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Title:

Specification for Heavy Duty Metro Escalators

PART 1: GENERAL REQUIREMENTS

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PART 1 – GENERAL REQUIREMENTS

1. Purpose

1.1. This specification is comprised of five parts which identify the *Employer's* technical requirements for the design, manufacture and installation of escalators. As this specification is being used by more than one mode within the *Employer's* organisation, it comprises core sections, which are common to all modes, and a number of annexes, each of which is specific to a particular mode. Where particular modes procure escalators, they will use the core documents and attach annexes for requirements which are specific to their environment and operating procedures.

1.2. The *Employer* has particular requirements for escalators, which are not adequately specified by laid-down industry standards. This document specifies technical requirements and highlights the areas where the needs of the *Employer* exceed national, European and international standards.

1.3. Refer to annexe.

1.4. This specification comprises five separate parts, as follows:

PART 1 – GENERAL REQUIREMENTS

PART 2 – MECHANICAL COMPONENTS

PART 3 – ELECTRICAL SYSTEM

PART 4 – QUALITY, INSPECTION, TESTING & COMMISSIONING

PART 5 – INFORMATION REQUIRED AT TENDER STAGE ONLY

2. Scope

2.1. This specification defines the *Employer's* requirements for the design, manufacture, installation, commissioning, maintenance and safe condition for use for escalators. It does not cover the individual requirements of each working site, or any contract-specific variances to this specification. These will be found in the site-specific documentation.

3. References

3.1. The text of this document cites other documents that provide information or guidance. These are listed in Appendix 1.1.

3.2. References to British Standards shall be taken to include the words 'or equivalent ISO, DIN, AFNOR or other European Standards', subject to the agreement of the *Employer*.

4. Abbreviations

4.1. The following abbreviations are used in this specification:

AFNOR	Association Francaise De Normalisation
ALARP	As Low As Reasonably Practicable
CCTV	Closed Circuit TeleVision
CDS	Conceptual Design Statement
CE	Committée Européene
CEN	European Committee for Standardisation
C of C	Certificate of Conformity
COSHH	Control of Substances Hazardous to Health
CRL	Crossrail Limited
DIN	Deutsche Industrie fur Normung
DPE	Dye Penetrant Examination
EEPROM	Electrically Erasable Programmable Read Only Memory
EMC	Electromagnetic Compatibility
EPC	Electronic Product Code
EPROM	Erasable Programmable Read Only Memory
EWL	Erection Working Line
EWP	Erection Working Point
FEA	Finite Element Analysis
FFT	Fast Fourier Transform (spectral analysis)
FLT	Full Load Torque

FMEA	Failure Mode and Effects Analysis
HSE	Health and Safety Executive
IDLH	Immediately Dangerous to Life or Health
IEC	International Electrotechnical Commission
IP	Ingress Protection
IRHD	International Rubber Hardness Degree
ISO	International Standards Organisation
LAN	Local Area Network
LCD	Liquid Crystal Display
LED	Light Emitting Diode
LOI	Limiting Oxygen Index
LSZH	Low Smoke Zero Halogen
LUL	London Underground Limited
ORR	Office of Rail Regulation
MPI	Magnetic Particle Inspection
MSPL	Mean Sound Pressure Level
MTBF	Mean Time Between Failures
MTTR	Mean Time To Repair
NDE	Non Destructive Examination
NICEIC	National Inspection Council for Electrical Installation Contractors
PESS	Programmable Electronic Safety Systems
PESSRAE	Programmable Electronic Safety Systems in Safety Related Applications - Escalators
PLC	Programmable Logic Controller
PWHT	Post Welding Heat Treatment
QA	Quality Assurance
QC	Quality Control
RAMS	Reliability Availability, Maintainability and Safety
RCD	Residual Current Device
RFID	Radio Frequency IDentification
RMS	Root Mean Square
RPM	Revolutions Per Minute
SCADA	Supervisory Control And Data Acquisition
SI	Système Internationale
SIL	Safety Integrity Level
SOR	Station Operations Room
SRV	Slip Resistance Value
TEFC	Totally Enclosed Fan Cooled
TDMA	Time Division Multiple Access
TfL	Transport for London
TI	Flammability Temperature Index
UHF	Ultra High Frequency
UKAS	United Kingdom Accreditation Service
UT	Ultrasonic Testing
VVVF	Variable Voltage, Variable Frequency

4.2. Refer to annexe.

5. Definitions

5.1. The following terms are used in this specification:

Castell lock - A proprietary, key-operated, mechanical interlock, with a unique, embossed number, that ensures that, the power cannot be turned on to the escalator, when the key is removed.

Castell key - The proprietary key, with a unique, recessed number, that operates a Castell lock.

Comb line - The intersection of the comb surface with the step tread surface.

Concession -The Concession process is the means by which the *Employer* controls the installation of materials, components or equipment that do not comply with the requirements of this specification.

Controller - The electrical and electronic systems that control and monitor the escalator, housed in one or more of the cabinets, including the cabinets themselves and all items mounted externally on them.

Duty cycle – A specified varying load pattern over a defined period.

Duty rating – The load per exposed step.

Engineering Hours – “Engineering Hours” means in relation to Stations, the period of time scheduled for the relevant Station to be closed on the relevant day in accordance with the Station Times Book each day of the week.

Erection working line (EWL) - A straight line connecting the upper and lower erection working points.

Erection working point (EWP) - The intersection of the finished floor level, the inclined erection working line (EWL), as defined by the *Contractor*, and the centre line of the escalator, at each landing.

Extensive / grouped materials - Where the mass and separation exceed the definition of limited/dispersed materials.

Fail safe - Used to describe any item of equipment that will default to a safe condition in the event of failure.

Field bus system – Industrial communication system that uses a range of media such as copper cables, fibre optics or wireless, with bit serial transmission for coupling distributed field devices (sensors, actuators, drivers, transducers, etc.) to a central control or management system.

Field wiring - All wiring relating to the escalator, that is external to the escalator controller.

Flight of escalators - A bank of two or more adjacent escalators sharing a common space.

Gear train - One or more reduction gearboxes, used to reduce the rotational speed of the motor(s).

Inching - Operation of the escalator at reduced speed under maintenance control.

Inching speed - The reduced speed at which the escalator runs when under maintenance control.

International standard – ISO (International Organization for Standardization) standard or CEN (European Committee for Standardization) standard;

Light slip test - A test carried out on an escalator to check that an unloaded machine stops within the specified stopping distances, for both the up and the down directions of travel.

Limited / dispersed materials - Where the mass is greater than 100g and less than 500g, and where there is a separation of not less than 0.5m between materials.

Load relieving ramp - (also known as unloading ramp or load discharge ramp) - A curved ramp made of a low-friction material, that supports the step chain at the upper curve of the escalator, such that the chain wheel loading is reduced.

Minor use materials - Where total mass and surface area do not exceed 100g or 0.2sqm respectively, regardless of separation between materials.

Normal speed - the speed at which the escalator runs when carrying passengers.

Programmable electronic system in safety related applications for escalators and moving walks/lifts (PESSRAE) - System for control, protection or monitoring based on one or more programmable electronic devices, including all elements of the system such as power supplies, sensors and other input devices, data highways and other communication paths, and actuators and other output devices, used in safety related applications.

Reversing tracks - The part of the track system that carries the step wheels around the main and idler shafts, thus causing reversal of the step direction (commonly referred to as “D” tracks).

Ride quality - Vibration of escalator steps relevant to passenger perception;

Safety line - The series circuit of safety devices in the field wiring and controller that enables and maintains the main contactor.

Single point failure - A single failure, which alone is the direct cause of a hazardous condition.

Step band – The endless assembly of step chains and steps.

Step nose – The intersection point of the step riser and the tread.

Test weight - A 22.7kg (50lb) weight used to simulate passenger loads during weight testing of an escalator. Test weights are stackable and have locating lugs, with corresponding, mating recesses, and integral carrying handles.

Transmission elements – all components which transmit power from the main drive motor to the steps and handrails, including the motor/gearbox coupling and the attachments between the step chains and steps.

Weight test - A test carried out on an escalator to check that a fully loaded machine stops within the required stopping distances, smoothly and safely, and that the brake holds the machine stationary.

5.2. Refer to annexe.

6. Safety considerations

6.1. The safe and reliable operation of escalators is of paramount importance to the running of the London rail network. Assurance must be provided to the *Employer* that all of the safety requirements have been met at each stage of the process.

6.2. Refer to annexe.

6.3. The provisions of the Health and Safety at Work Act 1974, Electricity at Work Regulations 1989, and Manual Handling Regulations must be followed at all times.

7. National and international standards and legislation

7.1. The escalator shall conform to all current relevant standards and legislation, in particular:

a) BS EN 115-1: Safety of escalators and moving walks;

b) BS 7801: Code of practice for safe working on escalators and moving walks;

c) BS EN 13015: Maintenance for lifts and escalators - Rules for maintenance instructions;

d) Railway Safety Principles Guidance (published by HSE/ORR) part 2 section B;

e) BS 8300: Design of buildings and their approaches to meet the needs of disabled people. Code of practice;

f) The Building Regulations. Approved Document 'B' Fire Safety;

g) The Building Regulations. Approved Document 'M' Access and Facilities for Disabled People;

h) The Fire Precautions (Sub-surface Railway Stations) (England) Regulations;

i) 2008/1579: Supply of Machinery (Safely) Regulations;

j) 2006/3418: The EMC Regulations.

7.2. Where a specific exemption has been agreed by the *Employer*, this is detailed in the text of this specification.

7.3. The complete escalator installation shall carry 'CE' marking in a prominent location visible to members of the public (see Part 2, clause 17.5.1 of this specification).

8. Design

8.1. Design submission

8.1.1. The *Contractor* shall submit arrangement and detail drawings, technical data, FEA reports (as appropriate), calculations and test reports to the *Employer* for review and formal acceptance.

8.1.2. All documentation shall be written in the English language. Where drawings and other data emanate from a non-UK source, an accurate translation shall be provided.

8.1.3. Data for review shall be submitted in Adobe PDF format. Where PDF files are created by scanning hard copies, the scanning resolution shall be such that all text shall be fully legible at A4 size or at A3 size (for drawings, etc.), as appropriate.

8.1.4. All documentation submitted electronically shall bear a file name which clearly indicates the unique document reference, and its revision status. The revision status shall be represented e.g. ABC123 revA.pdf. Where the document does not bear a revision letter, the revision date shall be substituted in yyyymmdd format, e.g. ABC123 rev20070131.pdf. Where a document is part of a multi-sheet set, the sheet number shall be added e.g. ABC123 sht1 revA.pdf or ABC123 sht1 rev20070131.pdf.

8.1.5. No acceptance of any of the *Contractor*'s drawings, plans or calculations by the *Employer* shall relieve the *Contractor* from full responsibility for their accuracy in every respect, nor from full compliance with the provision of the contract and specification, nor from product liability.

8.2. Design Changes

8.2.1. The *Contractor* shall not deviate from this specification without the written agreement of the *Employer*.

8.2.2. The *Contractor* shall notify the *Employer* of any design changes that he intends to make in order to comply with any new or revised statutory instruments.

8.2.3. Design changes shall be supported by drawings and calculations as appropriate. These shall be submitted to the *Employer* for review and formal acceptance.

8.3. Drawings

8.3.1. The *Contractor* shall ensure that all drawings, (both his own and those of sub-contractors), meet the following minimum requirements, as described below:

a) Each drawing shall bear a unique identification and revision status;

b) Assembly drawings shall incorporate, or be accompanied by, a parts list clearly identifying component drawing numbers and/or supplier's reference numbers;

c) Where drawings relate specifically to a particular escalator or location, they shall be clearly marked as such;

d) All drawings shall carry evidence of being checked and approved in accordance with the *Contractor's* drawing control system.

8.3.2. All drawings shall be fully legible when printed at A3 size.

8.4. Failure mode & effect analysis (FMEA)

8.4.1. Within the total system design, there shall be no potential for single point failures to cause injury or death.

8.4.2. The *Contractor* shall carry out an FMEA, in accordance with BS EN 60812 on critical parts of the escalator installation, which shall include, but not be limited to:

a) Steps;

b) Main drive shaft;

c) Tension carriage;

d) Step chains;

e) Drive machine and braking system;

f) Drive and control system, including all safety devices.

8.4.3. The FMEA shall identify all possible failure modes and the consequences of each failure, including potential damage that could occur to other parts of the escalator. The *Contractor* shall consider how predictable failures can be prevented by design or detected before they constitute a hazard. This shall include failures which can arise, over a period of time, as a result of degraded condition. The findings of the analysis shall be addressed by improved design or, where this is not practical, by identifying the actions to be taken to guarantee safe and reliable operation in the operation and maintenance manuals.

8.5. Finite element analysis (FEA)

8.5.1. The stresses in structures or components shall be calculated to demonstrate safe and reliable operation. Where FEA is used, the *Contractor* shall provide evidence that the study has been executed, checked and approved by persons having the appropriate qualifications and experience.

8.5.2. Further requirements for evaluating stresses in escalator steps are given in Part 2, clause 4.3 and Part 4, Appendix 4.2 - section 2 of this specification.

8.6. Controller software

8.6.1. Safety critical software assessment shall be subject to Notified Body approval.

8.7. Design check certificate

8.7.1. Refer to annexe.

8.7.2. Refer to annexe.

8.7.3. The designer's check certificate shall list the drawings, calculations or other data that it covers, together with their revision status.

8.8. Design risk assessment

8.8.1. The designer's check certificate shall be supported by a design risk assessment, confirming that all risks associated with the manufacture, installation, operation, servicing, dismantling and ultimate removal of the escalator have been considered and have been rated as "ALARP" (normally requiring a "low" or "negligible" risk score). Reference shall be made to FMEA studies. The *Contractor* shall forward a copy of his risk-scoring matrix to show how the risk analysis was made.

8.8.2. The implications of 2002/96/EC (WEEE) regulations and the requirement for 2002/95/EC (RoHS) compliance shall be clearly identified.

9. Basic design parameters

9.1. Rise

9.1.1. Refer to annexe.

9.2. Angle of inclination

9.2.1. Refer to annexe.

9.3. Landing lengths

9.3.1. The following shall apply:

a) At the upper landing, the step nose shall travel horizontally for a minimum distance of 2.0m from the comb line, before vertical formation takes place. (i.e. 5 flat steps);

b) At the lower landing, the step nose shall travel horizontally for a minimum distance of 1.2m from the comb line, before vertical formation takes place (i.e. 4 flat steps).

9.3.2. Refer to annexe.

9.4. Speeds

9.4.1. The speed (m/s) at which the escalator shall run will be specified in the site-specific contract documentation. The actual, calculated speed, (taking into account motor speed, gear and sprocket ratios) shall be within 5% of the specified speed, but shall not exceed 0.75m/s. The calculated speed is hereafter referred to as the normal running speed.

9.4.2. A maintenance speed of nominally 25% of the normal running speed shall be provided.

9.4.3. Requirements for 'stand-by operation' are described in Part 3, section 14 of this specification.

10. General technical requirements

10.1. Environmental conditions

10.1.1. Environmental conditions vary according to location but may be expected to be draughty, dusty and damp to varying degrees. The ambient temperature in machine rooms on the network typically varies between -5°C and +40°C.

10.1.2. The *Contractor* shall provide details of the heat output of each of the following:

a) Controller;

b) Motor and gearbox.

10.2. Other equipment and station fabric

10.2.1. Where station finishes are disturbed or damaged by the works, the *Contractor* shall make good the affected areas, to the satisfaction of the *Employer*. This shall include making good where equipment, conduit, wiring, trunking etc has been removed, altered or installed as part of the works.

10.2.2. The drilling, cutting or welding of the station structural fabric including walls, floors, steel support beams and tunnel segments is forbidden without the written approval of the *Employer*.

10.3. Loading

10.3.1. The escalator truss, tracks, track supporting brackets, transmission elements and steps shall be designed for a static load of 5kN/m^2 in accordance with BS EN 115-1. This figure shall be used when calculating safety factors.

10.3.2. Loadings for floor plates are defined in Part 2, clause 19.4 of this specification.

10.3.3. The drive system shall be capable of attaining normal speed when starting from rest, with the full test load applied, in order to recover the test load during brake testing (see Part 3, clause 3.1 and Part 4, Appendix 4.5 clause 6.5.5 of this specification).

10.3.4. The brake test load is defined in Part 4, Appendix 4.5 clause 6.1.4 and 6.1.5 of this specification.

10.3.5. Individual escalator steps, and the track system, shall be capable of carrying the distributed load that will be applied during brake testing, due to the concentration of the total test load on a limited number of steps (see Part 4, Appendix 4.5 clause 6.1.5 of this specification).

10.4. Factor of safety

10.4.1. For the truss and truss supports, load factors used in the design shall be consistent with BS EN 1990 and BS EN 1991 for normal operation, test loading and abnormal fault conditions.

10.4.2. For static calculations, transmission and braking elements, and anchoring devices, shall be designed with a factor of safety of not less than 5. This factor is determined as the ratio between the ultimate tensile or shear strength of the material (depending on the load case) and the stress arising from the maximum applied static load (i.e. 5kN/m^2 per exposed step on the passenger side).

10.5. Abnormal structural loading conditions

10.5.1. The escalator transmission elements, truss and supports shall be designed to withstand possible abnormal loadings due to a sudden arrest of the step band (e.g. due to a step/comb collision). For such a loading condition, the integrity of the structure is to be maintained and deflection is to be limited such that there is no risk of entrapment to passengers using the escalator.

10.6. Duty cycle

10.6.1. The escalator shall be designed to run continuously at the specified speed for a minimum of 20 hours per day, 7 days per week, 365 days per year. During each day it may be reversed at least once, or it may run in the same direction. For operational reasons, any maintained escalator may be run for up to 364 hours in any calendar year in Engineering Hours. The *Contractor* must advise LU if any maintained escalator reaches a run time of 300 hours in Engineering Hours in any calendar year, within 5 business days of this limit being reached.

10.6.2. The following duty cycle shall be applied to each daily period of twenty hours:

- 100% of full load for 3.5 hrs
- 65% of full load for 3.5 hrs
- 50% of full load for 5 hrs
- 30% of full load for 8 hrs
- 2% of full load, where an escalator is running during engineering hours.

10.6.3. The full load shall be calculated at 120kg per exposed step.

10.6.4. During engineering hours the escalator may be run at inching speed, with up to 6 starts per minute, followed by a period of rest, to be defined by the *Contractor*.

10.7. Component life expectancy

10.7.1. The non-wearing parts of the escalator, other than the balustrade, (e.g. truss and balustrade support steelwork) shall have a designed life of at least 40 years.

10.7.2. The balustrade shall have a designed life of at least 20 years. Throughout this period, the balustrade shall continue to satisfy the requirements defined in Part 2, sub-section 17.2 of this specification.

10.7.3. The fatigue life of all parts subject to cyclic loading shall be considered. Parts made of steel shall be designed to BS EN 1993-1-9. Parts made of aluminium shall be designed to BS EN 1999-1-3. In all cases, the calculated fatigue life shall be infinite.

10.7.4. For each component which is subject to wear, the *Contractor* shall indicate the expected life under the specified duty cycle, together with any particular maintenance activities that are required to ensure that this life is achieved.

10.8. Availability, reliability and maintainability

10.8.1. The escalator selected shall be of a type which has been thoroughly tested and has a proven track record of performance within a similar environment. The *Contractor* shall provide a RAMS (reliability, availability, maintainability and safety) plan covering the operation of the escalator for a period of 40 years under the specified duty cycle. Evidence shall be provided for the identified service lives of key components.

10.8.2. The *Contractor* shall identify how the proposed system shall achieve the required availability target. This shall be by combination of maintainability and reliability: that is, the system shall be designed for ease of maintenance, with comprehensive self-diagnosis and all major components readily accessible. For electrical systems, 'plug out, plug-in' philosophy shall be adopted wherever practicable. Design for maintainability shall not be a substitute for high reliability. It is not acceptable to offset short MTBF by redundancy or very short MTTR, or both.

10.8.3. The reliability shall be expressed in terms of hours run between failures.

10.9. Component interchangeability and identification

10.9.1. Component parts shall be designed to be removable using portable tools and equipment. No part or parts subject to wear shall be welded or otherwise permanently fixed to adjacent members.

10.9.2. Consumable items shall be designed to be freely interchangeable.

10.9.3. The design shall ensure that replacement parts are accurately located.

10.9.4. Bought-out items shall carry the manufacturer's name and part number.

10.10. Maintenance access

10.10.1. Human Factors principles shall be considered in the design, particularly with regard to providing access for maintenance and inspection.

10.10.2. The escalator shall be designed and installed such that all maintenance operations, including replacement of major components, can be carried out without affecting the service availability of any adjacent escalator(s). i.e. without the need for removal of parts from any adjacent escalator(s).

10.10.3. Refer to annexe.

10.10.4. The *Contractor* shall take care when positioning cable trays, electrical equipment cabinets, conduits, stop pushbuttons, inching sockets and lubrication pipes, to ensure that maintenance access is not impeded. Additionally, stop pushbuttons shall be located so as to be easily accessible, but not prone to accidental operation. The location of all such items shall be agreed with the *Employer* prior to installation.

10.10.5. Refer to annexe.

10.11. Fire performance of materials

10.11.1. Materials used for the construction of the escalator, other than the permitted exceptions described in clause 10.11.2 below, shall meet the fire safety performance requirements as described in Part 4, section 10 of this specification with regard to:

a) Flammability (including the risk of explosion);

b) Smoke emission;

c) Toxic fume emission.

Note: This is in addition to compliance with The Fire Precautions (Sub-surface Railway Stations) (England) Regulations – see clause 10.11.10 below.

10.11.2. The requirements specified in Part 4, section 10 of this specification shall not apply to the following:

a) 'Minor use materials' (see section 5 definition) – single, or joined items, providing they have:

i) a total mass not more than 100g and, in the case of surface coatings;

ii) an area of not greater than 0.2sq.m;

b) Material samples which differ only in colour to those already tested, providing the colourant does not exceed 5% (by weight);

c) Materials located within non-public rooms where the volume of the room is <75m^3; where the rooms' structure meets the requirements of a 60 minute fire rated compartment; and where a fire detection and alarm system, as described in sub-section 10.12, is installed that covers that room;

d) The handheld inching device which is housed within the enclosure described in Part 3, clause 17.1.6 of this specification, when not in use.

10.11.3. The requirements of LUL Standard 1-085 are incorporated within this specification. Where the *Contractor* proposes to use materials that are non-compliant with the fire safety performance requirements, described in Part 4, section 10 of this specification, the *Contractor* shall apply to the *Employer* for a Concession. The Concession application must describe why it is necessary to use the non-compliant items and must contain enough additional detail to allow the *Employer* to determine what risk is associated with its installation and use. This may include:

a) Manufacturer's technical data sheets;

b) COSHH (Control of Substances Hazardous to Health) data sheets;

c) Fire test data (even if the material does not meet the performance levels required in the standard, it is often helpful to know by what extent it has failed);

d) Drawings and/or method statements for the installation;

e) Component lists;

f) For small items, samples.

Note: The *Contractor* is advised that applications for Concession, due to nonconformity to the fire performance requirements of Part 4, section 10 have been granted previously for certain manufacturers/types of the following:

a) Permali FR782 step chain guide material;
b) Rubber/polyester handrail material;
c) Polyurethane wheel tyre material;
d) Grease and oil lubricants.

10.11.4. Any Concession application, as described in clause 10.11.3 above must be accompanied by a risk assessment. The assessment shall include consideration of all the following factors:

a) Ease of escape;

b) Level and integrity of lighting;

c) Fire compartmentation and time rating;

d) Ventilation;

e) Dispersal volume for smoke and toxic fumes;

f) Suppression systems available, and their effect upon visibility when discharged;

g) Detection systems available and ease of detection;

h) Potential ignition sources;

i) Risk of vandalism;

j) Risk of explosion;

k) Existing logged non-fire compliances on site and fire load of non-fire compliant material;

l) Effect of fire on other safety critical (signalling) equipment and balance of other non-fire risks;

m) Operational effect;

n) Spaces and cavities for air behind surfaces, and areas for combustible rubbish to accumulate;

o) Training and operating practices;

p) Persons at risk.

Note: The *Employer* can give guidance to support the items to be considered, in preparing the risk assessment.

10.11.5. The *Contractor* shall provide a schedule of combustible materials to be used for the construction of the escalator.

10.11.6. The *Contractor* shall provide certification for all combustible materials used in the construction of the escalator, to demonstrate compliance with the requirements of Part 4, section 10 of this specification.

10.11.7. The *Contractor* must obtain agreed Concessions for any non-compliant materials prior to installation (see clause 8.2.1).

10.11.8. The *Contractor* shall be responsible for undertaking any testing required to confirm compliance with the requirements of this specification.

10.11.9. Fire performance testing shall be undertaken by UKAS (or equivalent) accredited test houses.

10.11.10. The fire performance requirements of this specification are separate and independent of the fire resistance, fire protection and fire prevention requirements of The Fire Precautions (Sub-surface Railway Stations) (England) Regulations.

Note: A materials installation that complies with those Regulations may not necessarily comply with the fire performance requirements of this specification – this is, in part because the Regulations do not address the smoke and toxic fume emission requirements, which are covered in Part 4, section 10 of this specification.

10.12. Fire protection

10.12.1. Refer to annexe.

10.12.2. The design of the truss and the balustrade steelwork shall permit the attachment of sprinkler heads and associated range pipework. The truss and the balustrade steelwork shall not be required to support large bore water mains.

10.12.3. The *Employer* will co-ordinate the design (by others) of the necessary fixings to the escalator truss. The fixing of brackets to the truss by means of welding, or by the drilling of holes in the truss, shall

not be permitted. The *Contractor* shall confirm the acceptability of the proposed fixings prior to site installation work commencing.

10.13. Surface coatings

10.13.1. All ferrous parts except for transmission elements shall be painted, powder coated or electro-plated for corrosion protection.

10.13.2. All paint and powder surface coating finishes shall be compliant with the fire performance requirements defined in Part 4, section 10 of this specification. A list of paint and powder coat finishes, which currently meet the fire performance requirements described in Part 4, section 10 is given in Appendix 1.2. This list is subject to potential change during the period of the contract. Any change to the list will be notified to the *Contractor* by the *Employer*, at the earliest opportunity. Inspection and validation of all surface coating finishes shall form part of final inspections of components and assemblies.

10.13.3. The use of hot dip galvanising is mandatory when the escalator is to be in a semi-outdoor location (see site-specific documentation). For underground locations, hot dip galvanising is optional unless the site-specific documentation indicates otherwise.

10.13.4. Steelwork to be painted shall be free from corrosion. Grit blasting is the preferred method of cleaning, and shall be carried out to Sa 2½ quality in accordance with BS 7079 clause 3.1. Manual cleaning processes using percussion needle guns, wire brushes and scrapers shall be adopted only where blast cleaning is not practicable. In this instance preparation to St3 shall apply.

10.13.5. Coating colours shall be as follows:

a) Skirting panels shall be painted black, except when stainless steel they shall be unpainted;

b) Machinery guards shall be to BS 4800 - poppy red 04E53;

c) Passenger emergency stop switches shall have a silver body with red lid and red base;

d) Controller and isolator shall be painted the same colour;

e) Balustrade steelwork to be black or zinc coated;

f) There is no preference of colour for motors and gearboxes.

10.13.6. Unless specified above, for safety colour conformance or specific engineering requirements, non-ferrous, stainless steel and plastic surfaces shall be free of surface coatings.

10.13.7. On-site re-finishing of structural steelwork shall be carried out in accordance with the following:

a) Surfaces shall be cleaned to remove all deposits, corrosion products, swarf, loose or blistered paint, dirt and any other matter which might prevent the satisfactory adherence of the new paint coatings to either metal substrate or to existing sound paint surfaces;

b) Manual methods shall be used. All loose, flaking or blistered paint and loose corrosion deposits shall be removed using scrapers and wire brushes. Care shall be taken to avoid creating ridges, burrs, cuts and other defects. The resulting dust, together with any residual oil and grease deposits, shall be removed. Preparation shall leave a surface corresponding to St3 quality as defined in BS 7079 Part A1;

c) Where applicable, existing paint shall be scraped back to a firm edge and the edges feathered using a powered flap wheel or other suitable tool;

d) Painting shall commence as soon as the surface has been prepared to minimise degradation of the prepared surface. If any significant deterioration of the surface occurs before painting, further preparation to the appropriate standard shall be carried out;

e) Paint shall conform to clause 10.13.2 and the colour shall match that of the surrounding paint, in accordance with clause 10.13.5;

f) Application shall be in accordance with manufacturer's recommendations;

g) All areas of metalwork made bare during preparation shall be primed with the primer extending a minimum of 25mm over adjacent sound painted areas before undercoats and finishing coats are applied;

h Stripe coats shall be applied to all edges, joints, corners and welds. The stripes shall extend 25mm in all possible directions from the feature;

i) Manufacturer's recommendations with respect to inter-coat abrading shall be followed. This is especially important for the harder types of paint such as two-pack epoxy.

Note: The requirements of LUL Standard E3722 are incorporated within this clause.

10.14. Datum points

10.14.1. Datum points shall be clearly defined and permanently marked in convenient locations on fixed parts of the escalator truss and station fabric at both landings, as agreed with the *Employer*. The *Contractor* is responsible for surveying the site to establish these points. If the datum points have already been established by others, the *Contractor* shall confirm that they are correct and provide supporting documentation. Datum points shall be related to the EWP's, and shall be marked with an accuracy of ± 1mm.

10.15. Noise, vibration and ride quality

10.15.1. Noise levels measured at 1m range from any point of the escalator shall not exceed 80dB(A). Noise level measurements shall exclude frequencies exceeding 2kHz.

10.15.2. Noise levels on the passenger side shall not exceed 60dB(A) measured at 1m from any point of the escalator equipment.

10.15.3. Vibration levels arising from the drive machine shall be to BS ISO 10816-3 zone A.

10.15.4. Vibration levels for travel on the escalator shall be measured and processed in accordance with ISO 18738-2 (DPC: 10/30195968DC) and as described in Part 4, sub-section 12.10 of this specification.

Note: Of particular importance is the frequency caused by the interaction between the step chain and the step chain sprocket. For example, an escalator running at 0.75m/s with a nominal step chain pitch of 133mm will have an approximate frequency of 5.64 Hz.

10.15.5. At the escalator completion stage, the achieved ride quality shall not exceed the values in row A of table 1.1. For the remainder of the asset life, the maximum FFT vibration level for each maintained escalator shall not exceed the value in row B of table 1.1:

Row	Maximum at frequency equivalent to 0.75m/s in FFT using 8 sec FFT length (mg)	Maximum RMS (mg)	Average RMS (mg)
A	17.5	15.0	12.0
B	20.0	n/a	n/a

Table 1.1: Achieved ride quality

Note: Table 1.1 is repeated in Part 4 sub-section 12.10.

10.15.6. Measurement of FFT and RMS shall be taken at a speed of 0.75m/s, without load, over the length of the incline, in both the normal direction of operation and in the opposite direction. It is acknowledged that, where escalators have been running in the same direction for a protracted period of time, adjustments will be required to enable such escalators to be reversed. In such circumstances the Contract Manager decides whether measurements in the opposite direction are required and where the Contract Manager decides that such measurements are required, he shall issue an instruction to that effect and agrees the necessary preparatory works and adjustments necessary to take such measurements and then return the escalator to operate in its normal direction of operation.

10.15.7. Any adverse variance with the FFT threshold specified at row B of table 1.1, above, will be a deficiency. The procedure for correcting such deficiency shall be as set out in paragraph 2.4.2 of Schedule 2 of the Maintenance Terms. The *Employer* shall include such deficiencies in a Form PM45 report and treat as Form PM45 defects for the purposes of the application of paragraph 2.7 of Schedule 8 of the Maintenance Terms.

10.15.8. RMS values shall be measured and assessed over the life of the asset as a means of determining the ride quality deterioration rates and remedial action thresholds.

10.16. Bearings

10.16.1. Components subject to continuous rotation shall be fitted with rolling element type bearings. Sealed for life bearings, with twin rubber seals, shall be used where the loading conditions and r.p.m.'s enables them to be used for the expected service life. Where lubrication is required, a lubrication nipple shall be provided in the housing and bearings shall be fitted with end shields.

10.17. Castings

10.17.1. Castings shall be free from blow-holes, sand inclusion, porosity, and chilled spots. They shall be examined for rounded, linear and planar defects using an appropriate NDE technique and shall be proven sound to a declared acceptance level, which shall be agreed with the *Employer*.

10.18. Lubrication

10.18.1. All moving and/or rotating components shall be lubricated with appropriate lubricant.

10.19. Auxiliary drive chains and sprockets

10.19.1. All chains shall be ISO 'B' series standard steel roller chains, in accordance with ISO 606. The minimum practical number of joining links shall be used and in any event shall not be more than 3 in number per chain. Joining links shall be retained by spring clips or split pins.

10.19.2. Sprockets shall be steel, shall have machine-cut teeth and shall be readily detachable from the shaft on which they are mounted.

10.20. Fixings

10.20.1. Wherever possible, screw threads shall be of ISO metric coarse pitch preferred sizes to BS 3643-1. The *Contractor* shall obtain the agreement of the *Employer* for any instances where this requirement is not met.

10.20.2. Threads shall be locked by mechanical or chemical means, although for the truss, main drive and idler shaft fitted bolts, this requirement is optional. Hexagon locknuts shall be of an all-metal type. All bolts that transmit torque shall be precision fitted into accurately bored or reamed holes.

10.20.3. All fasteners (except fitted bolts) shall be zinc plated in accordance with BS EN ISO 1461 for protection against corrosion. Cadmium plated fasteners shall not be used.

10.20.4. Threaded fasteners shall be tightened to the appropriate torque value in accordance with the requirements specified on the drawings and the *Contractors* standards. Torque values for all critical fixings shall be identified.

10.20.5. Washers shall be of suitable diameter and thickness, in relation to holes and slots, to provide adequate support and contact area.

10.20.6. When fixing into concrete, brickwork or blockwork, chemical resin anchors shall be used.

10.20.7. Where it is necessary to attach items to structural steelwork, clamp-type bolts such as Lindaptors shall be used.

10.20.8. In potentially wet locations, stainless steel fixings shall be used.

10.20.9. No fixings other than those specified within this document shall be used without the prior written agreement of the *Employer*.

10.21. Shims

10.21.1. Where shims are used for adjustment, a maximum of four shims shall be used at any one location, with total thickness not exceeding 3mm.

10.21.2. Where the adjustment gap exceeds 3mm, a thick packer shall be substituted for some of the shims.

10.21.3. All shims shall be made of metal.

10.22. Dimensional constraints

10.22.1. The following clearances shall be provided:

Note: these requirements are more stringent than those of BS EN 115-1

a) The clearances between treads of adjacent steps, and between treads and risers of adjacent steps, shall be between 1mm and 4mm. The clearance gaps shall be equal at both left and right hand sides of the steps;

Note: An increase in step to riser clearance of up to 10% is acceptable in the area of the transition curves, subject to the written agreement of the *Employer*.

b) Where guidance of the step is achieved by the wheels or step chain, the clearance between the sides of the steps and the adjacent skirting shall be between 1mm and 3mm, and the sum of the clearances at both sides shall not exceed 5mm;

c) The sum of the clearances between handrail lip and balustrade mouldings at any point on the escalator shall not exceed 6mm;

d) Clearance shall be provided between roller chains and adjacent fixed structures to allow for the maximum sag permitted in the chain manufacturer's recommendations.

10.22.2. At the landings, the steps shall be level within 2mm measured over the whole of the visible flat landing area.

10.23. Welding

10.23.1. Welding shall be carried out to BS EN 1011-1 or agreed equivalent.

10.23.2. The *Contractor* shall prepare a schedule outlining his fabrication process for acceptance by the *Employer*. The schedule shall include a welding procedure specification to BS EN ISO 15609-1 for each type of joint, and a welding plan (weld map) shall be prepared, to show particular weld procedure specifications against particular types of joint. Welding symbols shall be to BS EN 22553 or agreed equivalent.

10.23.3. The management and supervision of the fabrication process shall be clearly defined. Inspection hold points shall be identified in the procedure, for each stage of the process.

10.23.4. Items requiring post weld heat treatment (PWHT) shall be clearly identified and be accompanied by details of the procedure for PWHT.

10.23.5. Repairs to any weld joint, other than those classified as non-critical (NDE classification reference L4), shall only be made with the prior agreement of the *Employer*. The following information shall be submitted:

a) Details of the weld defect(s), including type, size, position, total number of items affected and any other relevant information;

b) A repair method statement detailing the removal of the defect(s), preparation of the weld area, weld method and subsequent NDE.

10.23.6. Welds shall be subject to NDE as detailed in Part 4, section 5 of this specification.

10.24. Signs and notices

10.24.1. Refer to annexe.

10.24.2. Except where otherwise stated in clause 10.24.4, signs and notices shall be manufactured by one of the methods below:

a) 1mm minimum thickness aluminium sheet, silk-screen printed or enamelled, with radiused corners and all sharp edges removed. To enable fixing they shall be pre-drilled with a hole of suitable diameter in each corner;

b) Engraved aluminium, brass or stainless steel plate with the lettering in-filled in a contrasting colour.

10.24.3. Text, pictograms and colours shall be coded in accordance with BS ISO 7010.

10.24.4. The 'Treatment for electric shock' notice, shall be made of plasticised card to enable it to be easily handled if required for emergency use. It shall not be fixed, but shall be slipped into a three-sided retaining frame to enable easy withdrawal.

10.24.5. If separate tools are required for hand-winding, a shadow outline of the hand-winding tools shall be painted in a contrasting colour, on the wall or surface upon which the tools are located.

10.24.6. Signs and notices shall be fixed with screws, rivets or masonry nails, as appropriate, and shall not reduce the enclosure protection rating of any equipment. Signs shall not be affixed with adhesives unless specifically instructed by the *Employer*.

10.24.7. Details of safety notices on the controller cabinet(s) are given in Part 3, sub-section 28.9 of this specification.

10.24.8. Refer to annexe.

10.25. Handling, packaging, storage and delivery

10.25.1. All major components shall be adequately packaged to prevent damage during storage and delivery to site. The type and size of packaging shall take account of the handling constraints of each working site. In the case of handrails, storage shall meet the requirements of BS ISO 2230. The site-specific documentation will give more information on the individual delivery arrangements.

10.26. Power supply harmonics

10.26.1. Refer to annexe.

10.27. Condition monitoring

10.27.1. Refer to annexe.

11. Review documentation

11.1. To be provided following contract award

11.1.1. A design submission schedule shall be submitted for acceptance by the *Employer*, including key dates for the supply of finalised drawings, calculations and data sheets.

11.1.2. Technical information shall be submitted for acceptance by the *Employer* and to enable site works to be planned, including all interfaces with others. This shall include:

a) Survey reports;

b) A conceptual design statement for the escalator truss;

c) An assembly drawing of the escalator truss giving locations of joints and supports;

d) Details of static and dynamic loadings applied to the support structure;

e) Documentation to support agreed EWP's;

f) A plan of the equipment in the machine room;

g) A detailed design control plan, including evidence to demonstrate that Human Factors have been considered;

h) A detailed test plan, demonstrating how the testing requirements (Part 4 of this specification) will be met;

i) Evidence to demonstrate compliance with the design requirements for harmonics immunity, as described in Part 3, section 11 of this specification;

j) An EMC control plan and installation policy;

k) EMC HAZID survey report;

l) Proposed cable route for remote / condition monitoring systems;

m) Method statements for the delivery of materials to site;

n) Heat output of each controller, motor and gearbox;

o) Schedule of combustible materials.

11.1.3. A RAMS plan and supporting evidence shall be submitted to the *Employer* for acceptance.

11.2. To be provided prior to manufacture

11.2.1. Fully detailed technical information shall be submitted, for formal review and acceptance. This shall include as a minimum:

a) A design risk assessment;

b) All parts lists, manufacturing drawings and processes for the escalator components;

c) Calculations to verify the selection of motors, gearboxes, chains, chain anchors, brakes and other major components, confirming that the performance requirements of this specification will be met;

d) Detailed calculations to verify the design of the tracks and track brackets;

e) Step type test report;

f) FMEA studies;

g) FEA reports, as appropriate;

h) Manufacturers' data sheets for all bought-out items, including characteristic graphs, material composition, etc. where appropriate;

i) Electrical circuit diagrams;

j) Site-specific field wiring, cable containment layout and earthing drawings;

k) An EMC test plan or EMC test report;

l) Documentary evidence demonstrating Notified Body assessment of safety critical software, safety critical devices, communication interface and any associated software change control;

m) Simulation test and inspection (pro forma) sheets, showing simulation test requirements and expected operation of the electrical system against set run and fault signals, for factory and site testing;

n) Designer's check certificates;

o) Method statement for handrail splicing and vulcanisation procedure and the anticipated strength of the finished joint;

p) Design solutions for any special interface works, as identified in the site-specific documentation.

11.3. To be provided prior to commissioning

11.3.1. The following items shall be provided:

a) All test certificates;

b) Declaration of Conformity Certificates as appropriate;

c) EMC Technical File;

d) Factory and site installation test sheets;

e) Confirmation of step serial numbers allocated and data from RFID tags;

f) A full size printed copy of the wiring schematic and component layout for the control system, to be inserted in the pocket in the control cabinet;

g) A hard copy of the draft operation and maintenance manual.

11.4. To be provided on completion of successful commissioning tests

11.4.1. The following items shall be provided:

a) Raw data from deceleration measurements taken during brake tests;

b) Raw data from vibration level measurements taken for ride quality tests;

c) A hard copy of the operation and maintenance manual.

12. Records

12.1. Delivery media format

12.1.1. Data shall be delivered using one of the following media formats, as appropriate:

a) CD-ROM to BS 7061 (all data including manuals, and software);

b) Hard copy (manuals only).

12.1.2. CD-ROMs shall be clearly labelled with the content description, originator's name, date of writing and (where appropriate) the file format used.

12.1.3. Electronic data shall be in Adobe PDF format.

12.1.4. Electronic data shall be virus-free.

12.2. Asset data

12.2.1. Refer to annexe.

12.3. As-built drawings and parts lists

12.3.1. A schedule of all drawings and parts lists used in the manufacture and installation of the escalator shall be provided, in electronic format. The schedule shall include, as a minimum, the following information:

a) Drawing/parts list number;

b) Revision status and date;

c) Title;

d) Originator (company name).

12.3.2. A complete set as-built of drawings of the escalator, including general arrangements, assemblies, sub-assemblies, component details, site installation plans and electrical diagrams, shall be provided in electronic format.

12.4. Controller software

12.4.1. Copies of controller software shall be supplied.

12.4.2. All software shall be password write protected. Passwords shall be agreed with the *Employer*.

12.5. Declaration of Conformity certificates

12.5.1. Certificate(s) of Declaration of Conformity stating that the completed installation is in compliance with:

a) The Low Voltage Directive 2006/95/EC;

b) Safety of Machinery Directive 2006/42/EC;

c) EMC Directive 2004/108/EC, BS EN12015 and BS EN 12016;

d) Statutory Instrument 2006/3418.

12.6. Operation and maintenance manual

12.6.1. The manual shall be of a comprehensive 'Field Service' type, and shall contain sufficient information for the escalator to be operated, maintained, overhauled and repaired using fault finding techniques.

12.6.2. The manual shall be provided in both of the following formats:

a) Hard copy A4 size loose-leaf format, contained within a hardback 4-hole ring-bound folder and fully indexed;

b) Electronic copy of the complete hard copy document.

12.6.3. The following particular items shall be included, as a minimum:

a) Table of contents;

b) General description of the escalator;

c) Operating instructions including applicable safety procedures;

d) Instructions for the replacement of all serviceable component parts of the escalator;

e) Details of all routine adjustment or settings;

f) Procedure for periodic testing of the mechanical brakes, including the curve characteristics of springs and solenoids;

g) Procedure for periodical testing of safety devices;

h) Completed escalator data entry form;

i) Bearing schedule;

j) Recommended lubricants;

k) Recommended servicing intervals;

l) Recommended NDE requirements including frequencies;

m) Recommended electrical inspection and testing requirements for 3 yearly periodic inspections;

n) Service parts list and recommended spares holding;

o) EMC maintenance requirements;

p) Assembly drawings and electrical circuit diagrams;

q) Controller software programme file names;

r) Manufacturers' product information sheets for any bought-out items;

s) Cleaning procedures;

t) Details of any modifications made during the installation and testing periods.

12.6.4. The *Contractor* shall provide any revisions to the maintenance manual, which may arise during the defects liability period.

12.7. Safe use and operation hand book

12.7.1. The operating instructions for the escalator shall be provided as a hand book for use by station staff. This hand book shall be provided in electronic format.

12.8. Training

12.8.1. The *Contractor* shall:

a) Provide a training module on the safe use and operation of the escalator;

b) Provide an on-site training course, in the safe use and operation of the escalator, to 5 nominated staff members.

Document history

Revision	Date	Notes
01	October 2010	First issue.
02	April 2011	For document change detail see separate document.
03	May 2011	Approved for use in Pan-TfL escalator PQQ. For document change detail see separate document.
04	August 2011	For document change detail see separate document.
05	-	Rev. 05 of Part 1 does not exist (rev. suffix of parts aligned @ rev.06).
06D	February 2012	DRAFT for use – Pan-TfL. For document change detail see separate document.
06	April 2012	APPROVED for use – Pan-TfL. Changes since DRAFT rev.06 = 'Engineering Hours' definition added to clause 5.1. Clause 7.1 i) and j) revised, 10.6.1 and 10.6.2 revised. No other changes.
07	July 2012	APPROVED for use – Pan-TfL. 'FFT' & 'RMS' added to clause 4.1. 'Ride quality definition added to clause 5.1. 'Ride quality added to sub-section 10.15 heading. Clause 10.15.4 revised. Clause 10.15.5 - 10.15.7 added. Clause 11.4.1 changed. 'Draft BS ISO 18738-2 (DPC: 10/30195968DC)' added to Appendix 1.1 references. LUL 10.24.1 table 1.2.was table 1.1. No other changes.

Appendix 1.1 - References

Only references which are contained in the text of this specification are listed below. This is not intended to be an exhaustive list. References in the text are made to latest editions unless specific editions are cited.

National and international standards

BS 476-6	Fire tests on building materials and structures — Part 6: Method of test for fire propagation for products
BS 476-7	Fire tests on building materials and structures - Part 7: Method of test to determine the classification of the surface spread of flame of products
BS 1449-1.1	Steel plate, sheet and strip – Part 1: Carbon and carbon-manganese plate, sheet and strip – Section 1.1 General specification
BS 3643-1	ISO metric screw threads Part 1: Principles and basic data
BS 4235-1	Specification for metric keys and keyways. Parallel and taper keys
BS 4800	Schedule of paint colours for building purposes
BS 4999-141	General requirements for rotating electrical machines. Specification for standard dimensions
BS 6716	Guide to properties and types of rubbers
BS 6853	Code of practice for fire precautions in the design and construction of passenger carrying trains
BS 7061	Specification for volume and file structure of compact read only optical disks (CD-ROM) for information interchange
BS 7079	General introduction to standards in preparation of steel substrates before application of paints and related products. Introduction
BS 7608	Code of practice for fatigue design and assessment of steel structures
BS 7671	Requirements for electrical installations. IEE Wiring Regulations. Seventeenth edition
BS 7801	Escalators and moving walks - Code of Practice for safe working of escalators and moving walks
BS 8300	Design of buildings and their approaches to meet the needs of disabled people - Code of practice
BS EN 115-1	Safety of escalators and moving walks. Part 1: Construction and installation
BS EN 1011-1	Welding - Recommendations for welding of metallic materials. Part 1: General guidance for arc welding
BS EN 1289	Non destructive examination of welds. Penetrant testing of welds. Acceptance levels
BS EN 1291	Non-destructive testing of welds. Magnetic particle testing of welds. Acceptance levels
BS EN 1711	Non-destructive examination of welds. Eddy current examination of welds by complex plane analysis
BS EN 1712	Non destructive examination of welds. Ultrasonic examination of welded joints. Acceptance levels
BS EN 1990	Eurocode – Basis of structural design
BS EN 1991	Eurocode 1: Actions on structures
BS EN 1993	Eurocode 3: Design of steel structures
BS EN 1999	Eurocode 9: Design of Aluminium structures
BS EN 12015	Electromagnetic compatibility – Product family standard for lifts, escalators and moving walks - Emission
BS EN 12016	Electromagnetic compatibility – Product family standard for lifts, escalators and moving walks - Immunity
BS EN 13015	Maintenance for lifts and escalators – Rules for maintenance instructions
BS EN 13501-1	Fire classification of construction products and building elements – Part 1: Classification using data from reaction to fire tests - AMD
BS EN 22553	Welded, brazed and soldered joints. Symbolic representation on drawings
BS EN 50085-1	Cable trunking systems and cable ducting systems for electrical installations –

	Part 1: General requirements
BS EN 50085-2-1	Cable trunking systems and cable ducting systems for electrical installations – Part 2-1: Cable trunking systems and cable ducting systems intended for mounting on walls and ceilings
BS EN 60034-1	Rotating electrical machines – Part 1:Rating and performance
BS EN 60034-8	Rotating electrical machines – Part 8: Terminal markings and direction of rotation
BS EN 60034-9	Rotating electrical machines – Part 9: Noise limits
BS EN 60034-14	Rotating electrical machines – Part 14: Mechanical vibration of certain machines with shaft heights 56mm and higher. Measurement, evaluation and limits of vibration severity
BS EN 60085	Electrical insulation – Thermal evaluation and designation
BS EN 60204-1	Safety of machinery - Electrical equipment of machines – Part 1: General requirements
BS EN 60309-2	Plugs, socket-outlets and couplers for industrial purposes – Part 2: Dimensional interchangeability requirements for pin and contact - tube accessories
BS EN 60332-3-24	Tests on electric and optical fibre cables under fire conditions – Part 3-24: Test for vertical flame spread of vertically-mounted bunched wires or cables – Category C
BS EN 60332-3-25	Tests on electric and optical fibre cables under fire conditions – Part 3-25: Test for vertical flame spread of vertically-mounted bunched wires or cables – Category D
BS EN 61439-1	Low-voltage switchgear and controlgear assemblies. General rules
BS EN 60529	Degrees of protection provided by enclosures (IP code)
BS EN 60812	Analysis techniques for system reliability - Procedure for failure modes, effects analysis (FMEA)
BS EN 60947-1	Specification for low-voltage switchgear and control gear – Part 1: General rules
BS EN 61000-3-2	Electromagnetic compatibility (EMC) – Part 3-2: Limits for harmonic current emissions (equipment input current Less than or equal to 16A per phase)
BS EN 61000-4-4	Electromagnetic compatibility (EMC) - Part 4-4: Testing and measurement techniques - Electrical fast transient/burst immunity test
BS EN 61000-4-8	Electromagnetic compatibility (EMC). Testing and measurement techniques. Power frequency magnetic field immunity test
BS EN 61000-4-9	Electromagnetic compatibility (EMC). Testing and measurement techniques. Pulse magnetic immunity test
BS EN 61000-4-16	Electromagnetic compatibility (EMC). Testing and measurement techniques. Test for immunity to conducted, common mode disturbances in the frequency range 0 Hz to 150 kHz
BS EN 61034-1	Measurement of smoke density of cables burning under defined conditions – Part 1: Test apparatus
BS EN 61034-2	Measurement of smoke density of cables burning under defined conditions – Part 2: Test procedure and requirements
BS EN 61131-1	Programmable controllers – Part 1: General information
BS EN 61131-2	Programmable controllers – Part 2: Equipment requirements and tests
BS EN 61131-5	Programmable controllers – Part 5: Communications
BS IEC 61000-3-4	Electromagnetic compatibility (EMC) – Part 3-4: Limits – Limitation of emission of harmonic currents in low-voltage power supply systems for equipment with rated current greater than 16A
BS ISO 48	Rubber, vulcanized or thermoplastic. Method for determination of hardness (hardness between 10 IRHD and 100 IRHD)
BS ISO 2230	Rubber products - Guidelines for storage
BS ISO 2631-4	Mechanical vibration and shock. Evaluation of human exposure to whole-body vibration. Part 4: Guidelines for the evaluation of the effects of vibration and rotational motion on passenger and crew comfort in fixed-guideway transport systems
BS ISO 7010	Graphical symbols – Safety colours and safety signs – Registered safety signs
BS ISO 7267-2	Rubber covered rollers – Determination of apparent hardness. Part 2: Shore-type durometer method
BS ISO 10005	Quality management systems - Guidelines for quality plans
BS ISO 10816-3	Mechanical vibration – Evaluation of machine vibration by measurements on non-

	rotating parts. Part 3: Industrial machines with nominal power above 15 kW and nominal speeds between 120 r/min and 15 000 r/min when measured *in situ*
BS EN ISO 37	Rubber, vulcanized or thermoplastic. Determination of tensile stress-strain properties
BS EN ISO 252	Conveyor belts. Adhesion between constitutive elements. Test methods
BS EN ISO 1461	Hot dip galvanised coatings on fabricated iron and steel articles - Specifications and test methods
BS EN ISO 4589-2	Plastics – Determination of burning behaviour by Oxygen Index Part 2: Ambient-temperature test
BS EN ISO 4589-3	Plastics – Determination of burning behaviour by Oxygen Index Part 3: Elevated temperature test
BS EN ISO 5817	Welding. Fusion-welded joints in steel, nickel, titanium and their alloys (beam welding excluded). Quality levels for imperfections
BS EN ISO 9001	Quality management systems – Requirements
BS EN ISO 9004	Managing for the sustained success of an organisation – A quality management approach
BS EN ISO 10012	Measurement management systems – requirements for measurement processes and measuring equipment
BS EN ISO 15609-1	Specification and qualification of welding procedures for metallic materials. Welding procedure specification. Arc welding
BS HD 60269-2	Supplementary requirements for fuses for use by authorized persons (fuses mainly for industrial application).Examples of standardized systems of fuses A to J
PD 5304	Guidance on safe use of machinery
Draft BS ISO 18738-2 (DPC: 10/30195968DC)	Escalators and moving walkways – Measurement of ride quality

LUL Engineering Standards

1-085	Fire safety performance of materials
E3722	Maintenance and protection of metal structures against corrosion

Other Standards, Acts and Regulations

2002/95/EC (RoHS)	Directive 2002/95/EC of the European Parliament and of the Council of 27 January 2003 on the restriction of the use of certain hazardous substances in electrical and electronic equipment
2002/96/EC (WEEE)	Directive 2002/96/EC of the European Parliament and of the Council of 27 January 2003 on waste electrical and electronic equipment (WEEE)
2004/108/EC	The Electromagnetic Compatibility Directive, which is implemented into UK law by the Electromagnetic Compatibility Regulations 2006
2006/95/EC	Council direction on the harmonisation of the laws of member states relating to electrical equipment designed for use within certain voltage limits
2006/42/EC	The Safety of Machinery Directive
ENV 50204:1996	Radiated Electromagnetic Field from Digital Radio Telephones Immunity Test
HASAWA74	Health and Safety at Work Act 1974
IEC /TR 61158	Digital data communications for measurement and control. Fieldbus for use in industrial control systems
ISO 606	Short pitch transmission precision roller and chain wheels
PM45	Escalators: periodic thorough examination
	Railway Safety Principles and Guidance: part 1 and 2 (HSE/ORR)
	The Building Regulations. Approved Document ‘B’ Fire Safety
	The Building Regulations. Approved Document ‘M’ Access and Facilities for Disabled People
	National Institute for Occupational Safety and Health (NIOSH) Guide to Chemical Hazards
SI 1989/635	Health and Safety – The Electricity at Work Regulations1989

SI 1992/2793	Health and Safety – The Manual Handling Operations Regulations 1992
SI 2008/1579	Health and Safety – Supply of Machinery (Safety) Regulations 2008
SI 2006/3418	The Electromagnetic Compatibility Regulations 2006.
SI 2009/782	The Fire Precautions (Sub-surface Railway Stations) (England) Regulations 2009

Appendix 1.2 - Approved surface coatings

Note: The finishes listed below have been tested and meet the fire performance of materials requirements of Part 4, section 10 of this specification, for the categories specified. Other finishes may be used if the *Contractor* can demonstrate compliance with the requirements of this specification

Paint systems for ferrous metals

Code	Substrate	Type	System	Maximum total dry thickness	Category
US1	Iron or steel	Oil-based gloss	i) Zinc phosphate primer ii) Oil based undercoat iii) Oil based gloss	80µm	Wall and ceilings
US2	Iron or steel	Oil-based eggshell	i) Zinc phosphate primer ii) Oil based eggshell iii) Oil based eggshell	80µm	Wall and ceilings
US3	Iron or steel	2 pack solvent borne epoxy	i) 2 pack epoxy finish ii) 2 pack epoxy finish	190µm	Wall and ceilings
US4	Iron or steel	2 pack solvent borne epoxy	i) 2 pack epoxy primer ii) 2 pack epoxy finish	80µm	Wall and ceilings
US5	Iron or steel	Bitumen	i) Bitumen paint	300µm	Wall and ceilings
US6	Iron or steel	MIO system	i) Zinc phosphate primer ii) Coloured MI0 iii) Coloured MI0	160µm	Wall and ceilings
US7	Iron or steel (not ceilings)	Polyurethane pigmented gloss anti-graffiti	i) Epoxy primer ii) Gloss finish iii) Gloss finish	130µm	Walls only
US8	Iron or steel (not ceilings)	Polyurethane pigmented satin anti-graffiti	i) Epoxy primer ii) Gloss finish iii) Gloss finish	130µm	Walls only
US9	Grit blasted iron or steel only	Waterborne epoxy paints	i) 2 pack primer ii) 2 pack colour iii) 2 pack colour	100µm	Walls and ceilings
US10	Iron or steel	Zinc rich paint	i) Oil based paint	100µm	Walls and ceilings

Paint systems for zinc coated steel

Code	Substrate	Type	System	Maximum total dry thickness	Category
UG1	Zinc or zinc coated steel	Vinyl MIO system	i) Wash pre-treatment ii) One coat finish	100µm	Walls and ceilings
UG2	Zinc or zinc coated steel	2 pack solvent borne epoxy	i) 2 pack primer ii) 2 pack primer	85µm	Walls and ceilings
UG3	Zinc or zinc coated steel	Vinyl MIO system	i) Wash pre-treatment ii) One coat finish	125µm	Walls and ceilings
UG4	Zinc or zinc coated steel	2 pack solvent borne	i) Wash pre-treatment ii) Epoxy primer iii) Epoxy finish	160µm	Walls and ceilings
UG5	Zinc or zinc coated steel	2 pack solvent borne	i) Wash pre-treatment ii) Epoxy primer ii) Polyurethane undercoat ii) Polyurethane finish	160µm	Walls and ceilings
UG6	Zinc or zinc coated steel	Waterborne coating	i) Wash pre-treatment ii) Waterborne MIO	90µm	Walls and ceilings

Paint systems for aluminium coated steel

Code	Substrate	Type	System	Maximum total dry thickness	Category
UA1	Aluminium or aluminium coated steel	2 pack solvent borne epoxy	i) 2 pack epoxy primer ii) 2 pack epoxy finish	100µm	Walls and ceilings
UA2	Grit blasted aluminium sprayed steel	Polyurethane pigmented gloss anti-graffiti	i) 2 pack finish ii) 2 pack finish	120µm	Walls and ceilings
UA3	Grit blasted aluminium painted steel	2 pack solvent borne epoxy	i) 2 pack colour ii) 2 pack colour	100µm	Walls and ceilings

Paint suppliers guide

System US1	
Zinc phosphate primer:	Macpherson zinc phosphate primer 3181 007
Oil-based undercoat:	Macpherson high opacity undercoat 3081
Oil-based gloss:	Macpherson gloss finish 2001
System US2	
Zinc phosphate primer:	Macpherson zinc phosphate primer 3181 007
Oil-based eggshell:	Macpherson low odour eggshell 2081
System US3	
2 pack epoxy finish:	Ameron Amerlock 400 colour
System US4	
2 pack epoxy primer:	E. Wood Copon EA3 and EA9 primer
2 pack epoxy finish:	E. Wood Copon EA3 and EA9 finish
System US5	
Bitumen paint:	Bitumastic Intex B1162
System US6	
Zinc phosphate primer:	Crown heavy duty zinc phosphate primer brushing 5PD
Coloured M10:	Crown MIO undercoat or finish brushing 2MB
System US7	
Epoxy primer:	TOR Torlife masonry primer EP105
Gloss finish:	TOR Torlife satin finish PU803
System US8	
Epoxy primer:	TOR Torlife masonry primer EP105
Satin finish:	TOR Torlife satin finish PU803
System US9	
2 pack primer:	Ameron Amercoat 2201A
2 pack colour finish:	Ameron Amercoat 300A
System US10	
Oil-based paint:	Galvatech Zinga

System UG1 Wash pre - treatment: One coat finish:	 Croda Mebon Mordant solution 1410 or 'T Wash' from various suppliers Croda Mebopro DM
System UG2 2 pack epoxy primer: 2 pack epoxy finish:	 E. Woods Copon EA9 and EA3 primer E. Woods Copon EA9 and EA3 finish
System UG3 Wash pre-treatment: One coat finish:	 Croda Mebon Mordant solution 1410 or 'T.Wash' from various suppliers Dacrylate Vinadac 41 High build M10
System UG4 Wash pre-treatment: Epoxy primer: Epoxy finish:	 Croda Mebon Mordant solution 1410 or 'T.Wash' from various suppliers Sigma Sigmacover primer Sigma Sigmacover CM
System UG5 Wash pre-treatment: 2 pack epoxy: 2 pack epoxy undercoat: 2 pack epoxy P.U.finish:	 Croda Mebon Mordant Solution 1410 or 'T.Wash' from various suppliers Leigh Epigrip K267 HS High build M10 Leigh Resistex K251 polyurethane undercoat Leigh Resistex K651 finish
System UG6 Wash pre-treatment: Waterborne M10:	 Croda Mebon Mordant solution 1410 or 'T.Wash' from various suppliers Dacrylate Dacquacoate High build M10 120 Line
System UA1 2 pack epoxy primer: 2 pack epoxy finish:	 E. Wood Copon EA3 and EA9 primer E. Wood Copon EA3 and EA9 finish
System UA2 2 pack finish:	 TOR Torlife AU close finish PU801
System UA3 2 pack colour:	 Ameron Amerlock 400 colour

Powder coating systems for ferrous metals

Product	Supplier	Pre-treatment	Thickness	Category
Spectrum 4 polyester BB.M	Du Pont	Iron phosphate conversion coating	50-65µm	Fixed locations not ceilings
Syntha Pulvin polyester G	H B Fuller	Zinc phosphate conversion coating	50-95µm	Fixed locations and rolling stock
Ferro RVP 491 polyester	Ferro Drynamels	Zinc phosphate conversion coating	40-60µm	Fixed locations and rolling stock
Bonalux AG	Ferro Drynamels	Zinc phosphate conversion coating	60-70µm	Fixed locations and rolling stock
Hydralon polyester coral 0254	Hydralon	Zinc phosphate conversion coating	40-60µm	Fixed locations and rolling stock
Rilsan ESY nylon 11 epylon	Elf Atochem	Epoxy primer	85µm	Fixed locations
Rilsan Es nylon 11	Elf Atochem	Epoxy primer	110µm	Fixed locations
Spectrum 4 polyester BB.G	Du Pont	Iron phosphate conversation coating	60-70µm	Exterior exposure

Powder coating systems for aluminium

Product	Supplier	Pre-treatment	Thickness	Category
Spectrum 4 polyester BB.M	Du Pont	Chromate conversion coating	65µm	Fixed locations and rolling stock
Spectrum 4 polyester BB.G	Du Pont	Chromate conversion coating	60-70µm	Fixed locations not ceiling
Syntha Pulvin plus polyester M	H B Fuller	Chromate conversion coating	50-75µm	Fixed locations and rolling stock
Syntha Pulvin plus polyester metallic	H B Fuller	Chromate conversion coating	50-75µm	Fixed locations and rolling stock
Syntha Pulvin polyester G	H B Fuller	Chromate conversion coating	50-95µm	Fixed location
Ferro RVP 491 polyester	Ferro Drynamels	Chromate conversion coating or grit blast	40-60µm	Fixed locations and rolling stock
Bonalux AG	Ferro Drynamels	Zinc phosphate conversion coating	60-70µm	Fixed locations and rolling stock
Hydralon polyester coral 0245	Hydralon	Chromate conversion coating	40-60µm	Fixed locations and rolling stock
Duraplast FR colours	Ferro Drynamels	Zinc phosphate	70µm	Fixed locations and rolling stock
Duraplast FR metallic	Ferro Drynamels	Zinc phosphate conversion coating	130µm	Fixed locations and rolling stock

Appendix 1.3 – Refer to annexe

Annexe – for LUL

LUL 1. Purpose

LUL 1.3. The traditional LUL escalator environment, encompasses upper and lower machine chambers and incline stairway below the passenger area. The escalator shall be designed to maximise use of these areas for maintenance and to minimise the impact of downtime.

LUL 4. Abbreviations

LUL 4.2. The following abbreviations are used in annexes for LUL:

DNO	Distribution Network Operator
EMC	Electromagnetic Compatibility
HAZID	HaZard IDentification
HSE	Health and Safety Executive
LUL	London Underground Limited
LMC	Lower Machine Chamber
ORR	Office of Rail Regulation
QUENSH	Quality, Environmental, Safety and Health
SOR	Station Operations Room
THD	Total Harmonic Distortion
UMC	Upper Machine Chamber
VVVF	Variable Voltage Variable Frequency

LUL 5. Definitions

LUL 5.2. The following terms are used in annexes for LUL:

Machine room – The enclosed space below the concourse, where the escalator machinery, control gear and other equipment is housed.

LUL 6. Safety considerations

LUL 6.2. Escalator installation and testing involve certain operations that might present risks. All operations shall be covered by a risk assessment that demonstrates that the risks have been considered in accordance with QUENSH requirements.

LUL 8. Design

LUL 8.7. Design check certificate

LUL 8.7.1. The *Contractor* shall provide a signed design check certificate for his total design, as required by LUL Engineering Standard 1-538. The category of design check, and the endorsement thereof, shall be in accordance with 1-538 clause 3.16. Where appropriate, the design shall be broken down into elements, with different design check categories being allocated to each element.

LUL 8.7.2. The designer's check certificate shall be provided to the *Employer* prior to manufacture of the escalator, to enable the *Project Manager* to make a "Compliance Submission", as required by LUL Engineering Standard 1-538.

LUL 9. Basic design parameters

LUL 9.1. Rise

LUL 9.1.1. The *Employer* will advise the nominal vertical rise (subject to confirmation by survey by the *Contractor* after contract award) in the site-specific documentation.

LUL 9.2. Angle of inclination

LUL 9.2.1. The angle of inclination shall be 30° unless otherwise specified in site-specific documentation.

LUL 9.3. Landing lengths

LUL 9.3.2. LUL drawing numbers 01-02-014 and 01-02-015 provide guidance to understanding the requirements of clause 9.3.1 above.

LUL 10. General technical requirements

LUL 10.10. Maintenance access

LUL 10.10.3. The truss design shall permit maintenance access from each side, from each end, and from below. No items requiring regular adjustment or inspection (e.g. resetting of electric safety devices) shall be sited such that removal of steps or floor plates is necessary to gain access.

LUL 10.10.5. The *Contractor* shall indicate the areas required for the removal of steps and chain from the escalator. Removal of steps shall be possible from the underside of the truss into the upper machine chamber and from the passenger side at either the upper or lower return stations of the escalator.

LUL 10.12. Fire protection

LUL 10.12.1. The design of the escalator shall allow for a fire detection and suppression system to be installed by others, in compliance with LUL Engineering Standards 1-081, 1-082, 1-083 and 1-084. The system comprises the following:

a) Point fire detectors: in the UMC/LMC only, as applicable;

b) Manual call points: in the UMC/LMC only, as applicable;

c) Aspiration smoke detection: in the UMC and at high level in balustrade area on both sides of the escalator;

d) Escalator water suppression system: in the escalator truss, balustrade and machine room;

e) Sounders and strobes in the UMC/LMC and escalator incline.

LUL 10.24. Signs and notices

LUL 10.24.1. Machine room signing shall be provided in accordance with table 1.2.

'Text' (BS ISO 7010 ref.*) *- If applicable	**LUL drawing (for information)**	**Location**
'No Smoking' (P002)	384-944	Upper and lower machine rooms, near entrance.
'Hand-winding Tools'	384-946	Above hand-winding tools (unless these are integral with the drive).
'Fire Point' (F001, F002, F003)	384-948	Above machine room fire fighting equipment.
'Oil Granules Bin'	384-950	Above oil granules bin.
'Unauthorised Access Prohibited' (P004) 'Report to Operations Room/Station Supervisor for Permit' (M001)	384-952	On the outside of machine room access doors and hatches.
'Caution' (W001)	384-953	Wherever a potential hazard exists that is not covered by another sign.
'CAUTION - Door Opens onto Passenger Concourse' (W001)	384-954	On the inside of machine room door access doors or hatches that open directly on to a passenger area.

'Text' (BS ISO 7010 ref.*) *- If applicable	**LUL drawing (for information)**	**Location**
'Keep Machine Room Clean' (M001)	384-958	Near machine room entrance door.
'Mind the Step' (W001)	384-959	Wherever there is an unexpected step.
'DANGER - Moving Machinery' (W001) 'Unauthorised Access Prohibited' (P004)	384-960	On dust tray doors.
Treatment of electric shock	384-962	Local to electrical equipment cabinets.
'No Entry While Escalators are Moving' (P004)	384-965	On the outside of machine room access hatches where it is unsafe to enter whilst the escalators are moving.
'DANGER - Moving Machinery' (W001) 'Unauthorised Access Prohibited' (P004)	384-967	Machine room side of incline access gates. Maintenance barrier.
Flammable material store - Authorised contents	384-968	Inside of flammable material store lid.
'Limits of Permit to Enter Zone'	384-969	Wall of machine room where shared between two different permit zones.
'Flammable Material Store' (W021) 'L&EE Authorised Contents Only' (M001)	384-970	Outside of flammable material store.
'EXIT' (E001, E002 – With arrows when required)	-	Wherever required to indicate the nearest machine room authorised exit route. To BS 5499
'NO EXIT'	-	At the entrance to any passageway that does not lead to an exit route.
Guard location diagram (size 610mm x 508mm)	-	On the upper machine chamber wall

Table 1.2: Signs, notices and labels

LUL 10.24.8. The retention of any signing within a machine room and any signing additional to that given in table 1.2 shall be stated in the site-specific documentation.

LUL 10.26. Power supply harmonics

LUL 10.26.1. The *Contractor* shall satisfy the requirements of LUL Standard 1-100, as described in Part 3, section 2 of this specification.

LUL 10.27. Condition monitoring

LUL 10.27.1. Condition monitoring, as described in LUL specification SPC-LAE-TM00-0585427 shall be provided if specified in the site-specific documentation.

LUL 12. Records

LUL 12.2. Asset data

LUL 12.2.1. London Underground's escalator data entry form (MR-F-31260, formerly FRM-LAE-TM00-0585231) shall be completed and submitted in both electronic and signed hard copy formats.

LUL Appendix 1.1 - References

Only references which are contained in the text of this annexe are listed below. This is not intended to be an exhaustive list. References in the text are made to latest editions unless specific editions are cited.

National and international standards

BS 7671	Requirements for electrical installations. IEE Wiring Regulations. Seventeenth edition
BS 8300	Design of buildings and their approaches to meet the needs of disabled people - Code of practice
BS ISO 7010	Graphical symbols – Safety colours and safety signs – Registered safety signs
BS EN 115-1	Safety of escalators and moving walks. Part 1: Construction and installation
BS EN 61000-2-4	Electromagnetic compatibility (EMC) – Part 2-4: Environment – Compatibility levels in industrial plants for low-frequency conducted disturbances
BS EN 61000-3-4	Electromagnetic compatibility (EMC) – Part 3-4: Limits – Limitation of emission of harmonic currents in low-voltage power supply systems for equipment with rated current greater than 16A
BS EN 61000-4-13	Electromagnetic compatibility (EMC). Testing and measurement techniques – Harmonics and interharmonics including mains signalling at a.c. power port, low frequency immunity tests

LUL Engineering Standards

1-081	Design and installation of fire protection systems and compartmentation measures
1-082	Active fire protection systems and portable fire equipment
1-083	Passive fire protection systems
1-084	Maintenance of fire protection systems and compartmentation measures
1-100	Load Change Application Requirements for Electrical, Compressed Air and other services
1-193	Electromagnetic Compatibility (EMC) with LU Signalling System Assets
1-538	Assurance
1-552	Contract QUENSH conditions manual

LUL Engineering Specification

SPC-LAE-TM00-0585427	Escalator condition monitoring technical specification

London Underground Forms

MR-F-31260	Escalator data entry form

LUL Drawings

01-02-014	Step & comb dimensions upper landing
01-02-015	Step & comb dimensions lower landing
34-905	Maintenance Barrier

36-913	‘Stand On The Right’ Notice & Base (including sign 384-7926)
36-917	‘Stand On The Right’ Notice & Base (including sign 384-7927)
42-71-002	Equipotential bonding/earthing for LUL escalator design
384-944	‘No smoking’ Sign
384-945	‘Immobilisation’ Notice
384-946	‘Handwinding tools’ Sign
384-948	‘Fire point’ Sign
384-950	‘Oil granules bin’ Sign
384-952	‘Unauthorised access prohibited…’ Sign
384-953	‘Caution’ Sign
384-954	‘Caution – door opens onto passenger concourse’ Sign
384-958	‘Keep machine room clean’ Sign
384-959	‘Mind the step’ Sign
384-960	‘Danger/moving machinery’ Sign
384-962	Notice - Treatment for Electric Shock
384-965	‘No entry while escalators are moving’ Sign
384-967	‘Danger/moving machinery’ Sign
384-968	‘Flammable material store – authorised contents’ Sign
384-969	‘Limits of permit to enter zone’ Sign
384-970	‘Flammable material store – L&EE authorised contents’ Sign
384-991	Passenger Warning Notice
559-905	Staple for maintenance barrier
584-949	Emergency Stop Switch (half diamond)
584-12005	Key switch module assembly

LUL Appendix 1.3 – Not applicable for LUL

Annexe – for Crossrail

CRL 1. Purpose

CRL 1.3. The purpose of this specification is to define the requirements for the provision and integration of escalators into the surface and below ground station designs on the Crossrail Project (CRL).

CRL 4. Abbreviations

CRL 4.2. The following abbreviations are used in annexes for CRL:

ALARP	As Low As Reasonably Practicable
CRL	Crossrail Limited
EER	Electrical Equipment Room
THD	Total Harmonic Distortion
VVVF	Variable Voltage Variable Frequency

CRL 5. Definitions

CRL 5.2. The following terms are used in annexes for CRL:

Electrical Equipment Room - The space below and adjacent to the upper truss section for the provision of the escalator controllers, main power switching and escalator interface connections.

CRL 6. Safety Consideration

CRL 6.2. Escalator installation and testing involve certain operations that may present risk. All operations shall be subject to an agreed risk assessment that clearly demonstrates that the risks have been considered in accordance with an agreed ALARP process.

CRL 8. Design

CRL 8.7. Design check certificate

CRL 8.7.1. The *Contractor* shall provide a signed design check certificate for his total design, as required and agreed with the *Employer*. The category of design check, and the endorsement thereof, shall be in accordance with an agreed process. Where appropriate, the design shall be broken down into elements, with different design check categories being allocated to each element.

CRL 8.7.2. The designer's check certificate shall be provided to the *Employer* prior to manufacture of the escalator, to enable the *Project Manager* to make a "Compliance Submission", as required by the CRL technical assurance process.

CRL 9. Basic design parameters

CRL 9.1. Rise

CRL 9.1.1. The nominal vertical rise details described in Appendix 1.3 of this specification is subject to confirmation by survey by the *Contractor* after contract award.

CRL 9.2. Angle of inclination

CRL 9.2.1. The angle of inclination shall be 30^{o}.

CRL 9.3. Landing lengths

CRL 9.3.2. Not applicable for CRL.

CRL 10. General technical requirements

CRL 10.10. Maintenance access

CRL 10.10.3. The truss design shall permit maintenance access from above.

CRL 10.10.5. Steps shall be withdrawn from the truss from the passenger side of the escalator to allow for all regular maintenance activities to be completed during engineering hours.

CRL 10.12. Fire protection

CRL 10.12.1. The design of the escalator shall allow for a fire detection and suppression system in compliance with the CRL 'Fire Safety Engineering Principles': CRL1-XRL-E1-GTA-CR001-00001. The system comprises the following:

a) Point fire detector: in the EER;

b) Manual call point in the EER;

c) Aspiration smoke detection: in the EER and at high level in balustrade area on both sides of the escalator;

d) Escalator water suppression system: in the escalator truss.

CRL 10.24. Signs and notices

CRL 10.24.1. Additional signage shall be provided in accordance with the CRL Signage Strategy.

CRL 10.24.8. Not applicable for CRL.

CRL 10.26. Power supply harmonics

CRL 10.26.1. The electrical installation and equipment associated with the escalator design shall comply with CRL1-PDP-O8-TPL-CRG03-00001: EMC Management Plan.

CRL 10.27. Condition monitoring

CRL 10.27.1. Not applicable for CRL.

CRL 12. Records

CRL 12.2. Asset data

CRL 12.2.1. CRL's escalator data entry form, as agreed with the *Contractor*, shall be completed and submitted in both electronic and signed hard copy formats.

CRL Appendix 1.1 - References

Only references which are contained in the text of this annexe are listed below. This is not intended to be an exhaustive list. References in the text are made to latest editions unless specific editions are cited.

National and international standards

BS 7671	Requirements for electrical installations. IEE Wiring Regulations. Seventeenth edition
BS EN 61000-3-2	Electromagnetic compatibility (EMC) – Part 3-2: Limits for harmonic current emissions (equipment input current Less than or equal to 16A per phase)
BS EN 61000-3-12	Electromagnetic compatibility (EMC) – Part 3-12: Limits for harmonic currents produced by equipment connected to public low-voltage systems with input current greater than 16A and equal to or less than 75A per phase

Other

G5/4-1	Planning levels for harmonic voltage distortion and the connection of non-linear equipment to transmission systems and distribution networks in the United Kingdom. (Electricity Association)

CRL Engineering Strategies

CRL1-PDP-O8-TPL-CRG03-00001	EMC Management Plan
CRL1-XRL-E1-GTA-CR001-00001	Fire Safety Engineering Principles
C100-ATK-N2-RSP-CR002-00001	Architectural common components design stage F1 specification – JX10 Extract
C100-ATK-N2-RSP-CR002-00001	Architectural common components design stage F1 specification – JV21 Extract
C100-ATK-N2-RSP-CR002-00001	Architectural common components design stage F1 specification – JY73 Extract
C100-ATK-A-RST-CRG02-50001	Escalator constructability & maintenance C100 Architectural Components

LUL Engineering Standard

1-066	Lighting of London Underground Assets

CRL Engineering Drawings

C100-ATK-A-DDD-CR001_Z-53000	Escalator Speaker/Stand On The Right Notice
C100-ATK-A-DDD-CR001_Z-53001	Decking Mounted Luminaire
C100-ATK-A-DDD-CR001_Z-53002	Escalator General Details
C100-ATK-A-DDD-CR001_Z-53003	Escalator General Assembly
1D0205-G0G00-M00-P-50018	Half Diamond Emergency Stop Switch

CRL Appendix 1.3 – Escalator nominal vertical rise details

The following nominal vertical rise details are subject to confirmation by survey by the *Contractor* after contract award:

Bond Street location	Description	Vertical Rise (m)	Number of escalators
Eastern Ticket Hall	ES1 - GL00/ Ticket Hall to XR Platform level -5	25.700	3
Western Ticket Hall	ES2 - GL00/ Ticket Hall to Interchange Link	14.570	3
Western Ticket Hall	ES3 - Interchange Link to XR Platform	7.660	3

Bond Street station escalators

Farringdon location	Description	Vertical Rise (m)	Number of escalators
ETH - ESC I	Intermediate Level to Crossrail Platform	14.700	2
ETH - ESC II	Ticket Hall to Intermediate Level	16.000	3
WTH - ESC I	Ticket Hall to Thameslink Platform	5.520	3
WTH - ESC II	Thameslink Platform to Crossrail Platform	20.480	3

Farringdon station escalators

Liverpool Street location	Description	Vertical Rise (m)	Number of escalators
West End	ES3 - CRL Platform to AP9	18.940	3
West End	ES5 - AP9 to Moorgate street ticket hall	16.960	3
East End	ES1 - AP2 to Broadgate Ticket Hall with inclined PRM lift 8	14.590	3
East End	ES2 - CRL Platform to AP2	14.210	3
East End	ES6 - Broadgate ticket hall to street with inclined PRM lift 9	4.670	3

Liverpool Street station escalators

Paddington location	Description	Vertical Rise (m)	Number of escalators
ESC1-141	Departures Road to Ticket Hall	10.750	2
ESCII-142	Departures Road to Ticket Hall	10.750	3
ESCIII-143	Ticket Hall to Platform	6.675	2
ESCIV-144	Ticket Hall to Platform	6.675	2
ESCV-145	Ticket Hall to Platform	6.675	2
ESCVI-146	Ticket Hall to Platform	6.675	2

Paddington station escalators

Tottenham Court Road location	Description	Vertical Rise (m)	Number of escalators
Eastern TH	E10-12 Escalators from Eastern Entrance LU Ticket Hall Level to Lower Concourse level -04.	17.570	3
Western TH	E1-3 Escalators from Western Entrance Street level to Platform level - 04	23.540	3

Tottenham Court Road station escalators

Whitechapel location	Description	Vertical Rise (m)	Number of escalators
Durward Street	E1-3 Lower concourse to CRL platform	22.600	3

Whitechapel station escalators