
PART 1 GENERAL**1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section describes the requirements for the electrical equipment and includes:
 1. General
 2. Products
 3. Execution
 4. Electric Power Equipment
 5. Ropeway Equipment
 6. Communications
 7. Wind Monitoring System

1.3 DELIVERY, HANDLING, STORAGE

- A. Comply with General Conditions and Division 1 Section "Product Requirements".

1.4 WARRANTY

- A. Comply with General Conditions and Division 1 Section "Product Requirements".

1.5 RELATED SECTIONS:

1. 34 14 13 Aerial Tramway General Requirements
2. 34 14 14 Aerial Tramway Ropeway Equipment

1.6 REFERENCE STANDARDS

- A. The primary reference standards for the Project are listed below. The ropeway system shall conform to all applicable requirements of these documents including codes and standards referenced therein.
 1. ANSI B77.1-2011.
 2. California Building Code Title 24 Part 2
 3. Federal OSHA Parts 1910 and 1926.
 4. CAL/OSHA Title 8, Chapter 4, Subchapter 6.1
 5. National Electrical Code, NFPA 70-2011
 6. Minimum Design Loads for Buildings, ASCE 7-10
- B. When the drawings and specifications call for materials of construction of better quality or larger size than required by codes, laws, rules and regulations, the drawings and specifications shall take precedence. If the drawings and specifications differ, the specifications shall take precedence.

1.7 QUALITY ASSURANCE

- A. The work of this section shall be performed by a company which specializes in the type of Aerial Tramway Electrical work required for this Project, with a minimum of 5 years of documented successful experience and shall be performed by skilled workmen thoroughly experienced in the necessary crafts.
- B. Manufacturer shall specialize in manufacturing the type of Aerial Tramway Electrical specified in this section, with a minimum of 5 years of documented successful experience, and have the facilities capable of meeting all requirements of Contract Documents as a single-source responsibility and warranty.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Comply with General Conditions and Division 1 Section "Product Requirements".

PART 2 PRODUCTS**2.1 UNAUTHORIZED MATERIALS**

- A. Materials and products required for work of this section shall not contain asbestos, polychlorinated biphenyls (PCB) or other hazardous materials identified by the OWNER.

2.2 ACCEPTABLE MANUFACTURERS

- A. Products of the manufacturers specified in this section establish the minimum functional, aesthetic and quality standards required for work of this section.

2.3 SUBSTITUTIONS

- A. Comply with General Conditions and Division 1 Section "Product Requirements" using form in Division 1 Section "Substitution Request Form".

2.4 MATERIALS

- A. Materials and equipment shall conform to respective publications and other requirements as specified herein and as indicated in the contract documents, and shall be the products of manufacturers regularly engaged in the manufacture of such products.
- B. Wherever standards have been established by Underwriter's Laboratories, Inc, (U.L.), the materials shall bear the U.L. label.

2.5 WIRE AND CABLE

- A. Wire:
 - 1. Feeders and Branch Circuits larger than 8 AWG: Copper, stranded conductor, 600 volt insulation, THHN/THWN, XHHW.
 - 2. Feeders and Branch Circuits 10 AWG and smaller: Copper solid conductor, 600 volt insulation, THHN/THWN, XHHW, or MTW.
 - 3. Control Circuits: Copper, stranded conductor, 600 volt insulation, THHN/THHW, MTW, TC.
 - 4. Control circuit conductors operating at 24 VDC to ground shall be #18 CU stranded or larger with an overall covering and color coded.
 - 5. Shielded control wiring shall be #18 CU Stranded or larger, color coded insulation, with an overall foil shield and drain wire, and overall covering.
 - 6. Control wiring at 120 VAC to ground shall be #14 CU stranded or larger with insulation rated 600 V or greater and be color coded.
 - 7. Wiring shall not be installed once it has been removed.
 - 8. Wiring installed in ropeway cabins shall be #18 CU conductor or larger, with insulation conforming to B Cords.
- B. Cords: Oil-resistant thermoset insulated multiconductor flexible cord with identified equipment grounding conductor, suitable for hard usage in damp locations.

2.6 CONTROL SWITCHES AND STATIONS

- A. Description: Heavy duty oil tight control switches and stations.
- B. Manufacturers:
 - 1. Allen-Bradley
 - 2. Cutler-Hammer
 - 3. Telemecanique
 - 4. Approved Equal

2.7 INSTRUMENTS AND SENSORS

- A. To be determined during design review.

2.8 CONTROL DEVICE ENCLOSURES

- A. Description: Shop fabricate and wire control device enclosures for groupings of more than one device
- B. Use hinged cover enclosures rated NEMA 12 in dry and weather protected locations.
- C. Use hinged cover enclosures rated NEMA 4 in wet or weather exposed locations.

- D. Terminal Blocks: NEMA ICS 4.
- E. Fabrication: shop assemble using plastic wiring trough to route internal wiring.
- F. Manufacturers:
 - 1. Hoffman Engineering
 - 2. Rittal
 - 3. Approved Equal

2.9 BOXES

- A. All wiring junction boxes in wet or exterior locations shall be NEMA 4 construction with hinged covers.
- B. Control enclosures in wet or exterior locations shall not be penetrated in the top surface.
- C. All control wiring junction boxes in dry locations shall be NEMA 12 construction.
- D. All remote control and push button enclosures shall be NEMA 4 construction with hinged covers.
- E. Main control and drive cabinets shall be NEMA 4 construction.
- F. All power wiring junction boxes shall be galvanized steel, sized for the number of wires passing through or terminating in the box. Boxes shall not be smaller than trade size 4" square.

2.10 RACEWAYS

- A. All wire shall be run in conduit raceways sized according to the NEC, and not smaller than trade size 1/2".
- B. All conduit runs in dry and weather protected locations shall be electrical metallic tubing (EMT).
- C. All conduit runs in wet or weather exposed locations shall be Intermediate Metallic Conduit (IMT), or rigid metallic conduit (RMC).
- D. All conduit runs exposed to physical damage shall be IMT or RMC.
- E. All conduit runs embedded in concrete shall be RNC or RMC, with bends over 30 degrees of RMC. Penetrations at the concrete surface shall be RMC.
- F. Raceway systems made of ferrous metals shall be corrosion protected by galvanization.

2.11 MOTORS

- A. All electric motors shall be NEMA rated, UL listed, rated for 1.15 service factor.
- B. All electric motors in wet or exposed locations shall be NEMA rated totally enclosed fully drip proof suitable for wet or damp locations.
- C. All motors controlled by variable frequency drive (VFD) motor controllers shall be rated for VFD operation.

PART 3 EXECUTION

3.1 EXAMINATION AND PREPARATION

- A. Verify that any interior location is physically protected from weather.
- B. Verify that mechanical work which is likely to injure conductors has been completed.
- C. Completely and thoroughly swat raceway system before installing conductors.

3.2 INSTALLATION

- A. Install work in accordance with manufacturer's instructions.

- B. Install individual components in enclosures.
- C. Connect control devices to systems controller to achieve proper system operation.
- D. Neatly train and secure wiring inside boxes, equipment and panelboards.
- E. Use wire pulling lubricant for pulling 4 AWG and larger wires.
- F. Make splices, taps, and terminations to carry full ampacity of conductors without perceptible temperature rise.
- G. Terminate spare control conductors with electrical tape.

3.3 WIRING METHODS

- A. Exposed interior locations: Building wire in raceway.
- B. Above accessible ceilings: Building wire in raceway.
- C. Wet or damp interior locations: Building wire in raceway.
- D. Exterior locations: Building wire in raceway.
- E. Underground locations: Building wire in raceway.
- F. Wire minimum size:
 - 1. Use no wire smaller than 12 AWG for power and lighting circuits.
 - 2. Use 10 AWG conductor for 20 ampere, 120 volt branch circuit home runs longer than 75 feet (23 M); and for 20 ampere, 277 volt branch circuit home runs longer than 200 feet (61 M)
- G. Electrical Identification
 - 1. All cabinets and control junction boxes shall be neatly and permanently labeled to match the as-built drawings.
 - 2. All wires shall be labeled to match as-built drawings.
 - 3. All cabinets and control junction boxes containing circuits over 50 volts to ground shall be neatly and permanently labeled with maximum voltage contained.
- H. Control Wiring
 - 1. Each control switch located in the terminal areas shall have the control conductors placed in one continuous run from the switch to the main control interface or to intermediate junction boxes with labeled dedicated barrier strips.
 - 2. No splices or other wire terminations are to be made in raceways or wire pull boxes.
 - 3. Low voltage control wiring to sensors and devices not exposed to public access may be run in cords or tray cable mechanically secured to structural components.
- I. Grounding
 - 1. Grounding Conductors: Grounding conductors shall be bare copper wire, or insulated with green insulation, or clearly marked with green tape or other similar markings at all exposed locations.
 - 2. Ropeway Ground: The power and control system of the ropeway shall be bonded to the service entrance ground with #6 CU or larger wire. All metallic parts of the ropeway and related equipment shall be grounded to the ropeway power and control system.
 - 3. Structural metal parts shall be considered grounded when mechanically connected to other grounded components.
 - 4. Mechanical connections shall be welded or solidly bolted bare metal, clean of paint or other insulating materials prior to making connections.
 - 5. Bonding connections in underground or wet or damp locations shall be by exothermic welding, or by properly sized compression connection system.
 - 6. Control System Ground: The control system circuits shall be configured such that any inadvertent ground on a control circuit shall cause the ropeway to stop.
 - 7. Control Switches: Control switches not mechanically grounded to grounded structures shall have an additional CU ground wire run in the conduit and connected to the system equipment ground. The ground wire shall be sized equal to the control wire

3.4 ADJUSTING

- A. Adjustments of all systems and sensors shall be done by the CONTRACTOR under supervision of the SYSTEM SUPPLIER.
- B. Preliminary adjustments shall be made prior to Acceptance Testing.
- C. Final adjustments and instructions shall be noted on the as-built drawings and operational procedures as required.

PART 4 ELECTRIC POWER EQUIPMENT**4.1 ELECTRIC SERVICE**

- A. Electrical Service from Tower equipment shall be provided by the CONTRACTOR to coordinate with the new system equipment requirements. Where the service provides power and support for a primary drive power unit and an auxiliary drive power unit, the electrical service from the tower and distribution equipment shall be independent and redundant for each system. No failure of power and support equipment for one power unit system shall result in a failure of the other system.
- B. Primary Drive Power Unit: Electric service from the Tower for the ropeway system shall be installed as required to support the new systems by the CONTRACTOR.
 - 1. Line voltage at the service from the Tower is 480 VAC, 3Ø, 4W.
 - 2. Service from the Tower equipment shall be sized in accordance with design loads as defined by the SYSTEM SUPPLIER.
 - 3. CONTRACTOR shall be responsible for the service from the Tower and all on-site conduit and wiring.
 - 4. SYSTEM SUPPLIER shall be responsible for all pre-wired assemblies.
 - 5. Cabinets shall be arranged in close proximity and shall conform to the requirements of NEC 230.71 with not more than six (6) disconnecting switches.
- C. Upper Terminal Support Power
 - 1. Upper terminal support power shall be provided from Transbay Transit Center.
 - 2. Ropeway system controls and support equipment that require electric power shall be supplied from the Transbay Transit Center.
 - 3. Care shall be taken in design and installation to prevent interconnection between the two Service systems

4.2 PRIMARY GROUNDING

- A. Primary grounding systems for the main electrical ground connection at service from the Tower shall be the grounding system for the Transbay Tower.
- B. CONTRACTOR shall bond all equipment supplied for the ropeway system including system neutrals, equipment enclosures, non-current carrying metal parts of equipment, metal raceway systems, grounding conductors, plumbing systems, and lift equipment ground point.
- C. All grounding conductors shall be copper.

4.3 SECONDARY GROUNDING

- A. SYSTEM SUPPLIER shall supply control system ground buss to comply with ANSI B77.1-2011. Ground points shall be established at each terminal.

4.4 POWER DISTRIBUTION

- A. SYSTEM SUPPLIER shall provide distribution equipment, transformers, and panelboards as required to provide for the ropeway system; and lighting, heating, and ventilation as required for each terminal's system mechanical and electrical equipment.
 - 1. At both terminals, SYSTEM SUPPLIER shall be responsible for power distribution to ropeway system and system ventilation requirements for normal and emergency operation of the system. SYSTEM SUPPLIER shall not be responsible for passenger comfort heating and ventilation in terminals.

- B. Power distribution and ropeway power equipment at the lower terminal will be ducted in conduit to location near the terminal equipment.
 - 1. SYSTEM SUPPLIER shall provide an equipment disconnecting means for the entire ropeway system and support equipment at the nearest practical point to the terminal equipment.
 - 2. The interface location and arrangements for electrical distribution equipment will be coordinated between the SYSTEM SUPPLIER and the CONTRACTOR.
 - 3. SYSTEM SUPPLIER shall provide all equipment and components for the ropeway system on the downstream side of the equipment disconnect.
 - 4. CONTRACTOR shall provide and install the wire and duct from the Transbay Center distribution to the ropeway equipment disconnect.
- C. Power distribution and ropeway power equipment at the upper terminal will be ducted in conduit to location near the upper terminal equipment.
 - 1. SYSTEM SUPPLIER shall provide an equipment disconnecting means for the upper terminal support system and equipment at the nearest practical point to the upper terminal equipment.
 - 2. The interface location and arrangements for electrical distribution equipment will be coordinated between the SYSTEM SUPPLIER and the CONTRACTOR.
 - 3. SYSTEM SUPPLIER shall provide all equipment and components for the ropeway system on the downstream side of the equipment disconnect.
 - 4. CONTRACTOR shall provide and install the wire and duct from the Transbay Transit Center distribution to the ropeway equipment disconnect.
- D. SYSTEM SUPPLIER will only be responsible for distribution as required by the ropeway system and support equipment required by this specification.

4.5 LIGHTING FIXTURES

- A. SYSTEM SUPPLIER shall supply door operated light fixtures in all control cabinets and panels larger than 30 inches high or 20 inches wide.
- B. SYSTEM SUPPLIER shall provide lighting specified for the passenger cabins.
- C. CONTRACTOR shall provide general terminal lighting for electrical equipment and machinery spaces.

4.6 CONVENIENCE OUTLETS

- A. CONTRACTOR shall provide 120 VAC dedicated outlets required for equipment operation and support (e.g. battery chargers, power supplies).
- B. CONTRACTOR shall provide 120 VAC duplex outlets to support maintenance operations in the equipment areas of each terminal. Outlets shall be spaced such that no more than 10 feet of portable cord is required to support any maintenance task.

4.7 SPACE HEATING

- A. SYSTEM SUPPLIER shall provide all space heating systems and equipment required for normal and emergency operation of the system. CONTRACTOR shall install and connect heating systems.
- B. SYSTEM SUPPLIER shall provide heat as required for any ropeway subsystems that may require special heat systems (e.g. gearboxes, brake systems, hydraulic systems, control enclosures). CONTRACTOR shall install and connect heating systems.

4.8 VENTILATION

- A. SYSTEM SUPPLIER shall provide all ventilation systems and equipment required for normal and emergency operation of the system. CONTRACTOR shall connect the ventilation systems.

PART 5 ROPEWAY EQUIPMENT

5.1 SYSTEM SUPPLIER

- A. SYSTEM SUPPLIER shall provide all design, integration, materials, and labor necessary to provide systems necessary to system operation. Systems shall be coordinated with the requirements of other portions of this Specification.

5.2 LOWER TERMINAL

- A. Propulsion drive systems, logic control systems, and terminal support equipment shall be located in the lower terminal.
- B. Primary Drive Systems
 - 1. SYSTEM SUPPLIER shall provide motors and motor controls for the system motive power and other functions as required by the system design.
 - 2. Where redundant systems are required, these requirements apply to both systems.
 - 3. Primary propulsion shall be provided by Main Drive system consisting of a minimum of AC electric motor and variable frequency drive (VFD) inverter system.
 - 4. AC motors and VFD inverters shall have the following:
 - a. Design, construction, and adjustment in coordination with the manufacturer and according to recommended practice.
 - b. Matched and coordinated components to provide a complete integrated drive system.
 - c. Four quadrant operating capability.
 - d. Control and feedback regulation able to maintain full torque at zero speed.
 - e. Inverter rated motors of cast iron construction.
 - f. Proper rating for installation at sea level elevation.
 - g. Compliance with IEEE 519-1992.
 - h. Power Factor correction adjustable from 0.85 to 1.0. Final adjustment to be coordinated with the local electric utility.
 - i. Performance to regenerate negative power from the motors into the power line during operation. Emergency generator supplied power for the Tower is adequately base loaded to allow for regenerative braking during Auxiliary Alternator operation.
 - 5. The main drive system shall be able to start the system from a stopped condition at any point along the line with a cabin loaded to 110% of design load.
 - 6. The main drive system shall be able to provide a controlled stop of the system from a full speed condition at any point along the line with a cabin loaded to 110% of design load.
 - 7. The main drive system shall be able to provide a smooth acceleration, continuous running, and smooth deceleration with less than 1% speed regulation under any combination of loading from 0% to 110% of design load.
 - 8. The main drive system shall be designed using the calculated load cycle of the system to operate at 100% of design load for 500,000 trip cycles without maintenance beyond inspection, cleaning, lubrication and adjustment.
 - 9. The motor and controller shall be equipped with the following control circuits which shall be individually annunciated by the ropeway control system:
 - a. Motor cooling ventilation failure
 - b. Motor over temperature
 - c. Converter bridge over temperature
 - d. Under voltage on the power supply
 - e. Loss of phase on the power supply
 - f. Loss of speed feedback
 - g. Overload for rated operating conditions.
 - 10. Each safety circuit shall have a test switch or procedure to verify proper operation during periodic maintenance.
 - 11. Each circuit shall have a latching function requiring manual reset by operating personnel.
 - 12. The VFD inverter systems shall include the following:
 - a. Enclosure Lighting
 - b. 120 VAC Receptacle
 - c. Line Volt Meters
 - d. Load Volt Meters
 - e. Load Ammeters

13. VFD inverter systems shall have adjustable acceleration rates capable of acceleration from zero to full speed between 1 and 20 seconds.
 14. VFD inverter systems shall have test procedures to verify proper function of the ropeway 110% and 115% over speed detection devices.
 15. VFD inverter systems shall have test procedures to verify proper operation of braking systems in compliance with ANSI B77.1-2011 2.1.2.6.
 16. The AC motors and VFD Inverters shall be manufactured by ABB, or approved equal.
 17. VFD inverter system assemblies shall be reviewed and accepted by an independent testing agency.
 18. VFD inverter systems shall be installed in an outside environment within the lower terminal enclosure at the street level of the Mission Park Plaza. Final arrangement of the electrical and mechanical equipment will be coordinated between the OWNER, CONTRACTOR and SYSTEM SUPPLIER during design review of the system.
- C. Stand-By Drive System
1. A secondary propulsion system shall be provided by a Stand-by Drive system in the event of failure of the Primary Drive System.
 2. The Stand-By drive system shall have the same requirements as the Primary Drive System. The gondola system shall operate with no perceived difference to the user on either drive.
 3. Provisions shall be made to alternate operation of the system using the Primary and Stand-By drive systems on a daily or weekly basis, such that the 2 drive systems accumulate approximately the same number of hours annually.
 4. Provision shall be made to continue operations continuously on either drive system while the other drive system is involved in heavy maintenance.
 5. It shall be possible to make any required mechanical installation or adjustments to the system for removal and replacement involving maintenance operations during a single over night shift from close of business to opening the next morning.
- D. Auxiliary Alternator Power
1. In the event of a utility power failure, the main drive system VFD inverter and motor shall be powered by an auxiliary alternator system.
 2. The auxiliary alternator system shall be provided by CONTRACTOR to supply power for the emergency load requirements of the Transbay Center building.
 3. The auxiliary alternator system will automatically provide emergency power to the main power supply from the ropeway system.
 4. The CONTRACTOR supplied auxiliary alternator system shall be designed to absorb regenerative braking power from the VFD inverters.
- E. Evacuation Auxiliary
1. The ropeway system shall be equipped with an Evacuation Auxiliary system.
 2. The Evacuation Auxiliary system shall be an independent mechanical system designed to return the cabin to a terminal in the event of a total power failure or a major mechanical failure, as detailed in Related Sections.
 3. Operation of the Evacuation Auxiliary system shall be independent from all other power and control systems:
 - a. Evacuation system shall not depend on utility power or the auxiliary alternator supply.
 - b. The Evacuation Auxiliary drive control logic system shall operate from a different power supply from the two main drive systems.
 - c. Battery storage and charging systems for the evacuation system and controls shall be independent from all other systems.
 4. The control logic system for the Evacuation Auxiliary system shall be independent from the main and stand-by control logic system:
 - a. The control logic system for the evacuation auxiliary is anticipated to be minimal with manual operation.
 - b. The control logic system shall include manual shut-down switches at all attendant stations, docking controls, and appropriate interlocks.
- F. Support systems
1. Additional Motor Controls
 - a. Additional motors and controls required by the system shall be installed in accordance with NEC Article 430.
 - b. Variable speed drive controls or solid-state soft-start systems, if required by other systems, shall be manufactured by the same manufacturer as the main drive controllers.
 - c. Additional contactors and starters shall have full load rating in accordance with NEC Article 430.

5.3 UPPER TERMINAL

- A. Upper terminal systems shall include a call button for on-demand service.
- B. Track Rope Monitor System
 - 1. If track ropes are fixed anchor tensioned, they shall have a tension monitor system to ensure that the tension is within the design limits.
 - 2. Track ropes shall have devices or procedures to verify that tensions have not exceeded the design limits at an interval period conforming to the system manufacturer and rope manufacturer recommendations.
- C. Track Rope Tension System
 - 1. Track ropes shall have an active tension system to reduce the track tension in the event of earthquake. The tension system shall be located at the upper terminal.
 - 2. The track rope tension system shall automatically extend additional length of track rope to allow the Transbay Transit Center building and the Mission Park Plaza to move a differential distance during a seismic event and maintain the rope tension within acceptable limits.
 - 3. Tension system shall be automatically triggered by seismic activity or motion that increases the tension beyond allowable limits. Allowable upper limit shall not be more than 150% of design tension.
 - 4. The tension system shall release hydraulic valves allowing the system to extend a fixed distance of 6 inches.

5.4 Platform doors

- A. Passenger platform cabin entry positions at each terminal shall have platform doors as defined in Related Sections.
- B. Platform doors shall be electrically operated.
 - 1. Door operation shall be monitored and controlled by the logic control system.
 - 2. Door operators shall be mounted in the header jamb.
 - 3. Door operators shall be concealed from passenger view by removable panels for maintenance operations.
- C. Doors shall lock in the closed position.
 - 1. When not commanded to be open, doors shall automatically return to the closed position and lock.
 - 2. Platform doors shall be able to be unlocked and opened manually from the cabin side without tools or keys.
 - 3. Platform doors shall be able to be unlocked and opened electrically from the station side by maintenance personnel using keys or tools not accessible to the passengers.
 - 4. Platform doors shall be able to be unlocked and opened manually from the station side by maintenance personnel using keys or tools not accessible to the passengers.
- D. Door Closing
 - 1. Both vehicle and station automatic doors shall operate as a single unit. Automated control commands shall act on the cabin and platform as a coordinated pair.
 - 2. Door closing shall be annunciated by audio and visual warning signals.
 - 3. An obstruction to the closing of a door panel shall be detected by obstruction sensor(s).
 - 4. An obstruction detected by either a station door or a vehicle door shall result in the recycling of that door with only its corresponding cabin or platform door. No other doors on the station platform or vehicle shall recycle unless triggered by an associated obstruction detection device.
 - 5. When closing, door control shall detect an obstruction of 25 mm (1 inch) or greater located at any point along the closing edges.
 - 6. When such obstruction is detected, the door shall not lock.
 - 7. When an obstruction is sensed during the closing cycle and prior to the operation of the door closed travel limit switch(es):
 - a. The respective door set, in coordination with the matching vehicle doors, shall release the door operator closing force for a period of 0 to 5 seconds (adjustable).
 - b. During this release time, the doors shall be capable of being pushed back manually, having the door closing force fully removed.
 - c. Following the release period, the doors shall try to close again.
- E. Cabin and Station Door Operation
 - 1. Logic control system shall provide automatic operation and monitoring of cabin and station doors.
 - 2. Cabin and station doors shall be monitored for unscheduled opening.
 - a. Unscheduled door opening protection shall be provided by the logic control and cause a visual and audible alarm at the operator control panels.
 - b. If any cabin or platform door is unlocked for any reason, the system shall be prohibited from entering or leaving the station.

- c. If any cabin or platform door is unlocked for any reason as a system is entering or leaving the station platform area, the process of braking the system to a full stop shall be immediately initiated.
 - d. If any cabin door unlocks for any reason while the system is in motion, the system shall be caused to stop.
 - e. In the event of any unscheduled platform door opening, a reset by authorized personnel shall be required prior to the restoration of normal operation.
3. Door Control Interlocks. Door control protection interlocks shall be provided by the logic control.
- a. Control interlocks shall ensure that the cabins are properly docked prior to enabling the automatic unlocking and opening of the cabin and platform doors:
 - 1) Cabins are properly aligned at the station platform.
 - 2) System is at Zero speed.
 - 3) Propulsion power is removed from the motors.
 - 4) System docking brakes are applied.

5.5 PASSENGER CABIN

A. Cabin Power Systems

1. Cabin shall have operational controls, communications, lighting and ventilation powered by battery systems.
2. Cabin door electric operators shall be powered by direct connection to power rail connections in docking position at the station. No power shall be available to automatically operate the doors when the cabin is not in the stations.
3. Cabin shall have an independent "Control" battery system to provide power for the logic control system and operational communications.
 - a. Battery power shall be able to provide for continuous operation of all control logic functions for 5 hours without charging in the station.
 - b. Cabin battery power shall not be required to operate the system control logic functions from the main control and move the cabins if the battery fails.
4. Cabin shall have an independent "Support" battery system to provide power for the support communications and lighting. Battery power shall be able to provide for continuous operation of the cabin communications and interior lighting for 5 hours without charging in the station.
5. Cabins shall be powered by electric power routed through the winch drive haul ropes. The electric power feed shall provide charging power to all batteries.
6. The ventilation system shall be capable of providing its stated design capacity continuously when the cabin is powered. In the event of a power failure, the ventilation system shall be capable of providing 500 cfm for a period of 60 minutes.
7. In addition to the other items listed, the battery system shall be able to disengage the track rope brakes. Track brake release function shall be operable by controls in the main control panel at the lower terminal.

B. Maintenance Controls

1. Cabin shall have a maintenance control station with all of the operational controls and displays accessible.
2. Maintenance controls shall include a manual door operating control.
 - a. While in the station, it shall be possible to open or close the cabin and platform doors using a manual switch at the maintenance station.
 - b. Door opening and closing by the maintenance personnel shall conform to the requirements of Platform Doors and Cabin Doors.
3. Maintenance controls shall include a voice communications system to communicate to each terminal and the control station.

C. Cabin Doors

1. Cabin passenger entry positions shall have automatic doors as defined in Related Sections.
2. Cabin doors shall be electrically operated.
 - a. Door operation shall be monitored and controlled by the logic control system.
 - b. Door operators shall be mounted in the header jamb.
 - c. Door operators shall be concealed from passenger view by removable panels for maintenance operations.
3. Doors shall lock in the closed position.
 - a. When not commanded to be open, doors shall automatically return to the closed position and lock.
 - b. Cabin doors shall be able to be unlocked and opened manually from the platform side without tools or keys.
 - c. Cabin doors shall be able to be unlocked and opened electrically from the cabin side when the cabin is in the station by attendant personnel from the cabin control panel.

- d. Cabin doors shall be able to be unlocked and opened manually from the cabin side by attendant personnel using keys or tools not accessible to the passengers.
- 4. Door Closing
 - a. Door closing shall be annunciated by audio and visual warning signals.
 - b. An obstruction to the closing of a door panel shall be detected by the obstruction sensor(s).
 - c. When closing, door control shall detect an obstruction of 25 mm (1 inch) or greater located at any point along the closing edges.
 - d. When such obstruction is detected, the door shall not lock.
 - e. When an obstruction is sensed during the closing cycle and prior to the operation of the door closed travel limit switch(es):
 - 1) The respective door set, in coordination with the matching vehicle doors, shall release the door operator closing force for a period of 0 to 5 seconds (adjustable).
 - 2) During this release time, the doors shall be capable of being pushed back manually, having the door closing force fully removed.
 - 3) Following the release period, the doors shall try to close again.
- D. Lighting
 - 1. Cabin interior lights shall be switchable from the control desk.
 - 2. Lighting systems shall be powered by the Support battery system.
 - 3. Cabin lighting shall have 2 levels of lighting.
 - a. Lighting level for boarding and alighting passengers.
 - b. Lighting level for operation on line to allow passenger viewing through the windows.

5.6 LOGIC CONTROL SYSTEMS

- A. System propulsion and control systems shall be installed in the Lower Terminal.
- B. SYSTEM SUPPLIER shall supply a logic control system and associated control switches as required for normal operation to comply with the requirements of ANSI B77.1-2011.
- C. The main logic control system for the ropeway system shall be installed in exterior mounted cabinets at the Plaza level near the terminal. Final arrangement of the electrical and mechanical equipment will be coordinated between the OWNER, CONTRACTOR, and SYSTEM SUPPLIER during design review of the system.
- D. System controls for normal operation shall be available at the main control panel in the lower terminal and at the security control points for the Transbay Center.
 - 1. Full operational controls shall be available at the control cabinet in the lower terminal with or without attendants in the cabins.
 - 2. Additional control panels shall be available at the Security Control Station, the Fire Control Station, and the Building Engineer's office.
 - 3. The condition of each switch and sensor in the logic control system shall be monitored and annunciated at the control panel.
 - 4. Each switch or sensor in the system shall be monitored and annunciated in case of an "Open" or "Fault" condition.
 - 5. Logic control system shall monitor and display the location of the cabin along the line at the control panel.
- E. Logic controls shall be arranged such that the system operates in normal mode in fully automated operation without support personnel in either terminal or the cabin.
 - 1. System controls shall be arranged to provide for scheduled operation or for on-demand operation using a call button on the passenger platform.
 - 2. In scheduled operation, the cabin shall arrive at a passenger platform, open the doors, dwell for a programmable delay time, close the doors, and travel to the opposite platform. The automated process will repeat and continue until interrupted by command from the control panel. The controls shall be programmable for no less than three scheduled modes on each of seven days.
 - 3. In on-demand operation, the cabin shall arrive at a passenger platform, open the doors and dwell for a programmable delay time, optionally close the doors and wait for a passenger call button. When called, the cabin will travel to the calling platform and open the doors for a programmable delay time. The cabin interior will have a station request button for PARK and for PLAZA.
- F. All normal operational commands and fault conditions shall be digitally recorded on an electronic storage system.
 - 1. The daily operation data shall be recorded with all system control events, date and time into a data file for

future analysis.

2. All system normal trip START and DOCK events shall be recorded with date and time.
 3. All faults or events monitored by the system shall be recorded with condition, date, and time.
 4. All STOP events shall be recorded with relevant information as follows:
 - a. Monitored stop condition
 - b. Running speed
 - c. Cabin location
 - d. Each motor current
 - e. Date and time.
 5. Electronic records shall be recorded to a redundant record logging system such that a failure of the recording system does not damage any of the data.
 6. Electronic records shall maintain a minimum of 50 days of records without manual backup by operations personnel.
 7. Electronic records system shall have provisions for permanent archive of the recorded data.
- G. System operating speed
1. System normal trip operation shall be automatically controlled by the control logic program over the entire speed profile from trip start to slow and dock at the return terminal.
 2. Maximum running speed shall be adjustable by the operator at the main control panel.
 3. The running speed shall follow the speed profile up to the maximum programmed speed or the maximum set speed, whichever is lower.
 4. Operating speed shall be continuously compared to the target reference. Any difference of greater than 10% shall cause an alarm condition and the process of braking the system to a full stop shall be immediately initiated.
 5. Control logic shall allow the direction of travel to be selected from the starting location after a stop.

5.7 MANUAL CONTROL STATIONS.

- A. Manual control stations shall not be accessible to the public. They shall be either in restricted spaces or under key.
- B. A manual control station shall be placed in the lower terminal.
- C. Manual control stations shall have, as a minimum:
 1. Cabin call switch
 2. Normal Stop switch
 3. Emergency Shutdown switch
 4. Lift communications system.

PART 6. COMMUNICATIONS

6.1 TERMINAL COMMUNICATIONS

- A. No overhead communications line shall be used.
- B. Voice and Control Communications between the terminals shall use wireless data transmission.
- C. SYSTEM SUPPLIER shall coordinate with OWNER to provide terminal communication feeds to the control station. Such communications feeds shall include all system communications fully annunciated at the control station.

6.2 CABIN COMMUNICATIONS

- A. The CONTRACTOR will provide security surveillance cameras for the cabin. The SYSTEM SUPPLIER shall coordinate with the CONTRACTOR to determine interface needs.
 1. The SYSTEM SUPPLIER shall install the CONTRACTOR supplied cameras. The SYSTEM SUPPLIER shall provide suitable communications and power to the cameras so that the camera feeds may be incorporated into the overall project security protocol. The SYSTEM SUPPLIER shall carry all camera video feeds, in full motion video to the lower terminal over wi-fi.
 2. The exact camera models, quantity and configuration have not been established at the time of this specification. The selection of the cameras will include project-wide considerations beyond the scope of this specification. For reference, exemplar model cameras which may be similar to the CONTRACTOR selected, CONTRACTOR supplied cameras include: Panasonic WV-SF138, Supercircuits PC221-HR, Brickcom VD-

500AF and Sarix IM10LW10-1V.

3. The SYSTEM SUPPLIER shall assume two such cameras will be required in the cabins and that an additional covert "pinhole" or "lipstick" camera may be required. In the event of a power failure, the video transmission for all cameras shall continue for a minimum of 60 minutes.
- B. A Call for Assistance Station (CFA) shall be installed in the cabin. The CFA shall include recorded two-way voice communication that is continuously monitored by a dedicated, fixed, day/night camera with an event recording sequence. One of the CONTRACTOR supplied cabin cameras (see above) may be used to satisfy this requirement. The CFA shall also have an alarm button that triggers the camera recorder.
- C. SYSTEM SUPPLIER shall establish a Wireless Ethernet communications network between the lower terminal and the cabin.
 1. SYSTEM SUPPLIER shall provide all design, materials, and testing to establish a Wireless Ethernet communications network between the lower terminal and the cabin.
- D. The network shall consist of a radio frequency (RF) communication from an access point (AP) at the lower terminal to a subscriber module (SM) on the cabin.
- E. SYSTEM SUPPLIER shall provide system modules necessary to create a complete communications network.
 1. System shall have AP and SM units for point to point network.
 2. All locations shall have transient suppression devices as recommended by the manufacturer.
 3. The system shall include power supplies and other necessary equipment housed in weather tight enclosures as recommended by the manufacturer.
 4. System components shall be hardened to operate over an operating temperature range of -40°F to 167°F.
- F. At the Access Point in the lower terminal, the digital data shall be transmitted to the monitoring equipment for processing and display at control stations.
 1. The network shall have an Ethernet router for connection to other networks if required by the OWNER.
 2. The router or network shall have an Ethernet switch device which conforms to the 802.11 g, n specification with at least two (2) spare ports.
- G. Wireless Ethernet communications system shall be designed and proposed by SYSTEM SUPPLIER. The wireless communications system shall be subject to OWNER approval to be established at design review.

6.3 CABIN COMMUNICATION SYSTEM

- A. Operational and Control Communications
 1. Communications and signaling for system operations and safety systems shall be provided by the SYSTEM SUPPLIER using systems demonstrated in service at previous installations.
 2. Communication system designs shall have proven successful record of a minimum of 3 years service at a minimum of 2 other installations.
- B. Cabin Network Communication System
 1. The SYSTEM SUPPLIER shall provide Wireless Ethernet communications to the passenger cabin using the wireless network.
 2. The network to the cabins is intended to carry video from cameras mounted on the cabin and to carry information video to the cabin when necessary.
 3. Adequate mounting space shall be provided for antennas, wiring, and weather tight enclosures required for the network equipment.

PART 7. WIND MONITORING SYSTEM

7.1 WIND MONITORS

- A. SYSTEM SUPPLIER shall provide all materials, instruments, mounting, wire, equipment, and software to provide a complete wind monitoring system for the system.
- B. Wind instruments shall monitor wind direction and velocity.
- C. Wind instruments shall be located near the top of the upper terminal. Instrument location shall be coordinated during design review.

- D. Each wind indicator shall provide velocity and direction information to the control system and monitors located in the control cabinet and security monitoring desks.
- E. Wind instrument data shall be available for continuous electronic monitoring by the OWNER.

7.2 WIND INSTRUMENTS

- A. All anemometer sensors shall be identical model and manufacturer.
- B. Anemometer sensors shall use ultrasonic sensing and contain no moving parts.
- C. Anemometer sensors shall provide output data in a digital format transmitted over RS-232 or RS-485 communication protocol.
- D. Preferred suppliers:
 - 1. NovaLynx Corporation WindSonic
PO Box 240
Grass Valley, CA 95945-0240
U.S.A.
Phone: (530) 823-7185 (800) 321-3577
Fax: (530) 823-8997
Email: nova@novalynx.com
 - 2. Gill Instruments Ltd WindSonic
Saltmarsh Park, 67 Gosport Street
Lymington, Hampshire, England SO41 9EG
Tel: +44 (0)1590 613500
Fax: +44 (0)1590 613501
 - 3. Vaisala Instruments WMT50
888 824 7275
 - 4. Approved Equal
- E. Wind instruments shall be connected to monitoring equipment in the lower terminal control.
- F. The wind monitoring system in the lower terminal control shall display wind speed and direction at each instrument location. The monitor system shall provide a two level alarm indication at each location.
 - 1. The first level alarm shall indicate wind speed exceeding the set limit with visual indication in the control room.
 - 2. The second level alarm shall indicate wind speed exceeding the set limit with audible indication in the control room.
 - 3. The limits for each level and each location shall be independently adjustable.
- G. The wind monitoring system information shall be displayed at each of the remote control panel locations for monitor by security and facilities personnel.

END OF SECTION