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Elevator and Escalator Working Group

Design and Installation of Heavy-Duty Hydraulic Elevators

Abstract: This recommended practice contains guidelines for transit, commuter rail and intercity passenger systems to use to specify heavy-duty elevators with a rise of 40 ft or less.

Keywords: heavy-duty elevators, low-rise elevators, transit passenger elevators

Summary: This recommended practice addresses the specific heavy-duty elevator needs of North American transportation systems. This document is intended as a guideline of technical provisions for the specification, design and construction of new elevators that can provide safe, clean and reliable service in the harsh, heavy-usage, high-abuse environment of transportation systems.



Foreword

The American Public Transportation Association is a standards development organization in North America. The process of developing standards is managed by the APTA Standards Program's Standards Development Oversight Council (SDOC). These activities are carried out through several standards policy and planning committees that have been established to address specific transportation modes, safety and security requirements, interoperability, and other topics.

APTA used a consensus-based process to develop this document and its continued maintenance, which is detailed in the [manual for the APTA Standards Program](#). This document was drafted in accordance with the approval criteria and editorial policy as described. Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

This document was prepared by the Elevator and Escalator Working Group, as directed by the Rail Standards Policy and Planning Committee.

This document represents a common viewpoint of those parties concerned with its provisions, namely transit operating/planning agencies, manufacturers, consultants, engineers and general interest groups. The application of any recommended practices or guidelines contained herein is voluntary. APTA standards are mandatory to the extent incorporated by an applicable statute or regulation. In some cases, federal and/or state regulations govern portions of a transit agency's operations. In cases where there is a conflict or contradiction between an applicable law or regulation and this document, consult with a legal adviser to determine which document takes precedence.

This document supersedes APTA RT-EE-RP-002-03, which has been revised. Below is a summary of changes from the previous document version:

- Reformatted to align with the new APTA Rail Transit standards.
- Title changed from "Heavy Duty Transportation System Elevator Design Guidelines" to "Design and Installation of Heavy-Duty Hydraulic Elevators"
- Sections have been reorganized and renumbered for clarity.
- Revised multiple definitions for clarity and accuracy.
- Global revisions to section headings, numbering, and overall text flow, including capitalization, punctuation, spelling and grammar.
- Technical edits made to sections previously numbered 1.03, 1.04, 1.05, 1.06 and 1.12 (now sections 1.2, 1.3, 1.4, 1.5 and 1.11).
- Technical edits made to sections previously numbered 2.01, 2.02, 2.03, 2.04, 2.05, 2.08, 2.11, 2.13, 2.14, 2.15, 2.16, 2.17, 2.18 and 2.19 (now sections 2.1, 2.2, 2.3, 2.4, 2.8, 2.6, 2.13, 2.10, 2.11, 2.12, 2.11, 2.13, 2.14 and 2.15).
- Removed all language and sections referencing rack and pinion drive systems.
- Added Appendix A – Safety Certification Checklist



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Introduction

This introduction is not part of APTA RT-EE-RP-002-03, "Design and Installation of Heavy-Duty Hydraulic Elevators."

APTA rail transit safety standards and recommended practices represent an industry consensus on practices for rail transit systems to help achieve a high level of safety for passengers, employees and the general public. This recommended practice provides guidelines for the specification, design and installation of heavy-duty hydraulic elevators.

APTA recommends the use of this document by:

- individuals or organizations that operate transit systems;
- individuals or organizations that contract with others for the operation of transit systems; and



- individuals or organizations that influence how transit systems are operated (including but not limited to consultants, designers and contractors).

Scope and purpose

The objective of this recommended practice is to address the specific heavy-duty elevator needs of North American transportation systems. This document is intended as a guideline of technical provisions for the design and construction of new elevators that can provide safe, clean and reliable service in the harsh, heavy-usage, high-abuse environment of transportation systems.

NOTE: This document is not intended to be a complete, procurement-ready technical specification. This guideline does not address any issues related to demolition of an existing elevator. When demolition of an existing unit is needed, additional requirements must be considered and addressed on a case-by-case basis.

This recommended practice is the result of the combined efforts of the members of the APTA Elevators and Escalators Working Group over the past several years. Membership of the working group includes transit agencies, railroads, consultants, and elevator and escalator component manufacturers for transportation systems. Each transit agency may find it necessary to make changes to suit their specific needs and environment. However, the stringent provisions are the result of the members’ combined experiences and, in general, reflect transportation requirements and the need for improved safety and reliability. There are also “Notes to specifier” in the text to guide the user in preparation of a procurement specification document.

It is expected that some manufacturers will be quick to say these requirements will add to the cost of the procurement. Transit agency experience has shown the high life cycle maintenance costs associated with the manufacturer’s “standard” product when used in a transportation environment. Higher expense upfront will be more than compensated for by the overall reduced life cycle costs.

The working group has also established certain design parameters for elevators to be considered for transit applications, as shown in **Table 1**.

TABLE 1
Maximum Rise of Hydraulic Elevators Per Type in This Document

	Recommended	Without Drilling	Drilling limited to less than 16 ft. of travel
Elevator Type	Direct plunger	Single-stage holeless	Roped hydraulic
Maximum Rise	40 ft	16 ft	40 ft

Note: These maximums apply to this document only.

The working group does not recommend the use of telescoping or cantilevered hydraulic elevators in transportation applications.

NOTE TO SPECIFIER: Class C1 or C3 loading is recommended if the elevator is going to be used to move equipment of any kind that is over 25% of the rated capacity of the elevator.

NOTE TO SPECIFIER: minimum standard design drawings should be provided that show all connections with other disciplines, as shown in **Table 2**.



TABLE 2
Elevator Drawing Sheet Count

Vertical Transportation (VT) Sheet	Title	15%	30%	60%	90%	100%	
1	General Notes and Elevator Key Plan & Code Analysis	Graphical dimensions and data	X	X	X	X	
2	Standard Details		X	X	X	X	
1 per Group of Elevators	Elevator hoistway plan and machine room/control space		X	X	X	X	
1 per Group of Elevators	Elevator hoistway and machine room control space section		X	X	X	X	
1 for each different configuration	Cab Shell – typical with fixtures				X	X	X
1 per Group of Elevators	Elevator Corridor Section					X	X
1 for each different configuration	Individual car and hall fixtures					X	X
	Fire Command Station					X	X

Transit agencies should coordinate design of elevators with all applicable disciplines affected. This can include architectural, MEP (mechanical, electrical, plumbing), structural, communication, HVAC, and fire/life/safety designers.

The use of this guideline will provide improved availability and reliability of transportation elevators and, most importantly, will improve customer safety, satisfaction and convenience. The results can only be an increase in the public’s confidence in the transportation system’s ability to meet their needs.

Design and Installation of Heavy-Duty Hydraulic Elevators

1. General

1.1 General description

This document provides design guidelines for the fabrication, installation and testing of low-rise (under 40 ft of travel) elevators intended for use in a public transportation environment.

1.2 Temporary and permanent electrical power services

Temporary power for installation shall be made available to the contractor at the time of the installation. Permanent power shall be made available for testing.

1. For the elevator drive systems: 208, 220 or 480 V, three-phase, three-wire, 60 Hz terminating in a disconnect switch within sight of the controller.
2. For lighting and GFCI receptacles: 120 V, one-phase, three-wire, 60 Hz terminating at the elevator controller location.
3. Separate disconnect for cab lighting and wiring to cab.
4. Separate service for tank heaters and/or coolers and sill heaters where required.

1.3 Related codes, standards and publications

1. American National Standards Institute (ANSI)
2. ASME A17.1, A17.2.3, A17.5 applicable edition

NOTE TO SPECIFIER: It is important to identify which edition of ASME A17.1 is applicable for the agency's jurisdiction, as different editions may affect procurement and installation.

3. Canadian Standards Association, CSA B44
4. National Fire Protection Association (NFPA) 130, "Fixed Guideway Transit and Passenger Rail Systems," Annex C-2.
5. ANSI C1, National Electric Code (NFPA 70)
6. Americans with Disabilities Act Accessibility Guidelines (ADAAG)
7. Canadian Welding Bureau (CWB)
8. American Welding Society (AWS)
9. ASTM International
10. International Standards Organization, ISO 281/I-1997
11. Applicable version of International Building Codes (IBC)
12. Occupational Safety and Health Administration (OSHA)

Any additional requirements imposed by local agencies must also be incorporated into elevator installations. In case of a conflict between codes, regulations or standards, the most stringent requirement should take precedence.

1.4 Submittals

1. **Product data:** Submit manufacturer's product data within four weeks of notice to proceed (NTP) for each system proposed for use. Include the following:
 - a. Electrical characteristics and connection requirements.
 - b. Within 60 days after NTP, and prior to installation, the contractor shall submit detailed interim and revenue service maintenance programs, showing functions to be performed and their scheduled frequency.
 - c. Oil performance data sheets.
 - d. Coordinated delivery schedule.
 - e. The contractor should supply a rigging plan that is approved by the owner.
 - f. Manufacturer's recommended preventive maintenance plan, including interim maintenance procedures where applicable.
 - g. Pre-acceptance test forms.
 - h. Safety data sheets (SDS) and product data sheets (PDS) shall be submitted with an index listing each product, along with the application method of the product, approximate quantity of product per elevator, and the component the product is applied to or associated with. The contractor shall allow six weeks for review of SDS by the owner.
2. **Shop drawings:** Submit approval layout drawings to scale. Include the following:
 - a. Car, guide rails, buffers and other components in hoistway
 - b. Maximum rail bracket spacing
 - c. Maximum loads imposed on guide rails requiring load transfer to building structure
 - d. Loads on hoisting beams
 - e. Clearances and travel of car run-by
 - f. Clear inside hoistway and pit dimensions
 - g. Location and sizes of access doors, hoistway entrances and frames
 - h. Governor and tension sheave showing governor reset access
 - i. Car and hall fixtures
 - j. Remote hydraulic piping layouts specific to each elevator
 - k. Refuge space on top of car and pit
 - l. Machine room and hoistway layout
 - m. Signal and operating fixtures, operating panels, and indicators
 - n. Cab design, dimensions and layout
 - o. Hoistway door and frame details

NOTE TO SPECIFIER (optional specification for fast-track projects): Shop drawings (or cut sheets with standard dimensions, if available) shall be provided in an acceptable format by the contractor for approval within three weeks of notice to proceed.

1.5 Manuals and documentation

1.5.1 Operating and maintenance manuals

Prior to installation, the installer shall submit three preliminary sets of operation and maintenance manuals for approval six weeks after NTP. After owner approval and prior to the beginning of acceptance testing, the approved manuals shall be provided in an acceptable format by the installer. After approval and substantial

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completion, the final manuals are due no more than 30 days after any punch list items are completed. The manuals shall include the following:

1. Complete table of contents.
2. Complete instructions regarding operation and maintenance of equipment. Included will be complete illustrated, exploded views of all assemblies, and a complete, illustrated, exploded view for identifying all system parts.
3. Complete nomenclature, lead time and location of replaceable parts, OEM and installer part numbers, current cost, and source. If the product source is another vendor, the contractor shall include the name and address of the other vendor.
4. Copies of the approved preventive maintenance plan.
5. Descriptions of safety devices.
6. Safety rules, tests and procedures, including testing of all systems and subsystems.
7. Troubleshooting techniques.
8. Detailed lubrication and cleaning schedule indicating weekly, monthly, quarterly, semiannual and annual lubrication, as well as a description of each lubrication point, lubrication type and specification.
9. SDS and PDS for all chemicals and lubricants used.

1.5.2 Close-out documentation

1. The contractor shall provide to the owner copies of all documents related to maintenance, safety, operations, design changes, modifications, retrofits, etc., that relate to any part, component, equipment, system, subsystem, or material and services applicable to the elevator provided.
2. All of the above referenced shall be provided by the installer as it pertains to the original installation through the end of the warranty period.
3. The referenced material shall be provided within 30 days of publication or internal distribution by the OEM. The material, even if labeled “PROPRIETARY,” shall be delivered to the owner without prejudice or delay and at no additional cost.
4. The final accepted operations and maintenance manual is to include items in Section 1.5.1 in addition to as-built versions of the following:
 - a. Control and schematic electrical wiring diagrams of controller, including wiring of safety devices to connections with remote indication and control panels for each elevator and group of elevators.
 - b. Electrical layout showing placement of lighting, light switches, receptacles, light fixtures, disconnect switches, communication and convenience outlets in machinery room and pits.
 - c. Complete detailed drawings and wiring diagram of elevator fault-finding device and connection to annunciator panel.
 - d. Electronic and hard copies of ladder diagrams, logic and program.
5. Provide all additional materials and documents specified by the owner.

NOTE TO SPECIFIER: Make reference to contract documents for additional deliverable requirements including but not limited to specialized diagnostic and repair tools, training, and/or spare parts.

1.6 Training

NOTE TO SPECIFIER: Properties with a third-party maintenance contractor should not require as much time and training by the contractor and can be reduced to eight hours of safety-related facets of equipment operation.

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1. The installer will provide 40 hours of local training for the owner and their representatives in the proper use, operations and daily maintenance of elevators. This includes the use of a laptop or specialized maintenance and/or diagnostic tools to adjust parameters and settings and troubleshoot. Review emergency provisions, including emergency access and procedures to be followed at the time of failure in operation and other building emergencies. Train owner personnel in normal procedures to be followed in checking for sources of operational failures or malfunctions. Provide manuals for all material covered in the training program. This training will take place at the discretion of the owner at any time prior to the end of the warranty period.
2. (OPTIONAL) Provide a 60-minute (minimum) video describing and demonstrating daily maintenance, emergency procedures and troubleshooting techniques for electrical and mechanical failures and malfunctions.

1.7 Quality assurance

NOTE TO SPECIFIER: It is recommended that this section be as restrictive as job circumstances and local procurement regulations permit.

1. **Contractor:** Provide elevators manufactured by a firm with a minimum of 10 years' experience in fabrication of elevators.
2. **Installer:** Supervising mechanics with a minimum of 10 years' experience in installation of elevators. Provide administrative, field support crews and stock material during construction and warranty period. Documentation shall be required to demonstrate compliance with this requirement.
3. **Regulatory requirements:** Elevator system design and installation shall comply with the version of ASME A17.1 in effect for this contract.
4. **Permits and inspections:** The contractor is to provide licenses and permits and perform required inspections and tests.
5. **Regulatory agencies:** Elevator design, materials, construction clearances, workmanship and tests shall conform to the requirements of the codes and regulations listed in Section 1.3.
6. **Welding:** Welding shall be performed in accordance with the requirements of AWS or CWB. Welders shall produce evidence of current certification by AWS or CWB.
7. **Labeling:** Every elevator controller should be clearly marked permanently on the controller with rated load and speed, manufacturer serial number, and the designated owner identification.
8. **Requirements of regulatory agencies:**
 - a. The contractor shall obtain and pay for all necessary permits, and perform such tests as may be required for acceptance and approval of elevators by jurisdictional agencies.
 - b. The contractor shall notify the proper inspectors to witness required testing.

NOTE TO SPECIFIER: The following item may be appropriate in order to inspect and observe construction methods that would be difficult or impossible to observe after installation is complete.

9. (OPTIONAL) **Factory visit:** The contractor should provide for the cost of up to three of the owner's representatives to visit the factory where the elevator is being manufactured.

1.8 Delivery, storage and handling

Should the building or the site not be prepared to receive the elevator equipment at the agreed-upon date, the contractor will be responsible to provide a proper and suitable storage area on or off the worksite.

1.9 Warranty

1. Acceptance is conditional on the understanding that the warranty covers defective material and workmanship. The warranty period shall be one year from the date of revenue service. The warranty excludes ordinary wear and tear or improper use, vandalism, abuse, misuse or neglect or any other causes beyond the control of the elevator contractor, and this express warranty is in lieu of all other warranties, express or implied, including any warranty of merchantability or fitness for a particular purpose.

NOTE TO SPECIFIER: Paragraph 2 below is an option for third-party maintenance during the warranty period. It is recommended to estimate the period of interim maintenance if possible.

2. Interim maintenance is required between beneficial use and revenue service. This service will be performed according to the approved maintenance plan, with no extra charge for overtime required to return the elevator to service. Vandalism and acts beyond normal wear and tear are excluded.
3. The completed elevators should not be used for construction service or to move materials and personnel for the purpose of construction. In the event that the contractor has no option but to use the elevator for construction service, the elevator contractor should provide elevator protection and cleaning. The elevator protection should include protection of the interior finishes, car doors, hoistway doors, entrance frames, and sill protection. The cleaning should include a complete clean down of the elevator hoistway, elevator exterior, elevator interior, lighting, and mechanical equipment. Components stripped of lubricants during cleaning should be lubricated.
4. Proof of interim maintenance documents will be required prior to final acceptance.

1.10 Maintenance service

1. The approved maintenance service consisting of regular examinations, adjustments and lubrication of the elevator equipment should be provided by the elevator contractor for a period of 12 months after the elevator has been approved for revenue service. This service should not be subcontracted but shall be performed by the installer. All work shall be performed by competent employees during regular working hours of regular working days and shall include emergency 24-hour callback service at no extra cost. This service shall not cover adjustments, repairs or replacement of parts due to negligence, misuse, abuse or accidents caused by persons other than the elevator contractor. Only parts and supplies as used in the manufacture and installation of the original equipment shall be provided.
2. Verification of On-Site Records: Per ASME A17.1-2016, Section 8.6, the Contractor should maintain a physical or digital record on-site. The Contractor's failure to produce the following during an audit should result in a Notice of Non-Compliance:
 1. Detailed logs of specific tasks performed (e.g., "Cleaned Pit," "Tested Fire Service").
 2. Oil usage logs for hydraulic units showing no unexplained loss of fluid.
 3. The unique checkout procedures for all software-based safety functions.
3. **Monthly Reconciliation:** On the first of each month, the Contractor should provide a digital summary of the previous month's maintenance control program (MCP) entries. This summary must match the physical logs kept on-site. Discrepancies between "remote billing hours" and "on-site log entries" must be reconciled within five (5) business days.

Proof of maintenance, documents and all as-built documents to complete the O&M manuals will be required prior to final acceptance.

1.11 Design criteria

1. **General:**
 - a. Elevators shall be designed with provisions for thermal expansion and contraction of complete elevator assemblies.

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- b. It is recommended that all elevator components should be supported by the original component manufacturer for a period of no less than 20 years.
 - c. Elevators should be designed without the use of any proprietary software.
 - d. Hydraulic pipe runs should not cross expansion joints.
- 2. Operational requirements:**
- a. Hours of operation shall be considered as 24 hours per day, seven days per week.
 - b. Motors should be designed for 120 starts per hour.
- 3. Environmental requirements:**

NOTE TO SPECIFIER: Interior installations include facilities such as airports and controlled environments with no corrosive elements. Exterior installations should be used for all light rail, heavy rail, commuter rail and bus applications, whether exposed to the weather or not. Language should be adjusted to account for local environmental conditions.

- a. Elevators shall be capable of operating with full-specified performance capability while exposed to the following range of climatic and environmental conditions.
 - Interior installations: Elevators shall be designed to operate in a temperature range of 32 °F to 120 °F, dry bulb, and all conditions of relative humidity while exposed to airborne dust and debris.
 - Exterior installations: Elevators shall be designed to operate while exposed to the natural elements of weather, including sunlight, rain, slush, snow and ice; all conditions of relative humidity; and exposure to salt, deicing chemicals, airborne dust, and debris, and corrosive elements.
 - b. Electrically heated slabs at each landing door are permitted. Heating areas shall be 1 ft wider on each side of the car door and at least 8 ft long, and shall be designed per manufacturer recommendations.
- 4. Fasteners:**
- a. Fasteners shall be compatible with materials being fastened.
 - b. Fasteners shall be furnished with self-locking nuts or retaining rings (spring washers, toothed disks).
 - c. Fasteners shall be equal to or of greater corrosion resistance than the most corrosion-resistant metals being fastened.
- 5. Ride quality:**
- a. All elevators should have a jerk rate no greater than 6.5 ft/s³.
- 6. Car frame:**
- a. Cantilevered car frames are not permitted.

1.12 Job conditions

- 1. **Protection:** During installations, and until elevator systems are fully operative, the contractor should make necessary provisions to protect systems from damage, deterioration, injury to pedestrians and the general public, and environmental conditions.
- 2. **Coordination requirements:**
 - a. Alterations: The contractor should coordinate any alterations required to accommodate elevators with the owner.
 - b. Floor finish in cab: The contractor shall install cab flooring as specified.
 - c. Lock and key requirements: The contractor shall coordinate lock and key requirements with the owner.
 - d. Locations: The contractor should coordinate the location of sump pits, pumps, pipes, sprinklers, heat and smoke detectors, hoistway HVAC wiring, and other related wiring with the elevator installer.

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NOTE TO SPECIFIER: Elevator code prohibits connections of elevator pit drains to sanitary lines. The owner may need to address drainage issues related to hydraulic elevators and the inherent environmental conditions that may apply.

- e. Safety training: The contractor should attend appropriate safety training programs provided by the owner at no extra cost.
- f. Methodology: The contractor should meet with the owner and provide a written method of drilling and installation for approval.
- g. Electrical: The installer should coordinate with the contractor and appropriate trade in relation to CCTV, communications, heat and smoke detectors, shunt trip breakers, power, and cab lighting requirements.
- h. Construction schedule: The installer should coordinate deliveries, installation and testing with the contractor.

2. Products

NOTE TO SPECIFIER: This portion of this document encompasses holeless, roped and in-ground hydraulic equipment.

2.1 Acceptable manufacturer

1. Provide hydraulic elevators as specified.

2.2 Summary of features

1. Elevator number
2. Elevator use
3. Contract load (in pounds)
4. Loading classification (A, C2, or C3)
5. Contract speed (in FPM)
6. Travel distance
7. Number of stops
8. Number of openings
9. Hoistway fire rating
10. Machine location
11. Machine type
12. Car and hoistway door size
13. Car and hoistway door type
14. Car and hoistway door operation
15. Hoistway entrance
16. Clear cab dimensions
17. Door-reversal device
18. Car operating panel
19. Car position indicator
20. Car direction indicator
21. Hall call stations
22. Communication system
23. Cab ventilation or cab air conditioning (choose one)

2.3 Hydraulic power unit

1. The hydraulic system should be of compact design suitable for operation under the required working pressure in accordance with the applicable version of ASME A17.1. The pump unit should not be mounted in the hydraulic-fluid storage tank. The pump should be driven with a one-piece multi-groove V-belt. The direction valve should control flow for up and down directions hydraulically and should include an integral check valve. A control section including control solenoids should direct the main valve and control: up and down starting, acceleration, transition from full speed to leveling speed, up and down stops, pressure relief, and manual lowering. All of these functions should be fully adjustable for maximum smoothness and to meet contract conditions. The system is to be provided with a muffler and a low-pressure switch. Provide a ball type shut-off valve in both the machine room and the elevator pit.
 - a. Included in the reservoir should be an oil fill strainer with air filter, return line tank discharge filter (sock filter) and a Y-strainer in the suction line.
 - b. The tank shall have a reserve capacity in accordance with OEM recommendations and sight glass with markings for minimum and maximum oil level.
 - c. Provide a ball valve to facilitate removal of pump and/or motor without draining of oil tank reservoir.
2. (OPTIONAL) Tank heater: The tank should have a thermostatically controlled heater with cold weather kit if required.
3. (OPTIONAL) Oil cooler: The cooling unit should have an adjustable thermostat control and a 10 μ m filter. Remote installation is recommended to discharge heat outside the machine room.

NOTE TO SPECIFIER: Consider the temperature of the environment that the machinery and piping will be subject to. Some locations with severe temperature ranges may require both heaters and coolers for the hydraulic elevator system. Piping layouts also can affect the temperature of the hydraulic oil and must be considered when deciding on the final design.

2.4 Controller

NOTE TO SPECIFIER: Remote monitoring is an important part of elevator installations in public transportation facilities. The design guidelines in this document will provide elevators capable of connections to many transit monitoring systems. This document does not provide any design guidelines for remote monitoring. It is recommended that transit agencies remain consistent with the preferred controller type in use on their systems, either PLC or microprocessor.

1. The controller shall be provided, governing starting and stopping, as well as preventing damage to the motor from overload or excessive current. It shall automatically cut off the motor current and bring the car to rest in the event that any of the safety devices are activated. The controller shall be mounted in a vented cabinet within the machine controller room. The controller shall utilize soft-start characteristics.
 - a. Selective collective operation: As defined by ASME A17.1.
 - b. Provide intermittent automatic operation, once every three hours through the entire run of the hoistway. Cycling shall be the full 24 hours each day throughout the year.
2. Controller should include a reduced voltage solid-state starter rated for 120 starts per hour.
3. All diagnostic tools should be provided to view activity, troubleshoot, diagnose/clear faults and adjust parameters as necessary. This includes everything to perform code-required tests and inspections.

NOTE TO SPECIFIER: A digital display integrated into the controller is preferred. Consider the NEMA rating to reflect environmental conditions of the machine room.

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4. Provide a separate battery powered unit that senses loss of power. When loss of power occurs, the elevator shall descend to a predetermined landing and open the doors automatically. After a predetermined time, the doors shall close and the elevator shall remain inoperative until normal power is restored. The door open and alarm buttons shall operate under battery power.
5. Provide a means to resynchronize jacks when multiple jacks are supplied, such as when twin-post or holeless dual-jack systems are present.

2.5 Jack hole and casing (for hole-type elevator only)

1. The jack hole shall be drilled by using a rotary drill. No hammer drilling or blasting shall be allowed. The hole shall be located within 1 in. of the approved shop drawing location.
2. A Schedule 10 galvanized or stainless steel drill casing shall be provided. The drill casing shall be installed plumb so the hydraulic jack can be installed perfectly plumb.
3. Prior to the installation of the drill casing, the contractor shall submit for approval a drawing showing the details of the installation of the hydraulic jack unit inside the drill casing. The drawing shall show all dimensions of the hydraulic jack, PVC liner, sand fill, drill casing, all couplings, and the details for securing the PVC liner to the elevator pit.

2.6 Hydraulic jack unit

1. The hydraulic jack unit shall be of sufficient size to lift the gross load to the height specified at the rated oil pressure and speed, and shall be factory tested to ensure adequate strength and freedom from leakage. No brittle material, such as gray cast iron, shall be used in the jack construction. All pipe sections shall be secured to one another with threaded connections.
2. The jack shall consist of the following parts: a non telescoping plunger of heavy seamless steel tubing accurately turned and polished; a stop ring welded to the plunger to positively prevent the plunger leaving its cylinder; an internal packing or seal of suitable design and quality; a drip ring around the cylinder top; and a cylinder made of steel pipes and provided with a pipe connection, air bleeder valve and oil drain plugs all positioned above the pit floor. The cylinder shall be furnished at the bottom with a safety bulkhead with an orifice to limit the speed of the car's descent to 15 ft/min in the event that the outer case fails. Weld brackets to the cylinder for supporting the jack on pit channels. A platen plate shall be mounted with neoprene rubber sound dampeners designed to isolate the platen plate from the car frame with a safety factor of four.
3. If the jack must be supplied in sections, the sections shall be threaded and the cylinder shall be polished at the threaded joint.
4. All hydraulic piping shall use a minimum of Schedule 80 pipe with threaded or welded fittings outside the machine room or pit. All buried piping shall be welded and left uncovered until accepted and approved by the owner. Consider heat tracing for exposed piping.
5. An oil scavenging pump should be provided to drain weep oil via tubing back to the pump unit tank. 120 V power supply should be provided in the pit.

2.7 Hole type jacks

1. The jack should be fabricated with an integral sleeve for connection to the PVC liner. The interstitial space between the PVC liner and the jack shall be capable of being monitored by a port on the pit plate.
2. The complete outer cylinder shall be waterproofed with a factory-applied extruded pipe coating to protect the casing from corrosion. The pipe coating shall consist of 10 mils of butyl rubber or approved equal adhesive and 40 mils of heat-applied polyethylene overcoating. The coated pipe shall be protected during shipment with sheet steel wrap. The jack unit shall be installed accurately, centered and plumb.

3. Install the jack unit in separate PVC outer liner constructed from Schedule 80 PVC pipe. The liner shall have a dished seamless bottom, a water stop ring attached to the liner and embedded in the pit floor, and sealed joints to prevent moisture seeping into the annular space between the liner and cylinder. The top of the liner shall be attached to the integral sleeve on the hydraulic jack.
4. After centering the jack unit, affix it to the pit channels. Use stainless steel shims to level the pit channels. Fill the space between the steel casing and the PVC liner with clean, dry sand to maintain plumbness and support the PVC liner.
5. Provide one Victaulic fitting between the ball valve and jack unit.

2.8 Hydraulic plunger

NOTE TO SPECIFIER: Select the following for holeless hydraulic elevators only.

1. **Hydraulic plunger:** Two accurately ground and polished hydraulic single stage plungers shall be provided. The bottom of each shall be fitted with a positive stop designed to prevent the plungers from leaving their cylinders. The top of each plunger shall be fastened to the car frame.
2. **Hydraulic cylinder:** Two hydraulic cylinders designed to stand upright on the pit floor, on either side of the car, shall be provided. Each cylinder shall be constructed from steel pipe with a machined steel flange at the upper end and a heavy steel bulkhead at the lower end. Each cylinder shall be connected to the oil line with equal runs of the same size pipe. A packing gland with guide bearing, wiper ring and packing specifically designed for hydraulic elevator service shall be mounted at the top of each cylinder, along with an oil collector ring and drain hole. Each cylinder shall be finished with a coat of rust-inhibiting air-dry enamel and have an air bleeder valve and oil drain plug positioned above the pit floor. The plunger surface shall be a minimum of 20 $\mu\text{in rms}$ and shall not exceed 35 $\mu\text{in rms}$ for the entire plunger length in engagement with the cylinder seals. The plunger seals shall be urethane cup design with integral wipers or approved equal.
3. **Cylinder mounting assembly:** Base of cylinders to be elevated above pit floor by a pedestal weldment, including the following:
 - a. Dead-end hitch plate for pit shackles and two mounting surfaces for slack rope switch.
 - b. Pedestal and cylinder to be secured to the wall by a steel bracket around the full 360° circumference; to fasten to the wall mounting surface with two horizontally spaced bolts; and adjustable for width-wise, depth-wise and vertical adjustment.
 - c. Scavenger pump: A single oil scavenging pump should be provided to drain weep oil from both cylinders via tubing back to the pump unit tank. 120 V power supply should be provided in the pit.

2.9 Roped hydraulic elevators

1. **Cylinder:**
 - a. Two cylinders shall be provided. The top of the cylinder shall be equipped with a cylinder head with drip ring and self-adjusting packing. The plunger shall be constructed of selected steel tubing or pipe of proper diameter machined true and smooth with a fine polished finish. The plunger shall be provided with a stop ring electrically welded to it to prevent the plunger from leaving the cylinder. The plunger and cylinder shall be installed plumb and must operate freely with minimum friction.
2. **Cylinder mounting assembly:**
 - a. Base of cylinders to be elevated above pit floor by a pedestal weldment, including a dead-end hitch plate for pit shackles and a mounting surface for slack rope switch.
 - b. Pedestal and cylinder to be secured to the wall by a steel bracket around the full 360° circumference, to fasten to the wall mounting surface with two horizontally spaced bolts, and adjustable for width-wise, depth-wise, and vertical adjustment.

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3. **Sheave:**
 - a. Rotating sheave to be mounted to fixed shaft through ball or roller bearings.
 - b. Sheave support base to be attached to top of plunger with single 1¼-in. UNC bolt.
 - c. Adjustable rope retainers shall be provided over the full 180° arc of contact.
 - d. Sheave to be supported by two rails through cast aluminum slipper guides with removable UHMW polyethylene gibs.
 - e. Suspension ropes to be 8×19 construction with an independent wire rope core; shackles to be of the wedge rope socket type.
4. **Governor and safety:**
 - a. Supply as required by code.
 - b. No remote testing of the safety is permitted.
 - c. A manual reset switch shall remove power from the driving motor and control valve should any rope become slack.

NOTE TO SPECIFIER: Jurisdictions vary on whether they allow a remote reset of the governor and safety.

5. **Oil line support stands:** Oil line support stands shall be supported with an adequate number of support stands. Stands shall be anchored to the floor or wall and adjustable in height. Rubber isolation clamps shall secure the oil line to the stand around the full 360° circumference.
6. **Low-pressure switch:** Low-pressure switch to be pre-installed to rupture valve or oil supply line.
7. **Hydraulic piping:** All piping shall use a minimum of schedule 80 pipe with threaded or welded fittings outside the machine room or pit. All buried piping shall be welded and left uncovered until accepted and approved by the owner. Consider heat tracing for exposed piping.
8. **Scavenger pump:** An oil scavenging pump should be provided to drain weep oil via tubing back to the pump unit tank. 120 V power supply should be provided in the pit.

2.10 Wiring, conduit, cables and conductors

NOTE TO SPECIFIER: All wiring should be suitable for power-washing maintenance and be rated for wet locations.

1. **Conduits:**
 - a. Unless otherwise specified, all electrical conductors in the pits and hoistways, except traveling cable connections to the car, shall be provided in rigid steel conduit with steel outlet boxes, except that a small amount of flexible conduit, no more than 3 ft, may be used where conduit is not subject to moisture or embedded in concrete.
 - b. All raceways shall be threaded galvanized rigid steel conduit complying with ANSI C80.1.
 - c. Where permitted, flexible metal conduit shall be fabricated in continuous length from galvanized steel strip, spirally wound and formed to provide an interlocking design with a gray XLPO Thermoset Type 2 outer jacket.
 - d. Conduit fittings and bodies shall meet ANSI/NEMA FB 1; threaded type, material to match conduit.
 - e. Terminal boxes, pull boxes and other similar items shall be of approved construction, thoroughly reinforced and shall meet ANSI/NEMA FB 1.
 - f. All electrical boxes exceeding 150 in³ shall be supported independently of the conduits.
 - g. Where permitted, flexible heavy-duty service cord, type SO, may be used between fixed car wiring and switches on car door reversal devices.
 - h. Communication power and communication data conduit and junction boxes shall be separated from each other.

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- i. All conduit terminating in steel cabinets, junction boxes, wireways, switch boxes, outlet boxes and similar locations shall have approved insulation bushings. If the bushings are constructed completely of insulation material, a steel locknut shall be installed under the bushing. At ends of conduits not terminating in steel cabinets or boxes, the conductors shall be protected by terminal fittings having an insulated opening for the conductors.
- j. All conduits terminating in NEMA 4X boxes shall be backed up with flat rust-resistant steel plates to fit the entire area where the conduit penetrated the box.
- k. Connect motors and other components subject to movement or vibration to the conduit systems with flexible conduit with gray XLPO Thermoset Type 2 outer jacket.
- l. All solid state and electrical components located on top of the car enclosure or in the hoistway shall be installed within NEMA 4X enclosures.
- m. Conduit sizing, arrangement and support:
 - Size conduit per NEC for conductor type installed or for Type THWN conductors, whichever is larger; ¾ in. minimum size for conduit.
 - Conduits for small devices such as door switches, interlocks, etc. shall be permitted at ½ in.
 - The total overall cross-sectional area of the wires contained in any conduit shall not exceed 40% of the internal area of the conduit.
 - Arrange conduit to maintain headroom and present a neat appearance.
 - Route exposed conduit parallel and perpendicular to walls and adjacent piping.
 - Maintain minimum 6 in. clearance between conduit and piping. Maintain 12 in. clearance between conduit and heat sources such as flues, steam pipes and heating appliances.
 - Arrange conduit supports to prevent distortion of alignment by wire pulling operations. Fasten conduit using galvanized straps, lay-in adjustable hangers, clevis hangers or bolted split stamped galvanized hangers.
 - Group conduit in parallel runs where practical and use conduit rack constructed of galvanized steel channel with conduit straps or clamps. Provide space for 25% additional conduit on racks.
 - Do not fasten conduit with wire or perforated pipe straps. Remove all wire used for temporary conduit support during construction, before conductors are pulled.
 - No conduit shall be attached to a cable tray or installed within 6 in. of a cable tray or light fixture except for termination.
 - Approved strain boxes shall be installed for all vertical runs in accordance with code.
- n. All screws used for terminal connections of all wiring (machine room, hoistway and pit) shall be provided with “star washers” of proper size and type.

NOTE TO SPECIFIER: For modifications and elevator replacements, the contractor shall furnish all materials and completely wire all parts of the electrical equipment of the elevators, including electrical devices on hatch doors. All car wiring and conduit shall be replaced with new, including car junction boxes. All existing conduit and wiring shall be removed and wall/floor slabs patched with fire rated material.

2. Conductors:

- a. Unless otherwise specified, conductors, exclusive of traveling cables, shall be 98% conductivity copper, solid for size 10 AWG and smaller, and stranded for size 8 AWG and larger. Conductors shall be stranded or solid coated annealed copper in accordance with the NEC for Type THHW.

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- b. Where 16 and 18 AWG are permitted by code, either single conductor cable in accordance with code for Type TF, or multiple conductor cable may be used, provided the insulation of single conductor cable and outer jacket of multiple conductor cable is flame-retardant and moisture-resistant.
- c. Insulation voltage rating: 600 V.
- d. Insulation shall be ANSI/NFPA 70, Type THHN/THWN, XHHW or THW.
- e. The use of PVC insulation shall not be permitted.
- f. All power conductors shall be identified as to phase and voltage by means of color-impregnated insulation, as follows:

Voltage	ØA	ØB	ØC	Neutral	Ground
120/208 V	Black	Red	Blue	White	Green
277/480 V	Brown	Orange	Yellow	White	Green

- g. For wire sizes No. 8 AWG and larger, color banding tape, minimum 2 in. wide, may be used at all accessible locations in lieu of colored insulation.
- h. Multiple conductor cable shall have color-coding or other suitable identification for each conductor. Conductors for control boards shall be in accordance with code.
- i. No joints or splices shall be permitted in wiring except at outlets. Tap connectors may be used in wireways provided that they meet all UL requirements.
- j. All wiring shall test free from short circuits or grounds. Insulation resistance between individual external conductors and between conductors and ground shall be not less than 1 MΩ.
- k. Where size of conductors is not given, capacity shall be such that maximum current shall not exceed limits prescribed by code.
- l. Equipment grounding shall be furnished and installed. Ground conduits, supports, controller enclosures, motors, platform and car frames, and all other non-current-conducting metal enclosures for electrical equipment shall be in accordance with code. The ground wires shall be copper, green, insulated and sized as required.
- m. Terminal connections for all conductors used for external wiring between various items of elevator equipment shall be solderless pressure wire connectors in accordance with code. The contractor may at their option make these terminal connections on No. 10 or smaller conductors with approved terminal eyelets set on the conductor with a special setting tool, or with an approved pressure type terminal block. Terminal blocks using pierce-through serrated washers are not acceptable.
- n. Provide all necessary conduit and wiring between all remote machine rooms and hoistway.

3. Traveling cables:

NOTE TO SPECIFIER: Coordinate traveling cable requirements with owner’s security requirements—i.e., card readers, cameras , etc.

- a. Traveling cables from junction box on car to junction box in hoistway shall consist of flexible traveling cables.
- b. If junction boxes are specified in hoistway, they shall conform with requirements previously stated and be equipped with terminal blocks. All connections to terminal blocks shall be made with either terminal eyelet connections or pressure wire connectors of the clamp type that meet UL 486 requirements for stranded wire.

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- c. Terminal blocks shall have permanent indelible identifying numbers for each connection. The outer covering must remain intact between junction boxes. Abrupt bending or twisting producing distortion of cable is not permitted.
 - d. Cables shall be free from any possible contact with hoistway structure, car or other equipment. Furnish and install shields or pads to protect the cables.
 - e. Each traveling cable should provide a minimum 10% spare for each conductor type.
 - f. Provide separate traveling cables for car safety, communication, power and signaling. Each traveling cable shall be hung from the car and secured with wire mesh grips.
 - g. If required, junction boxes shall be provided on the top of the elevator cab.
 - h. All insulated wiring, control wiring and wiring in traveling cables shall be tag-coded at their terminals in the motor room. Hoistway junction box, elevator cab junction box, and push-button stations within the cab shall match the approved wiring diagrams.
 - i. The emergency stop switch in the car shall be connected to all alarm bells in a manner that will cause the bells to ring when the emergency stop switch is in the “On” position.
- 4. Motor circuits:**
- a. Contacts in elevator motor circuits that are to be opened by governors or other safety devices shall be copper to carbon or other approved material of the non-fusing type. Contacts on control and signal relays and switches shall be commercially pure silver. Contacts on switches breaking heavy motor circuits shall be copper to carbon or, if of metal, shall have supplementary breaking contacts and shall operate with suitable wiping action, or shall be of approved equivalent design and construction. They shall be equipped with suitable blowout coils, vanes, barriers, etc., where necessary to prevent undue arcing and heating.
 - b. Car and hall operating signal circuits shall not exceed 48 V.
 - c. Each major component of equipment shall have the manufacturer’s name, type, class or catalog number on a metal plate securely attached to the item of equipment in a conspicuous location.
 - d. All cabinets containing motor drives, filter boxes, transformers and power reactors shall be supported on rails and isolated from the base building structure with elastomer pads having a minimum static deflection of $\frac{3}{8}$ in. (Mason Type N or equivalent). All connections to and from the cabinetry shall be flexible in order not to compromise the isolation system. Use non-rigid conduit for the final electrical connection, with all other conduit supports and clamps provided on a neoprene sponge insert.

NOTE TO SPECIFIER: Careful coordination with other engineering disciplines is required to ensure that proper grounding methods are followed in the elevator machine room.

- e. Supply installation and connections of fused main line disconnect switch of the lockable type for the elevators in the machine room.
- f. Signal to the controller in the machine room to indicate special emergency condition due to lobby smoke detector activation. Smoke detectors in the elevator lobby and machine room shall be in accordance with ASME A17.1. Furnish and install means to automatically disconnect the mainline power supply to the elevator prior to the application of water.
- g. Car lighting and fan circuit for the elevators shall be located in circuit breaker panels in the machine room.
- h. Provide permanent light fixtures with switches and duplex-grounded receptacles in the elevator machine room and elevator pit. Receptacles in the pit shall be ground fault circuit interrupter type.

2.11 Cab enclosure

NOTE TO SPECIFIER: Cab finishes are typically designed by an architect. This section provides design guidelines for the cab shell, cab front, floor and dome only. The final cab finishes should be detailed in the bid drawings developed in coordination between the architect and the elevator designer. This guideline is focused on key items for materials and finishes.

1. Although an elevator car sized to fit a gurney or emergency stretcher is not required by ASME A17.1, it may be a requirement of the local governing code and is recommended for consideration.
2. Where fire-rated shaft construction is required for an elevator hoistway, the applicable local governing code should be adhered to.
3. Where solid shaft construction is not required, the hoistway and the car enclosures may be partially glass. An observation car may have glass on a minimum of one wall or a maximum of three walls, including glass entry car doors or doors with vision panels.
4. The glass observation panels should be operable, opening into the car so that the panels can be cleaned and access is provided for cleaning the hoistway glass panels from within the car. Each panel should be secured with a cylinder lock with a restricted key and should be fitted with a limit switch that will engage the safety circuit shutoff feature as required by code. A handrail should be at each glass observation panel.
5. A17.1 code requirements include the following, which must be reviewed by the designer:
 - a. Cab configuration and materials shall be as per contract drawings. Plan on stainless steel Type 316 #4 or hairline finish with vertical grain as a minimum for all stainless steel.
 - b. Appropriate cab flooring materials shall be durable, slip-resistant and liquid-resistant.
 - c. Seamless and resilient elevator cab flooring shall be poured or laid in accordance with manufacturer's instructions over a minimum of one $\frac{3}{4}$ in. thick marine-grade tongue-in-groove plywood substrate, secured with construction adhesive and/or countersunk stainless steel fasteners. For additional protection, it is recommended to coat flooring substrate with epoxy or other means of creating a moisture barrier.
 - d. Resilient flooring systems shall be self-extinguishing, have 200 °F heat resistance, 11,700 psi compressive strength, 2200 psi tensile strength, and 5000 psi flexural strength.
 - e. Lighting should be LED (with neutral color temperature of ~4100 K) and vandal-resistant.
 - f. Handrails should have 1.5 in. outside diameter Type 316L stainless steel #4 brushed finish. Wall connectors should have security type fastenings and should be the same material and finish as the handrail. Handrail height should conform to code requirements placed on non-entry walls. The handrail should be able to support a load of 600 lb measured in the center of the rail without separating from the wall.

NOTE TO SPECIFIER: The material selection, type, pattern and finish requires careful consideration for durability, ease of maintenance and appearance for finished solid enclosures. Materials and finishes for exposed parts of elevator car enclosures shall include:

- Satin stainless steel: ASTM A666, Type 316, with hairline vertical satin finish.
- Textured stainless steel: ASTM A666, Type 316, titanium nitride or oxide colored, with coined or embossed texture rolled into exposed surface. Surface may be satin polished, satin relieved, color-coated and satin relieved or color-coated and bright relieved after rolling.

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NOTE TO SPECIFIER: Textured stainless steel products may be used, particularly where there is no or little exposure to deicing or coastal salt. Crevice corrosion can be a significant problem in coastal areas. It is advisable to use textured stainless steel above wainscoting, not below, where moisture and salts will cause corrosion.

- Nickel silver extrusions: ASTM B 151 (ASTM B 151M), alloy UNS No. C74500.
- The desired thickness of stainless steel should always be shown in inches. ASTM does not define stainless steel gauges, and each producer has its own definition. The specifier will have no legal protection if a gauge number is specified and the thickness is not what was desired. List a minimal thickness or a nominal thickness with an acceptable tolerance variation. The nominal thicknesses typically associated with 12 and 14 gauges are as follows:
 - 12 gauge: 0.109 in. (nominal)
 - 14 gauge: 0.078 in. (nominal)
- Most stainless steel finishes with an obvious grain are directional. If all the panels are not installed in the same rolling or polishing direction, there will be color variation from panel to panel.

NOTE TO SPECIFIER: Guidelines for observation cars:

- Where glazing is used, safety-glazing material must be specified in accordance with ANSI Z97.1. These are defined as glazing constructed, treated or combined with other materials to minimize cutting and piercing injuries when broken by human contact. The following may be used, when in compliance with ASME A17.1 and Z97.1:
 - Laminated glass: Two or more sheets of glass held together by one or more interlayers of plastic material.
 - Tempered glass: A single sheet of specially heat or chemically treated glass that cannot be cut, drilled, milled or polished after treatment.
 - Wired glass: A single sheet of glass with wire completely embedded in it.
 - Safety plastic: One or more sheets laminated of synthetic plastic in the form of fibers or flakes that are poured and molded and that contain an organic substance of large molecular weight.
 - Organic coated glass: A single sheet of glass with an applied organic coating (plastic) on one or both sides.
 - Safety insulating: Two or more sheets of glazing separated by air space as a complete assembly.
- Where enclosures include panels of glass, transparent or translucent plastic, they shall be a minimum $\frac{1}{16}$ in. thick laminated glass complying with 16 CFR §1201.1, §1201.2; laminated or safety glass or plastic complying with CAN/CGSB-12.1.

2.12 Ceiling type

1. The recommended clear height under the ceiling canopy is a minimum of 8 ft, 0 in. Ceiling canopies are recommended to be stainless or enameled steel not less than 0.109 in. (12 gauge) nominal thickness.

NOTE TO SPECIFIER: If cove lighting is used at non-entry walls the underside and return of the cove shall be 12 gauge Type 316 stainless steel, #4 brushed finish with grain running the direction of the cove. Each corner of the cove shall be reinforced with hangers the same gauge as the cove. A vandal-resistant lens cover shall be placed between the cove return and ceiling.

2. A two-speed exhaust ventilation fan is recommended. The finish and material of fan enclosure and blade shall match the finish and material of the ceiling. Exhaust blowers can be designed with a hood or protective housing.

2.13 Hoistway equipment

NOTE TO SPECIFIER: If the hoistway is fire-rated, confirm that the entrance design complies with local jurisdiction. Hoistway fascia can be avoided by recessing the hoistway landing sills or, if ASME A17.1 2000 (as amended) rules apply, by providing a door lock on the car door. It is recommended to plan on fascia in all front and rear opening installations. Fire suppression systems other than water system sprinklers could be utilized (if sprinklers are not an option).

NOTE TO SPECIFIER: If the elevator controller is installed inside, the hoistway controller cabinet needs to be designed to NEMA 4X.

1. Entrance frames should be of welded or bolted construction for complete one-piece unit assembly. All frames should be securely fastened to fixing angles mounted in the hoistway and recommended to be a minimum of 11 gauge Type 316L stainless steel. Provide an additional Type 316L stainless steel sill angle support. The sill should be Type 316L stainless steel or nickel silver extrusions: ASTM B151 (ASTM B151M), alloy UNS No. C74500.
2. Entrance doors shall be of hollow metal construction with vertical internal channel reinforcements. Panels front and rear, framing, operating levers, and integral hardware shall be Type 316L stainless steel; panel recommended to be a minimum of 12 gauge and have a No. 4 finish.

NOTE: For exterior installations, doors should be designed to operate while exposed to the natural elements of weather, including sunlight, rain, slush, snow and ice; all conditions of relative humidity; and exposure to salt, deicing chemicals, airborne dust and debris, and corrosive elements.

3. Entrance finish recommended to be Type 316L stainless steel #4 finish.
4. Sight guards should be Type 316L stainless steel.
5. A suitable car frame should be provided with adequate bracing to support the platform and car enclosure. The buffer striking plate on the underside of the car-frame platform assembly must fully compress the spring buffer mounted in the pit before the plunger reaches its lower limit of travel. Provide welded or bolted ASTM 123 galvanized or Type 316L stainless steel channel uprights affixed to crosshead and plank channels with welded or bolted bracing members and gusset plates, which will remove strain from the car enclosure.
6. The car platform should be fabricated to the same type and grade material as the car frame (galvanized or stainless steel).
7. Provide a sill-mounted closer at all landings.
8. Roller guides shall be mounted on the top and bottom of the car frames to engage the guide rails.

2.14 Signal devices and fixtures

1. A Type 316 stainless steel #4 vertical finish car-operating panel shall be provided with vandal-resistant push buttons designed to bottom out against the panel plate and not the contacts.
2. Provide keyed switch in car operating panel or hall push button station as directed to shut down the elevator.
3. Braille/Arabic designations shall be flush with inconspicuous mechanical mounting.
4. Provide a service cabinet with a locked flush hinged or sliding door and integral certificate frame. Certificate frame shall have durable Plexiglas window and be accessible from the back side of the locked door. Minimum window size to be approved by the owner. The cabinet shall contain the following key type controls:
 - a. Light switch
 - b. Two-speed fan switch
 - c. Inspection switch, conforming with code
 - d. Independent service switch

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- e. Duplex 120 Vac GFCI convenience outlet
 - f. Emergency Stop switch
5. Engrave the car operating panels with the following:
- a. No Smoking: Minimum 1 in. high lettering and graphic symbol
 - b. Elevator number over operating buttons: Minimum ¼ in. high lettering
 - c. Elevator capacity: Minimum ¼ in. high lettering
 - d. Firefighters' operating instructions: Minimum ⅛ in. high lettering
 - e. Other information as dictated by local code
6. A vandal-resistant car position indicator shall be provided integral with the car operating panel.
7. A hands-free communication device designed in response to ADAAG requirements shall be provided.

NOTE TO SPECIFIER: The Americans with Disabilities Act requires two-way communication between the cab and the outside world. ASME A17.1 also requires communication between remote machine rooms and the elevator cab. This can mean at times that there are two modes of communication in the elevator cab.

8. One emergency telephone shall be placed at each elevator waiting area on each level, and one emergency telephone shall be placed at each area of rescue assistance. Emergency telephones with blue LED light shall be constructed pursuant to a minimum NEMA 3R rating and be UL and FCC approved and ADAAG compliant. The emergency phones shall be capable of off-site live monitoring of emergency conversations.
9. A software management system shall establish an automatic connection with each phone on a prearranged schedule. Phones will be tested at least one time in every 24 hours. The connection shall be initiated either by the PC or the telephone. Log and archive all call activity at each phone.
10. Each elevator must be connected to an alarm monitoring system (AMS), which will monitor an alarm relay that is activated whenever the elevator goes into and leaves an alarm state. The alarm will trigger an existing email distribution list when the alarm is enabled and disabled.
11. The AMS should be connected to a transit agency's network.
12. All critical devices, such as emergency phones, CCTV, etc. shall be powered from an uninterruptible power supply.
13. A stainless steel vandal-resistant directional lantern visible from the corridor shall be provided in the car entrance.
14. Separate space as recommended by the owner, other than the elevator machine room, shall be provided for the SCADA and/or telecommunication system interface.
15. Hall fixtures shall be provided with necessary stainless steel, vandal-resistant push buttons and key switches for elevator operation in NEMA 4X rated enclosures. Braille/Arabic designations shall be flush with inconspicuous mechanical mounting.
16. An adjustable electronic chime bell shall sound in the car to tell a passenger that the car is either stopping at or passing a floor served by the elevator.

2.15 Door operator equipment

1. Provide a high-speed, heavy-duty harmonic waterproof door operator with encoderless VVVF drive and the following features:
- a. ½ hp motor and heavy-duty sprocket, chain, belt and sheaves
 - b. Closed loop regulated speed performance
 - c. Handheld keypad programming
 - d. Ability to store adjustments in the keypad and download to another operator
 - e. Adjustable door obstruction reversal
 - f. Optical cams with LED indicators
 - g. Test switches for open, close, nudging and speed zone setup

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- h. Universal inputs for open, close and nudging
 - i. Reversing switch to back up the door reversal device
- 2. Provide a non-contact door reversal device with light immunity and a waterproof rating. The door reopening device shall cause both the car and hoistway doors to reverse should they detect an obstruction in the elevator entrance. The electrical wiring device shall be supplied with weathertight quick-disconnect terminals to facilitate replacement. The infrared curtain detector shall include the following:
 - a. A protective infrared detector field extending from 1½ in. above the car sill to a height of 68 in.
 - b. A fail-safe control system to prevent the doors from closing in case of power loss to the detector
 - c. A one-piece full-door-height protective lens cover designed to be completely waterproof and to resist impact, abrasion and vandalism

3. Execution

3.1 Installation

- 1. The contractor shall install complete and operating elevators in accordance with architectural and structural design drawings and the OEM's instruction and approved shop drawings inside a watertight hoistway.
- 2. Clear instructions must be spelled out in the general terms and conditions relating to the installer being ready for the inspection, as well as the owner being ready for items such as emergency power testing, fire alarm and smoke detector testing, and communications. Special consideration should be given to authority having jurisdiction (AHJ) lead times to schedule acceptance tests.

3.2 Field testing

- 1. The owner shall identify the tests required and all responsible parties.
 - a. The contractor shall notify the owner 14 days prior to each scheduled test.
 - b. The contractor shall perform testing in the presence of an owner representative.
 - c. The contractor shall notify the appropriate local authorities having jurisdiction a minimum of 14 days in advance of final acceptance tests.
 - d. The contractor shall provide all instruments, materials and labor required for tests specified herein.
 - e. The contractor shall pre-test all devices within his control and provide documentation to prove compliance prior to jurisdictional inspection.
- 2. Acceptance testing shall be performed in accordance with or ASME A17.2.2 procedures with the following additions or adaptations:
 - a) Test period: The elevator shall be subjected to a test for a period of one-hour continuous run with full specified load in the car. During the test run, the car shall be stopped at all floors in both directions of travel for a standing period of 10 seconds per floor.
 - b) Speed load tests: The actual speed of the elevator car shall be determined in both directions of travel with full contract load and with no load in the elevator car. Speed shall be determined by a tachometer. The actual measured speed of the elevator car with full load shall be within 10% of rated speed. The maximum difference in actual measured speeds obtained under the various conditions outlined between the up and down directions shall be checked.
 - c) Fire detection and suppression testing if required.
- 3. After the elevator is accepted by the local jurisdiction, a second post-acceptance inspection will be conducted (without weights) to determine specification compliance above and beyond the code requirements of the acceptance inspection.

3.3 Reinspection

1. If any equipment is found to be damaged or defective, or if the performance of the elevator does not conform with the requirements of the contract specifications or the safety code, no approval or acceptance of elevators shall be issued until all defects have been corrected. When the repairs and adjustments have been completed and the discrepancies corrected, the owner shall be notified and the elevator reinspected. Rejected elevators shall not be used until they have been reinspected and approved.

NOTE TO SPECIFIER: Consider a reinspection penalty in addition to any additional fees imposed by the AHJ to the responsible party to be identified in the contract for repeated inspections. Significant liquidated damages should be considered if any punch list items are not completed within one follow-up inspection, and the contractor should be back-charged as identified in the contract.

3.4 Adjusting and cleaning

1. All equipment shall be adjusted prior to final testing and acceptance.
2. Paint exposed work soiled or damaged during installation.

Definitions

beneficial use: When the elevator is placed into service, which may be prior to the site being ready for public use.

contractor: The party with overall responsibility to design and install a complete operating elevator system.

construction service: The use of the elevator during construction for transporting material or non-elevator personnel before final acceptance.

elevator: As defined by ASME A17.1.

elevator, freight: As defined by ASME A17.1.

elevator, hydraulic: As defined by ASME A17.1.

elevator, passenger: As defined by ASME A17.1.

elevator, roped-hydraulic: As defined by ASME A17.1.

final acceptance: The point at which the owner accepts the elevator project as being complete including all submittal requirements. This may be a different point in time than substantial completion.

installer: The responsible party who installs the elevator.

interim maintenance: Maintenance performed by the contractor from the point of substantial completion, but prior to revenue service.

notice to proceed: The date which the elevator installer is notified to proceed with the project.

owner: The owner in control of the facility.

revenue service: The date the elevator is placed in use for public service.

substantial completion: The point at which the elevator is ready for use, whether the site is finished or not. This is where the jurisdictional inspection usually takes place.

firefighter emergency recall: As defined by ASME A17.1.

Abbreviations and acronyms

µm	micrometer
ADAAG	Americans with Disabilities Act Accessibility Guideline
AHJ	authority having jurisdiction
AMS	alarm monitoring system
ANSI	American National Standards Institute
ASME	American Society of Mechanical Engineers
ASTM	ASTM International (formerly the American Society of Testing and Materials)
AWS	American Welding Society
CCTV	closed-circuit television
CSA	Canadian Standards Association
CWB	Canadian Welding Bureau

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FCC	Federal Communications Commission
FPM	feet per minute
GFCI	ground fault circuit interrupter
HVAC	heating, ventilation and air conditioning
Hz	hertz
IBC	International Building Codes
ISO	International Standards Organization
K	kelvins
LED	light-emitting diode
MΩ	megohms
MEP	mechanical, electrical, plumbing
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association
NTP	notice to proceed
O&M	operations and maintenance
OEM	original equipment manufacturer
OSHA	Occupational Safety and Health Administration
PDS	product data sheets
PLC	programmable logic controller
psi	pounds per square inch
PVC	polyvinyl chloride
rms	root mean square
SCADA	supervisory control and data acquisition
SDS	safety data sheets
UNS	Unified Number System
V	volts
VVVF	variable voltage variable frequency
Vac	volts alternating current

Document history

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Appendix A: Safety certification checklist

For projects that require safety certification for elevators, the following items should be considered at a minimum:

TABLE 2
 Safety Certification Checklist

Certifiable Items	Evidence and Date	Responsible Party
Ramps, stairs and elevators shall be included in order to satisfy ADAAG requirements and emergency egress requirements, and to provide convenient and efficient mobility between transit system elements.		
Provide elevators as required, and walkway and structural access ramps shall meet applicable accessibility requirements.		
Public-facing signage for accessibility and wayfinding shall be per applicable accessibility standards.		
Provision shall be made to drain liquids that get into the elevator car through the elevator floor, by channeling it in a manner that does not affect the operation of the elevator.		
The subfloor shall be made of nonabsorbent materials and shall be sealed.		
Floor finishes shall be nonslip even when wet.		
Provisions shall be made to reduce water, snow, ice and debris tracking into the elevator car and door.		
The landing outside the car shall be graded to drain away from the car, complying with applicable accessibility requirements.		
The elevator pit shall be designed to prevent water infiltration.		
Provide watertight and conditioned machine room with required lighting, in proximity to the hoistway.		
If required by local emergency responders, the elevator car shall be of such a size and arrangement to accommodate an ambulance gurney.		
"Flame spread" ratings shall conform to the applicable building code definition for the material being used.		
If security cameras are installed, they shall conform and function as specified.		
Supply a two-way communication system that conforms to ASME A17.1 and local requirements.		
All safety-critical sensors should be connected to a monitoring system or SCADA network.		
The elevator car shall accommodate the physical mounting of a hands-free phone system. Each car shall have a unique identifier per an agency's security.		
Elevator car fans shall function in accordance with applicable codes.		
The elevator controller shall provide for the automatic descent/ascent to the closest landing during a power outage or malfunction, in accordance with applicable codes.		

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TABLE 2
Safety Certification Checklist

Certifiable Items	Evidence and Date	Responsible Party
Lighting in the elevator car shall satisfy camera operation needs and be vandal-resistant.		
Appropriate lighting for sump pits shall be provided in accordance with applicable codes.		
If specified, one emergency telephone shall be placed at each elevator waiting area on each level, and one emergency telephone shall be placed at each area of rescue assistance.		
If specified, emergency telephones with blue LED light shall be constructed pursuant to a minimum NEMA 3R rating and be UL and FCC approved and ADAAG compliant.		
If specified, the emergency phones shall be capable of off-site live monitoring of emergency conversations. A software management system shall establish an automatic connection with each phone on a prearranged schedule. Phones will be tested at least one time in every 24 hours. The connection shall be initiated either by the PC or the telephone. Log and archive all call activity at each phone.		
If specified, each elevator must be connected to an alarm monitoring system, which will monitor an alarm relay that is activated whenever the elevator goes into and leaves an alarm state. The alarm will trigger an existing email distribution list when the alarm is enabled and disabled.		
If specified, the AMS shall be connected to an agency's network.		
Elevator cars shall be vented with fans and have a battery backup to power the fan for a minimum of two hours.		
Any MEP equipment, if installed outside, shall be protected from vandalism.		
The elevator controller shall provide for the automatic descent/ascent to the closest landing during a power outage or malfunction unless the elevator has a backup emergency power source (i.e., generator). In that case the elevator should be equipped with emergency power operations.		
Lighting in the elevator car shall be vandal-resistant and not obstruct the function of any cameras within the elevator.		
The sump pit shall have appropriate lighting, as required.		
If specified, electrically heated slabs at each landing door are permitted. Heating areas shall be 1 ft wider on each side of the car door and at least 8 ft long, and be designed per manufacturer recommendations.		
If specified, all critical devices such as emergency phones, CCTV, etc. shall be powered from an uninterruptible power supply.		
Federal, state or applicable local approvals are required for elevator commissioning.		
Elevators on systems that have electrified railway operation shall be grounded and bonded in accordance with transit agency standards.		