| Issue / Revision Description: | | Date: |
|---|---|---|
| 07 | | **July 2012** |
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Document Status:

**APPROVED for use Pan-TfL**


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Title:

# Specification for Heavy Duty Metro Escalators

## PART 3: ELECTRICAL SYSTEM

| Format | Document Number | Revision |
|---|---|---|
| **A4** | **SPC-LAE-301941170 PART 3** | **07** |

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# PART 3 – ELECTRICAL SYSTEM

## 1. Scope

**1.1.** Part 3 defines the requirements for the escalator electrical system, over and above the general requirements stated in Part 1. The technical requirements for the electronic tags, which store step identification data, are described in Part 2, clause 4.6 of this specification. The electronic tag system shall be independent of the escalator control system.

## 2. Escalator power supply

**2.1.** The escalator shall operate from a nominal 400Va.c. 3 phase and neutral 50Hz supply. The *Employer* will confirm the source and tolerance levels of the supply at the time of placement of the contract (see section 11 and site-specific documentation).

**2.2.** The escalator drive and control system shall be capable of withstanding a voltage drop of 30% for 400ms (or better), where the escalator is carrying passenger loads, not in excess of 50%.

Note: This is to enable the escalator to 'ride through' the vast majority of power system faults remote from the site.

**2.3.** Refer to annexe.

**2.4.** Refer to annexe.

**2.5.** Refer to annexe.

**2.6.** Refer to annexe.

## 3. Power rating

**3.1.** The drive motor and control system shall be of sufficient power kW rating to meet all operational and testing requirements. In particular, the motor and drive and control system must be able to recover the maximum weight test load (i.e. start in the 'up' direction under full load, at normal operating speed, at minimum ambient temperature), several times, allowing for brake adjustments to be made and the test to be repeated.

## 4. IP rating

**4.1.** All electrical equipment shall be rated to a minimum of IP55 to BS EN 60529, with exception of the following:

a) High heat output components, which shall be rated at a minimum of IP54;

b) Encoders, which shall be rated at a minimum of IP65;

c) The escalator status indication panel in the station operations room (if required), which shall be rated at a minimum of IP23.

## 5. Electromagnetic compatibility (EMC)

**5.1.** The method of achieving EMC compliance within a railway environment is described in Part 4, section 9 of this specification. For documentation requirements – see Part 1, sections 11 and 12 of this specification.

## 6. Earth bonding

**6.1.** All earthing and equipotential bonding shall meet the standards cited in BS 7671 (see clause 29.1.1 below).

**6.2.** The *Contractor* shall provide site-specific earthing drawings and calculations.

**6.3.** Refer to annexe

**6.4.** Refer to annexe.

**6.5.** Refer to annexe.

## 7. Safety and stop devices

### 7.1. General requirements

**7.1.1.** In relation to the design to prevent combined failures of hardware or software malfunction, the *Contractor* shall provide evidence of Notified Body approval in the form of Certificates of Conformity.

**7.1.2.** Following award of contract, the *Contractor* shall provide the procedure for periodic testing of electric safety devices that are not self-checking. These tests shall be practical to implement and shall not permit the escalator to be returned to service in an unsafe condition. The procedures shall be included within the operation and maintenance manual.

**7.1.3.** Photoelectric (optical) sensors shall not be used.

Note: The use of 'optical' safety devices is prohibited in the *Employer's* environment because experience has shown that dust and dirt build-up on the outside of optical devices causes spurious tripping, with the resultant risk of passenger cascade falls and service disruption.

### 7.2. Field bus systems

**7.2.1.** Field bus systems can be used to communicate safety critical information, but they shall not be used to replace the hardwired safety line.

**7.2.2.** Where field bus systems are used to communicate safety critical information, the system shall conform to, or better than, the safety measures provided by a Type 3 field bus described in IEC /TR 61158. The *Contractor* shall demonstrate that the level of safety is equivalent to, or better than, that with hardwired systems, or that the bus system is supported by a hard-wired safety system.

### 7.3. Programmable Electronic Safety Systems (PESS)

**7.3.1.** Where programmable electronic safety systems (PESS) are used to implement safety devices, the *Contractor* shall:

a) Declare all such safety devices;

b) For safety devices required by BS EN 115-1, confirm that the safety integrity level (SIL) used is in accordance with BS EN 115-1;

c) For any safety devices that are over and above the requirements of BS EN 115-1, provide a statement of the safety integrity level (SIL) used;

d) Provide conformation that the test procedures for PESSRAE, stated in Annex D of BS EN 115-1 have been followed and that the design guidelines have been followed, as stated in Annex E of BS EN 115-1;

e) Provide comprehensive details of Certificates of Conformity provided by the Notified Body for all safety devices that have been implemented as programmable electronics safety systems (PESS).

### 7.4. Passenger emergency stop switches

**7.4.1.** Refer to annexe.

**7.4.2.** Passenger emergency stop switches shall be fitted on the left and right hand side, at the top and bottom of each escalator, approximately in line with the comb, with all push panels facing the escalator.

**7.4.3.** If the escalator is above 10m rise, additional stop switches shall be fitted on the incline balustrade decking, at a maximum spacing of 15m measured along the decking. The push panels shall face the escalator. The exact spacing shall be arranged such that the position of the stop switches does not coincide with decking panel joints. The number of stop switches on the incline shall be as shown in table 3.1 below:

Note that this exceeds the requirements of BS EN 115-1

| Rise | No. of stop switches on incline |
|---|---|
| <10m | 0 |
| ≥10m <12.5m | 1 on each side of the step band |
| ≥12.5m <17.5m | 2 on each side of the step band |
| ≥17.5m <25m | 3 on each side of the step band |

**Table 3.1: Additional passenger emergency stop switches**

**7.4.4.** The space between the stop switches and the handrail shall be not less than 150mm, and no greater than 500mm.

**7.4.5.** Where passenger emergency stop switches are fitted between two escalators, each pairing shall be aligned.

**7.4.6.** Refer to annexe.

**7.4.7.** When the push panel of a passenger emergency stop switch is operated, it shall remain in the pushed position. The red LED (in the lid) shall illuminate and remain illuminated until the push panel is reset. The panel shall be released mechanically, by turning a key in the lid of the switch housing.

### 7.5. Manually operated stop devices

**7.5.1.** Emergency stop pushbuttons shall be fitted at the following locations:

a) On the main control cabinet door;

b) – d) Refer to annexe.

**7.5.2.** Refer to annexe.

### 7.6. Step speed monitor

**7.6.1.** Excessive speed or underspeed of the step band shall be monitored by a safety device with suitable resolution.

### 7.7. Handrail speed monitoring

**7.7.1.** Handrail speed shall be monitored by safety devices with suitable resolution.

### 7.8. Missing step devices

**7.8.1.** The missing step monitoring devices shall be either mechanically operated safety switches or inductive devices.

### 7.9. Step band anchor interlock switches

**7.9.1.** Interlock switches shall be provided which prevent the escalator being started while the step band is anchored (see Part 2, clause 10.12 of this specification).

### 7.10. Stop key switches in Newel ends

**7.10.1.** Where inverter braking applies, a 'stop' key switch shall be provided at each newel end, as described in Part 2, clause 17.5.1 of this specification. Operation of this key switch shall stop the escalator by application of the mechanical brakes.

## 8. Protective devices

**8.1.** The disconnect times of all circuits shall be compliant with BS 7671. Where the safety line voltage is 50V or more, it shall additionally be protected by a manually resettable 30mA RCD.

**8.2.** The set of motor thermistors on each motor shall be monitored separately and appropriate messages shall be displayed on the controller screen. It shall not be possible to re-start the control system until the temperature has fallen to a safe level.

**8.3.** Activation of a 'gearbox oil level low switch' while the escalator is running shall not cause the escalator to stop. It shall not be possible to restart the escalator until the oil level is restored to the correct operational level. An appropriate message shall be displayed on the controller screen.

## 9. Incoming power supply isolation

**9.1.** A fused isolator assembly, interlocked by a 'Castell' key (or equivalent) mechanism, shall provide independent, safe means of isolation of the escalator electrical system, without interrupting the power to any other escalator. The key type and the precise location of the assembly shall be agreed with the *Employer*.

**9.2.** The mechanical locking off system shall have the following:

a) A 'Castell' (or equivalent) lock system preventing the isolator being turned on unless the key is inserted and in its locked and turned position. The key shall not be withdrawable unless the isolator is in the 'off' position;

b) The isolator cabinet door shall be interlocked with the isolator so that the door cannot be opened unless the isolator is turned off;

c) The isolator cabinet door interlock may only be defeated by inserting and turning the key in its lock.

**9.2.1.** The mechanical locking off system shall facilitate addition of padlocks.

**9.3.** Each isolator shall have a key with a unique key code. The *Employer* shall allocate a unique, escalator specific code for each incoming power supply isolator assembly.

**9.4.** Integral supply fuses shall provide protection from short circuit conditions. They shall be rated for motor start currents and transformer transient currents, whilst retaining discrimination from the supply fusing.

**9.5.** For a flight of escalators, isolators shall be co-located and numbered from left to right in ascending numeric order and correspond to the escalator number(s) as detailed in the site-specific documentation.

**9.6.** The normal duty cycle of the isolator is up to 500 unloaded switching operations, and up to 5 load switching operations per year.

**9.7.** Performance tests shall be carried out in the factory prior to the isolator being dispatched to site.

**9.8.** The control system shall be designed to facilitate the LU standard escalator isolation procedures, without any requirements for additional controller actions to restore full functionality. The standard procedures are as described in clauses 9.8.1 and 9.8.2 below.

**9.8.1.** The standard escalator energisation (start up) procedure is as follows:

a) Insert the Castell key;

b) Switch on the isolator;

c) Switch on the circuit breaker;

d) Start the escalator.

**9.8.2.** The standard escalator isolation procedure is as follows:

a) Stop the escalator;

b) Switch off the circuit breaker;

c) Switch off the isolator;

d) Remove the Castell key.

## 10. Drive and control system

### 10.1. General

**10.1.1.** The escalator control system design shall use 'open protocol' regarding the supply of all equipment.

**10.1.2.** Any special tools required to test or change parameters of the drive and control system shall be provided to the *Employer*.

### 10.2. Drive selection criteria

**10.2.1.** The control system shall be fitted with a fully rated VVVF drive system.

**10.2.2.** To assist the full load weight testing of each escalator, the drive system shall be able to achieve 100% load powered recovery without slipping backwards or tripping the overload protection system. This requirement must be taken into consideration during the selection of the type of drive to be used for a specific site.

**10.2.3.** During each stage of the weight test procedure, the escalator drive and control system shall start the escalator under 25%, 50%, 75% and full load conditions – to recover the tests weights.

Note: It may be necessary to repeat weight tests several times, allowing for brake adjustments to be made.

### 10.3. Simulation testing

**10.3.1.** Simulation tests shall be carried out in the factory prior to the drive and control system being despatched to site (see Part 4, section 7 of this specification).

### 10.4. Inverter drive system

**10.4.1.** The VVVF drive controller shall satisfy the following requirements:

a) Current limit for acceleration and roll back load limit up to at least 150% FLT;

b) Reconnect facility, for short term or transient under-voltage ride-through spinning load (to synchronise the supply phase with the motor voltage when the motor is regenerating);

c) Programmable acceleration and deceleration characteristics and current or torque limits;

d) Frequency skip setting, to prevent the inverter driving the motor at a speed equal to its natural frequency;

e) Self-protecting for output terminal short circuit;

f) Self protecting and alarm output for any internal fault;

g) Long life rating for the power capacitors in the d.c. link (the component life shall be declared);

h) Integral key pad and clearly legible display (either LED or LCD preferred) for comprehensive parameter setting and monitoring of the unit;

i) Comprehensive alarm and fault self diagnostics accessible to the control system.

**10.4.2.** The drive system shall be entirely compatible with the control system, so that full communication for both control and monitoring purposes is achieved.

**10.4.3.** The control system shall automatically select the appropriate drive settings for each mode of starting.

**10.4.4.** The drive system shall be employed to start the motor in all modes of operation.

**10.4.5.** The drive system shall be configured to limit the full load starting current to no more than twice the full load running current.

**10.4.6.** Refer to annexe.

**10.4.7.** Refer to annexe.

### 10.5. PLC/Microprocessor control system

**10.5.1.** Programmable controllers shall meet the requirements of BS EN 61131-1, BS EN 61131-2 and BS EN 61131-5.

**10.5.2.** The retention of memory settings within the system is a required safety feature. The system shall retain all programs and settings, in the case of a power failure in non-volatile memory. There shall also be a facility to prevent an unauthorised change of settings.

**10.5.3.** The main control unit(s) shall have the following minimum capability:

a) Real time clock;

b) Fail safe processor(s);

c) Comprehensive alarm and fault self diagnostics for real time historic logging (alarm stack) of at least the last 200 faults;

d) An RS232/RS422/RS485 or Ethernet communication port for monitoring and communication mounted within the controller;

e) Security key and ‘engineer’ level password access facilities.

**10.5.4.** The safety integrity level (SIL) for any safety relevant software shall be fully justified.

**10.5.5.** All data transfers between the controller and external diagnostic devices shall be logged and password protected, and shall only be achieved via the serial interface and a portable plug-in unit or Personal Computer. EEPROM or EPROM’s shall be programmed off line. The *Contractor* shall advise the *Employer* of the configuration software package and network communication protocol(s).

## 11. Power supply harmonics

**11.1.** Refer to annexe.

**11.2.** Refer to annexe.

## 12. SCADA

**12.1.** The *Contractor* shall fit a communication processor and interface device that enables future connection with the station LAN infrastructure.

**12.2.** Provision shall be made so that the escalator data, such as alarm records and fault logs, shall be transferred through Industrial Ethernet to a third party SCADA / monitoring device or panel. The *Contractor* shall advise the *Employer* of the options available to communicate with a remote escalator status monitoring device or panel.

## 13. Braking system

### 13.1. General

**13.1.1.** Each drive unit shall be equipped with its own brake, and these brakes shall operate in unison at all times.

**13.1.2.** For all modes of operation, unless inverter braking is employed, the mechanical operational brakes shall be applied simultaneously, when any stop device is activated, and shall remain applied when the escalator is stationary.

**13.1.3.** If required, a facility to delay the application of the auxiliary brake, up to a maximum of 3 seconds shall be incorporated. The delay can be achieved via a variety of methods, as long as they are fail safe. The auxiliary brake shall still apply immediately in the event of an overspeed or underspeed, or carriage switch activation.

**13.1.4.** For all modes of operation, if confirmation of lifting of the braking system is not received within 3 seconds, the start shall be aborted.

**13.1.5.** A means shall be provided to enable the effectiveness of the brake system to be tested under normal stopping conditions and foreseeable failure modes (i.e. independent activation of operational brake and auxiliary brake). Brakes that can be released by hand shall require continuous application of manual pressure to keep them open.

**13.1.6.** The testing and setting requirements for the braking system are specified in Part 4, sub-section 12.8 of this specification.

### 13.2. Inverter braking

**13.2.1.** Where inverter braking is employed, the *Contractor* shall provide a detailed risk assessment/FMEA. This shall include the following:

a) A listing of all possible failures of each component;

b) Details of those failures that could lead to a dangerous situation;

c) Mitigation measures that have been taken to prevent the dangerous situation arising;

d) Confirmation that no single failure could lead to a dangerous situation;

e) A list of stopping conditions for which inverter braking will not be used.

**13.2.2.** Hardwired safety timers in accordance with BS EN 60204-1, or a design that can be demonstrated to be equivalent, shall be used as back-up devices to apply mechanical brakes after a pre-defined period of time.

**13.2.3.** The sequence of application, with the inverter acting as the operational brake, shall remain as described in clause 13.1.2 with the following exceptions, whereby the mechanical brakes shall apply immediately:

a) Inverter failure;

b) Underspeed;

c) Time-out of hardwired mechanical brake safety timers referenced in clause 13.2.2 above;

d) Operation of any safety device when 'test' mode is selected;

e) Escalator overspeed;

f) Carriage switch activated;

g) Power failure.

**13.2.4.** The rate of sampling to determine the deceleration shall be a minimum of 10 samples per second.

**13.2.5.** An inverter braking system is the preferred braking method, for normal stopping conditions.

## 14. Stand-by operation (economy power mode)

**14.1.** The escalator control system shall include the facility for 'stand-by operation' for slow speed operation during periods of intermittent passenger usage.

**14.2.** Unless specified otherwise, in the site-specific documentation, the escalator shall detect the entering of a user. Once passenger activity has been detected, the escalator shall accelerate to its normal speed. The escalator shall decelerate automatically to 0.2m/s, for stand-by operation, following no detection of passenger movement onto the escalator for an adjustable period of time. Acceleration and deceleration shall be at an acceptable rate of less than 0.5m/s² to achieve a smooth transition. The parameter settings and method of detection of users shall be agreed with the *Employer*.

**14.3.** A facility to over-ride stand-by operation shall be incorporated within the control system. Detailed design and password requirements shall be agreed at the design stage.

## 15. Control selector switch

**15.1.** A three position switch providing selection between 'normal', 'test' and 'inch' modes of operation shall be mounted on the front door of the main control cabinet and give a clear indication of the mode of control selected.

## 16. Start-up operation

**16.1.** Start 'up' and start 'down' key switches shall be incorporated in the upper and lower landing newel boxes (described in Part 2, clause 17.5.1 of this specification).

**16.2.** With the control selector switch, on the main control cabinet door, in 'normal' position, it shall be possible to start the escalator from the following locations in either direction:

a) Upper landing key switches (newel end);

b) Lower landing key switches (newel end).

**16.3.** With the control selector switch in 'test' position, it shall be possible to start the escalator in either direction from pushbuttons on the front door of the main control cabinet only.

**16.4.** In order to protect against the possibility of inadvertent re-starting of the escalator, due to a jammed start key switch defect, the input signal to the control system from the start key switches in the newels shall be 'edge-triggered' (i.e., they shall only initiate a start sequence when they change their condition).

Moreover, if a start key switch has been jammed for more than 10 seconds, the controller screen shall display a warning message. It shall not be possible to run the escalator until the defect is resolved and controller reset pushbutton is pressed.

## 17. Inching

### 17.1. General requirements

**17.1.1.** The *Contractor* shall demonstrate that the portable handheld inching control device is either safely compatible with, or not physically interchangeable with, other LUL escalator inching devices (see clause 17.1.2 below).

**17.1.2.** The LUL standard portable handheld inching control device, described in clause 17.1.1, connects, via a plug, to a 10 pin socket with plug/socket pin number allocation as described in table 3.2 below.

| Pin number | Device |
|---|---|
| 1 | Stop pushbutton connection |
| 2 | Stop pushbutton connection |
| 3 | Link to pin 4 |
| 4 | Link to pin 3 |
| 5 | Ready indicator connection |
| 6 | Ready indicator connection |
| 7 | Feed to ‘Inch’ (common/run) pushbutton |
| 8 | ‘Up’ signal from ‘Up’ pushbutton |
| 9 | ‘Down’ signal from ‘Down’ pushbutton |

**Table 3.2: Inching device pin number allocation summary**

**17.1.3.** The inching control device shall include an ‘inch’ (common/run) pushbutton.

**17.1.4.** The labelling text shall be agreed by the *Employer* at the design stage.

**17.1.5.** The inching control device shall be permanently marked to identify the station and escalator number.

**17.1.6.** A storage facility shall be provided to house the handheld inching control device. If this facility is within the controller cabinet, it shall be in a separate compartment, accessible without gaining access to the controller interior.

**17.1.7.** The approximate locations for required inching sockets are given below. The precise location of the inching sockets shall be agreed with the *Employer*, at the design stage:

a) Controller cabinet door;

b) Within the truss at the upper landing return station;

c) Within the truss at the lower landing return station;

d) Upper newel (behind lockable enclosure);

e) Lower newel (behind lockable enclosure);

f) - h) Refer to annexe.

**17.1.8.** Refer to annexe.

**17.1.9.** Refer to annexe.

### 17.2. Inching operation

**17.2.1.** With the control selector switch in the 'inch' position, it shall be possible to run the escalator at inching speed by the use of a handheld inching control device. It shall not be possible to start the escalator at normal speed when 'inch' mode is selected.

**17.2.2.** The escalator shall only operate in 'inch' mode, when the 'inch' pushbutton as well as either the 'up' or the 'down' pushbutton, (on the handheld inching control device), are pressed. If the 'up' and 'down' pushbuttons are pressed simultaneously, the escalator shall remain inoperative, i.e. they shall be electrically interlocked. Upon release of any of the pushbuttons the brakes shall apply.

**17.2.3.** The start sequence shall only commence following activation of the 'inch' pushbutton and either the 'up' or 'down' pushbutton. i.e. Upon reset of a safety device, the control system shall not have already commenced the start sequence.

**17.2.4.** Removal of a dummy plug shall interrupt the safety line to stop or prevent starting the escalator and display an appropriate message on the controller screen.

**17.2.5.** Removal of another dummy plug, or further unit plugged in, shall display an appropriate message on the controller screen. e.g. 'Check inch pendants'.

**17.2.6.** With a handheld pendant plugged in, it shall not be possible to start the escalator in 'normal' or 'test' mode.

**17.2.7.** Selection of 'normal' or 'test', with an inching device plugged in shall inhibit a start command and display an appropriate message on the controller screen. e.g. 'Check inch pendants'.

## 18. Controller screen

**18.1.** A real-time visual display screen shall be provided on the front of the controller. It shall be LCD type, with a touch sensitive screen or integrated keypad for interrogation purposes.

**18.2.** Status and fault messages shall be displayed on the controller screen. For guidance, these shall include, but not be limited to the messages listed in Appendices 3.1 and 3.2.

**18.2.1.** The message display shall consist of at least two lines, with at least 20 characters per line.

**18.2.2.** If more than one fault exists, they shall be shown on the controller screen in succession at intervals or on a dedicated screen.

**18.2.3.** When a message does not fit on one line, the message shall be displayed on two lines, or alternatively scrolled horizontally.

**18.3.** All escalator electrical system faults shall be date and time stamped and recorded within the control system memory, and sent to an historical alarm data log on the controller screen display.

**18.3.1.** The controller screen shall store the following information for later interrogation:

a) At least the last 200 faults;

b) At least the last six stopping distances;

c) Stand-by operation 'on'/'off' and direction of running.

**18.4.** Kinked link fault data shall be recorded as a single fault, clarified by the number of operations during the current run operation recorded as statistical information.

**18.4.1.** A flashing warning message "kinked link – check step chains", or similar, shall be displayed in the event of six consecutive kinked link faults being recorded.

**18.5.** The controller screen shall display the following information, without the use of a password:

a) All normal and fault status conditions;

b) Speed and direction of travel of the stepband and handrails, with units of measurement clearly displayed;

c) Statistical information;

d) Historical status and alarm data log.

**18.6.** Security key 'engineer' level password access facilities shall be provided for the following password protected adjustments:

a) Real time clock;

b) Lubrication settings (to allow continuous 'on'/'off' timing control, adjustable within pre-set limits);

c) Adjustable parameter settings;

d) Screensaver facility delay, if needed to extend the life of the controller screen.

**18.7.** The procedure for user interface with the controller screen shall be documented within the safe use and operation handbook, described in Part 1, clause 12.7.1 of this specification.

## 19. Volt free contacts for escalator status monitoring

**19.1.** Volt-free contacts shall be used to provide indications to a remote escalator status indication panel located in the station operations room, as described in section 27.

**19.2.** The volt-free terminals shall be wired to a clearly labelled termination point within the UMC/Electrical Equipment Room, in a location to be agreed with the *Employer*. This termination point is required for the connection of the remote status indication panel by the *Contractor*, and also the future connection of an alternative remote monitoring system by others.

**19.3.** The passenger emergency stopped signals from the appropriate stop switch operated shall be made available to activate a CCTV camera monitor. For simplicity, a maximum of three signals shall be provided: upper, lower and incline.

## 20. Main controller front panel door layout

**20.1.** A generic layout shall be provided for the control devices and labelling, fitted on the main control cabinet front door. Appendix 3.3 is provided for guidance.

## 21. Control pushbuttons

**21.1.** All pushbuttons shall be shrouded with the exception of the emergency stop pushbutton which shall be the positive displacement type and shall lock 'off' once operated, with a twist action to release.

## 22. Device status monitoring and reset

**22.1.** A 'controller reset' facility shall be incorporated to prevent restarting of the escalator following the operation of a safety device (and subsequent local reset, if applicable), operation of a protective device, protective circuit or main power or driving/braking contactor welded. The 'reset' pushbutton shall be provided on the front door of the main control panel. See Appendices 3.1 and 3.2 for requirements.

**22.1.1.** The exceptions to clause 22.1 whereby safety devices do not require a 'controller reset', following being reset locally, are as follows:

a) Passenger emergency stop switches: mechanically reset by key in lid;

b) Emergency stop switch isolator, described in clause 7.5.2: manual operation;

c) Emergency stop pushbuttons on truss: latching button - twist to reset;

d) Dummy plugs for handheld inching device sockets: replace dummy plug;

e) Emergency stop on handheld inching device: latching button - twist to reset.

**22.2.** The status of all driving and braking function related contactors shall be monitored. If a monitored contactor has not switched on when required, the controller screen shall display a fault message and prevent any further running until the fault has been rectified. Moreover, if a monitored contactor has not switched off (for example, because contacts have welded), then the controller screen shall also display a fault message and prevent any further running until the fault has been rectified.

**22.3.** The status of the braking system shall be monitored. Once the control system activates a brake, it shall check that the brake has actually lifted by monitoring the relevant contact. If a brake has not lifted, the controller screen shall display a fault message, and prevent further running until the fault has been rectified. The output from these status switches shall be used to reduce the current to the brake once it has lifted.

**22.4.** If any safety device is activated, such as the carriage switch, the brakes shall be applied. Once the safety device is reset, the control system shall confirm that the operational and auxiliary brakes are applied before the escalator can be re-started. The *Contractor* shall demonstrate that the arrangement used for confirming that the brakes are applied is fail safe and will not lead to a dangerous situation in the case of a fault (e.g. the loss of the connection of a pair of contacts shall not lead to a dangerous situation).

Note: The use of redundancy and cross checking in the arrangement used for confirming the status of the brakes is considered an effective method of meeting such a requirement.

## 23. Kinked link indication

**23.1.** The step chain shall be monitored to detect chain 'kinking', caused by inadequate/ineffective lubrication.

**23.2.** The control system shall record a single fault message to register a kinked link condition.

**23.3.** A fault message shall be displayed on the controller screen as described in clause 18.4.

## 24. Lubrication

**24.1.** The lubricator, (see Part 2, section 11 of this specification) shall be powered by a motor of maximum voltage rating, 230V.

**24.2.** The lubricator shall be prevented from running while the escalator is stationary.

**24.3.** Loss of the lubricator power supply while the escalator is running shall display a fault message on the controller screen and shall not cause the escalator to stop. It shall not be possible to restart the escalator until the lubricator power supply is restored.

**24.4.** Timer settings shall be adjustable within pre-set limits to satisfy the lubrication requirements of the escalator. The rationale for the design of the lubrication system, in particular the settings, shall be justified by the *Contractor* at the design stage.

## 25. Electrical equipment cabinets

### 25.1. General

**25.1.1.** Electrical equipment cabinets shall be metallic. (see sub-section 25.2, below).

**25.1.2.** All electrical equipment cabinets shall be sized to suit actual requirements (i.e. not oversized).

Note: Site-specific spatial constraints may dictate that a generic design is inappropriate.

**25.1.3.** Cabinet sides and base shall be rigid (not prone to flexing).

**25.1.4.** Door(s) shall be rigid and shall not be easily removable from their hinges.

**25.1.5.** Door(s) shall be locked by use of tool-operated, 8mm triangular lock or locks (EMKA type or equivalent). A key locking system is not acceptable.

**25.1.6.** The location of electrical equipment cabinets shall allow easy access, shall not cause any obstruction to other equipment and shall be maintainable.

**25.1.7.** The air temperature rise inside cabinets, when operating, shall not exceed the ambient by more than the limits stated in BS EN 61439-1.

**25.1.8.** Electrical equipment cabinet(s) shall be designed to minimise the detrimental effects of high heat output components on reliability and component service life.

Note: Design and maintenance requirements for electrical equipment cabinet(s) construction, component layout and ventilation are key to maximising reliability and service life.

### 25.2. Drive and main control system cabinets

**25.2.1.** The drive and main control system shall be housed in free standing cabinet(s) and mounted on an integral plinth of minimum 100mm from the floor to avoid the effects of flooding. The plinth shall prevent the accumulation of dirt and dust under the cabinet and shall incorporate a means of securing the controller and plinth assembly to the floor.

**25.2.2.** Cabinet(s) shall be fabricated from a minimum of 2mm mild steel sheet, or stainless steel.

**25.2.3.** Refer to annexe.

**25.2.4.** Access to equipment within cabinets shall be via front mounted, (not self-closing) side hinged doors.

**25.2.5.** Provision shall be made to permit cable entry from above.

**25.2.6.** A storage facility shall be provided inside the main control cabinet, for wiring diagrams folded to A4 size.

**25.2.7.** The surface coating shall be applied in accordance with the manufacturers' instructions to give complete and even coverage with no flakes, cracks or damage.

## 26. Drive motors

### 26.1. Operational requirements

**26.1.1.** Each motor shall conform to quality Grade B (Special) for vibration as defined in BS EN 60034-14.

**26.1.2.** The noise level generated by each motor under no load shall not exceed 73 db (A) MSPL. Irrespective of this requirement, the cumulative noise level generated by the escalator equipment shall not exceed the level stated in Part 1, clauses 10.15.1 and 10.15.2 of this specification.

**26.1.3.** The duty cycle of the motor is defined in Part 1, sub-section 10.6 of this specification. See Part 4, section 8 for testing requirements.

**26.1.4.** All motors shall be identically rated and selected for their compatibility and similar performance requirements.

### 26.2. Design requirements - general

**26.2.1.** Totally Enclosed Fan Cooled (TEFC) squirrel cage induction motors shall be provided.

**26.2.2.** Motors shall be designed for reversible operation.

**26.2.3.** Motors shall meet the requirements of BS EN 60034-1, BS EN 60034-8, BS EN 60034-9, BS EN 60034-14, and BS 4999-141.

Note: Conformance with IEC72 is sufficient to prove conformance with BS 4999-141.

**26.2.4.** The *Contractor* shall provide torque/speed and current/speed curves for the motor, as part of the design submission.

**26.2.5.** The *Contractor* shall design and install to prevent earth leakage through the bearings.

### 26.3. Rotor shaft

**26.3.1.** The rotor shaft shall be a parallel type with a keyway on the output end to close fit limits, and shall conform to BS 4999-141, and BS 4235-1.

**26.3.2.** Where drive couplings are used, the rotor shaft shall be capable of accepting a precision fit coupling.

### 26.4. Electrical design

**26.4.1.** A thermistor shall be provided in each motor winding, to protect against overload.

**26.4.2.** The stator windings and the rotor shall be resistant to condensation.

### 26.5. Winding design

**26.5.1.** The *Contractor* shall demonstrate that the full load torque is sufficient to allow recovery of the full load on the escalator to the upper landing, for weight testing purposes. The *Contractor* shall state the actual multiple of full load torque required to allow recovery of the full load.

**26.5.2.** The motor shall be S1 rated, in accordance with BS EN 60034-1, at a duty rating of 120kg per exposed step.

### 26.6. Terminal box

**26.6.1.** Terminal markings and rating plates shall be in accordance with BS EN 60034-8.

### 26.7. Insulation

**26.7.1.** All internal conductors shall be insulated throughout their length.

**26.7.2.** Cable lugs shall be insulated.

**26.7.3.** Motor thermal class (insulation class) shall be Class 'F', as defined in BS EN 60085.

## 27. Remote escalator status indication (Station Operations Room)

### 27.1. General requirements

**27.1.1.** Escalator status indications shall be provided in the Station Operations Room, in compliance with the Railway Safety Principles and Guidance – Part 2, section B - clause 50. Refer to site-specific documentation for station specific requirements.

**27.1.2.** Refer to annexe.

**27.1.3.** The escalator status indications shall provide station staff with the following information during normal passenger service:

a) Escalator stopped or out of service;

b) Direction of travel;

c) Notification that a passenger emergency stop switch has been operated.

### 27.2. Construction

**27.2.1.** Refer to annexe.

**27.2.2.** A set of four indications shall be provided for each escalator, together with a single indication to show that the power supply to the panel is 'on'. Each indication shall be labelled according to its meaning. Indication labels and colours shall be as shown in table 3.3 below:

| **Indication** | **Colour** |
|---|---|
| POWER ON | Green |
| STOPPED | Red |
| UP | Green |
| DOWN | Green |
| PASSENGER EMERGENCY STOP OPERATED | Red |

**Table 3.3: Escalator status indications**

**27.2.3.** There shall be two push/touch buttons on the assembly. These shall be labelled 'ACKNOWLEDGE' and 'INDICATOR TEST'.

**27.2.4.** The status indication panel shall make provision to enable monitoring of all escalators on a station, or as described in the site-specific specification.

### 27.3. Functional requirements

**27.3.1.** If an escalator stops during normal passenger service, then its corresponding 'stopped' indication shall illuminate and an audible alarm shall sound. This state shall continue until either the escalator is re-started or the 'acknowledge' push/touch button is pressed.

**27.3.2.** The tone and volume of the audible alarm shall be adjustable from within the unit. The volume range shall be nominally from 75dB(A) to 85dB(A), as measured at 1 metre from the unit, with the unit installed within the SOR.

**27.3.3.** When the 'acknowledge' push/touch button is pressed, the audible alarm shall switch off and the 'stopped' indication shall remain constantly illuminated. On re-start of the escalator, the indication shall also switch off.

**27.3.4.** If a passenger emergency stop is operated, the 'passenger emergency stop' indication shall illuminate. This state shall continue until either the passenger emergency stop is locally reset, or the 'acknowledge' push/touch button is pressed.

**27.3.5.** If the 'indication test' push/touch button is pressed, all the indications shall illuminate, and the audible alarm shall sound, for as long as the button is held. This function shall not affect the normal operation of the panel or escalator.

### 27.4. Wiring

**27.4.1.** Refer to annexe.

**27.4.2.** Refer to annexe.

**27.4.3.** Refer to annexe.

**27.4.4.** Refer to annexe.

## 28. Electrical components – General

### 28.1. Isolators

**28.1.1.** Isolators shall be rated for on-load switching.

**28.1.2.** The handle of the isolator shall provide a mechanical, visual 'on' and 'off' indication.

**28.1.3.** If isolator auxiliary contacts are provided, they shall be interlocked such that disconnection of the main contacts cannot be carried out without first disconnecting the auxiliary contacts.

### 28.2. Circuit protection

**28.2.1.** All circuits shall be adequately protected. Whenever possible, miniature circuit breakers shall be used in place of fuses.

**28.2.2.** Due consideration shall be given to prevent nuisance tripping from magnetic inrush of currents during transformer or coil excitation.

### 28.3. Fuses

**28.3.1.** The main supply shall be protected by fuses to BS HD 60269-2.

**28.3.2.** Fuse labels shall state the rating and cartridge designation, corresponding to the schematic wiring diagrams.

### 28.4. Over current, over voltage and under voltage protection

**28.4.1.** Over current, over voltage and under voltage protection device settings shall be agreed with the *Employer* at the design stage.

Note: For under voltage tolerance requirement, see clause 2.2 above. For residual current protection requirement, see clause 8.1 above.

### 28.5. Contactors

**28.5.1.** Contactors shall be capable of operating at a rate equivalent to 180 starts per hour, and shall be fail-safe in their operation, i.e. the main contacts shall be open when de-energised.

**28.5.2.** Arc shields and magnetic blow-out coils shall be provided where necessary.

### 28.6. Relays

**28.6.1.** On solid state devices, suitable surge protection against voltage transients shall be provided.

**28.6.2.** All relays shall be fail-safe in their operation, and where required they shall have additional contacts for monitoring purposes.

### 28.7. Cables

**28.7.1.** Cables shall be LSZH and shall be compliant with the fire performance requirements described in Part 4, section 10 of this specification.

**28.7.2.** All wiring and cable runs shall be suitably supported and protected.

**28.7.3.** Cabling within the enclosures shall be neatly loomed and secured by cable ties, spiral wrapping or internal trunking as appropriate. Any supporting material shall be of a flame retardant, non toxic type.

**28.7.4.** Cables or looms of wires connected to an enclosure door shall be fitted with a spiral harness or similar, to protect them from any damage.

## 28.8. Cable terminations

**28.8.1.** All wiring shall be brought to terminal blocks for interconnection to other equipment. Wiring shall be terminated with solderless crimped connectors, except where cage clamp terminals are used.

**28.8.2.** All terminals shall be labelled and shall be laid out for ease of access.

**28.8.3.** Terminals which remain live after the incoming power supply is isolated shall be shrouded and suitably labelled to indicate this.

**28.8.4.** A minimum of 5% additional terminals for control circuits shall be provided as spares, and also sufficient earth terminals to accommodate any unused cores of multicore cables.

## 28.9. Safety notices and identification labelling

**28.9.1.** The control system equipment shall be fitted with clearly worded safety notices in accordance with BS ISO 7010.

**28.9.2.** Every item of equipment shall be fitted with an identification label, in accordance with the relevant label drawing or list..

**28.9.3.** Notices and identification labels shall be made from either aluminium or plastic laminate e.g. 'Traffolyte' or equivalent and engraved.

**28.9.4.** The manufacturer's nameplate shall be fixed on the outside of each control system cabinet, detailing the information as defined in BS EN 60947-1 and BS EN 61439-1 and other additional relevant items, including the following:

a) Manufacturer's name or logo;

b) Type designation;

c) A serial number, traceable to the purchase or contract order number;

d) Date of manufacture;

e) Total assembly weight in kg.

**28.9.5.** The following electrical equipment notices/labels are detailed for standardisation purposes:

a) "ISOLATOR", 7mm high, with "No_", in 40mm high text below. Labels shall be positioned on the front of the main power isolator. Text font shall be Arial, black;

b) "DRIVE", 7mm high, with "No_", in 40mm high text below. Labels shall be positioned on the front of the drive cabinet. Text font shall be Arial, black;

c) "CONTROLLER", 7mm high, with "No_", in 40mm high text below. Labels shall be positioned on the front of the controller. Text font shall be Arial, black;

d) Refer to annexe;

e) "Danger high voltage", text font shall be Arial 10mm high;

f) "Isolate by removal of 'Castell' key before opening the door", text font shall be Arial 8mm high;

Note: labels d) and f) may be combined into one label.

g) A warning label, reading "Danger" and describing the various 'live' supplies in each electrical equipment cabinet. Text font shall be Arial 6mm high for "Danger" and 4.5mm high for the 'live' supplies;

h) Identification labels for all pushbuttons, switches, components, indicators, terminals and control panels. Text font shall be Arial 4mm high, black.

Note: N$^{o}$_ denotes the escalator number as detailed in the site-specific specification.

**28.9.6.** All labels shall be durably fixed with screws or rivets, as appropriate and shall not reduce the enclosure protection rating of any equipment. No labels shall be affixed with adhesives unless specifically instructed by the *Employer*. Self-adhesive labels shall not be used.

**28.9.7.** All cables shall be fitted with individual identification labels at both ends. Each label shall state escalator number and route designation. For example an escalator number 1, cable designated N shall read '1-N'.

**28.9.8.** Within all electrical equipment cabinets, the cores of all cables and terminals shall be identified by markings, which shall correspond to the schematic wiring diagram.

**28.9.9.** Every item of operational equipment shall be clearly labelled at all times, including during installation.

## 29. Field wiring

### 29.1. General requirements

**29.1.1.** The whole of the installation shall be undertaken in accordance with BS 7671 and good EMC practices. It shall be certificated in accordance with BS 7671.

**29.1.2.** All cables used shall be LSZH, in trunking or on perforated cable trays or in conduit.

**29.1.3.** Cables installed on cable tray shall be armoured or braided to provide adequate mechanical protection, as appropriate.

### 29.2. EMC compliance

**29.2.1.** The field wiring forms part of the escalator control system, therefore, the type of field wiring installed shall comply with the requirements of the *Contractor's* EMC certification for the control system.

### 29.3. Cable containment

**29.3.1.** Surface coatings shall be in accordance with Part 1, sub-section 10.13 of this specification.

**29.3.2.** Where cable tray/trunking attach directly to structural surfaces, stand-off brackets shall be used to give a minimum clearance of 40mm.

**29.3.3.** All cable tray/trunking shall be designed to have 20% minimum spare capacity for future cables.

**29.3.4.** Fixings shall support the full width of cable tray/trunking.

**29.3.5.** Trunking shall be in accordance with BS EN 50085. Cable trays shall be perforated formed from plain steel sheet in accordance with BS 1449-1.1.

**29.3.6.** Minimum thicknesses of cable trays shall be 1.0mm, for up to 150mm wide, 1.2mm for up to 450mm wide and 1.5mm for tray in excess of 450mm wide.

**29.3.7.** Cable tray shall only be cut along a line of plain metal, i.e. not through the perforations. All cut edges shall be filed smooth, prepared and treated with a zinc rich paint.

**29.3.8.** Where it is necessary to cut holes in the tray for the passage of cables, these holes shall be bushed.

**29.3.9.** Adjacent sections of cable tray shall not have gaps larger than 5mm between them.

**29.3.10.** Flexible conduit lengths shall not exceed 1m.

### 29.4. Wiring and cabling

**29.4.1.** Certificates of Conformity are required to demonstrate compliance with the fire performance requirements of Part 4, section 10 of this specification. If a distributor supplies the cable, the distributor

shall obtain the relevant authorisation signature confirming compliance from the manufacturer of the cable, and include this as part of the C of C.

**29.4.2.** Galvanised straps or stainless steel ties shall be used for retaining cables. Plastic cable ties shall not be used.

**29.4.3.** All unused cores within multicore cables shall be connected to earth at each end and labelled to identify as 'spare'.

**29.4.4.** Plug and socket connections are permitted but it must not be possible to cross connect adjacent devices or adjacent escalators. When adjacent escalators have newel box control panels side by side - plugs must not be inter-changeable.

**29.4.5.** No tee or other joint shall be permitted without the permission of the *Employer*, in writing.

## 30. 110V power socket on the passenger side

**30.1.** The *Contractor* shall install a 110Va.c. socket within the top and bottom pit area of the escalator.

**30.2.** The type of socket outlet shall be to BS EN 60309 socket outlet - rated at 16 amps.

**30.3.** The *Contractor* shall connect each 110V socket outlet into an existing socket outlet ring final circuit, which shall be isolated before any work commences.

**30.4.** The existing circuit shall be verified by inspection, testing and certification before work commences in accordance with BS 7671.

**30.5.** The modified circuit shall be verified by inspection, testing and certification upon completion, in accordance with BS 7671.

## 31. Lighting

**31.1**. Refer to annexe.

**31.2.** Refer to annexe.

## 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 3 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 = clauses 9.8, 9.8.1 and 9.8.2 added. No other changes. |
| 07 | July 2012 | APPROVED for use – Pan-TfL. No changes. |

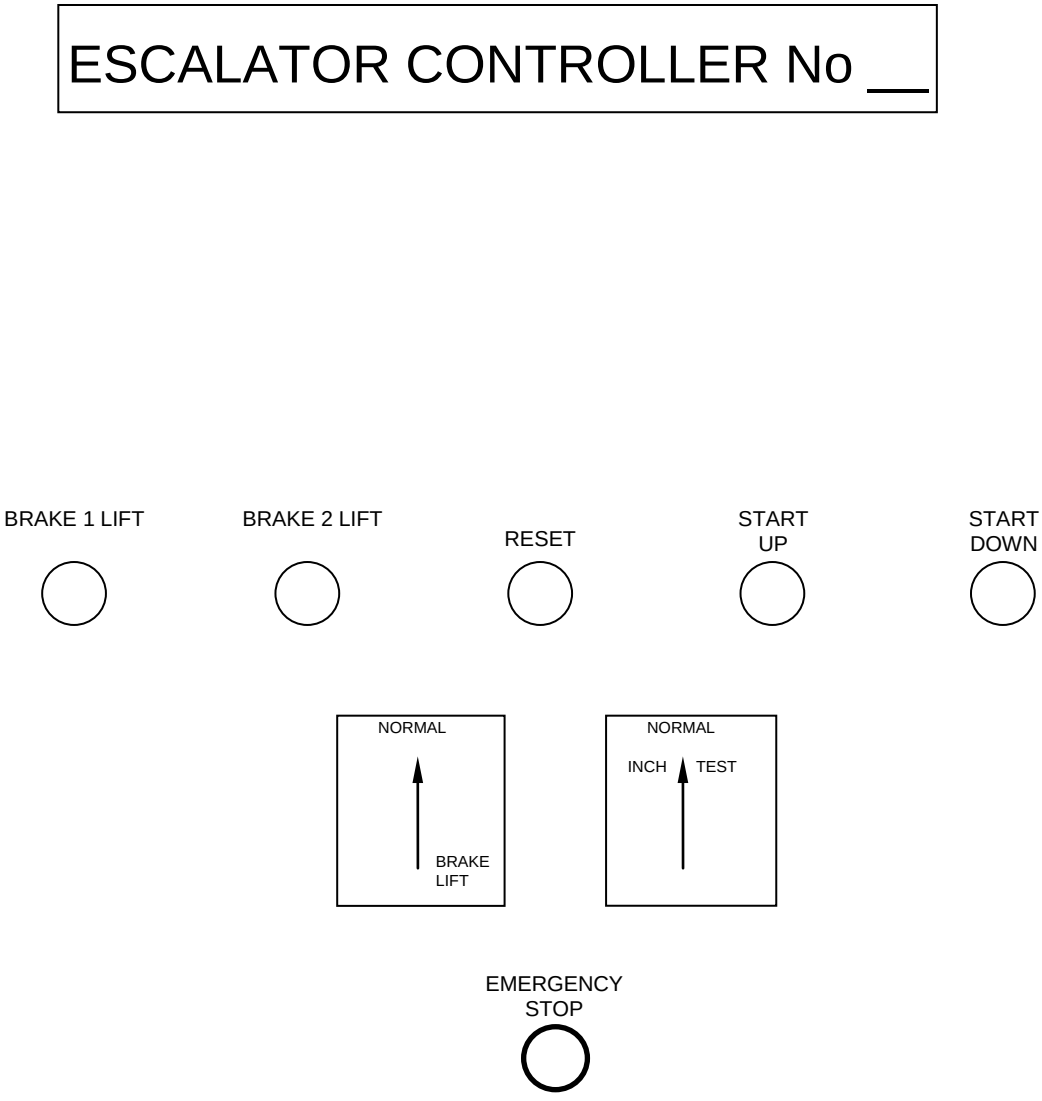
## Appendix 3.1 - Safety and stop devices – controller screen fault messages & system response

| Safety device | Fault message (typical) | Stop drive | Controller reset |
|---|---|---|---|
| Brake lift selector switch | Brake lift selected | Yes | No |
| Carriage switch (left) | Carriage tension switch - left | Yes | Yes |
| Carriage switch (right) | Carriage tension switch - right | Yes | Yes |
| Comb switch (upper – left) | Comb switch operated - upper - left | Yes | Yes |
| Comb switch (upper – right) | Comb switch operated - upper - right | Yes | Yes |
| Comb switch (lower – left) | Comb switch operated - lower - left | Yes | Yes |
| Comb switch(lower – right) | Comb switch operated - lower - right | Yes | Yes |
| Emergency stop switch isolator in LMC | Isolator in lower chamber | Yes | No |
| Emergency stop pushbutton on controller | Controller emergency stop push | Yes | Yes |
| Emergency stop pushbutton on truss | Inch station plug / Truss stops | Yes | No |
| Floor plate switch (upper) | Floor plate switch - upper | Yes | Yes |
| Floor plate switch (lower) | Floor plate switch - lower | Yes | Yes |
| Handrail entry switch (upper – left) | Handrail entry switch - upper - left | Yes | Yes |
| Handrail entry switch (upper – right) | Handrail entry switch - upper - right | Yes | Yes |
| Handrail entry switch (lower – left) | Handrail entry switch - lower - left | Yes | Yes |
| Handrail entry switch (lower – right) | Handrail entry switch - lower - right | Yes | Yes |
| Handrail speed monitors | Left handrail underspeed | Yes | Yes |
| | Right handrail underspeed | Yes | Yes |
| Inch dummy plugs | Inch station plug / Truss stops | Yes | No |
| Motor end shaft cover interlock (if applicable) | Handwinding interlock | Yes | Yes |
| Missing step device – upper | Missing step detected - upper | Yes | Yes |
| Missing step device – lower | Missing step detected - lower | Yes | Yes |
| Passenger emergency stop upper | Passenger emergency stop upper | Yes | No |
| Passenger emergency stop intermediate/s | Passenger emergency stop intermediate_ | Yes | No |
| Passenger emergency stop lower | Passenger emergency stop lower | Yes | No |
| RCD fault | RCD fault | Yes | Yes |
| Sagged step - upper | Sagged step detected - upper | Yes | Yes |
| Sagged step - lower | Sagged step detected - lower | Yes | Yes |
| Step band interlock (left) - incline | Step band anchor - left | Yes | Yes |
| Step band interlock (right) - incline | Step band anchor - right | Yes | Yes |
| Step speed monitor | Escalator underspeed | Yes | Yes |
| | Escalator overspeed | Yes | Yes |

## Appendix 3.2 - Protective and monitoring devices – controller screen fault messages & system response

| Protective device | Fault message (typical) | Stop drive | Controller reset |
|---|---|---|---|
| Kinked link switches | Kinked link detected | No | No |
| Motor thermistors | Motor thermistors | Yes | Yes |
| Gearbox oil level switch | Gearbox oil level low | No | Yes |
| Control system | Brake contactor welded | n/a | Yes |
| | Auxiliary brake lift failed | Yes | Yes |
| | Auxiliary brake failed running | Yes | Yes |
| | Check No.of inch units fitted | n/a | No |
| | Drive not ready | Yes | Yes |
| | Drive unit fault | Yes | Yes |
| | Lubricator overload | No | No |
| | Lubricator supply failed | No | Yes |
| | Main contactor fault | Yes | Yes |
| | Operational brake lift failed | Yes | Yes |
| | Operational brake failed running | Yes | Yes |
| | Overload fault | Yes | Yes |
| | Phase failure | Yes | Yes |
| | PLC module/processor fault | Yes | Yes |
| | Ready to inch | n/a | n/a |
| | Regenerate unit fault | Yes | Yes |
| | Start keyswitch jammed | Yes | Yes |
| | Start sequence failed | Yes | Yes |
| | Stopping distance too long | n/a | Yes |

## Appendix 3.3 - Main control cabinet front door basic layout - provided for guidance



## Annexe – for LUL

### LUL 2. Escalator power supply

**LUL 2.3.** The escalator electrical system shall be designed to be compatible with a supply as described in BS EN 61000-2-4, class 3.

**LUL 2.4.** Following award of contract the *Employer* will perform tests to determine the level of Total Harmonic Distortion (THD) present in the mains power supply and provide the *Contractor* with a copy of the test results, carried out over a period of 4 days, including the complete weekend.

| Note: Clause LUL 2.3 applies, irrespective of the results of these tests. |
|---|

**LUL 2.5.** Within 4 weeks of the escalator load being applied the *Contractor* shall provide a report of a site test of harmonic characteristics, carried out over a period of 4 days, including the complete weekend, and power factor as described in section 3.5.3. of LUL Standard 1-100.

**LUL 2.6.** The power supply cable will be run, by others, to the vicinity of the incoming supply isolator (described in section 9). The *Contractor* shall liaise with the *Project Manager* prior to connecting the escalator electrical system to this power supply.

### LUL 6. Earth bonding

**LUL 6.3.** The *Employer* will provide a copper or aluminium earth bar adjacent to the incoming (earthed) supplies, of suitable size to accommodate all earthing requirements.

**LUL 6.4.** LUL drawing number 42-71-002 is a representative diagram of the minimum requirements for equipotential bonding - this drawing is provided for guidance only.

**LUL 6.5.** The *Contractor* shall securely bond all extraneous conductive parts within the equi-potential zone, which are within the scope of works, to the earth terminal as required by BS 7671. The *Contractor* shall inspect and report any pre-existing non-compliances of earthing and equipotential bonding, within the defined equipotential zone to the *Project Manager*, so that corrective works can be arranged.

### LUL 7. Safety and stop devices

#### LUL 7.4. Passenger emergency stop switches

**LUL 7.4.1.** Passenger emergency stop switches (known as 'half-diamonds') shall be provided to LUL drawing number 584-949.

**LUL 7.4.6.** Where a fixed staircase is located adjacent to an escalator, additional 'half-diamonds', aligned with those on the escalator, shall be installed, with their push panels facing the staircase. All push panels shall be arranged to stop the escalator. Where the decking between an escalator and a fixed staircase is greater than 1400mm measured between the escalator handrail and the edge of the staircase, no additional 'half-diamonds' shall be fitted.

#### LUL 7.5. Manually operated stop devices

**LUL 7.5.1.**

b) At each truss inch socket location, as described in clause LUL 17.1.7 below;

c) At the top of the incline, on the unguarded side of each access incline gate;

d) In the case of central escalators in flights of 3 or more, on the opposite side of the truss to the inch sockets, at approximately 10m spacing.

Note: see maintenance access requirements described in Part 1, sub-section 10.10 of this specification.

**LUL 7.5.2.** An emergency stop switch isolator shall be provided in the LMC to facilitate a safe isolation procedure for emptying dust trays.

## LUL 10. Drive and control system

### LUL 10.4. Inverter drive system

**LUL 10.4.6.** The VVVF drive shall be of the active front end type, in order to limit the harmonics drawn from the supply.

**LUL 10.4.7.** The VVVF drive system shall include an automatic regenerative unit, unless specified otherwise in the site-specific documentation.

## LUL 11. Power supply harmonics

### LUL 11.1. Emissions

**LUL 11.1.1.** The escalator electrical system shall comply with BS EN 61000-3-4, table 1.

Note: The supply $R_{sce}$ is assumed to be 33. The load application in accordance with LUL Standard 1-100 will be based on the harmonic current limits in BS EN 61000-3-4, table 1.

**LUL 11.1.2.** If the escalator electrical system is not compliant to BS EN 61000-3-4, table 1, the *Contractor* shall provide details of the harmonic injection currents (Amps) for up to the 50th Harmonic. The *Employer* will submit a revised load application, which may or may not be successful.

### LUL 11.2. Immunity

**LUL 11.2.1.** The electrical system shall be designed for immunity to harmonics in accordance with the highest levels present on a supply as defined in BS EN 61000-2-4, class 3. Where the test report as described in clause LUL 2.4. shows harmonics in excess of these levels, the escalator shall also be compatible with these levels.

Note: Both LUL and DNO supplies are nominally 400Va.c. 3 phase 50Hz but the LUL supply has inherently higher harmonic levels. BS EN 61000-4-13 provides further details of the levels of harmonics that are likely to be present in an industrial environment together with suitable test methods to demonstrate equipment immunity compliance. The 11th and 13th harmonics, which are derived from the LUL DC traction system, are higher than generally encountered.

## LUL 17. Inching

### LUL 17.1. General requirements

**LUL 17.1.7.**

f) Within the machine room at the transition between the incline and upper landing, on one, common side;

g) Within the machine room at the transition between the incline and lower landing, on one, common side;

h) On the incline, on one, common side – at approximately 10 metre spacing on the truss.

**LUL 17.1.8.** Inching socket assemblies mounted on the truss shall each be fitted with a latching emergency stop pushbutton (twist to release).

**LUL 17.1.9.** The assemblies described in clause LUL 17.1.8 above shall be fitted such that they do not protrude beyond the envelope of the escalator truss, to prevent accidental stoppage.

Note: see maintenance access requirements described in Part 1, sub-section 10.10 of this specification.

## LUL 25. Electrical equipment cabinets

### LUL 25.2. Drive and main control system cabinets

**LUL 25.2.3** Cabinet height shall not be greater than 1800mm from finished floor level and overall dimensions minimised, without restricting access to internal components, (1200mm wide x 800mm deep are preferred maxima). The control system design shall consist of no more than two cabinets within this size range.

## LUL 27. Remote escalator status indication (Station Operations Room)

### LUL 27.1. General requirements

**LUL 27.1.2.** The location of the escalator status indication assembly within the SOR, and the method of fixing, shall be agreed between the *Contractor* and the *Employer*.

### LUL 27.2. Construction

**LUL 27.2.1.** The assembly enclosure shall be of unpainted stainless steel construction, and shall be of a compact design.

### LUL 27.4. Wiring

**LUL 27.4.1.** The supply to the assembly will be 230Va.c. 50Hz rated at 13A and will be provided by others. The *Contractor* shall take the electrical supply from a local isolator or terminal block fed from a local fuse board, as instructed by the *Employer*.

**LUL 27.4.2.** Internal circuits within the assembly, and between the SOR and the controller, shall use low voltage a.c., derived from a transformer within the assembly.

**LUL 27.4.3.** Unless specified otherwise, in the site-specific documentation, the interface cabling between each escalator controller and the Station Operations Room will be installed by the *Employer*. The *Contractor* shall provide a technical specification for the interface cable.

**LUL 27.4.4.** Unless specified otherwise, in the site-specific documentation, the *Contractor* shall be responsible for connection to the power supply point and testing.

## LUL 28. Electrical components – General

### LUL 28.9. Safety notices and identification labelling

**LUL 28.9.5.** d) “Immobilisation or isolation” to LUL drawing number 384-945 on the main power supply isolator.

## LUL 31. Lighting

**LUL 31.1.** The BS 8300 requirement of a 100lux lighting level is satisfied by lighting levels in the station.

**LUL 31.2.** Not applicable for LUL.

# Annexe – for CRL

## CRL 2. Escalator power supply

**CRL 2.3.** Not applicable for CRL.

**CRL 2.4.** Not applicable for CRL.

**CRL 2.5.** Not applicable for CRL.

**CRL 2.6.** Dual power supplies shall be provided for all escalators. The changeover switch shall be situated local to the power supply.

## CRL 6. Earth bonding

**CRL 6.3.** All individual a.c. powered equipment shall meet the applicable requirements of the following:

a) BS EN 61000-3-2;

b) BS EN 61000-3-12.

**CRL 6.4.** The *Contractor* shall ensure that the level of Total Harmonic Distortion (THD) present in the mains power supply is within the acceptable requirements identified from G5/4-1.

**CRL 6.5.** All extraneous conductive parts within the equi-potential zone, which are within the scope of this specification, shall be securely bonded to the earth terminal as required by BS 7671.

## CRL 7. Safety and stop devices

### CRL 7.4. Passenger emergency stop switches

**CRL 7.4.1.** Passenger emergency stop switches shall be provided to CRL drawing number ID0205-G0G00-M00-P-50018.

**CRL 7.4.6.** Staircases do not apply to Crossrail.

### CRL 7.5. Manually operated stop devices

**CRL 7.5.1.** Not applicable for CRL.

**CRL 7.5.2.** Not applicable for CRL.

## CRL 10. Drive and control system

### CRL 10.4. Inverter drive system

**CRL 10.4.6.** The VVVF drive shall contain an active filter in order to limit the harmonics drawn from the supply.

**CRL 10.4.7.** The VVVF drive system shall make use of an automatic regeneration system where it is appropriate and following agreement with the *Employer*.

## CRL 11. Power supply harmonics

### CRL 11.1. Emissions

**CRL 11.1.1.** The electrical installation and associated equipment shall comply with the CRL EMC management plan.

**CRL 11.1.2.** All individual a.c. powered equipment shall meet the applicable requirements of the following:

a) BS EN 61000-3-2;

b) BS EN 61000-3-12;

c) G5/4-1.

### CRL 11.2. Immunity

**CRL 11.2.1.** The electrical system must take into account planning levels for 400V systems, specified in G5/4-1.

## CRL 17. Inching

### CRL 17.1. General requirements

**CRL 17.1.7.** Not applicable for CRL.

**CRL 17.1.8.** Not applicable for CRL.

**CRL 17.1.9.** Not applicable for CRL.

## CRL 25. Electrical equipment cabinets

### CRL 25.2. Drive and main control system cabinets

**CRL 25.2.3** Not applicable for CRL.

## CRL 27. Remote escalator status indication (Station Operations Room)

### CRL 27.1. General requirements

**CRL 27.1.2.** Not applicable for CRL.

### CRL 27.2. Construction

**CRL 27.2.1.** Not applicable for CRL.

### CRL 27.4. Wiring

**CRL 27.4.1.** Not applicable for CRL.

**CRL 27.4.2.** Not applicable for CRL.

**CRL 27.4.3.** Not applicable for CRL.

**CRL 27.4.4.** Not applicable for CRL.

## CRL 28. Electrical components – General

### CRL 28.9. Safety notices and identification labelling

**CRL 28.9.5.** d) Mandatory notice, blue background, with white lettering: “Inform Station Supervisor if escalator immobilisation/isolation required”. Nominal size of label: 150mmx100mm.

## CRL 31. Lighting

**CRL 31.1.** The provision of lighting in the vicinity of the escalator is the responsibility of the *Contractor*. For lighting design and levels, refer to the following CRL strategies and LUL Engineering Standard:

a) C100-ATK-N2-RSP-CR002-00001: Architectural common components design stage F1 specification – JX10 Extract;

b) C100-ATK-N2-RSP-CR002-00001: Architectural common components design stage F1 specification – JV21 Extract;

c) C100-ATK-N2-RSP-CR002-00001: Architectural common components design stage F1 specification – JY73 Extract;

d) C100-ATK-A-RST-CRG02-50001: Escalator constructability & maintenance C100 Architectural Components;

e) 1-066: Lighting of London Underground Assets.

**CRL 31.2.** Decking mounted luminaries shall comply with the design requirements of CRL drawing C100-ATK-A-DDD-CR001_Z-53001.