NSW GOVERNMENT

TS 04955.4:2.0

Standard

Services, Systems and Equipment

Part 4: Escalators and Moving Walks

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1.0	31/08/2022	First issue
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Preface

This standard is the second issue as TS 04955.4.

This document forms part of TS 04955 series of documents related to services, systems and equipment.

This document sets out the minimum performance requirements for the design, construction, installation, testing and commissioning of publicly accessible escalators and moving walks installed in transport facilities and related transport infrastructure.

This version has been updated to make this document applicable to metro.

This document should be read in conjunction with TS 04955.1.

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1 Scope

This standard specifies the foundational requirements for design, construction, installation, testing and commissioning of publicly accessible escalators and moving walks in public transport facilities and related transport infrastructure within Transport network.

This document outlines minimum requirements for escalators and moving walks installations which take into account the following:

- customer use and amenity
- site-specific requirements and fit-for-purpose application
- technical requirements and interfaces
- equipment intended life cycle.

This document does not apply to conveyors used for materials and goods handling, temporary conveyors used for construction and industrial applications, or loading ramps.

2 Application

This document applies to personnel involved in the provision of publicly accessible escalators and moving walks within the Transport network.

This document applies to the whole-of-life cycle including planning, design, construction, commissioning, operation, maintenance and decommissioning of escalators and moving walks.

This document applies to all new installations.

This document applies to all upgrades, including additions, or changes to existing installations.

This document should be read and applied in conjunction with TS 04951.1, TS 04955.1 and relevant legislation, Australian standards and TfNSW standards.

3 Referenced documents

The following documents are cited in the text. For dated references, only the cited edition applies. For undated references, the latest edition of the referenced document applies.

Australian standards

AS 1670.1 *Fire detection, warning, control and intercom systems – System design, installation and commissioning – Part 1: Fire*

AS 1735.1.1 *Lifts, escalators and moving walks – Part 1.1: General requirements*

AS 1735.5.1 *Lifts, escalators and moving walks – Part 5.1: Safety of escalators and moving walks – Construction and installation (EN 115-1:2017, MOD)*

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AS 1735.5.2 *Lifts, escalators and moving walks – Part 5.2: Safety of escalators and moving walks – Rules for the improvement of safety of existing escalators and moving walks (EN 115-2:2017, MOD)*

AS 2118.1 *Automatic fire sprinkler systems – Part 1: General systems*

Transport for NSW standards

TS 03677 (T HR EL 12004 ST) *Low Voltage Distribution and Installations Earthing*

TS 03743 (T HR EL 12005 ST) *Bonding for 1500 V DC Traction Systems*

TS 03954 *Low Voltage Electrical Installations*

TS 04951.1 *Functional Spaces – Part 1: Principles*

TS 04955.1 *Services, Systems and Equipment – Part 1: Principles*

TS 04992 *Surface Transport Fixed Infrastructure Physical Security Standard* (This document is not publicly available; to obtain access email standards@transport.nsw.gov.au)

Legislation

Disability Standards for Accessible Public Transport 2002 (Cth)

4 Terms, definitions and abbreviations

The following terms, definitions and abbreviations apply in this document:

LV low voltage

MTBF mean time between failures

MTTR mean time to repair

RAM reliability, availability and maintainability

repair direct action taken to effect restoration (Source: IEC 60050-192); the actions restore (but do not enhance) the functionality of the item

SFAIRP so far as is reasonably practicable

TfNSW Transport for NSW

TGSI tactile ground surface indicator

Transport network the transport system (transport services and transport infrastructure) owned and operated by TfNSW, its operating agencies or private entities upon which TfNSW has power to exercise its functions as conferred by the Transport Administration Act or any other Act.

transport system means the transport services and transport infrastructure of the State for all modes of transport (Source: *Transport Administration Act 1988* (NSW))

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5 Functional outcomes

5.1 General requirements

All new escalators and moving walks and equipment that are partially or completely replaced as part of existing equipment renewal shall comply with AS 1735.1.1, AS 1735.5.1 and AS 1735.5.2.

In addition to the requirements in TS 04955.1, the following requirements shall be complied with for all publicly accessible escalators and moving walks:

- universal access (for able-bodied and mobility-impaired passengers) including visual and tactile information, architectural and visual cohesion
- remote alarm monitoring
- passive security via visibility and clear lines of sight (for example, where glazing is installed)
- vandal and misuse resistance.

All escalators and moving walks should be standardised and ensure that they are consistent across the Transport network in SFAIRP.

The procurement and installation of escalators and moving walks shall comprise all labour and materials necessary to form a complete installation of the escalator and moving walk. The completion of tests, adjustments and commissioning shall be undertaken to result in an effective working installation. This shall be with respect to the following:

- dimensional compatibility
- technical interfaces, for example, power supplies, security (closed circuit television), fire alarm, emergency warning and intercommunication system (EWIS), finished floor levels, and other similar interfaces
- programming of sequential operations to interface with the work and eliminate confrontation
- interdisciplinary coordination.

5.2 Vandal and misuse resistance

Escalators and moving walks in transport facilities are heavily exposed to vandalism and misuse that can lead to high maintenance costs and breakdowns. To ensure an acceptable level of reliability and aesthetic condition, all elements of the escalators and moving walks shall be designed to increase resistance against vandalism and misuse (especially impact and etching damage) SFAIRP.

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5.3 Requirements for new and existing installations

The following processes shall be applied for new and existing installations:

- New installations – Where an escalator or a moving walk is provided as part of new facilities, a proposal shall be submitted early in the design phase to ensure optimal coordination and integration of the new equipment into the transport facility design.
- Existing installations – Where an escalator or a moving walk is retrofitted to existing facilities, or replacement of an existing escalator or a moving walk takes place, the following shall be carried out:
    - a condition survey of the existing machine room, truss, pits and so on to examine existing accommodation, and evaluate if any remedial work is required to accommodate the new equipment
    - a survey of the location for the proposed new escalator or moving walk and relevant work required to accommodate the new equipment identified.

Escalators and moving walks shall be of compact type (all equipment fully enclosed within the escalator truss or when conditions permit, within a purpose-built external machine room located beneath the respective escalator or walkway).

Escalators and moving walks shall be designed for heavy-duty public systems and to operate:

- in the local environment (for example, transport system)
- in the facility location's expected environmental exposure (for example, temperature and humidity extremes) and
- under the expected people and goods loading intensity.

No machinery and control equipment shall be located within the escalator step band.

5.4 Design requirements

5.4.1 General

Design, operation and maintenance parameters shall be agreed with relevant stakeholders to ensure that the proposed equipment is fit for purpose, including agreed design criteria, features, capacities, operational capacities and reliability targets.

Coordination with structure, architecture and services may influence the selection of escalators and moving walks. Examples include taking into account the following:

- optimal location within the facility
- structural fixtures and loadings
- dimensional constraints

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- fire engineering operations in event of fire alarms
- heat outputs of equipment and required ventilation
- electrical supply requirements
- maintenance access.

Designs and installations shall ensure the ride comfort and amenity of the passengers.

Escalators and moving walks shall be of the reversible type, capable of operating in either direction.

Step edges shall be able to be clearly identified by the passengers. A total of three edges of each step tread shall be finished to show clear demarcation between steps. Demarcations shall be resistant to wear and mechanical damage.

> Note: Methods of demarcation may be proposed for consideration. Refer to AS 1735.5.1 for more information.

Plastic combs shall not be used.

Comb lighting shall be provided.

5.4.2 Design life

Escalators and moving walks shall be reliable and involve low levels of maintenance. The minimum design life of escalators and moving walks shall be 30 years.

All components shall be designed to maximise service life and minimise maintenance effort under heavy-duty public service and harsh environmental conditions.

Design life for individual components shall be as detailed within TS 04955.1.

5.4.3 Design for ease of maintenance

The escalator and moving walk shall be designed to allow ease of access for inspection and maintenance with minimal need to remove surrounding equipment.

All routine maintenance shall be carried out on site. Maintenance shall not require access from the external sides of the truss.

The drive machine, controller and related equipment shall not be located within the escalator or moving walk step band, as this restricts ease of access for inspection, maintenance, repair and replacement of parts.

As the accumulation of materials (grease, oil, dust, paper) represents a fire risk, cleaning of the truss trays shall be possible and easily accessible.

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5.5 Reliability, availability and maintainability

Escalator and moving walk systems and equipment shall be able to meet the RAM targets given in Table 1.

Table 1 – Operational considerations

Reliability (MTBF)	Availability	Maintainability (MTTR)
≥1800 hours	≥99.8%	≤1.5 hours

Availability is calculated as shown in Equation 1.

$$\text{Availability} = \frac{\text{MTBF}}{\text{MTBF} + \text{MTTR}} \times 100\%$$

Equation 1 – Availability

Escalator and moving walk hours of operation shall be based on an assumed operation of 24 hours per day, 7 days per week, 52 weeks of the year, for the loads shown in Table 2 for the life expectancies detailed within this document and TS04955.1.

Table 2 – Operational load characteristics

Type of load	Application	Duration and frequency
Peak load	100% of brake test load (1450 N/step)	30 minutes every 3 hours
Average load	40% of brake test load	Between load peaks

The following moving parts shall be designed or tested accordingly:

- bearings
- step rollers
- step chains
- handrail drive
- drive chain
- drive machine
- gear box
- tension carriage
- lubrication system
- braking systems
- step and pallet clearances

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- comb plates
- step and pallet track and transition wear.

Escalators and moving walks shall be designed to achieve a minimum of 100,000 operational hours between major repairs under all conditions imposed by the publicly used transport system (that is, an environment subject to high numbers of passengers). In addition:

- The escalators and moving walks shall be designed to achieve a minimum of 260,800 operational life cycle hours.
- Major repairs shall be documented within operations and maintenance manuals detailing frequency of such repairs.
- Major repairs shall be scheduled at appropriate intervals.
- Major repairs shall be scheduled at times that minimise public and facility inconvenience.

5.6 General characteristics

Escalators shall have general characteristics as specified in Table 3.

Table 3 – Escalator general characteristics

Description	Attributes
Inclination (slope)	≤30°
Step width (minimum)	1000 mm
Minimum step depth	380 mm
Minimum clear height above step	2300 mm
Maximum speed	0.65 m/s (for metro 0.75 m/s) (lower rise escalators may be designed for lower nominal speeds than the maximum speeds)
Minimum number of flat steps at both landings	4 (where feasible at speeds of 0.65 m/s) 5 (where feasible at speeds of 0.75 m/s)
Horizontal movement of the steps from the comb plate at both landings	1600 mm (where feasible)
Transition radius of curvature	Between the range of 1.5 m and 2.6 m (<0.65 m/s), depending on the site application, passenger demand and density in compliance with AS 1735.5.1
Safety factor for step (minimum)	Eight with a minimum load of 1450 N/step and in compliance with AS 1735.5.1
Safety factor for step chain	Eight over ultimate tensile stress
Maximum noise level	60 dB measured at 1.5 m above or at the side around the escalator

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Moving walks shall have general characteristics as specified in Table 4.

Table 4 – Moving walks general characteristics

Description	Attributes
Inclination (slope)	10° to 12°
Pallet width (minimum)	1000 mm
Minimum pallet depth	115 mm
Minimum clear height above pallet	2300 mm
Maximum speed	0.5 m/s
Number of flat pallets at both landings	4
Horizontal movement of the pallets from the comb plate at both landings	400 mm
Transition radius of curvature	Between the range of 1.5 m and 2.6 m, depending on the site application and in compliance with AS 1735.5.1
Safety factor for step (minimum)	Eight with a minimum load of 1450 N/step and in compliance with AS 1735.5.1
Safety factor for step chain	Eight over ultimate tensile stress
Maximum noise level	60 dB measured at 1.5 m above or at the side around the moving walk

5.7 Waterproofing

Where escalators and moving walks are subject to direct weather exposure or indirect water carried by pedestrian movement (for example, escalator pits and machinery spaces may be subject to ground water, marine environments or severe weather) they shall be designed to include waterproofing provisions.

Escalators and moving walks shall be designed and constructed so that any ingress of water does not adversely affect their operation. Any treatment and drainage required shall be compliant with the requirements of the local authority and the operator and maintainer.

Trusses and all steel work shall be hot-dip galvanised to minimise opportunity for corrosion.

Landings shall slope away so as to mitigate water flowing in.

In addition, all truss, trays and cladding shall be fully sealed and watertight.

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5.8 Machine rooms and pits

5.8.1 General

The drive machine, controller and related equipment shall not be located within the step band.

Both in-the-truss and remote machine room designs shall not have obstructions (such as supporting posts for the upper support beam, partitions, or piping) that prevent easy access to the drive machine and controller. Remote machine rooms requiring doors shall be secured against public access in accordance with TS 04992. In-the-truss machine rooms shall be secured against public access in accordance with TS 04992.

Machine rooms and pits shall be reserved for the installation of motors, drives, and controllers of various sizes and placements. Adequate clear workspace and passageways shall be provided on at least three sides of the machine or two sides where walls interfere. The layout of cables, wiring and services in escalator pits and spaces shall allow for free and safe access to the equipment.

Each machine controller shall be mounted with an adequate clear workspace in front of the controller. Where workspace for the control equipment is tight, the equipment shall be easily movable and positively secured with fixed mechanical aids to eliminate any manual handling risks.

Escalator machine pits shall be provided with movable floor plates over the full area of the pit. Floor plates shall be removable by one person without the use of special equipment.

The effects of dirt and dust shall be addressed for all escalators and moving walks.

5.8.2 Drainage of escalator and moving walk pits

All indoor and outdoor escalator and moving walk pits and machinery spaces shall be provided with a sump at the lowest point of the pit for water, oil, and other liquids to drain to. The sump shall be connected to a main drainage system. A float switch shall be provided to automatically stop operation of the escalators and moving walks in the case where the water level exceeds a predetermined adjustable level.

Where escalators and moving walks are subject to ground water with high mineral content or a marine environment, they shall be designed to address these conditions.

5.8.3 Pit barriers

Removable barriers shall be provided. They shall be placed at each end of an escalator to guard the pit opening when the floor plates are removed.

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5.9 Energy efficiency measures

The escalators shall be supplied with energy efficiency provisions, such as continuous operation where the monitoring system has to adapt the energy consumption to the actual passenger traffic load and automatic interrupted operation at non-peak hours.

During periods of non-use, escalators and moving walks shall automatically slow to improve energy efficiency. When operating at slow speeds the escalator shall monitor approach areas and increase speed as passengers approach. Acceleration shall commence prior to a passenger reaching the comb plate.

5.10 Operating controls

5.10.1 General

For normal operations, escalators and moving walks shall be provided with key switches. Key switches shall include the following features:

- The escalator shall be provided with key-operated switches at each end at the upper and lower landings.
- Each key switch shall provide starting and direction selection. Each key switch shall be clearly and permanently labelled to indicate these features.
- The key switch shall have up and down direction positions, and a centre position. The key shall be removable only in the centre position.

Escalators and moving walks shall have an emergency stop button or buttons. The following apply to emergency stop buttons:

- Escalators shall be provided with manually operated emergency stop buttons in visible and easily accessible positions at or near the landings of the escalator.
- The distance between stop buttons to be used for emergency situations shall not exceed:
    - 30 m for escalators
    - 40 m for moving walks.
- The stop buttons shall be located beneath a cover. As a preventative measure against misuse, when opened, the cover shall raise a local audible alarm.
- For escalators with rises above 12 m, additional stop buttons shall be provided along the incline.

Traffic flow LED lighting shall be provided to indicate the running direction of the escalator or moving walk.

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5.10.2 Emergency operation

Escalators and moving walks may be required as part of a path of egress as determined by site-specific fire and performance engineered solutions. Where this is the case, escalators running in the opposite direction to egress shall have the control functionality to be brought to a slow or soft stop automatically in the event of a signal being sent to the unit control system.

6 Technical requirements

6.1 Structural elements

6.1.1 Truss

The truss shall be made of welded steel profiles.

The steel used in the truss shall be hot-dip galvanised.

The sides of the structure shall be of framework design (lattice type).

As a minimum, chords, truss posts, support angles, and diagonals shall meet the strength standards of steel ST 52-3 grade, cold or hot formed and steel ST 37-2 grade.

Each truss structure shall be designed and constructed to carry safely the dead load of the escalator and any additional loads attached to the truss, in addition to the passenger load.

The dead load includes escalator and moving walk equipment, drive machine, controller, truss-covering and so on and additional loads include external cladding and fall over side protection.

The maximum deflection measured between the unloaded bare truss position and the under full load truss position of the complete installed escalator, shall not exceed one thousandth of the distance between supports.

Site installation difficulties and constraints shall be taken into account. For example, site installation constraints may require the truss to be broken down into sections, which can be reassembled on site with bolted spliced joints.

The truss structure shall enable the installation of the escalator or moving walk sprinkler protection systems. Sprinkler installations shall not encroach into the minimum required working area.

6.1.2 Truss trays

Truss trays shall be provided at the landings, and for the entire length and width of the trusses to collect dust, debris, lubricants and any moisture or water entering into the escalator. Truss trays shall be fully sealed and of watertight construction to prevent oil leaking below the truss. They shall be sloped for proper drainage.

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Any accumulation of oils, lubricants and contaminated liquids shall be contained to prevent discharge into the water drainage system or elsewhere external to the escalator. Escalators or moving walks shall be designed to provide clear access for the purpose of cleaning the trays and catch basins.

6.1.3 Supports

The number and structure of supports shall be designed to achieve the following:

- ensure a maximum deflection of the truss of less than one thousandth of the distance between supports
- prevent direct structure-borne noise from being transmitted to the building
- comply with seismic regulation
- allow for thermal expansion of the truss as necessary
- support the full load of the escalator or moving walk associated with its length.

The number of supports required shall be determined in the early design stages, for example at reference design. This shall ensure the required coordination between the escalator designer and site design.

To avoid unnecessary obstructions along the circulation path below the escalator, and where practicable, clear span escalator trusses should be installed where the rise is less than 8 m.

The truss shall bear on the supporting steel or concrete beams with shim packs with vibration dampening pads of resilient material.

6.2 Fire protection systems

Fire protection systems shall be installed in accordance with AS 1670.1 and AS 2118.1.

Where detection systems are required within the building in accordance with AS 1670.1, thermal detectors shall be installed within the top and bottom pits of the escalator and moving walk.

Where sprinkler systems are required within the building in accordance with AS 2118.1, sprinklers shall also be installed within the escalator truss due to the risks associated with internal features (for example, oil, debris and so on).

Where sprinklers are required beneath the escalator and moving walk truss:

- fixings of pipework shall be supported from the sides of the truss
- fixings shall not penetrate the oil pan in the underside of the truss.

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6.3 Steps and pallets

Escalator steps and moving walk pallets shall be of one-piece robust design, made of die-cast aluminium.

Steps shall be in compliance with the load test requirements of AS 1735.5.1.

Both the tread surface and riser face shall be fitted with longitudinal grooves.

The step rollers shall have lifetime lubricated sealed ball or roller bearings.

The step rollers shall be rated for severe, heavy-duty service.

Step roller bearings shall have an L10 rating of 100,000 hours.

The unit design shall allow for quick and easy step or pallet removal at one or both of the landings. The unit design shall permit removal without disturbing balustrades.

The escalator or moving walk shall be designed to allow for quick and easy alignment of steps or pallets respectively when installing.

The step or pallet fixing (to the step chains/axles and step wheels) shall be designed such that the transfer of the driving forces to the step exerts minimal forces on the step.

Steps or pallets shall not be used as the sole means to maintain step chains in the correct tracking gauge.

6.4 Track system

The tracks shall continuously support the escalator or moving walks step and chain wheels. The tracks shall be designed for ease of renewal and provide smooth running surfaces. All joints in tracks should be diagonal across the width of the running track surface and comprise support block under the joints to ensure they stay aligned.

The chain wheel track should be adjustable in the neighbourhood of the top and bottom sprocket. The chain wheel tracks should be installed in such a way that the chain can lie tangential to the sprocket pitch line on both the upper and lower sides of the sprockets.

A guard shall be provided around the sprockets at each landing to retain a chain and step system in the event of chain breakage.

Auxiliary tracks shall be provided at both landings. Auxiliary tracks shall be designed to support the steps through the comb in the event of failure of a step wheel.

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6.5 Combs, comb plates, floor plates

Combs, comb plates and floor plates shall be wear-resisting, non-corrosive and anti-slip.

Combs shall be sectional and screwed to the comb plates allowing quick and easy removal and replacement. Combs shall be resistant to wear. Combs shall be designed such that when foreign bodies get trapped within, the combs either break or their teeth deflect and remain in mesh with the grooves of the steps.

The comb plate shall be of robust design, supporting heavy passenger loading without any part of the assembly touching the steps. Lateral and vertical fine adjustments shall be provided to allow the cleats of the step treads to pass between the comb teeth with minimum clearances.

Horizontal guides shall be provided at each landing to assist in ensuring that the steps enter the comb plate safely.

Floor plates shall be easily removable to allow step removal without dismantling any part of the balustrade.

Placement of floor plates shall be aligned with TGSI installations. Refer to *Disability Standards for Accessible Public Transport 2002* for TGSI placement installations.

6.6 Step or pallet chain and step wheels

The two main step chains shall be roller-type, of heat-treated steel construction supported at intervals by linkage wheels. The chain shall incorporate links, pins, bushes and rollers, and be supplied in precision matched lengths.

The tracking gauge of the step chains shall be maintained by axles between the step chains. Steps shall not be used as a sole means to maintain tracking gauge.

Steps shall be prevented from coming into physical contact with one another. Chains shall be prevented from sagging or buckling.

The quality and duty of replacement chains shall be equivalent to the originally supplied and installed chain from the manufacturer.

Constant distance shall be maintained between the step axles. Automatic tensioning devices shall be used to maintain the tension and compensate for wear of the step chain and wheels. To enable replacement of individual segments, step chains shall be constructed to permit removal of individual segments (at a minimum of every six-axle section).

Rollers shall be constructed of suitable material, with diameter sufficient to provide reliability, maintainability, smoothness of motion and sufficient to operate within the noise level requirements. The wheels, hubs and bearings shall have an L10 rating of 100,000 hours.

A test certificate confirming the tensile breaking load of the assembled step chain shall be provided from an approved test authority.

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The step chain shall be allowed to be shortened by one step when the tension carriage reaches its outer limit of travel.

A shielding device shall be provided to protect the chain, track guides and rollers against water, dirt and debris.

6.7 Electrical works

6.7.1 General

Escalators and moving walks installed near 1500 V dc track shall be installed in accordance with TS 03954 for LV requirements, and TS 03677 and TS 03743 for earthing and bonding requirements.

Note: Locations that constitute near to 1500 V dc track are defined in TS 03954.

6.7.2 Motor

The motor shall comprise a variable speed drive, three-phase ac induction motor, voltage of 400 V ±10%, and frequency of 50 Hz ±2%. Local power supply conditions shall also be taken into account. Localised power conditioners (for example, uninterruptible power supply (UPS)) shall be provided to mitigate the problem of high incoming voltages and harmonics, where present. Thermal overload devices shall be fitted within the motor windings. The motors shall be totally enclosed with external cooling fins.

The motor shall be mounted such that it guarantees accurate alignment following removal for repairs. Driving motors and motor switchgear shall provide a smooth start. The motor shall be designed to be energy efficient in its operation. The motor shall be designed to withstand a minimum of 20 automated restarts per hour.

6.7.3 Controller

The controller shall consist of a dust and waterproof metal cabinet containing all switchgear necessary for the control of the escalator or moving walk. The controller shall be an IP65 minimum rated enclosure.

The controller shall enable the selection of rated or maintenance speeds for the escalator or moving walk. The controller shall be connected to the power switchboard. The controller shall be designed to withstand 20 starts per hour.

All escalator and moving walk systems shall be free from controller systems that are required to be periodically programmed by the manufacturer.

The controller equipment shall be easily movable and positively secured with fixed mechanical aids to eliminate any manual handling risks.

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Inspection controls shall be provided to permit operation during maintenance, repair or inspection by means of portable and manually operated control devices. For this purpose, two inspection outlets (one at each landing) shall be provided within the machine space, to allow for the connection of the flexible cables of the portable control device. Inspection outlets shall be located such that any point of the escalator can be reached with the cable.

6.8 Balustrade and finishes

The design of balustrades and finishes shall be robust and make allowance for forces imposed in a public transport service environment subject to high numbers of passengers. The newel stand shall be rigidly supported.

Interior panels shall be easily removable to allow access to the handrail, safety devices and other equipment within the balustrade and truss.

All gaps between the balustrade and wall finishes shall be suitably covered to prevent access into the gap.

All panels shall be fitted with anti-drumming material on the reverse side to minimise noise levels generated by the escalator machinery.

Balustrade panels shall be constructed where practical in equal lengths for interchangeability.

Panels shall be sized so that two people, without the aid of special handling equipment, are able to remove a panel.

All exposed panel fasteners shall be flush fitting tamper resistant screws. Friction and clip fastening methods shall not be used.

Where balustrades comprise glazed panels, refer to TS 04992 for glazing requirements regarding design, visibility of heritage facades, passive surveillance and damage resistance.

Glazed panels shall have rubber spacers removed prior to handover to enable glass to expand and contract under the expected conditions.

6.9 Skirting

Skirting panels fixed adjacent to the moving surface shall be fabricated from smooth rigid materials and braced to prevent permanent deformation during passenger transit.

Skirting panels should be of satin stainless steel finish with an anti-friction material.

The skirting may not yield more than 4 mm under a single force of 1500 N acting at the most unfavourable point (point of maximum deflection) at right angles to the surface (over an area of 25 cm^2). All efforts to reduce the possibility of trapping between the skirting and the steps shall be employed.

Panels shall have smooth and flush fitting joins. Flush fitting fasteners shall be used.

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6.10 Skirt brush guards (deflector guards)

Double brush skirt guards shall be fitted to escalators at the point between the steps and balustrade skirting, in accordance with AS 1735.5.1.

The guards shall be designed (splayed) to prevent a passenger's foot being trapped beneath it and prevent the trapping of small-wheeled trolleys, baggage or strollers. The brush material shall be fire resistant and non-toxic when burned. The end terminations at each landing shall have purpose designed end caps positioned to eject a passenger's foot, baggage or pushchairs from beneath the guard and terminating before the comb or step intersection.

6.11 Handrail system

The handrails shall receive their motion from the main escalator or moving walk 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.

The newel sheaves shall be provided at the upper and lower landings. The newel sheaves shall be designed with nominally half wrap of the handrails around each sheave.

Pinch and pressure belt drive systems, where used, shall be designed for heavy-duty loading and be vandalism and misuse resistant.

Sheave and roller systems shall be designed and positioned so that lubricant cannot reach the surface of the handrail.

6.12 Braking systems

6.12.1 Operational brake

The escalator or moving walk drive mechanism shall be fitted with an electromagnetically released brake. The brake force shall be generated by guided compression springs. The brake shall be capable of being set to provide smooth consistent braking and cause the escalator or moving walk to stop and remain stopped under all conditions of load and speed. The brake shall be capable of being fitted with a manually operated device to allow hand winding.

An escalator or moving walk brake monitoring system shall be provided to prevent restarting of the escalator or moving walk where it has been determined that the brake lining has become insufficient for safe usage. The output from this monitor shall be made available for remote monitoring.

The monitoring system shall detect mechanical engagement of the brake with the motor for the purpose of stopping the escalator or moving walk to prevent the motor continuing to run while the brake is engaged.

The brake shall comply with stopping distances as specified in AS 1735.5.1.

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6.12.2 Auxiliary brake

All escalators and moving walks shall have an auxiliary brake.

The auxiliary brake shall become effective in either of the following conditions:

- before the speed reaches a value 1.4 times the rated speed
- when the steps or pallets change from the present direction of motion.

The auxiliary brake operation shall positively open the control circuit.

6.13 Safety features

Escalators and moving walks shall be designed to eliminate SFAIRP the risk of injuries to the passengers. Splits, linings, and crossings shall exclude SFAIRP any possibility of clothing getting caught or stuck.

The following operational safety measures shall be provided in escalators and moving walks:

- pit stop switch
- handrail entry devices – two at each landing
- step upthrust device
- step level (step sag) device
- handrail speed monitoring device
- broken handrail device
- missing step device
- comb impact device – at both sides of each comb
- broken step chain device – one per chain
- skirt obstruction switch
- tension carriage switch
- key switch, at both landings
- drive machine with:
    - operational brake
    - non-reversal device
    - motor thermic device, protection against overheating
    - overspeed governor
    - control device for brake lifting operation

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- main circuit breaker
- isolation switches at both landings
- inspection socket at each landing and a portable inspection control device
- asymmetric relay activated in case of non-symmetrical main current supply
- auxiliary brake on main drive shaft.

The following passenger safety measures shall be provided in escalators and moving walks:

- passenger emergency stop button at both landings and intermediate point (subject to rise) and alarm
- step gap illumination
- comb illumination
- step and comb demarcation
- skirt brush (deflector) guards
- transition radius of curvature
- four flat steps at both landings of an escalator
- minimum 400 mm horizontal travel of pallets at both landings of moving walkways
- traffic flow lights at both landings.

Safety signs shall be fixed at the escalator and moving walk entry points and detail mandatory actions in accordance with AS 1735.5.1. In addition to the mandatory signs prescribed in AS 1735.5.1, signs stating ‘take care with plastic shoes and loose clothing’ and ‘no bulky items, trolleys or luggage’ shall also be included.

Escalators and moving walks shall have the capability to provide acoustical signals at upper- and lower-level landings to aid visually-impaired people with distinguishing directions of travel.

6.14 Fault indication

Fault indicators shall be provided on the balustrade decking for the purpose of status indication and display of codes for fault-finding purposes.

6.15 Remote alarm and monitoring system

The remote alarm and monitoring system shall include a termination in the controller for an interface to the site operations systems through the following:

- a dedicated I/O board
- a dedicated communication port or connection, indicatively RS 232, RS 485 or RS 422.

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Escalator or moving walk controller data and signals shall be allowed to communicate with the asset operations systems for operational monitoring, data logging and provision of remote alarms and alerts.

The remote alarm and monitoring system shall be able to communicate via the BACnet protocol and shall allow for data points to be available for external interrogation and adjustment.

6.16 Materials

6.16.1 General

All materials shall comply with the relevant Australian standard. Material manufacturers and suppliers shall certify that the materials to be used conform to such standards.

The materials and finishes used in the escalator or moving walk installations shall be selected for site-specific conditions and fit for purpose.

Material data sheets shall be provided on request.

6.16.2 Castings, extrusions or profiles

All castings, extrusions or profiles shall be of adequate thickness and strength to meet the structural requirements and eliminate any risk of distortion in the finished surfaces. The thickness of such elements shall be sufficient to ensure their complete rigidity in the lengths required in the final installation.

6.16.3 Sealant

The sealant shall be compatible with the adjacent elements of construction in each location. All excess sealant shall be properly cleaned from exposed surfaces.

Installed sealant shall provide a smooth continuous surface to the full width of the joint and shall be tooled flat.

6.16.4 Painting

With the exception of self-finished surfaces and elements otherwise specified, the escalators and moving walks shall be painted with one coat in the factory after full and proper surface preparation, including priming, has been applied.

All steelwork shall be de-rusted, treated with rust inhibitor, primed and painted or galvanised.

6.16.5 Use of lubricants

Non-flammable lubricants shall be used on all escalator and moving walk components requiring lubrication including, but not limited to, all chains. All materials used for components that may

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come in contact with non-flammable lubricants shall be designed for compatibility. Lubricants shall be low smoke and emit no toxic materials during a fire.

All used lubricant and cleaning materials shall be disposed of appropriately considering environmental impacts.

6.16.6 Fire rating

All materials used in escalators and moving walks installed in underground stations shall be low smoke and emit no toxic gases during a fire.

6.17 Maintenance

All escalator and moving walk services, systems and equipment maintenance and upgrades shall comply with TS 04955.1. Maintenance regimes shall be developed in consultation and in accordance with supplier input to achieve the RAM targets detailed in Section 5.5.

The escalators and moving walks shall be proactively maintained and replaced at appropriate intervals in accordance with the manufacturer's recommendation.

7 Commissioning requirements

7.1 General

All testing and commissioning shall be carried out by suitably qualified testing personnel, experienced in such work and using appropriate instruments.

7.2 Inspections and tests

7.2.1 Dynamic tests on escalators and moving walks

Notwithstanding the requirements of AS 1735.5.1, the witness tests shall include the following dynamic tests:

- demonstrate the correct operation of the operational brakes and auxiliary brakes under full load at full speed conditions in both directions
- up and down direction tests under no load, full load conditions, including motor current readings and recording
- manual activation of the governor.

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7.2.2 Functional tests

The operational functions of all escalators and moving walks shall be tested, including but not limited to, the operation of the following:

- balustrade deflection test
- balustrade impact test
- truss cladding below 2.7 m off finished floor impact test
- all stop buttons, indicators and sounders, gongs and other like items
- all key switches and functions controlled thereby
- brake slide
- comb plate safety switch test
- handrail entry switch test
- special control features such as fire alarm, emergency switches, out of service switches and other such features.

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