3. For rod style arbors, mark the onstage side of each arbor tie bar at spreader plate locations with labels notifying the operator that a spreader plate is to be inserted at that position.
4. Paint the exposed faces of counterweights constituting pipe weight for each lineset with Safety Yellow enamel as defined by ANSI Z535.1. For those pipes with connector strips, pipe weight is to include the weight for those strips and associated hardware.
5. In locations agreed to by the Architect, provide signage at lock rail and loading gallery identifying the size and weight of each size and type of counterweight provided.
6. Number each batten, identically to its location on the index strip, on both ends as to be read from above and below with white characters on a dark background. Minimum viewing distance: 20'-0" (6000mm).
7. Except for linesets dedicated to potentially visually-sensitive locations, such as an orchestra shell, mark battens with a painted white stripe 1" wide running around the full circumference at the centerline of the proscenium in white and at 1'-0" (300mm) increments from the left and right of the centerline in white. Indicate the distance from the midpoint in 5'-0"(1500mm) increments. Mid line and ends excepted, increments may be marked with white indelible marker. Paint the end of each pipe and each extension with safety orange stripes 1'-0" (300mm) from the ends toward the midpoint. Mark the section of batten extension to remain in the batten with safety red stripes.
8. Number blocks as follows with white adhesive 36pt. sans serif numerals:

   a. Head Blocks: Consecutive set number s on each side plate 1" (25mm) from on-stage edges.
   b. Loft Blocks: Consecutive set numbers on the up-stage side plate followed by a stroke and the line number as counted from the arbor.
   c. Mule Blocks: Consecutive set numbers on the bottom side plate followed by a stroke and the line number as counted from the arbor.

9. In locations agreed to by the Architect, provide signage at control locations, loading gallery, grid iron identifying all pertinent hazards, avoidance procedures and consequences. In addition to safety requirement, list on the signage the standard size of system load capacities provided and their respective weights.

H. In locations agreed to by the Architect, provide signage identifying all pertinent hazards, avoidance procedures and consequences.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of Conditions:

1. Examine work prepared by others to receive work of this Section and report defects affecting installation to the Purchaser for correction. Commencement of the work shall be construed as complete acceptance of preparatory work by others. The sphere of inspection includes but is not limited to:

   a. Assurance mounting surfaces are ready to accept the Work.
   b. Verification of flatness, plumb and level of mounting conditions.
   c. Inspection of components of the Work to ensure no damage has occurred during shipping or storage.

2. Coordinate staging, sequencing and access.
3. Discrepancies:

   a. In the event of discrepancies, immediately notify the Architect.
   b. Do not proceed with the installation in areas of discrepancy until all such discrepancies have been fully resolved.

3.2 SITE CONDITIONS

A. Sequence delivery and installation of components to protect their long term viability. Of particular concern is protecting stage and acoustical draperies from abrasive construction dust and grit and protecting drapes from the accumulation of dust which can lead to an aesthetic finish concern, premature wear, and a combustion hazard due to fine dust particles.
B. Do not deliver stage or acoustic drapery to the site where the ambient relative humidity is greater than 65% for more than a 12-hour period.
C. If stage or acoustical drapery must be installed prior to room being clean, dry, and dust free, completely wrap and protect drapery from the infiltration of dust and thoroughly clean drapery prior to final testing. Drapery that shows wear or construction dust residue will be rejected.

3.3 PREPARATION

A. Verify field measurements at the site prior to installation and modify the system accordingly.

1. Deliver equipment to the site only after the building has been closed in. Coordinate storage at the site and ensure the materials and components are undamaged.
2. Do not install work until space is enclosed and weatherproof, wet-work in space is completed and nominally dry, work above is complete, and ambient conditions of temperature and humidity will be continuously maintained at values near those indicated for final occupancy.
3. Equipment and components that show wear or rusting due to excessive moisture will be rejected.
4. Protect the surrounding environment from damage by the Work.

B. Surface Preparation:

1. Clean surfaces as necessary prior to commencing the Work.

C. Inspection of Conditions: Require the Installer of each major component to inspect both the substrate and conditions under which Work is to be performed. Do not proceed until unsatisfactory conditions have been corrected in an acceptable manner. Commencement of the work shall be construed as complete acceptance of preparatory work by others.

D. Manufacturer's Instructions: Comply with manufacturer's installation instructions and recommendations, to the extent that those instructions and recommendations are more explicit or stringent than requirements contained in Contract Documents.

E. Inspect materials or equipment immediately upon delivery and again prior to installation. Reject damaged and defective items.

F. Provide attachment and connection devices and methods necessary for securing Work. Secure Work true to line and level. Allow for expansion and building movement.

G. Visual Effects: Provide uniform joint widths in exposed Work. Arrange joints in exposed Work to obtain the best visual effect. Refer questionable choices to the Architect for final decision.

H. Recheck measurements and dimensions, before starting each installation.

I. Install each component during environmental conditions and Project status that will ensure the best possible results.

J. Isolate each part of the completed construction from incompatible material as necessary to prevent deterioration.

K. Built-In Work: Provide anchor bolts, inserts, plates and any other anchorage devices and all other items specified herein to be built into concrete, masonry or work of other trades, with necessary templates and instructions. Provide such devices in ample time to facilitate proper placing and installation.

L. Coordinate temporary enclosures with required inspections and tests, to minimize the necessity of uncovering completed construction for that purpose.

M. Mounting Heights: Where mounting heights are not indicated, install individual components at standard mounting heights recognized within the industry for the particular application indicated. Refer questionable mounting height decisions to the Architect for final decision.

3.4 ERECTION, INSTALLATION AND APPLICATION:

A. Workmanship:

1. Workmanship shall be best quality; executed by workers skilled and experienced in the respective duties for which they are employed. Immediately notify the Architect if required Work is such as to make it impractical to produce required results.
2. Decisions as to the quality or fitness of workmanship in cases of dispute rest solely with the Architect, whose decision is final.

B. Install the system with care that the components are straight, plumb, true and aligned throughout. Tightly fit connections employing appropriate safety factors and arrange in an orderly manner.

C. Perform the Work in conformance with the best trade practices, fabricate and install items in accordance with manufacturers' recommendations and Architect's direction. Coordinate Work with trades doing adjoining work.

D. Install the system complete with all members and materials, and all bolts, nuts, washers, clips, fittings, supports, or other items required for attaching all equipment specified to the existing construction.

E. Perform required cutting, drilling, tapping and fitting to properly install and secure the Work in place. Cutting or drilling existing structural work shall have the prior review of the Architect. Perform the mechanical fabrication and workmanship in accordance with neat and mechanically acceptable practices such as clean drilled and punched holes without flash, hard smooth finish for sheared, machined, and cut edges, and proper fit of component and contiguous parts without irregularity where marching is intended. Welding shall meet qualifications of AISC manual and shall be without spatter and other evidence of poor practice. Welding of load bearing elements shall be performed by certified welders. Comply with AWS Code for procedures of manual shielded metalarc welding, appearance and quality of welds made and methods used in the correction of welding work. Moving parts shall have specified tolerances, shaft sizes, bearings, mounting, connections, and accessories coordinated into the work in a manner acceptable to the Architect. Do not incorporate wood construction or equipment into the Work except as set forth in the Specifications.

F. Erection:

1. Fastening:

    a. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing metal fabrications to in-place construction. Such fasteners include, but are not limited to: threaded fasteners for concrete and masonry inserts, through bolts, lag bolts, wood screws and other connectors as required.
    b. Provide metal fastenings and accessories in same texture, color and finish as adjacent materials, unless indicated otherwise.
    c. Prevent electrolytic action between dissimilar metals and materials.
    d. Space anchors within their load limit and shear capacity; ensure that they provide positive and permanent anchorage. Wood and other organic material plugs are not acceptable.
    e. Keep fastenings to a minimum, space evenly and install neatly.
    f. Fastenings which cause spalling or cracking of material to which anchorage is made are unacceptable.
    g. Where turnbuckles are employed in the suspension of overhead loads provide positive safetying in accordance with MS 33591B(AS) and as to provide equivalent resistance and strength to an equivalent locking clip system as defined under MIL-DTL-8878H Turnbuckles Positive Safetying.

2. Cutting, fitting and placement: Perform cutting, drilling and fitting required for installation of fabrications. Set work accurately in location, alignment and elevation, plumb, level, true and free of rack, measured from established lines and levels. Provide temporary bracing or anchors in formwork for items which are to be built into concrete, masonry or similar construction.
3. Connection to Building Structure:

a. Provide supports from the structure above sized and placed to meet the loading requirements indicated herein.
b. Provide connections to building structure through engineered clamps or mechanical connections. The use of chain or slings wrapped around structure shall not be accepted.
c. Supports to the structure above shall fully enclose or encircle the member to which it is being attached. Clamping devices designed to pinch one side of a beam flange shall not be accepted.
d. Hanging devices employing chain are subject to approval by the Architect and at a minimum are required to employ chain and connection devices specifically designed for overhead lifting as defined to OSHA (29 CFR 1926.251).
e. Where required, employ wall flanges to control lateral movement.

1. Provide wall blocking as required.

G. Hoisting Rope Connections:

1. Employ rope fastenings which develop not less than 100% of the manufacturer's rated breaking strength of the rope employed.
2. Qualified personnel are responsible for installing fasteners.
3. Equalization of Hoisting Rope Tension:

a. Provide means to substantially equalize the tensions between ropes which are in close proximity to each other.
b. Where suspension rope equalizers are employed, provide those of the individual compression spring or bar type. The latter type, provide the attachment by means of an entrapment bar to prevent separation of the equalizer bar from the lifted element. Extension spring type equalizers are not acceptable.

4. Reeve typical linesets with the specified wire rope for the lift lines and 3/4" synthetic rope for the purchase lines.
5. Employ one continuous length of cable for each lift line. The lengthening, joining or repairing of two or more sections of wire rope is prohibited. Mid-line splices are unacceptable.
6. Cut cable and compress sleeves only by use of the appropriate tool and operation for the cable and application.
7. Wire Rope Eye Splices: Form an eye on both ends of the lift line around an appropriate thimble. Close eyes with a copper compression sleeve. Crimp the sleeve with the appropriate tool per manufacturer’s instructions. After crimping, test the sleeve for compliance with manufactures requirements. In the event that the crimped sleeve does not comply with the specifications, cut the cable above the sleeve and form a new splice.
8. Secure the end of the lift line, at the appropriate trim to the batten connection device.
9. Other types of fasteners are permitted, provided that adequate tensile and fatigue tests have been made by a qualified testing agency and that the fasteners have been approved for the intended or similar use.
10. Align loads on pins via steel spacing washers to assure even loading. After closing the shackle, deform the cotter pin at the end to prevent unintentional loosening of the pin.
11. Secure the lift lines to the typical arbor tops by employing eyes and shackles. Form the eye as described herein.

3.5 TESTING, DEMONSTRATION, AND INSTRUCTION

A. Clearly record the date, time, personnel, details and results of all the following tests and demonstrations and any subsequent re-tests. This will form the start of a system log book to be handed over to the user after acceptance together with operation and maintenance manuals.
B. Inspect the completely assembled hoist system including all mechanisms, fittings, control panels, etc., and make good all deficiencies before certifying that the system is complete.
C. Certify compliance with tolerances specified in the Contract Documents.
D. Certify function of braking systems.
E. Certify speed, noise and stability compliance with the Contract Documents.
F. With hoist fully loaded, perform motor current checks. Test drive unit including the effect of a loss of one or more phases, of reduced voltage and of phase reversal. Test mobile control box and all indicators. record results of all tests.
G. Certify motion with full specified dynamic payload.
H. Provide demonstration and testing as required to obtain certification by the applicable legislative authority. This Contractor is solely responsible for obtaining such certification and all costs arising from the certification. Certification is a condition of substantial completion.
I. The completed installation of rigging equipment with draperies properly installed shall be tested and operated by the Contractor for the acceptance by the Architect.
J. The Contractor is completely and solely responsible for any testing required by the Architect and authorities having jurisdiction to ensure compliance with the Contract Documents and applicable laws and regulations.
K. In case the need for further adjustments becomes evident during the demonstration and testing, continue the Work until the systems operate properly.
L. If more than one (1) visit is required by the Architect's Consultant because the system does not fulfill this specification, pay for time and expenses of the Architect's Consultant during any extensions of the acceptance testing period.
M. Architect / Consultant Review

    1. Prior to testing and certification, coordinate with the Consultant the personnel required to be present during the events. Unless specifically designated by the Consultant, testing, certification and operation of equipment is to be performed solely by the Contractor. Where the Consultant or his designee deems it necessary to personally perform a test or operate equipment in order to determine compliance with the Contract, the Contractor shall coordinate the operation and provide the necessary approvals from authorities and organizations having jurisdiction over the Work.
    2. The Contractor's Project Manager, or a designee familiar with the engineering and installation of the system(s), will coordinate and be present at all certification and testing by the Architect and the Architect's Consultant.
    3. The contractor shall provide a minimum of two (2) weeks notice of readiness for inspection.
    4. Counterweight Rigging Inspection

        a. Contractor shall operate, or allow the Consultant to operate each lineset a minimum of two times, or as much as necessary, to ensure smooth operation both at the guide wall and at the gridiron / support structure.
        b. Contractor shall provide lifts or other required access to visually inspect all rigging components.
        c. Contractor shall provide tools and other hardware to inspect terminations and connections.

N. Owner Demonstration and Instruction

1. In addition to requirements in Division 1, provide the quantity of hours training indicated in the contract documents.
2. Demonstrate the full capabilities of the system(s), demonstrating how it meets specification, and demonstrates areas in which it exceeds specification.
3. Provide Training on this equipment system to be scheduled at times mutually agreed upon with the owner. This training time is to be divided into the following sessions as a minimum:

    a. Initial training
    b. Follow-up training.

4. Video record the initial and subsequent training sessions. Provide the owner with five (5) copies of a USB Stick of that recording, with the file in a standard format usable on a Windows or Macintosh OS without additional software downloads, in addition to other training materials.

O. Assurances:

1. At the time of the Architect's final review, provide a notarized affidavit stating compliance with the criteria of the Contract Documents and applicable standards, laws and regulations. Include certification that connections, including cable connections, have been made in accordance with applicable standards and manufacturer's recommendations. Where connection methods require specific torque, pressure, periodic tool calibration or measured dimension to ensure function, provide certification that such methods have been performed and record of activities.

3.6 PROJECT CREDIT

A. In publications where this project is mentioned give credit to:

1. The Design Architect
2. Theatre Consultant: Theatre Consultants Collaborative, Inc.

END OF SECTION 116100

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