



APTA STANDARDS DEVELOPMENT PROGRAM  
**RECOMMENDED PRACTICE**

American Public Transportation Association  
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APTA Heavy Duty Escalator  
Design Working Group

# Heavy-Duty Transportation System Escalator Design Guidelines

**Note:** Reclassified to Elevator & Escalator working group. Previously numbered APTA RT-FS-RP-007-02

**Abstract:** This *Recommended Practice* contains guidelines for transit systems to use to specify heavy-duty escalators for use in a transit environment.

**Keywords:** escalators, heavy-duty escalators, transit escalators

**Summary:** This design guideline is the result of the combined efforts of the members of the APTA Elevator and Escalator Technical Forum over the past several years. The objective is to address the specific heavy-duty escalator needs of North American transportation systems. It is intended as a guideline of technical provisions for the design and construction of escalators that can provide safe, reliable service in the harsh, heavy-usage, high-abuse environment of transportation systems. Membership of the Technical Forum includes transportation systems, consultants and escalator/component manufacturers.

**Scope and purpose:** This design guideline is not intended to be a 100 percent ready technical specification for all transportation systems. Transit agencies may find it necessary to make changes to suit their specific needs. 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 and comments in the text to guide the user in preparation of a procurement specification document. Be aware that these guidelines cannot and should not be used as a reference standard. Too much potential for conflict and confusion will result in poor coordination and design conflicts.

It is expected that some manufacturers will be quick to tell us that these requirements will “add to the cost of the procurement.” We all know from experience the high life-cycle maintenance costs associated with the manufacturer’s “standard” product when used in a transportation environment. Paying more up front will be more than compensated for by the overall reduced life-cycle costs. Most importantly, it will improve customer

This Recommended Practice 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 standards, practices or guidelines contained herein is voluntary. In some cases, federal and/or state regulations govern portions of a transit system's operations. In those cases, the government regulations take precedence over this standard. APTA recognizes that for certain applications, the standards or practices, as implemented by individual transit agencies, may be either more or less restrictive than those given in this document.

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safety, satisfaction and convenience. The result can only be an increase in the public's confidence in a transportation system's ability to meet its needs and, thus, an increase in ridership.



## Participants

The American Public Transportation Association greatly appreciates the contributions of the following members of the **Heavy Duty Elevator Design Working Group**, who provided the primary effort in the drafting of this *Recommended Practice*.

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## 1. General

### 1.1 General description

This section specifies requirements for design, fabrication, installation and testing of heavy-duty escalators.

These design guidelines are not enforceable by reference to this document, in whole or in part. Language from this design guideline must be incorporated directly into the technical specification in order to be binding. In the event of a conflict between any APTA reference standard and this specification, the technical specification shall prevail.

### 1.2 Temporary and permanent electrical power services

- Three-phase temporary power with the same characteristics as the permanent power shall be made available to the installer at the time of the setting of the truss. Permanent power shall be made available for testing. All power shall be provided at no cost to the installer.

**NOTE:** Close coordination with the electrical engineer is recommended to provide the proper power supply for a given installation. Some manufacturers may require transformers for certain voltages.

- For the escalator drive systems: 208, 220 or 480 volts, 3 phase, 3 wire, 60 hertz (Hz) terminating in a disconnect switch within sight of the controller.
- For lighting and GFCI receptacles: 120 volts, 1 phase, 3 wire, 60 Hz terminating in the escalator truss.

### 1.3 Design criteria

**NOTE:** Virtually every transit escalator installation will require a remote machine room to accommodate the controller, drives and related equipment to operate the escalator. Special care, planning and coordination are essential with architectural, structural, HVAC and electrical disciplines in this design. Typical locations are adjacent or under the incline of the escalator installation, although other locations may be appropriate for consideration. Alternates for this design may require significant truss extensions or wall-mounted control equipment requiring special access and protection from non-elevator personnel for maintenance.

#### 1.3.1 General

Escalators shall be designed with provisions for thermal expansion and contraction of complete escalator assemblies and for any movement of the facility caused by trains braking when fully loaded.

#### 1.3.2 Operational requirements

- Hours of operation shall be considered as 24 hours per day, seven days per week.
- Direction of travel shall be considered as either direction, and unit shall be up-and-down reversible.
- Rated speed shall not exceed 100 feet per minute (FPM). The no-load-to-full-load speed shall not exceed 4 percent of the rated speed.
- Escalator components shall be designed based on the design loads as defined in Section 2 of this document, following applied duty cycle during operation:
  - Three hours with 100 percent design load
  - Six hours with 50 percent design load
  - Fifteen hours with 25 percent design load

**NOTE:** The above-noted duty cycle is a general reference to stipulate anticipated load cycles encountered during normal operation. Duty cycles are utilized in design calculations for components to determine compliance with design and life requirements. Anticipated load, or duty, cycles should be reviewed and amended as needed for the anticipated usage requirements.

**NOTE:** Close coordination with various manufacturers' requirements for intermediate supports is necessary, especially where seismic requirements apply.

### 1.3.3 Structural requirements

- The installer shall provide escalator truss mounting angles and intermediate truss supports with attachments, sized as required to install escalators into wellway structural support system shown on the contract drawing.
- Escalator intermediate support points shall be provided by the installer where indicated on drawings. Details and calculations shall be submitted by the escalator installer for approval by the owner.
- Reaction loads shall be indicated on contract drawings.
- Seismic designs must be based on actual story drift data from the building's structural engineer.
- Seismic calculations shall be based on the APTA design loadings in this document.

**NOTE:** The provisions included in Section 1.3.3 are intended to provide the escalator manufacturer with information regarding the load-bearing capacity of the structure and require the designer to develop a contract drawing that defines the loading that the structure is designed to accept.

### 1.3.4 Environmental requirements

**NOTE:** Interior installations include facilities such as airports and controlled environments with no corrosive elements. Exterior installations should be used for all subway, rail and bus applications, whether exposed to the weather or not. The need for truss heaters should be evaluated as appropriate for all installations.

### General

Escalators shall be capable of operating with fully specified performance capability while exposed to the following climatic and environmental conditions:

- **Interior installations:** Escalators shall be designed to operate in a temperature range of 5 to 120 °F, dry bulb, and all conditions of relative humidity while exposed to airborne dust and debris.
- **Exterior installations:** Escalators 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 while exposed to salt, deicing chemicals, airborne dust, and debris, and corrosive elements; and in a dry-bulb temperature range of -10 to 105 °F.

### 1.3.5 Vibration

**NOTE:** The owner should be aware that sophisticated FFT requirement is recommended for future preventative maintenance efforts. If the owner desires to measure this information now or in the future, close coordination with the successful contractor is necessary to collect this information in the most effective manner for the equipment.

### 1.3.6 Fire protection

- No wood or wood products shall be used in escalators.

- LSHF (low-smoke, halogen free) wiring shall be used where commercially available throughout the escalator installation.
- PVC may not be used in the escalator installation.

## 1.4 Job conditions

### 1.4.1 Protection

During installations, and until escalator systems are fully operative, the contractor shall make necessary provisions to protect systems from damage, deterioration and environmental conditions.

**NOTE:** If the escalator is completed prior to station revenue, then special care must be taken to protect the escalator from damage during the remainder of construction at the site.

### 1.4.2 Coordination requirements

- **Alterations:** The installer shall coordinate any alterations required to accommodate escalators with the owner.
- **Cladding:** The installer shall review all appropriate contract drawings dealing with proposed methods of securing cladding to truss. The installer shall coordinate with other appropriate contractors prior to any such actual work.
- **Floor finish at landing plates and newels:** The installer shall coordinate with other appropriate contractors and/or trades.
- **Escalator pit heating and ventilation:** The installer shall install heaters and ventilating fans where required.
- **Lock and key requirements:** The installer shall coordinate with the owner.
- **Pit drainage:** Provide a means to prevent water from accumulating in the pit for outdoor escalators and indoor escalators subject to ground water or station washdowns.
- **Rigging plan:** The installer shall supply a rigging plan that is approved by the owner.
- **Safety training:** The installer shall attend appropriate safety training programs provided by the owner at no extra cost.
- **As-built drawings:** The installer is responsible for providing revised contract drawings to reflect the actual as-built condition, including all structural, architectural, electrical, mechanical and plumbing connections to the escalators.
- **Methodology:** The installer shall meet with the owner and provide a written method of installation for approval.

## 1.5 Quality assurance

### 1.5.1 Regulatory agencies

Escalator design, materials, construction clearances, workmanship and tests shall conform to the requirements of the codes and regulations listed in “Applicable codes, standards and publications,” at the end of this document.

### 1.5.2 Welding

Welding shall be performed in accordance with the requirements of the AWS or CWB. Welders shall produce evidence of current certification by the AWS or CWB.

### 1.5.3 Dimensions

Each escalator shall have a 40-in. (1,000 mm) or 32-in. (800 mm) nominal step width as specified and designed for a maximum of 30 degrees.

**COMMENT:** The ADA prohibits 24-in.-wide steps in below-ground transportation applications. However, there may be certain structural impediments when installing a new escalator in an existing wellway or station that may require an escalator with a 24-in. step. Also note that 40-in. steps are preferred to permit two lanes of pedestrian travel on the escalator, allowing fast-moving pedestrians to walk by standing pedestrians on the escalator steps.

Structural dimension requirements:

- The installer shall design and fabricate escalators to fit within the dimensions shown on contract drawings.
- The installer shall verify dimensions of wellways prior to manufacturing trusses. In the event of a discrepancy, the installer shall notify the owner immediately and shall not proceed with installation in the areas of discrepancy until the discrepancy has been fully resolved and the owner has instructed the installer to proceed. Failure of the installer to report discrepancies shall constitute an acceptance of existing work as fit and proper for the execution and completion of the installer's work.

### 1.5.4 Labeling

Every escalator shall be clearly and permanently marked on the controller with rated load and speed, braking torque, manufacture serial number, manufactured date, and the designated owner identification. Duplicate data plates for all motors, brakes and switches shall be mounted and labeled on the inside of the escalator controller.

### 1.5.5 Requirements of regulatory agencies

- The installer shall obtain and pay for all necessary permits, and perform such tests as may be required for acceptance and approval of escalators by jurisdictional agencies.
- The installer shall notify the proper inspectors to witness required testing.

### 1.5.6 Factory visit

**NOTE:** This section may be appropriate in order to inspect and observe construction methods that would be difficult or impossible to observe after installation is complete.

- The contractor shall provide for the costs of up to three of the owner's representatives to visit the factory where the escalator is being manufactured.
- The escalator shall be tested with the controller to be shipped with the escalator. The operating owner shall observe the steps and chain in operation and test selected devices.
- The installer shall not ship the escalator without the approval of the owner after the conclusion of the factory visit.

## 1.6 Submittals

**NOTE:** Be aware that the elevator/escalator industry has not established a uniform approach to building information modeling (BIM) designs or submittals. Special care and coordination must be used in the design stage before establishing any BIM requirements for escalator contractors.

### 1.6.1 Shop drawings

- The installer shall provide six copies of the shop drawings.
- Drawings shall include but not be limited to:
  - facsimile outline of escalator truss in profile and plan;
  - facsimile elevation of escalator balustrade;
  - vertical section through balustrade; and
  - truss midway between working points.
- Drawings shall show:
  - truss stanchion;
  - track system and supports;
  - drive system;
  - step nosing radius at upper and lower ends;
  - drive chains and gear train;
  - step chain or step links (including chain pitch, step and trailer wheels);
  - step assembly (including axle, step tread, frame and riser);
  - handrail system (including profile, guides, drive and tension device);
  - support details (including upper, lower, intermediate and slip joint), balustrade deck cover, interior panels, skirt panels and their moldings;
  - safety switches and operating devices;
  - motor and emergency brakes;
  - floor plates;
  - speed governor;
  - metal gauges;
  - radial, vertical and horizontal dimensions required for manufacture, and positions of lower and upper working points;
  - attachment of truss to structure;
  - major mechanical and electrical components within truss;
  - drainage and electrical interfaces;
  - hand and finger guards;
  - ceiling intersection guards;
  - passenger instruction signs;
  - emergency stop button; and
  - operating panel in upper and lower balustrades (including stop button, start and direction selection switches, and fault finder receptacle).
- All bearing ratings, identification and catalog numbers shall be provided.
- A complete schematic diagram shall be provided for the controller and all electrical devices.
- Test certificates for step chain shall be provided for approval.

### 1.6.2 As-built drawings

**COMMENT:** The specifier should stipulate a time frame from Notice to Proceed (NTP) to obtain these drawings.

As-built drawings shall show the following:

- truss stanchion;
- track system and supports;
- drive system;

- step nosing radius at upper and lower ends;
- drive chains and gear train;
- step chain or step links (including chain pitch, step and trailer wheels);
- step assembly (including axle, step tread, frame and riser);
- handrail system (including profile, guides, drive and tension device);
- support details (including upper, lower, intermediate and slip joint), balustrade deck cover, interior panels, skirt panels and their moldings;
- safety switches and operating devices;
- motor and emergency brakes;
- floor plates;
- speed governor;
- metal gauges;
- radial, vertical and horizontal dimensions required for manufacture, and positions of lower and upper working points;
- attachment of truss to structure;
- major mechanical and electrical components within truss;
- drainage and electrical interfaces;
- hand and finger guards;
- ceiling intersection guards;
- passenger instruction signs;
- emergency stop button; and
- operating panel in upper and lower balustrades (including stop button, start and direction selection switches, and fault finder receptacle).

### 1.6.3 Maintenance programs

Within 60 days after Notice to Proceed, and prior to the installation, the installer shall submit detailed interim and revenue service maintenance programs, showing functions to be performed and their scheduled frequency.

### 1.6.4 Operation and maintenance manuals

**NOTE:** Due to the critical nature of O&M manuals, it is recommended that this item be itemized in the project schedule of values.

Prior to installation, the installer shall submit six draft sets of O&M manuals for approval. After owner approval and prior to the beginning of acceptance testing, two sets of the approved manuals shall be provided by the installer. The manuals shall include the following:

- Complete table of contents.
- Complete instructions regarding operation and maintenance of equipment, including disassembly and assembly of drive system, handrail drive assembly and track system. Included will be complete, illustrated, exploded views of all assemblies and a complete, illustrated, exploded view for identifying all system parts.
- Complete nomenclature of replaceable parts, part numbers, current cost and warehouse location. If the product source is another vendor, then the installer shall include the name and address of the other vendor.
- Sample copies of a preventive maintenance chart.
- Descriptions of safety devices.

- Safety rules, tests and procedures, including testing of all systems and subsystems.
- Procedures for adjusting brake, handrail tension, handrail chain drive tension, step chain tension, track system, and mechanical components, including pictorials.
- Instructions for removing the floor plate, replacing comb segments, and removing and installing steps and interior panels.
- Troubleshooting techniques.
- Detailed lubrication and cleaning schedule indicating weekly, monthly, quarterly, semiannual and annual lubrication; and a description of each lubrication point, lubrication type and specification.
- Control and schematic electrical wiring diagrams of the controller, including wiring of safety devices to connections with remote indication and control panels for each escalator and group of escalators.
- Electrical layout showing placement of lighting, light switches, receptacles, light fixtures, disconnect switches and convenience outlets in the machinery room, truss envelope and pits.
- Complete detailed drawings and wiring diagram of escalator fault finding device and connection to annunciator panel.

All material shall be provided on a CD-ROM in a format approved by the owner.

### 1.6.5 Documentation

The referenced material shall be provided within 30 days of publication or internal distribution of any safety-related updates or changes to the equipment provided in this contract. The material, even if labeled “PROPRIETARY,” shall be delivered to the owner without prejudice or delay and at no additional cost.

The Material Safety Data Sheets (MSDS) and product data sheets shall be submitted with an index listing each product, along with the application method of the product, approximate quantity of product per escalator, and the component the product is applied to or associated with. The installer shall allow six weeks for review of MSDS.

The training syllabus shall be submitted within 60 days of the NTP.

### 1.7 Training

The installer will provide 40 hours of local training for the owner and his or her representatives in the proper use, operations and daily maintenance of escalators. The training shall:

- 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; and
- 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.

**NOTE:** Properties with a third-party maintenance contractor should not require as much time for training, and training by the contractor can be reduced to eight hours, with special consideration to itemizing training on the project schedule of values. Owner-maintained facilities may want to consider specifying a custom training video specific to the equipment in this procurement. Be aware that there is a significant cost involved to produce a professional video.

## 1.8 Warranty

The acceptance is conditional on the understanding that the warranty covers defective materials and workmanship. The warranty period shall be one year from the date of beneficial use. The warranty excludes ordinary wear and tear or improper use, vandalism, abuse, misuse, neglect or any other causes beyond the control of the escalator 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:** Consider adding time to the warranty period if special circumstances warrant.

## 2. Products

### 2.1 General

All escalators supplied under this contract shall be the products of a single manufacturer. The installer shall furnish and install escalators that shall comply with the following requirements:

- **Vertical rise:** As shown on contract drawings.

**NOTE:** Consider 27-degree escalators for very high rise escalators, generally over 10 m.

- **Inclination:** Not to exceed 30 degrees.
- **Nominal step width:** 1,000 mm (40 in.) or 800 mm (32 in.).
- **Speed:** Not to exceed 100 FPM.
- **Flat steps:** Three minimum for less than 10 m (32 ft, 10 in.) rise; four minimum for greater than 10 m (32 ft, 10 in.) rise

**NOTE:** Existing structural conditions often prohibit installations of escalators with more than three flat steps. Note that code minimum is two flat steps at both landings. Note that the flat step requirement does not mean that the escalator will have three flat steps simultaneously at both ends.

- **Maintenance speed:** No greater than 25 percent of rated speed.
- **Upper track radius:** Less than 10 m (32 ft, 10 in.) rise: 2.6 m (8 ft, 6 in.). Greater than 10 m (32 ft, 10 in.) rise: Consider larger radius.
- **Lower track radius:** 2 m (6 ft, 6.75 in.).

**NOTE:** Existing structural conditions often make it difficult to install escalators with a radius as recommended here. Every effort should be made to obtain the largest radius possible when planning a new escalator installation.

- **Static brake load** (load per step on the total number of exposed steps on the incline):
  - 1,000 mm step: 306 kg (674 lb)
  - 800 mm step: 245 kg (540 lb)
- **Dynamic brake load** (load per step running in down direction on exposed steps on the incline):
  - 1,000 mm step: 145 kg (320 lb)
  - 800 mm step: 116 kg (256 lb)
- **Motor duty load.** With a minimum step load per step (on incline only) as follows:
  - 1,000 mm step: 145 kg (320 lb)
  - 800 mm step: 116 kg (256 lb)
- **Step chain load.** To be based on the step loads as follows:
  - 1000 mm step: 145 kg (320 lb)

- 800 mm step: 116 kg (256 lb)

## 2.2 Controls and safety devices

### 2.2.1 Operating controls

- Escalators shall have key-operated switches, accessible at both upper and lower landings, located on the exterior deck above the newel base. Alternate locations may be used subject to approval by the owner.
- Each keyed switch shall be clearly and permanently labeled, including starting and direction selection.
- Interlocks shall be provided to bring the escalator to a smooth stop, in either direction of travel, before a change of direction may be made.

### 2.2.2 Safety devices

- Safety devices include but are not limited to those required by the edition of ASME A17.1 in effect for this installation.
- A lockable stop switch or disconnect shall be provided in both pits of escalators.
- A switch shall prevent operation of the escalator if any part of the floor plate is not in place. This shall not be a manual reset device.

### 2.2.3 Balustrades, skirt panels and decking

**NOTE:** If an escalator must be resistant to salt and dust (presumably containing corrosive pollutants) and there are humidity levels of 45 percent or above, type 304 stainless steel can start to corrode, at least superficially. It is presumed that all escalators will be in sheltered locations, which are exposed to the atmosphere. Sheltered areas are far more aggressive environments than exposed locations. In urban locations with moderate to high pollution, in industrial areas within 10 miles of a large saltwater body, where deicing salt is used, or where exposure to urine is likely, type 316 stainless steel with a smooth (no rougher than Ra 20 micro-inches or 0.5 microns) should be used. In urban areas with high pollution levels or industrial areas with moderate to high pollution, the type 316 should be cleaned at least quarterly to remove pollutants. Or if cleaning is not likely, then a higher grade of stainless steel should be used, such as 317L, 317 LMN or 904L. Type 304, with the same surface roughness restriction, should be considered only in rural areas and low-pollution urban areas where there is no possibility of salt or urine exposure. This is suggested based on the assumption that no staining of the surface is desired.

**NOTE:** In certain applications, such as airports, glass balustrade panels may be appropriate. In these circumstances, the specifier should be aware that replacement glass panels may be an issue once in operation. APTA recommends utilizing laminated safety glass, above and beyond the ASME A17.1 glass requirements, as well as consideration of the handrail V-groove requirement impact on the glass newel arrangement.

#### Balustrades and skirt panels

- Panels shall be a minimum of 3 mm solid type 316 stainless steel and backing panels, where used, shall be noncombustible and are subject to owner approval.
- Panels shall be constructed, when practical, in equal lengths for interchangeability.
- Panels shall be attached to permit easy removal for inspection, lubrication and adjustment of safety devices.
- Panels shall be sized so that no more than two people are required to remove a panel, and without the aid of special handling equipment.

- Requirements for exposed panel fasteners (where used): Panels shall be fastened to their respective supports or mating portions with tamperproof flathead machine screws.
- When the framework to which panels are fastened is less than 0.25 in. thick, steel backup plates with a minimum 0.25 in. thickness shall be added. These plates shall have tapped holes or clearance holes where necessary.

**NOTE:** Escalator cladding consists of enclosing the sides and bottom of the escalator, typically with 2 mm stainless steel with a No. 4 finish. It is typically performed by an ornamental metals contractor. It is critical to ensure that this work is specified in the appropriate section, even if only for the newel ends that may be exposed.

- Decking shall be a minimum of 2 mm thick solid type 316 stainless steel, identical in finish to balustrade.
- Decking between escalators shall be designed to support a live load of 175 lb/ft<sup>2</sup> without permanent deformation.
- Paneling, decking and other enclosures shall be supported on a steel frame.

## 2.2.4 Electrical equipment

### Motors

- The driving motors shall be AC induction motors with starters. Voltage 480 VAC, three phase, frequency 60 Hz.

**NOTE:** Other motor voltages are permitted where different voltage is present.

- The motors shall be totally enclosed with external cooling fins.
- The motor protection class shall be equivalent to IP55 insulation group F.
- Driving motors and motor switchgear shall provide a smooth start.

### Controller

- The escalator control equipment shall contain diagnostic capabilities as required for the ease of complete maintenance. The diagnostic system shall be an integral part of the controller and provide user-friendly interaction between the service person and the controls. All such systems shall be free from decaying circuits that must be periodically reprogrammed by the manufacturer.
- Switchgear shall be mounted in NEMA 4X cabinets with strip heaters and labeled terminal strips.
- The main controller shall use a programmable logic controller (PLC) to control and monitor the status of the escalator. The PLC shall be designed to communicate over Ethernet or approved equal.
- The PLC racks shall provide space for two future single-slot modules.
- The PLC in the remote control panel shall also have hardware and firmware provisions to communicate with interactive operator interface (monitor).
- The PLC shall store the last 99 safety device faults, accessible via laptop connection, panel view or remote communications.
- A copy of all working programs on approved computer medium, as well as a printed program listing, shall be provided.
- The PLC shall have one dedicated serial port, which supports RS-232-C signals. It shall be accessible in ladder logic and provide support for point-to-point and slave SCADA communication protocol systems. Alternatively, it must be usable for programming purposes or for access to remote programmers via modems.

## Main control switchgear

The main control switchgear of an escalator shall contain at least the following devices:

- Lockable main switch thermal and magnetic motor protection starter for up and down travel, hour counter, auxiliary contactors, phase failure device, phase sequence monitor and ground fault monitor.
- The controller cabinet shall contain a permanently mounted full-color view panel capable of providing fault and operating data.
- The indication shall be locked automatically. Reset shall be done by a separate switch installed in the controller. The emergency stop shall not be locked.
- All terminals shall have identification markings, and all cables shall be provided with cable markers.
- The controller shall be equipped a full-time regenerative variable frequency drive (VFD) capable of full-speed control for maintenance and future “sleep mode” operation.
- Electric power receptacles shall be furnished and installed in the upper and lower pits. Each receptacle shall be of the GFCI duplex type, waterproof, grounded, and rated for one 120 volts at 20 amperes. The receptacles in the pits shall be surface-mounted on the walls, not less than 30 in. from the floor.
- Relays shall be provided with visual indication that they are energized.
- Controllers in escalator pits shall have a flexible liquid tight connection of suitable length to permit removal for maintenance purposes.
- The controller shall be capable of operating the escalator in variable rated speed operation as per ASME A17.1-2010 requirement 6.1.4.1.1, regardless of the ASME A17.1 code in effect.

### (Optional)

- The escalator shall be provided with the capability of running at any speed up to and including the indicated contract speed. The speed of the escalator shall be user selectable and shall be displayed on the HMI.

**NOTE:** This technology is relatively new in North America to determine any advantages over any specific passenger detection system design. The specifier should investigate all appropriate design solutions (stanchion, radar, proximity, etc.) for the most effective, reliable nonproprietary system for the application.

- Activation of sleep mode and setting of the sleep delay and sleep speed parameters shall be performed on the PLC’s LCD display. The LCD display’s main screen shall indicate if the escalator is in sleep mode operation and what the sleep delay and sleep speed parameters are.

## Truss wiring and conduit

- Galvanized rigid pipe and/or liquid tight flexible metal conduit shall be used in the truss.
- In Class 2 circuits, SO cord may be used in lengths not to exceed 3 ft.
- Liquid tight flexible metal conduit must be CSA/UL approved.

## 2.3 Materials

### 2.3.1 Stainless steel

- Shapes and bars: ASTM A-276, type 304 or 316, A-554 for tubes.
- Plate, sheet and strip: ASTM A-240. Type 304 for interior installations and 316 for exterior installations.

### 2.3.2 Fasteners

- Fasteners shall be compatible with materials being fastened. Fasteners shall be furnished with self-locking nuts or retaining rings (spring washers, toothed disks).
- Fasteners shall be equal to or of greater corrosion resistance than the most corrosion resistant metals being fastened.

### 2.4 Finishes

- Stainless steel: No. 4 finish ASTM A-480.
- Aluminum castings and extrusions: Commercial mill finish.
- Galvanizing:
  - Sheet steel: ASTM A446 or A526, as applicable. Coating designation G185.
  - Other galvanizing: ASTM A123, ASTM A 153, ASTM A 385 or ASTM A 386, as applicable.
- Galvanizing touch-up: Zinc dust coating, MIL-P-21035 or MIL-P-26915.
- Paint and corrosion protection: Each escalator shall have the following minimum corrosion protection:
  - After welding, the truss shall be hot dipped galvanized with a coating in accordance with ASTM A90. A 100 percent zinc thermal spray coating to ASNI/AWS C.18-93 is an acceptable alternative.
  - Cast metal parts such as gear housings, chain sprockets and return station half circles shall be painted with a rust inhibitor primer coat after preparation by sandblasting.
  - Steel parts that are not specified to be galvanized shall be painted as follows:
    - Primer coat: 2 mil (dry film thickness) minimum thickness.
    - Second finish coat: 2 mil (dry film thickness) minimum thickness.
  - Bright or uncoated axles, shafts, etc., shall be protected by zinc chromate or chrome plating.
  - Oil collector chutes and collection trays shall be fabricated of galvanized steel.

### 2.5 Mechanical equipment

#### 2.6 Tracks

- Fabrication of tracks shall retain steps and running gear safely under load requirements and at the highest speed specified.
- Installer shall assemble and secure sections of track together for easy removal and replacement of defective sections. The system shall be adjustable, and connecting of the track sections by welding is not acceptable.
- Design of the mechanical components shall provide for easy installation and removal without the dismantling of parts of the structure.
- Tracks shall be properly supported on trusses to provide correct alignment and smooth transition to return stations. The rolling surface of the passenger side track shall be a minimum thickness of 3 mm. Return side track shall be a minimum thickness of 2 mm.
- The guiding system for the step chains and step wheels shall be of zinc plated or galvanized steel profiles with smooth and even running surfaces and with the joints cut diagonally to the running direction. The guide profiles shall not be welded together at the joints.
- A second, continuous guiding profile shall be provided above the step chain rollers so that the step chains are positively guided in the area of the escalator open to passengers.

### 2.6.1 Steps

- The entire step assembly shall be treated with not less than one coat of zinc chromate primer or iron phosphate and one coat of powder-coated enamel for corrosion resistance.
- Steps and their various attachments shall permit removal of steps without disturbing balustrades.
- The design shall permit the running of the drive without steps for convenience in cleaning and inspection.
- Step rollers shall have polyurethane tires on hubs, sealed roller bearings, and a diameter of no less than 3 in. Step rollers shall not require any additional lubrication and must be rated for severe, heavy-duty service. Step roller bearings shall have an L10 rating of 100,000 hours.
- Steps shall be constructed so as to be driven by step linkages to step or step rollers.
- Washers and nuts shall be provided as follows:
  - Tap bolts: Lock washers.
  - Through bolts: Lock nuts or owner-approved equal.

### Rated loads

- In addition to the minimum requirements given in the codes, the installer shall design the steps for a minimum load of 320 lb (145 kg) per 40-in. step or 256 lb (116 kg) per 32-in. step with an ultimate strength safety factor of 8.
- The steps shall carry the load under maximum concentric and eccentric loading conditions without failure.
- Die-cast aluminum steps shall not have more than 0.3 percent copper content.

**NOTE:** Low lubrication chains are becoming available in the North American market. The APTA working group does not have sufficient experience with these new chains to provide a complete set of recommendations. Owners interested in these types of chains should research appropriate sources for their application.

### 2.6.2 Step chain

- Chain shall be endless, roller-type step chains with one on each side of the step.
- Step chains shall be of heat-treated steel construction, supported at intervals by linkage wheels.
- A means to prevent steps from coming into physical contact with one another and to prevent chains from sagging or buckling shall be provided.
- A means to maintain constant distance between step axles shall be provided.
- An automatic tensioning device to maintain tension under load and to compensate for wear shall be provided. The device shall be located within the truss at the lower end.
- A means for individual fine adjustment of tension for each linkage shall be provided.
- Step chains shall be constructed to permit removal of segments as may be required for replacement purposes at a minimum of every six-axle section. Each escalator shall have at least two one-axle sections.
- Support wheels spaced to distribute load and to guide linkage throughout the run shall be provided. Rollers shall be constructed of polyurethane material, with a diameter sufficient to provide reliability, maintainability, smoothness of motion and to operate within the noise level requirements specified. The chain rollers shall have polyurethane tires, sealed bearings and diameters of not less than 4 in. They shall require no additional lubrication and be mounted outside chain link. The wheels, hubs and bearings shall have an L10 rating of 100,000 hours.
- Wheels shall be affixed to permit rapid replacement.

- Each pair of step chains shall be a matched set within manufacturing tolerances. Only precision, rollerfishplate chains of high-grade heat-treated steel shall be used as step chains. The pins, axles, bushing and rollers shall be hardened and ground.
- Step chain and chain pins shall have a surface pressure at engaging points that shall not exceed 30 N/mm<sup>2</sup> (3,450 psi). This is to be based on the step loads as defined in the step chain load requirement in Section 2.1.
- The safety factor shall be at least 6.
- A test certificate for the chain-breaking load shall be provided.
- A shielding device shall be provided to protect chain, track guides and rollers against water, dirt and debris.

### 2.6.3 Combplate assemblies

- Complete assemblies of wear-resisting, noncorrosive metal material with exposed anti-slip surfaces shall be fabricated.
- A separate switch for vertical and horizontal detection shall be provided.
- Combplate sections meeting the following requirements shall be provided:
  - Shall be removable to permit ease of replacement.
  - Shall be yellow in color for safety/demarcation.
  - Provisions for lateral and vertical fine adjustments shall be provided so that cleats of step treads pass between combteeth with minimum clearances.

### 2.6.4 Floor plates

- Shall have type 316 stainless steel frames at floor openings, designed to be supported on truss heads.
- Shall be designed to cover entire area of upper and lower landings.
- Shall be reinforced, as necessary, to be rigid and able to withstand a live load of 250 lb/ft<sup>2</sup> with zero permanent deformation.
- Shall be extruded or die-cast aluminum in a ribbed pattern transverse to the escalator axis. Ribs shall be designed to provide maximum traction, and will be finished in the same manner as the combplates.
- Shall have exposed portions constructed of material and finish to harmonize with steps and combplates.

### 2.6.5 Drive machinery

**NOTE:** The drive may be located within the truss for most applications. Where very high-rise escalators require larger HP motors, or if the client prefers to work on machinery while the escalators are being used as stairs, a drive outside the truss envelope may be selected. This could result in a cost increase of about 300 percent for the entire installation, as well as additional general construction costs to build and maintain the new room to locate the drive.

Select one:

- Motor and drive mechanism shall be mounted within the truss envelope at the upper end. Shafts shall be designed for ease of assembly or disassembly.
- Motor and drive mechanism shall be mounted outside the truss envelope in the upper head section. The drive shall be securely fastened to a bedplate and have chain guards provided around the drive chains. Shafts shall be designed for ease of assembly or disassembly.

### **Gear box requirements**

- Gear bearings shall be rated with an ABMA L10 life of 200,000 hours and housed in an oil-tight, dust-proof case. The case shall provide a convenient method of draining the oil.
- Synthetic lubricants shall be used, subject to owner approval.
- Rotating parts shall be provided with a means for lubrication and retention of lubricants.
- Sealed bearings shall be used.
- Exposed, moving drive elements shall be protected by metal housings, which shall provide access for lubrication of components.
- A low-oil sensor shall be provided to prohibit starting of the escalator on automatic operation with low oil in the gearcase.

### **Other**

- V-belt and tooth belt drives shall not be considered acceptable.
- Head shaft bearings shall be rated for ABMA L10, 200,000 hours.

#### **2.6.6 Drip pans**

- Galvanized, 3 mm steel, watertight drip pans for the entire length and width of trusses shall be provided. They shall also be sloped for proper drainage and collection of lubricants, as well as any moisture or water that may enter the escalator. They shall be constructed to prevent oil from leaking below the truss.
- Drip pans of sufficient size to collect and maintain, within truss areas, oil and grease drippings from step linkage and all forms of loose debris that maybe deposited from steps at turnaround points at the upper and lower portions of truss shall be provided. This system shall be separate from the water drain in order to prevent the discharge of lubricants into the drainage system.
- Access to drip pans at lower landings of escalators shall be provided for the purpose of cleaning drain catch basins.

#### **2.6.7 Handrails**

- Handrails shall receive their motion from the main escalator drive through direct gearing and drive shaft or drive chains, so that the handrail and steps operate at the same speed in each direction of travel. Driving and guiding wheels shall have a groove to accept the wedge on the underside of the handrail. The handrail shall have a V-shape wedge.
- A means to take up handrail slack using a tensioning device, where required, shall be located within escalators. In addition, a method of releasing the device for repair or removal of handrails shall be provided.
- Newels meeting the following requirements shall be provided:
  - Newels shall be designed and constructed so that the handrail will return into the newel end at a point inconspicuous and difficult for passengers to reach.
  - Newel sheaves shall be provided at the upper and lower newels.
  - Handrails, the handrail drive system and guides shall be so designed and installed that the handrail cannot be thrown off or disengaged while running and special design attention shall be given to the area where the handrail passes from the drive system to the guides.
  - Handrail rollers shall have sealed bearings rated at ABMA L10, 100,000 hours.
  - Friction drive sheaves and idlers shall be designed and positioned so that lubricant cannot reach the surface of the handrail. Marking and spotting of the handrail by drive equipment shall not be permitted. Provide sealed bearings rated at ABMA L10, 100,000 hours.

- The handrail shall be a composite of either vulcanized rubber or an approved equal with a synthetic fabric slider, and shall be constructed with a steel cable tension member providing a minimum strength of 25 kN over the splice area.
- Handrail guides shall be continuous on the exposed portion of handrails, constructed of type 316 stainless steel, shall not be subject to corrosion nor pitting, and shall have a polished or specially coated permanent finish to minimize frictional wear to the under surface of the handrail. On the unexposed portion, guiding shall be by adjustable rollers having sealed bearings, and set in a way so as not to cause wear on the handrail.
- Handrail gearbox, if provided, shall have bearings rated at ABMA L10, 200,000 hours.

## 2.6.8 Braking requirements

### Motor brake

- The brake shall be capable of stopping and holding a descending escalator with the following load on the exposed steps in the incline area:
  - 1000 mm wide step: 145 kg (320 lb) per step.
  - 800 mm wide step: 116 kg (256 lb) per step.
- The brake coil shall be insulated to Class F.
- A monitor shall be provided, and if brake lining becomes insufficient for safe usage, restart of the escalator shall be prevented.

### Step band lock

- A step band lock shall be manually applied and mechanically engaged to prevent movement of linkages while the escalator is disconnected from its power supply.
- An electrical interlock that shall prevent escalator drive motors from starting while the step band lock is engaged shall be provided.

## 2.6.9 Trusses

### General

- The deflection of the loaded truss shall not exceed one-thousandth of the span under a live load of 320 lb per 40 in. step and 256 lb per 32 in. step.
- The slip joint slide bearings shall not use grease for lubrication.
- A permanent identification shall be provided on the truss for the centerline at both ends of the escalator and in both transition curves.
- Permanent mark reflecting track system working point distances shall be provided at both ends of the escalator trusses.
- No intermediate supports are permitted for spans less than 50 ft.

**NOTE:** Local conditions may require the use of an intermediate support at lower spans than what are in these guidelines. Close coordination with the structural engineer is advised for these circumstances.

### Field splices, connections and shims

- Field splices shall be rigid and non-deforming, and shall maintain alignment.
- Field modification shall not compromise the paint and corrosion protection specified in Section 2.4.
- All shims shall be type 316 stainless steel.
- Support shims shall not exceed 2 in.

**NOTE:** Define clearly who is to provide cladding on the escalator truss. Coordination with the OEM on weight and fastening methods is essential. Generally, welding and drilling into the escalator truss should be avoided. Coordinate with the OEM to determine truss cladding installation methods to minimize impact on the truss integrity. If access is desired into the truss with an access panel, coordination with the OEM is recommended.

#### 2.6.10 Step chain tensioning device

- The step chain tensioning device shall be of a design that keeps the step chains at the correct tension.
- A pointer and scale shall be provided to gauge step chain tensioning and wear.
- Bearings, if used, shall be rated ABMA L10, 200,000.

#### 2.6.11 Lubrication system requirements

##### Step chain

- All parts, other than sealed items, requiring lubrication shall be designed for an automatic or remote lubricating system. The system shall operate only when the escalator is running, and the amount of lubrication shall be fully adjustable. A reservoir with a low-oil signal to the controller, and a minimum capacity capable of providing the OEM's required lubrication for one month of operation based on the specific operating hours for this installation, shall be provided.
- System shall be positive acting, located in the escalator pit.
- A reservoir level indications shall be provided where lubricants are contained within housings, supply tanks and larger filler cups.
- A means to maintain lubricant viscosity shall be provided where required.

##### Miscellaneous lubrication

- The installer shall furnish and mount on the controller cabinet a laminated lubrication chart for each escalator. The chart shall show the location of each lubrication point, the type of lubricant to be used and the frequency of lubrication.

##### Bearings

- Sealed bearings shall be used where possible.
- Bearings requiring manual lubrication shall be furnished with fittings to accommodate the use of a pressure gun for lubrication.
- Self-lubricating bearings or material other than ball or roller type

##### Manual lubrication

- Manual lubrication points shall be easily accessible and available.

#### 2.6.12 Indicators

- Escalator users shall be informed by means of indicator lights of the predetermined running direction of the escalator.
- A green light shall be illuminated at the entrance for escalator running direction, and the red lamp shall have a horizontal white stripe and shall be illuminated at the exiting end. No incandescent lamps shall be permitted.

#### 2.6.13 Room storage cabinet (when remote control room provided)

- A standard storage cabinet of not less than 20 ft<sup>3</sup> in volume (52 in. high × 36 in. wide × 18 in. deep) shall be provided in a room assigned by the owner.

- The cabinet shall have lockable doors and be mounted on legs or on a pedestal at a minimum of 4 inches off the floor.
- The cabinet shall be painted and marked for control purposes, as directed by the owner, and the installer shall store the wiring diagram, maintenance control plans, small parts, supplies, tools and other materials within it.

#### 2.6.14 Lock cylinders

- All locks and keys shall be as per owner approval.
- The owner shall verify with the installer that the requirements for hardware have not been amended or superseded.
- The installer shall provide the owner with length, finish and camming requirements of each cylinder required.

#### 2.6.15 Demarcation lights (if required)

- Demarcation lights shall be UL labeled and suitable for wet locations.

### 3. Execution

#### 3.1 Installation

- The installer shall install complete and operating escalators in accordance with the manufacturer's instruction and approved shop drawings.
- The installer shall install special tools in the room storage cabinet as specified in Section 2.6.13.

#### 3.2 Field testing

##### 3.2.1 General

- The installer shall notify the owner seven days prior to each scheduled test. The installer shall perform testing in the presence of an owner representative.
- The installer shall notify the appropriate local authorities having jurisdiction a minimum of seven days in advance of final acceptance tests.
- The installer shall provide all instruments, materials and labor required for tests specified herein.

##### 3.2.2 Acceptance testing requirements

Testing shall be performed in accordance with ASME A17.2.3 procedures with the following additions or adaptations.

##### **No-load tests**

The installer shall perform the following tests on each escalator without load:

- The comb impact device shall be tested and calibrated with an appropriate scale at both ends of the escalator in both the horizontal and vertical directions. No adjustments shall be permitted in between measurement of vertical and horizontal calibration.
- Measure braking deceleration rate with no load over five consecutive stops in the down direction using test equipment designed to obtain this information.

**NOTE:** Use the following test only if vibration requirements of Section 1.3.5 are specified.

- The escalator shall be tested to meet vibration requirements of Section 1.3.5 of this document. The meter and the method shall be identical for all tests.

### **Full-load tests**

The installer shall perform the following tests on each escalator under full load:

- Each escalator shall have a full dynamic brake load (as specified in Section 2.1) dynamic brake test performed on it. The stopping distance in the down direction shall meet all requirements of ASME A17.1.
- The escalator shall operate continuously for 40 hours after the acceptance test with no faults. If any fault occurs that shuts the escalator down, the fault must be corrected and a new 40-hour test will begin.

If either the no-load or full-load brake tests fail, both tests must be repeated with the same torque setting on the brake for both no load and full load.

## Applicable codes, standards and publications

Escalator designs and installations shall be of the heavy-duty type, and shall comply with the following:

**NOTE:** In case of a conflict between codes, regulations or standards, the most stringent requirement shall take precedence.

American National Standards Institute (ANSI), ASME A17.1, “Safety Code for Elevators and Escalators”; A17.2.3, “Escalators and Moving Walks Inspection and Maintenance Evaluation”; and A17.5, “Committee on Elevator and Escalator Electrical Equipment”; applicable editions.

Canadian Standards Association (CSA), CSA B44, “Safety Code for Elevators and Escalators.”

National Fire Protection Association (NFPA), NFPA No. 130, “Fixed Guideway Transit and Passenger Rail Systems,” and ANSI C1, “National Electric Code” (NFPA 70).

Americans with Disabilities Act (ADA). <http://www.ada.gov/>

Canadian Welding Bureau (CWB). <http://eng.cwbgroup.org>

American Welding Society (AWS). <http://www.aws.org/w/a/>

ASTM International. <http://www.astm.org/>

International Standards Organization, ISO 281/I-1997.

Anti-Friction Bearing Manufacturers Association (ABMA), Std. 9, “Load Ratings and Fatigue Life for Ball Bearings,” and Std. 11, “Load Ratings and Fatigue Life for Roller Bearings.”

Occupational Safety & Health Act (OSHA). <http://www.osha.gov/>

**NOTE:** Any additional requirements imposed by local agencies shall be incorporated into escalator installations.

## Definitions

**NOTE:** Special care must be taken to coordinate definitions with other parts of a larger procurement contract.

**authority having jurisdiction (AHJ):** As defined by ASME A17.1.

**beneficial use:** The time when the escalator is placed into service, which may be prior to the site being ready for public use.

**contractor:** The general contractor.

**escalator support:** The upper, lower and intermediate supports needed to support the total loads of the escalator.

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

**flat steps:** The distance, expressed in step lengths, that the leading edge of the escalator step travels after emerging from the comb before moving vertically.

**heavy-duty escalator:** An escalator designed specifically for transportation system usage.

**human-machine interface (HMI):** The software interface between the SCADA and the PLC.

**installer:** The responsible party who installs the escalator.

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

**Notice to Proceed (NTP):** The formal notification in which the escalator installer is notified to proceed with the project.

**owner:** The owner in control of the facility.

**revenue service:** The station or facility opening date.

**slip joints:** Sliding joints required to support escalators in transportation system and high-rise applications. They can be located at the top or bottom support areas but are generally located at the platform level or as indicated on the contract drawings.

**special tools:** Tools designed specifically for tasks associated with escalator examinations, maintenance and repair, or those that are required for these tasks and are not readily available through normal purchasing channels.

**step width:** The horizontal distance between skirt panels.

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

**system control and data acquisition (SCADA):** A system to connect various equipment in a geographic area.

**working points:** Points of intersection of step nosing line and the horizontal line of the top and bottom landing plates at finish elevation.

## Abbreviations and acronyms

<b>ABMA</b>	Anti-Friction Bearing Manufacturers Association
<b>ADA</b>	Americans with Disabilities Act
<b>AHJ</b>	authority having jurisdiction
<b>ANSI</b>	American National Standards Institute
<b>APTA</b>	American Public Transportation Association
<b>ASME</b>	American Society of Mechanical Engineers
<b>AWS</b>	American Welding Society

<b>BIM</b>	building information modeling
<b>CSA</b>	Canadian Standards Association
<b>CWB</b>	Canadian Welding Bureau
<b>FFT</b>	Fast Fourier Transform
<b>FPM</b>	feet per minute
<b>GFCI</b>	ground fault circuit interrupter
<b>HMI</b>	human-machine interface
<b>HP</b>	horsepower
<b>HVAC</b>	heating, ventilation, air conditioning
<b>kN</b>	kilonewton
<b>LCD</b>	liquid crystal display
<b>LSHF</b>	low-smoke, halogen free
<b>MSDS</b>	Material Safety Data Sheet
<b>NFPA</b>	National Fire Protection Association
<b>NTP</b>	Notice to Proceed
<b>O&amp;M</b>	operation and maintenance
<b>OEM</b>	original equipment manufacturer
<b>OSHA</b>	Occupational Safety & Health Act
<b>PLC</b>	programmable logic controller
<b>PVC</b>	polyvinyl chloride
<b>SCADA</b>	supervisory control and data acquisition
<b>UL</b>	Underwriters Laboratories
<b>VFD</b>	variable frequency drive