24.27 Communication and Monitoring Systems (CCTV)

Spatial provision shall be made in the most appropriate part of the Tram for the operational radio system, driver control units and tram position and detection system equipment, including the associated cabling, support equipment, microphones, speakers, antennae and power supplies. The cabling shall be installed and tested by the Tram Supplier.

These sub-systems will be supplied by the Infraco as free-issue items to the Tram Supplier, and shall be installed and functionally tested during the Tram manufacturing process. The Infraco and Tram Supplier shall work with the suppliers of these sub-systems to define and agree the interface requirements.

The Tram shall be fitted with cab-to-cab intercom facilities. The intercom facility will also provide communication between all four cabs when two Trams are coupled during the recovery of a defective Tram. This facility shall be fully duplex and hands-free.

The Tram shall be fitted with internal cameras that record digital images covering:

- The whole of the saloon, (including the passenger help points) with sufficient clarity to enable individuals to be identified for evidential purposes; and
- The views ahead/back from the cabs.

The resolution of recorded images and recording speed of images shall be of a quality from which it would be capable of being reliably used as part of an accident investigation, and in respect of the saloon images shall be of a quality to enable a conviction in the event of illegal activity. Appropriate labelling in accordance with regulations governing the use of such equipment shall be put in place. The cameras shall be of a hemispherical type without any detectable direction of the camera view. Additional information, i.e. time, date, camera number and the Tram number will be added to every image recorded.

The recorded Closed Circuit Television images will be capable of being retained on the Tram for not less than 72 hours at which point the system will restart recording and erase the retained image. Minimum frame rate shall be 16fps, per camera. Consideration should be given to providing a push-button in the cab to enable the driver to add an index-point to the recorded images.

Closed Circuit Television images shall be taken from the Tram for subsequent retention and analysis. This shall be done using a removable data storage medium rather than by data transfer. It shall be readily apparent to the Tram driver and to maintenance staff when the storage medium is not present on the Tram. The data storage medium shall be retained by a secure locking device, that is not released by a Tram system key. All data storage devices shall be interchangeable between trams.

All software required for off-Tram viewing, editing and analysis, shall be procured by the Infraco from the Tram Supplier. This shall include any non-standard supporting hardware and any associated licences.

24.28 Event Recorder

The Tram shall include a data recorder capable of providing time, speed and distance information at 1.0m resolution or better for the last day's operations, and at 10.0m resolution or better for the last seven days' operations. Additionally, the start and end of the following events shall be recorded:

- Horn;
- Bell;
- Traction;
- Brake;
- Hazard brake;
- Safety brake;
- Track brake;
- Driver's Safety Device;
- Door enable left present;
- Door enable right present;
- Manual sand command present;
- Tram Ready to Start;

- Hazard lights;
- Left indicator;
- Right Indicator; and
- Passenger Help Point.

Software enabling event recorder download data to be interrogated and displayed in both graphical and tabular format shall be provided. The software shall also enable all of the data to be exported into Microsoft Excel for further analysis.

The data shall be recorded onto a secure, removable data storage medium. The data recorded shall include the Tram number and date. The data shall be retained and be retrievable at least until 48 hours after the Tram has been shut down. The data storage medium shall be retained by a secure locking device,that is not released by a Tram system key. All data storage devices shall be interchangeable between trams.

The Infraco shall ensure that the Tram Supplier shall indicate how the distance base of the recorder shall be recalibrated in normal usage.

24.29 Public Address System

Automatic, audible announcements for destination and stops shall be made by means of a digital voice announcement system. The Tram Supplier shall supply a copy of any necessary equipment and software needed to upload new and amended announcements or to alter the times and places at which announcements are made. The system should allow for a sound quality of RASTI 0.7, or better.

Additionally, the Tram shall be fitted with both internal and external public address systems, selectable individually by the driver, to allow the driver to make direct announcements.

The following are additional to the requirements of the Rail Vehicle Accessibility Regulations 1998 (as amended):

- Rail Vehicle Accessibility Regulations permit audible announcements between stops to be omitted where the run time between stops is less than two minutes. This option is to be used wherever possible.

- Where stops are omitted the system shall automatically allow for this without intervention of the driver.

- At a stop, in addition to the Rail Vehicle Accessibility Regulations requirement of announcing the next stop and destination, the equipment must also be capable of announcing the current stop. The form of the announcement to be provided initially shall be:

  "This is <name of current stop>. This Tram is for <name of destination>. The next stop is <name of next stop>."

It shall be initiated by the door enable, and there shall be a short delay so that the door-enable tone is finished before the announcement starts.

24.30 Passenger Information System

The Tram shall be fitted with six external destination displays, one at each end above the cab and two on each side, one near each end. The side displays should not be obscured by open doors. These displays shall be capable of displaying as a minimum a service number and the ultimate destination of the Tram. The displays should be legible from an oblique viewing angle.

In addition to the text indicating the destination of a tram on both the side and cab exterior displays an area immediately preceding the text shall be reserved for a single symbol. This symbol shall be displayed in an array of LEDs of the same size and resolution as that of a text character. The symbol shall be in a single colour which is the same as that of the text display. It shall be possible to display a variety of characters including simple geometric shapes and representative symbols (e.g. an aeroplane to indicate AIRPORT as the destination). It shall be possible to select an appropriate symbol during the programming of the system which will then appear on the display when the driver selects his route.

The purpose of this feature is to assist passengers with reading difficulties to ensure that they board a tram on the correct route for their requirements.

Internal saloon displays shall be used to show information concerning the next stop and additionally a "Tram Stopping" sign. They shall also display the local time, and should also be able to display public service information. The number and location of these displays shall be such that the information shall be easily visible to passengers within any part of the Tram.

The internal visual displays shall display, successively:

- Screen 1: Tram to
- Screen 2: <Destination>
- Screen 3: Next Stop
- Screen 4: <Next Stop>

Stepping to the next stop name shall take place on arrival at a stop once the doors are enabled. Where stops are omitted, the displays shall take account of this automatically without the intervention of the driver.

The size of the Passenger Information Display font shall conform to the requirements of the Rail Vehicle Access Regulations 1998 (as amende). The brightness of the displays shall compensate for ambient light quality.

After leaving the stop before a terminus, the external destination indicators shall change to show the destination of the next trip, so that the Tram arrives at the terminus with the correct next destination already displayed.

24.31 Passenger and Inspector Alarm System

Passenger alarm devices shall be located in the saloon area, at every door area and at the disabled passengers area. These devices shall allow communication with the driver and the location of the active device shall be indicated on the driver's display. The communication system shall be fully duplex.

Request 'Stop' buttons shall be provided and shall be compliant with Rail Vehicle Accessibility Regulations 1998 (as amended) and shall:

- Become operable when doors are proved closed at a Tramstop;
- When the first one is pressed, sound a single audible warning in the cab, illuminate a warning light in the cab and illuminate the Tram stopping indicators (required by the Rail Vehicle Accessibility Regulations) 1998 (as amended) in the saloon;
- No further audible warning in the cab from subsequent button pushes; and

- Be positioned such that they can be easily activated by any passenger intending to disembark, but should not be positioned such that they can be inadvertently activated by standing passengers.

Request stop from the wheelchair spaces shall:

- Illuminate a different warning light in the cab.
- Create a door open request for the nearest door, so it opens as soon as enabled.
- Override the automatic close on that door for the next opening.

All request stop indications shall be cancelled by the next door enable command.

Devices shall be provided that enable the on-board inspector, working within the saloon or on an adjacent platform, to alert the tram driver to an incident.

The handheld, pocket sized device to be carried by the on-board inspector shall have 2 modes of operation. Mode 1 will provide an alarm to the driver to indicate that the inspector is experiencing difficulties or feels under threat. Mode 2 will alert the driver to an immediate emergency e.g. the inspector is under physical attack.

When the inspector initiates a Mode 1 alarm the handheld device will operate silently. If a Mode 2 alarm is initiated a loud 'panic alarm' sound will be emitted from the handheld device in order to deter the attacker.

The inspector's device shall be stored in a charger/holder in the Depot Duty Room for Drivers and Inspectors and picked up by the inspector as he begins his duty on the tram. The Inspector's device shall be equipped with a mounting device and sized such that it can be conveniently and comfortably be carried on the ticket issuing machine shoulder strap. Each cab of the tram shall be equipped with a receiver capable of responding to all alarm Modes transmitted within range.
It shall be possible to replace either the handset or the receiver with a spare in the event of failure or loss.

The handheld device and related system shall operate satisfactorily in the electromagnetic environment which will be encountered on the Edinburgh Tram Network.

24.32 Hauling or Propelling a Defective Tram

An emergency coupler will be provided at each end of each Tram. It will be used only for hauling or propelling a defective Tram. The couplers will normally be concealed behind a removable cover. Coupling must be possible at all locations on the Edinburgh Tram Network.

An empty Tram shall be capable of both hauling and propelling (but not both simultaneously) another empty Tram, which is incapable of movement under its own power, between any two points.

As well as mechanical coupling, the following control facilities shall be provided on a coupled pair of Trams:

- Track brake control of both Trams from the cab in use, assuming that each Tram's batteries have sufficient charge;
- Through intercom between all cabs; and
- Through control and power to hazard lights, brake lights and marker lights.
- The intercom, marker lights, brake lights and hazard lights shall be operational on both Trams even if the Tram being assisted has no battery power available.
- The Tram will have a true reverse direction capability from a leading cab, to allow the uncoupling of one Tram from another. This will be enabled with the use of a sealed switch.

24.33 Exterior Details and Livery

The exterior livery shall be as set out in Section 5 of these Employer's Requirements.

The paint shall typically be water based and should allow for the application and removal of advertising vinyl coverings without damage.

The Infraco shall ensure that the repair methods for the Tram shall be defined by the Tram Supplier and shall not import undue risk with regard to the processes and materials used.

The external lighting shall comply with Her Majesty's Railway Inspectorate Railway Safety Publication, Part 2, The Road Vehicles Lighting Regulations, 1989 and the amendment 1994.

The external lighting shall consist of Light Emitting Diode (LED) arrays wherever practicable, and shall be composed of:

Facing forward

- Two white dip-able symmetric headlights;
- Two white front position lights (integrated in the headlight cluster)(side lights);
- One fixed white centre headlight located centrally above the windscreen;
- Two amber direction indicators; and
- Two end outline marker light (white, at high level).

Facing rearward

- Two red rear position lights (tail lights);
- Two red brake lights;
- Two high intensity rear fog lights (red);
- Two amber direction indicators; and
- Two end outline marker lights (red) (at high level).

Side Markers. Four, or more, amber LED combination lights down both sides working as:

- Side marker lights;
- Direction indicators; and
- Side reflectors.

The Tram exterior shall be designed so as to prevent surfing by any individual.

The Tram exterior finish shall allow for easy repair to accidental damage and severe attacks of graffiti. The finish shall allow for the easy application and removal, if required in the future, of special finishes for advertising, such as self-adhesive vinyl.

24.34 Roof-Mounted Equipment

Much of the electrical traction and auxiliary equipment will be housed in equipment cases located on the roof of the Tram. The equipment cases will be robust, weatherproof and suitable for storage and operation in an exposed position. All enclosures will minimise the risk of condensation, and provide adequate and effective ventilation for cooling where required. The normal working of the roof-mounted equipment shall not be adversely affected by dust, wind, rain, snow or ice.

Access to the equipment within the equipment cases will be quick and straight-forward for suitably qualified and trained staff, working from high-level platforms. Standing areas shall have non-slip surfaces. Due regard will be given to the safety requirements considering the location at height and the working voltage. Specific measures will be required to mitigate the risk from charged capacitors and batteries, and equipment likely to be at high temperature. All metal enclosures shall be suitably earthed to the vehicle structure.

All the roof-mounted assemblies shall be easily removable with the minimum amount of disruption to the Tram, to allow repair by replacement. The use of plugs and sockets to allow quick connection and disconnection of assemblies is preferred. Cabling and piping shall be protected from accidental damage.

As far as is practicable, the equipment will be equally divided between the two end sections of the Tram to equalise weight distribution.

The location of the pantograph will be determined by the layout of the Tram and shall be mounted above a bogie and as near to the centre of the Tram as possible.

24.35 Pantograph

Infraco shall ensure that the pantograph for the tram fleet shall be supplied by Tramco.

The governing specifications for the pantograph shall be BS EN 50206-2, BS EN 50119 and Railway Safety Publication 2 - Guidance on Tramways, issued by the Office of the Rail Regulator.

The wire height requirements shall be confirmed, including the operational wire heights within the depot buildings, over-bridges and high load route areas.

A single roof mounted pantograph shall be provided compatible with the Edinburgh Tram Network OLE.

Failure of any porcelain insulators on the lightning protection or other equipment shall not allow flexible cables to fall onto the vehicle roof.

The pantograph mechanism shall raise and lower using an electric drive system. In the event of failure or emergency situation, it shall be possible to lower the pantograph using a hand-crank operated from inside the Tram.

In developing the OLE design, the following pantograph / OLE characteristics have been assumed.

- Maximum wire height 6.8 m
- Minimum wire height 4.3 m
- Profile to be developed
- Overall Collector Head width 1850mm assumed
- Carbon length 1000mm minimum
- Collector Head Depth 250mm
- Along track length to be developed
- Head mass (to be as low as reasonably achievable)
  - (a) Carbon 13.0 kg assumed
  - (b) Metallised Carbon 15.0 kg assumed
- Articulation (frame) dynamic mass 12.0 / 16.0 kg
- Head suspension 12000 N / m
- Frame damping raising 60 / 100 N sec / m
- Frame damping lowering 60 / 100 N sec / m
- Head suspension damping 8 / 12 N sec / m
- Quasi-static contact force 90 N / 180 N
- Friction frame hinge 8 N / 10 N

25 Tramstops

This Section of the Employer's Requirements defines the Tramstop requirements applicable to the Edinburgh Tram Network which the Infraco must comply with.

25.1 General

The Edinburgh Tram Network shall have Tramstops provided at the locations shown in Figure [1] – Edinburgh Tram Phases 1a and 1b Network Diagram of these Employer's Requirements.

All elements of the Edinburgh Tram Network infrastructure shall be designed, manufactured and installed to provide a layout and a suite of furnishings reflecting a fully integrated system and shall be of an economical design and construction that shall reflect economy of use, maintenance, overhaul and renewal.

Provision shall be made, in the form of space, agreed fixing details, local cable routes for data, power and lighting (where appropriate) for a local termination point (Tramstop equipment cabinet), to be provided at all Tramstops.

The Tramstop design aesthetic shall extend to the design of the associated street furniture cabinets, trackside isolator cabinets, point control, point heater cubicles, road junction control cabinets, detector loop cabinets, etc. which shall be visually compatible with the Tramstop furniture. Particular note shall be paid to the requirements laid down in the Tram Design Manual to ensure compliance.

The emphasis on this co-ordination shall ensure an integrated design approach within the urban environment.

25.2 Tramstop Definition

Tramstops shall provide passengers waiting for, entering or leaving the tram system with safe, comfortable, environmentally friendly, informative, high quality access and egress facilities.

Tramstops shall be of the following three types:

- Island platform stops;
- Side platform stops; and
- Combined side and island platform stops.

Platforms shall be long enough to cater for nominal tram vehicles with the extreme distance between the outer edges of the end passenger doors of the vehicle of up to 38.13 m.

Side platform stops shall provide passengers with an effective circulation area and shall be a minimum of 3.0 metres wide. Island platform stops shall be a minimum of 4.0 metres wide unless otherwise agreed with **tie**. A stopping tolerance of plus/minus 2.0m shall be allowed for in the platform length.

All platforms shall contain a minimum clear unobstructed envelope.

The platform height shall match the requirements of the tram to ensure level access in accordance with RVAR (Rail Vehicle Accessibility Regulations).

The layout of architectural elements on the platform shall be arranged to provide the user with ease of access and passage on / off the trams.

Access routes serving the platform shall be appropriate for the level of pedestrian activity and be, where practical, a direct route from key passenger generators.

Key views and vistas of the City of Edinburgh shall not be unnecessarily interrupted.

Platforms shall provide passengers with a clear view of approaching trams.

Tramstops shall maintain consistency of alignment with the track.

A Tramstop shall be defined as:

- That area bounded by the rear of any platform structure and the track crossing points at either end; (or for central stops the external track edge between the track crossing points at either end);
- Including any underground service ductwork and cabinet specifically associated with the stop, outside this zone in the immediate vicinity;
- Including all dedicated access routes to the nearest public road or key passenger generator; and
- Including all structures, systems (including cabinet), finishes etc required to deliver the functionality of the Tramstop.

25.3 Tramstop Requirements

25.3.1 General

Tramstop architecture shall reflect a coordinated design consistent with the overall design aspirations as outlined in the Tram Design Manual and in the CEC Code of Practice for Access and Mobility and shall be subject to the approval of **tie**.

All components used in the construction of the Tramstop shall comply fully with relevant British and European Standards.

Tramstops shall be compliant with amongst others:

- The requirements of the Tram Design Manual;
- Railway Safety Publication 2 – Guidance on Tramways, issued by the Office of the Rail Regulator;
- Disability Discrimination Act requirements;
- The outcome of consultation with the Mobility and Access Committee for Scotland (MACS);
- The Department for Transport Inclusive Mobility Guide to Best Practice on Access on Pedestrian and Transport Infrastructure; and
- The Building Regulations (Part M).

Reference should also be made to:

- Mobility-impaired access and egress to and from each platform, the minimum width of ramps provided on the Edinburgh Tram Network System shall be 2.0m between handrails;
- Ramps, if required, shall have a maximum gradient of 1 in 20;
- No ramp shall be longer than 10m without the incorporation of a landing;
- Landings shall be no shorter than the width of the ramp; and

- Mobility impaired tram access/egress points shall be clearly defined within the platform finish if required by the tram design and consistent with tram stopping tolerances.

Tramstops shall be of a design that ensures the mobility impaired are able to use them and all parts thereof without hindrance or confusion. All walking routes approaching or within the Tramstop area shall be clear of any form of obstruction.

Provision shall be made for those who require to use canes e.g. inclusion of tapping rails. Guardrails shall be provided with handrails.

Where appropriate, Tramstops shall be provided with handrails, balustrades, and general platform furniture, other than seating, of a design that inhibits their use as seating or as a climbing medium.

Tactile surfacing shall be provided as appropriate e.g. at platform edges, stairs or ramps (if applicable), and at dropped kerbs.

25.3.2 Platform Surface

The general platform surface shall be in accordance with the Tram Design Manual and will vary dependant upon location, but in all instances provision shall be made for tactile strips (400mm wide) to assist the visually impaired along the platform edge. The platform edge shall have a suitable 65mm wide delineation of the white or alternative inset line to the leading edge of the line-side coping, or other equivalent visual feature.

Disabled boarding points shall be indicated, if required, by use of tactile material indicating the position of the relevant tram doors.

Platform surfaces shall have a nominal cross fall away from the platform edge of 1:40 to a slot drainage system. Platform drainage will be dependant upon local topographical criteria.

The platform top surfaces shall be slip resistant and durable. Transition zones shall be provided, free of trip hazards, which can be clearly differentiated by those who are visually impaired.

25.3.3 Tramstop Furniture and Equipment

All Tramstop furniture and equipment on the platforms shall be constructed of materials and finishes that are resistant to scratching and ensure the easy removal of graffiti.

Emphasis shall be given to the reduction of 'clutter' and where possible elements shall be combined to provide a dual functionality.

The Tramstop furniture and equipment shall be designed to allow easy replacement of damaged components without affecting equipment, lighting and seating.

Tramstop furniture and equipment shall be designed to support the passenger service without maintenance intervention that results in any form of disruption to the service during service hours. The equipment provided at each location shall be appropriate to that location to limit any unnecessary clutter at Tramstops.

Tramstop furniture and equipment shall be of a modular design based around simple geometric shapes and of modular construction to enable their rapid replacement.

Components and materials shall be of a quality suitable for use in a densely populated and marine environment.

The design of the Tramstop furniture and equipment shall ensure that minor inspection, repairs and maintenance, including lamp replacement, can be carried out during the operational day with the minimum of disruption to passengers, and without disruption to passenger services.

25.4 Description of Tramstop and Street Furniture

25.4.1 General

Each Tramstop shall include the following components:

- Passenger Shelter / Canopied Waiting Area;
- Passenger Help Point;
- Passenger Emergency Call Point;
- Closed Circuit Television Cameras;
- Real Time Passenger Information Display Bus Tracker Reporting (where identified);
- Braille assistance;

- Public Address;
- Information Panel;
- System Logo and Stop Name;
- A perch rail/seat; and
- Advertising panel (6 sheet) - if permitted by Planning Authority;
- Ticket Vending Machines;
- Lighting;
- Litter bins.

Equipment placed on platforms shall not prohibit passengers from having a clear view of an arriving tram.

25.4.2 Shelters and Canopied Waiting Areas

Each platform shall contain facilities to provide passengers with weather protection (e.g., wind, snow and rain) in the form of a canopy or shelter designed and constructed to provide maximum visual transparency with minimum visual impact, consistent with offering the required protection.

Tramstop shelters shall be of a modular design based around simple geometric shapes, providing the necessary requirements for passenger use and comfort. A clear uninhibited view of arriving trams shall be available to passengers from within the shelter area.

Tramstop shelters shall permit future easy alteration to the capacity in terms of volume of passengers and equipment to meet emerging needs.

Lighting within the shelter shall provide a minimum of 50 Lux evenly distributed (controlled by sensor).

All shelters shall be provided with adequate drainage facilities to ensure all rainwater is carried away into the Tramstop drainage system.

Side infill panels together with back panels shall be of toughened transparent glass to provide a light visual appearance and with the Roof panel of complementary quality to provide passengers with protection from the weather. The design shall be such that it provides a safe environment for passengers in the event that glass panels are missing from the shelter as a result of breakage. The design of the shelter shall also take account of access requirements for maintenance and repair purposes.

Side panels shall provide sufficient depth to give weather protection but not obstruct the safe use of the Passenger Emergency Call and Help Points and shall meet the requirements of the visually impaired.

Shelter roofs shall be profiled to prevent build up of litter / debris on the top surface. The shelter structure, roof and wall panels shall, as far as is possible, be made from proprietary components in order to facilitate ease of replacement and repair.

25.4.3 Tramstop Lighting Columns

Platforms shall be provided with a minimum illumination level of 30 Lux.

Lighting shall be low energy, avoid glare to tram drivers and road users, have good colour rendition and be provided throughout the whole of the area occupied by the Tramstop.

The Tramstop lighting shall differ from the adjacent urban and or city lighting and shall emphasise the presence of the Tramstop to enable passengers to identify the Tramstop from a distance. Consideration should be given to the requirement to make use of local ambient lighting (which may need to be enhanced) to avoid additional clutter at the Tramstop.

Access routes to the stops shall, wherever practical, use existing street lighting as the sole or primary means of illumination. Where this is not possible then lighting of a similar level to the local road lighting shall be provided.

All platform shelter / canopy lighting shall enhance security in the waiting area.

Tramstop lighting shall not conflict with the requirements for Closed Circuit Television coverage and shall permit the attachment of other stop furniture or equipments as required.

Hinged columns, hinging parallel to the track, shall be provided for ease of maintenance.

Tramstop emergency lighting facilities shall be provided in all shelters where the adjacent road lighting would be inadequate in the event of a Tramstop power supply failure.

25.4.4 Tramstop Name Signs

Each Tramstop shall include an illuminated pole mounted Logo, or more than one if there are more than one access points from a public road, or a sign incorporating the Edinburgh Tram Network corporate identity visible from a distance of 50m.

Each Tramstop shall be provided with Tramstop name signage as part of the general furniture arrangement on each platform.

Tramstop name signs shall be legible to tram-borne passengers as early as possible on their approach to the platform.

An appropriate number of stand-alone Tramstop name signs shall be provided along the length of each platform. The construction and materials shall form part of the "family" of components forming the Tramstop furniture.

The Tramstop name sign support structures shall be incorporated within the line of any guardrails, should these be provided, and into the advertising / information display.

The Tramstop name signs and Logo shall be illuminated and shall be displayed on the tram arrival side of the shelter as well as along the platform.

25.4.5 Advertising / Information Signs and Displays

A Real Time Passenger Information Display (double sided) shall be provided at each platform.

This shall take the form of a dynamic multi line visual display which is legible in all weather conditions to passengers having normal vision and standing at a distance of 10.0m away.

The Real Time Passenger Information Display shall comply with the requirements described in the Employer's Requirements.

Passenger information regarding the tram service and safety notices shall be provided at all Tramstops in both writing and Braille.

All passenger-operated equipment shall be provided with clear unambiguous operating instructions in both writing and Braille.

A suitably enclosed weatherproof map (part of the Tramstop furniture) of the local area, bearing the words 'You are Here', shall be located in each platform shelter.

A suitably enclosed weatherproof information display or displays (indicating the locations of adjacent bus stops and bus related information, hospitals, local amenities and places of interest) shall also be located at each platform access/egress position.

At appropriate key interchange locations (refer to 35.4.1 - Overview to the Passenger Information Display System), provision shall be made within the Tramstop layout to provide a bus tracker information panel, which shall be provided and installed by others.

25.4.6 Litter Bins

Litter bins, where provided, shall be stainless steel (Minimum Grade 304 to BS 5135) to facilitate easy cleaning and shall have a lockable removable bin liner.

The location of bins shall not obstruct the main passenger circulation routes and shall ensure convenience of use.

A minimum of two litter bins per platform shall be provided each positioned mid-point between the shelter and the end of the platforms.

Lockable access covers shall be provided and the bins shall be designed to limit entry and retention of liquids.

The bin size shall be determined on the basis of a single collection per day.

25.4.7 Public Address

Speakers shall be provided at each lighting pole location and within the shelter to enable passengers to receive messages without volume settings being high and causing nuisance outside the area of the platform.

Induction loops shall be provided within the central area around the shelter position.

Further details of the public address system are contained in Section [35.13.2] – Workstation Capabilities.

25.4.8 Tramstop CCTV

Closed Circuit Television (pan, tilt and zoom) digital colour cameras shall be provided on each platform to enable colour pictures to be displayed at the Control Centre and other Closed Circuit Television monitoring authorities.

The canopies / shelters, stop lighting and publicity / information displays shall not inhibit the Closed Circuit Television coverage of the Tramstop or platform.

The total number of cameras on each Tramstop shall be dictated by the physical restraints associated with each individual Tramstop, however, a minimum of one per platform shall be provided.

25.4.9 Passenger Help Points and Passenger Emergency Help Points

Tramstops will be provided with one combined Passenger Help Point and one Passenger Emergency Help Point on each platform, providing two-way (duplex) audio communication between a person located on the platform and the operator located at the Control Centre.

The Passenger Help Points / Passenger Emergency Help Points detailed arrangements shall be in accordance with Section [35.13.2] – Workstation Capabilities.

25.4.10 Guardrails, Handrails and Cycle Racks

Platform guardrails shall be provided to the rear of any platform where there is a potentially dangerous interface with passing road vehicles, Network Rail or a significant change in level.

Splashguards shall be provided in vulnerable locations.

Where provided, guardrails shall be set at 1150mm above platform level and comply with the requirements for the mobility impaired.

Cycle parking frames will be provided at each Tramstop, where this is appropriate. These will be positioned within view of the Closed Circuit Television surveillance system.

25.4.11 Seating

Bench seats (with integral arm rests and perforated seating structure) shall be positioned on each platform and within each shelter a perch rail / seat shall be provided, designed to prevent the retention of liquids. In all instances the under seat space shall be open to meet security requirements.

25.4.12 Ticket Vending Machines (TVMs)

Ticket vending machines shall be located within or adjacent to the shelters. The TVMs shall be positioned in an appropriately shaded location to assist users in reading the machine's visual display. Ticket vending machines will be supplied to the Infraco, as free issue, by TEL.

Infraco shall make provision for the power and communication cable routes, cables and draw wires from the Tramstop equipment cabinet to the proposed ticket vending machine locations.

Sufficient spare ways within the power and equipment cabinet to accommodate ticket vending machines and a local ticket vending machine network connection will be provided. Further details regarding ticket vending machines can be obtained in 36.5 of these Employer's Requirements.

25.5 Electrical (LV) and Communication Facilities

All Tramstop electrical (LV) and communication equipment shall be accommodated within a Tramstop equipment cabinet. LV supplies shall be provided to the equipment cabinet from which local electrical supplies to Tramstop equipment will be fed.

A 230V, 13A or equivalent socket shall be provided within the Tramstop equipment cabinet.

A 110V supply shall be provided at a suitable location on each platform for cleaning purposes.

All power requirements for the Tramstop infrastructure and adjacent infrastructure equipment will be sourced from the local Distribution Network Organisation supply. All power supplies shall be adequately rated to support the requirements of the Tramstop equipment.

25.6 Layover Facilities

Layover facilities shall be provided in accordance [2.15]

26 Track

This Section of the Employer's Requirements defines the Track requirements applicable to the Edinburgh Tram Network which the Infraco must comply with.

26.1 Track Layout

The Infraco shall ensure that the track layout shall be in accordance with ETN Diagram at Figures [2] & [3] – Edinburgh Tram Phases 1a and 1b Network Diagram

26.2 Components

Trackwork components to be provided shall include, but are not limited to, the following:

- Rails (relate to Wheel / Rail interface: N.B. inc. hardness related to welding repair);
- Sleepers and points and crossing bearers;
- Turnouts;
- Points and points motors;
- Points baseplates and slippers;
- Points rollers;
- Crossings;
- Check rails and check rail fastening systems;
- Guard rails and guard rail fastening systems;
- Transition rails;
- Rail joints (fishplated and welded);
- Insulated rail joints;
- Isolatable rail joints and provisions for access to associated rail/cable connections;

- Rail movement joints;
- Rail fastening systems;
- Rail pads;
- Baseplates;
- Resilient baseplate systems;
- Rail embedment for street running track;
- Paved trackbed and concrete trackbed systems;
- Grooved rail drainage systems (including boxes);
- Buffer stops and vehicle arrestor systems;
- Ballast;
- Granular filtering;
- Granular blanketing;
- Geotextile membranes;
- Plastics membranes;
- Geosynthetic reinforcement;
- Provision and installation of signs and markers; and
- Grasstrack.

26.3 General Requirements

Tracks shall be designed and constructed for left-hand running under line of sight operation.

The maximum design speed shall be 80 km/h.

Where the Edinburgh Tram Network runs within an urban environment on non-segregated sections of tramway, the speed limit shall be the same as that for motor vehicle traffic.

The trackforms shall be applied as indicated at the documents System wide trackform Surface Finishes Version 3 ULE90130-SW-DRG-00069.PDF, ULE90130-SW-DRG-00070.PDF and ULE90130-SW-DRG-00071.PDF

The track shall facilitate ease of construction and minimise disruption to other road users and the public during the construction phase on all roads and across all junctions between Haymarket and Ocean Terminal via Princes Street.

The track shall minimise the potential for stray current and be in accordance with the requirements and codes of practice for stray current and the **tie** Earthing and Bonding Policy document. As the valid standard the EN 50122 shall be in force.

Ensure simplicity of overall maintenance and ease of rail replacement and relaying, minimising the disruption to other road users.

The track shall comply with the operational noise and vibration requirements as stated in the **tie** Noise and Vibration Policy. Detailed technical solutions will be determined during the Detailed Design Phase for areas identified as sensitive to Noise and Vibration. The assessment of these solutions shall be in line with the characteristics of the vehicles, the existing sub-structure and the structures adjacent to the track-bed.

The track shall integrate fully with roads, such that differences in roads surfaces, specifically finished levels and skid resistance, are minimised as far as is reasonably practicable.

The track shall integrate fully with surrounding area functionality and appearance, to ensure that hazards to pedestrians, the mobility impaired and cycle users are minimised as far as is reasonably practicable, and such that track surface finishes are in accordance with all design requirements, guidance and aspirations.

Adequate track formation shall be provided to facilitate the secure foundation for track installation.

The in-street track formation shall be of shallow design such that it permits minimum amount of public utility diversions and aids the high speed construction of the tramway.

The surface at pedestrian crossing points shall be level with the top of the running rails and surfaced in non-slip materials. These materials shall be chosen to be reasonably consistent with the character of the locality whilst providing clear indication to all users (including the visually impaired) of the correct point to cross the track and the extent of the Edinburgh Tram Network environment.

Track shall be a standard tramway track with steel rails set to Standard Gauge (1.435m) and shall be compatible with the Edinburgh Tram Network trams.

On ballasted sections of the route, road/rail equipment will be used for maintenance tasks such as tamping. These machines shall be equipped with suitably profiled wheels.

26.4 DKE, Structure Gauge and Clearances

The DKE adopted shall be the "Assumed Tram for Design", as presently defined in the SDS design documents.

Structure gauge and clearance drawings shall include the standards for staff maintenance walkways and tram evacuation walkways.

Adequate walkways are required throughout the route off-street. Appropriate signing shall be included to indicate the walkway.

26.5 Trackforms

Various trackforms, as presently shown in the SDS design documents, are required to suit the different domains in which the track lies along the route and in the Depot and sidings. The different trackforms provided shall comprise, but not necessarily be limited to:

- Flush-finished track in road areas and at Tramstops, including mixed operation with traffic of various kinds, or not; and with a variety of surface finishes;
- Track with grass flush finish;
- Track with plain concrete flush finish (e.g. in the depot and for certain structures, e.g. the A8 Underpass);
- Direct fixation track on structures;
- Ballasted track; and

- Special trackforms in the depot or at Tramstops.

The trackforms shall be designed and installed to take full account of the requirements for future maintenance of components, e.g. life-extension of rails by welding in situ, and the adjustment of the levels of rails and the adjacent surfaces, and of sectional renewal.

26.6 Specific Technical Requirements

Retention of alignment on small radius curves in the case of ballasted track where rails are continuously welded shall be considered. A minimum radius shall be established for the application of ballasted track, with an appropriate alternative trackform applied elsewhere.

For in-street track construction, and in the absence of sleepers or similar, a means of retaining the lateral and rotational position, such as tie-bars of the rail together with the track gauge shall be provided.

A standard trackform shall be provided which shall comprise a slab that shall be suitable for any of the road, pavior / block / sett and grass surface finishes. In effect the surface finishes shall be interchangeable without having necessarily to redesign or reconstruct the whole slab.

A special track form shall be used at sensitive locations to mitigate against ground borne noise and vibration. These locations will be identified by the Infraco in agreement with **tie**.

At the end of all terminating tracks, provision shall be made for a device for arresting Trams. These devices may include sliding friction or fixed type buffer stops, sand drags, architectural features such as planters, wheels stops or other means. The choice of such device(s) shall be made through risk analysis of the location, taking into account the risk to passengers, pedestrians and staff and to the vehicles and surrounding environment.

Rail shall be continuously welded wherever possible. The use of fish-plated joints shall be avoided although fishplated track may be proposed in the Depot to avoid the requirement for rail movement joints at turnouts.

26.7 The Wheel / Rail Interface

A report has been produced by SDS (ref: ULE 90130-SW-REP-00130 v3) which shall form the basis of development of this critical interface. The key factors will be recorded here.

26.8 Drainage

Drainage from trackwork shall be interfaced with the road and civils drainage systems. Adequate drainage within the trackwork system shall be provided such that the integrity of the installations is secure.

The Edinburgh Tram Network shall have a drainage system that, as a minimum, achieves accepted EU or BS standards and Good Industry Practice.

The drainage of all new bridge structures shall be positive and, unless otherwise required by the relevant local authority, all surface water shall be piped to the local storm water sewer systems by a defined drainage path.

Particular attention shall be paid to ensure that surface water drainage systems in the vicinity of traction substations and cable ducts are routed to avoid any risk of flooding of electrical equipment areas, point machine chambers, and the ducts themselves.

For on-street track, the track drainage system shall incorporate an insulated break from the storm water system.

Drainage proposals including any new flows into existing drains and the method of connection shall be approved by Scottish Water, SEPA and the City of Edinburgh Council Roads Department as appropriate.

26.9 Technical Requirements for Points and Crossings

All turnouts, crossings and interruptions to the continuity of the rail head shall be equipped with flange running sections or other design which minimises joint noise.

The design shall minimise flange squeal through tight radii and through junctions.

Points shall be provided with two movable blades so mounted to allow the use of magnetic track brakes and their safe passage through the point and crossing.

All points shall be freely trailable without damage to the blades or mechanism.

Points and crossings shall be designed so that they are capable of through stressing as required.

All points on the main line, likely at some time or another to be taken in the facing direction (including trailing, emergency crossovers), shall be equipped with detection and indication. Indication of trailing points likely to be taken at high speed shall be considered.

All points, when operated by hand lever, shall be capable of being thrown fully, by one throw of the lever, by a male or female person of slight build, without undue effort or strain. To this end, the maximum required effort to change the points shall not normally exceed 230Nm.

Some form of indication shall be incorporated into the mechanism to indicate that the point has thrown fully. Lever mechanisms requiring repeated operation to throw the points are not acceptable.

Efforts should be made to reduce friction and the effort to throw the points. Flange relief of the point tongues is one such feature.

Point tongue profiles and movement on all points shall conform to the same dimensions and tolerances.

Design tolerances shall be maintained in service with a relatively low level of attention.

Designs with potential for high wear rates or other high maintenance features are not acceptable.

Designs with the potential for lengthy infrastructure replacement periods are not acceptable, particularly in on-street areas.

Adequate, functional drainage must be provided to ensure that rail grooves and point machine pits are kept clear of rainwater, sand and rubbish from the street etc.

Pointwork in the depot site area shall be installed in a flush-finished trackform for 9 turnouts and 1 crossing at the beginning of the depot area. This flush-finished trackform will be designed for re-railing purposes only.

26.10 Technical Requirements for Point Operation

26.10.1 Point Machines and Mechanisms in General

All point machines, whether powered or not, shall be from the same family of machines and provided by the same supplier.

Point machines shall allow the points to be 'freely' trailable without damage to the blades or mechanism.

In street running track, point machines shall be installed between the rails of the track.

On ballasted track, in order to facilitate maintenance, they shall be installed to the side of the track, on the outside of a typical two track layout.

Point machines shall be capable of manual operation in a single throw by tram drivers using a removable point bar to be carried in the Tram drivers cab. Only one form of point bar shall be utilised on the system.

It shall be possible for the points to be changed by a male or female person of slight build, without undue effort or strain when the points are not affected by snow or ice. To this end, the maximum required effort to change the points shall not normally exceed 230Nm.

When operated by hand using the standard points operating bar, it shall not be possible to inadvertently partially throw the points, which shall always throw sufficiently to make the respective detection circuits at each lie of the points with a single movement of the lever.

A total number of 70 point operating bars shall be supplied.

All combinations of points and point machines shall be validated to demonstrate that:

- The machines shall exert sufficient force under all foreseeable circumstances to move the points blade into the required position;
- The points shall close and lock reliably under all foreseeable operating conditions;
- Detection settings shall have adequate maintenance tolerances to ensure that points detection setting testing shall be required no more than monthly on all points;
- The wheel/rail interface at the toes of the points shall be such that there is no derailment risk under all combinations of wheel wear, rail wear, and detection settings;
- Any tram driver shall be able to operate all points safely and without risk of injury; and

The enclosing case of the Point Machine shall be to Class IP 67 and be drained.

Point Machines shall not be overstressed in performing its duty. Efforts should be made to minimise friction and the effort to throw the points. Flange relief of the point tongues is one such feature and there are others such as PTFE slides and supporting rollers.

The flangeway in advance of the point tips shall not be less than 41mm. It shall be consistent with the wheel/rail interface report.

The amount by which nominally 'closed' point tongues may be open at their tips whilst still providing detection, shall be agreed as a part of the wheel/rail interface criteria.

Each Point Machine shall be clearly identified and robustly labelled.

Point Machines of all types and their drive and detector rods shall be insulated from the running rails and from the surrounding earth. Separate earthing connections for the drive motor (where fitted) and the machine case shall be provided.

Point Machines of all types shall normally not require maintenance more frequently than at three-monthly intervals although inspection may be carried out more frequently.

All Point Mechanisms shall incorporate at least one volt-free change-over contact in both the 'Normal' and 'Reverse' positions, in addition to those required for detection purposes.

In the case of Point Machines incorporating an over-centre device, it shall not be possible for the machine to be set in the 'null' position during powered or sprung operation, as applicable.

26.10.2 Specific Requirements for Motorised Point Machines

The Point Machines will operate from a 230Vac supply.

The Point Machine shall be capable of operating the two point tongues for the full throw required to provide the standard 'blades open' gap, to clear the backs of the flanges of the wheels. However, the throw shall not be so great as to flex the tongues further than necessary, thereby introducing unnecessary stress in the track components and load on the operating machine mechanism. This dimension 50mm,+5/-0mm will be finalised after the wheelset profile has been determined and the Wheel-Rail Interface Report has been finalised in the Detailed Design Phase.

26.10.3 Specific Requirements for Sprung Point Mechanisms

The Spring Point Mechanism shall be capable of being biased to effect a route to either lie of the points. The mechanism shall normally set the points in their 'Normal' position but by adjustment, they shall be capable of being set in the 'Reverse' position.

In both cases, it shall be possible to change the lie of the points using the standard points operating bar with an effort not exceeding 230Nm.

Only the incursion of a foreign body in the space between the point tongue and the stock rail shall prevent a satisfactory change in the lie of the points.

The lie of the points shall be continuously maintained in the 'Normal' (or if adjusted, 'Reverse') position by adequate spring pressure.

After having been forced across by the passage of a tram, the mechanism shall positively return the points to the 'Normal' position and provide the standard 'blades open' gap, to clear the backs of the flanges of the wheels.

If possible, by the rearrangement of components, the Spring Point Mechanism shall be convertible into a Bistable Point Mechanism for the avoidance of spares duplication.

26.10.4 Specific Requirements for Bistable (flip-flop) Point Mechanisms

The Bistable Point Mechanism shall be capable of being biased to effect a trailing route through either lie of the points, by use of a standard points operating bar. The mechanism shall normally retain the points in the position last trailed. However, by operation using the approved points operating bar, they shall be capable of being set in the alternative position.

Only the incursion of a foreign body in the space between the point tongue and the stock rail shall prevent a satisfactory change in the lie of the points.

The lie of the points will be continuously maintained in the position last trailed by adequate spring pressure.

After having been forced across by the passage of a tram, the mechanism shall positively leave both blades of the points held firmly across with the 'closed' point against the stock rail and provide the required 'blades open' gap, to clear the backs of the flanges of the wheels on the other side.

The amount by which nominally 'closed' point tongues may be open at their tips shall be within the same tolerances specified for points operated by powered Point Machines.

If possible, by the rearrangement of components, the Bistable Point Mechanism shall be convertible into a Spring Point Mechanism for the avoidance of spares duplication.

26.10.5 Specific Requirements for Hand-Operated Point Mechanisms (Point Levers)

Points operated by Hand-Operated Point Mechanisms shall normally be traversed in the facing direction subject to a 10 km/h track speed limit.

One throw of the lever shall fully throw the points to either 'Normal or 'Reverse' positions. Levers which require one or more attempts to complete the operation are not acceptable.

It shall not be possible to inadvertently partially throw the points, which shall always throw sufficiently to allow the respective 'points thrown' indication at each lie of the points to be given with a single movement of the lever.

Only the incursion of a foreign body in the space between the point tongue and the stock rail shall prevent a satisfactory change in the lie of the points.

After having been thrown, the mechanism shall positively leave both blades of the points held firmly across with the 'closed' point against the stock rail and provide the required 'blades open' gap to clear the backs of the flanges of the wheels on the other side.

The amount, by which nominally 'closed' point tongues may be open at their tips, shall be within the same tolerances specified for points operated by powered Point Machines.

26.11 Technical Requirements for Point Control and Indication

26.11.1 Detection

Where detection and indication is required, the mechanism shall be fitted with detection equipment capable of differentiating between a 'safe' and 'unsafe' gap. When closed, the detectors must be capable of detecting a minimum gap of 1.5mm although the 'unsafe' gap detection including a safety margin will be slightly greater than this at 2.5mm, +0/-0.5mm between the closed point tongue and the corresponding stock rail at each lie of the points. To be confirmed with wheel/rail interface criteria.

Each point tongue shall be independently detected through a separate mechanical connection to the point tongues, independent of the drive rod connection and as close as practicable to the tip of the tongue. Totally enclosed proximity switches are preferred for this duty.

26.11.2 Control

The Point Controller shall receive information from the Tram Position and Detection System (TPDS) and set the Points and Point Indicators and shall be driven by the output from the point detection.

The Point Controller shall acknowledge the requests from TPDS and make all the necessary safety checks before commanding the point machine to move the points.

When the Point Controller causes the Point Machines to change the points, it shall monitor the detection contacts in the associated Point Machine(s) to determine whether the points have fully thrown.

Once the points have been satisfactorily operated (i.e. been fully thrown), the Point Indicator shall show a sloping row of lights (or LED clusters), corresponding to the lie of the point to approaching trams. If the points have not fully thrown, a horizontal row of lights (or LED clusters) shall be displayed.

If an appropriate command has been set by personnel in the Control Centre, the Point Controller shall block any associated points requested by the tram on-board computer from its route code.

The Point Controller shall report to the adjacent Tram Position and Detection System and or SCADA when any of the following conditions apply:

- Failure of the Point Machine supply;
- Failure of the Point Indicator supply;
- Receipt of an indication of faulty point detection; and
- Failure of the Point Heaters supply.

When the relevant track circuits or mass detectors detect the presence of a tram in a prescribed area, the Point Controller will lock the points against any further signals to change them until the tram has left the prescribed area.

The Point Controller shall also afford the facility to set and control the associated points locally.

26.11.3 Indication

The lie of the points shall be indicated to trams approaching the toe of the points in a facing direction. Indication of trailing points likely to be taken at high speed shall also be considered. The specific requirements at each location are defined on the track layout diagram.

The basic technology and design of the point indicator shall be same as the tram signals. The colour shall not be white, red or green.

Point indicators shall exhibit the following standard aspects to drivers:

- Points set to left hand route: diagonal row of lights sloping upwards towards the left;
- Points set to right hand route: diagonal row of lights sloping upwards towards the right; and
- Points not detected: horizontal bar

The indicator shall be placed for visibility to the tram driver in the same basis as tram signals.

The means of illumination shall be by LEDs.

A minimum of five clusters in each row shall be provided.

All Point Indicators shall be located in agreement with the Operator and shall be co-located where relevant with tramway signals.

Each Point Indicator shall be clearly identified and robustly labelled.

The aspect shall be clearly visible in all weather conditions.

The Point Indicators shall normally not require maintenance more frequently than at three-monthly intervals although inspection may be carried out more frequently.

26.11.4 Control Cabinet

Controls to set and control the associated points locally shall be provided in a cabinet. These shall be operable while the relevant points are in direct view of the person operating them.

The Point Controller cabinet shall contain the power supply for the operation of the associated points and to all associated Point Indicators.

The Point Controller cabinet shall contain and control with an input from the SCADA system, the power supply to the point heaters mounted on the associated points.

The Point Controller shall not require maintenance more frequently than at six-monthly intervals although inspection may be carried out more frequently.

26.12 Indication of Hand Operated Point Mechanisms (Point Levers)

The lie of the points shall be indicated to trams approaching the toe of the points in a facing direction.

Upon the operating lever being thrown, a simple mechanical device will detect that the closing point tongue has closed to within the permitted tolerances specified above.

Detection of the fully thrown condition shall cause a mechanical indicator to display a corresponding indication to the tram driver. The indicator shall present an indication equivalent to that shown on lit indicators and be visible from the normal tram driver's operating position in the cab, when the tram is 5 metres to the rear of the point tips, in daylight and illuminated by the tram's headlights after dark. Failure to close the tongue to within this tolerance shall not allow the indicator to show a 'points thrown' indication. Both point tongues shall be detected, either individually or as a coupled pair.

26.13 Technical Requirements for Points Heating

Points heating systems will allow the efficient operation of points in low temperatures and shall be such that the components will not intrude into the surrounding infrastructure.

Points heating shall be electrically powered and shall be controlled automatically by sensing when the predefined temperatures for activation and deactivation have been reached.

Point Heating devices shall provide health status information via the SCADA to the Control Centre.

Point Heaters shall be capable of being manually activated and/or deactivated locally and from the Control Centre.

The locations at which point heating shall be provided will be agreed and shown on the track layout diagram.

Where more than one heater is controlled from a Point Controller, it shall energise each of them in sequence in order to limit the inrush current demanded.

The Point Controller shall monitor the local ambient temperature and humidity and control the supply to the point heaters accordingly.

The settings at which the point heaters are energised shall be adjustable within the limits of 0°C to + 5°C.

26.14 Tolerances

The following definition of construction and maintenance tolerances shall be developed and agreed between Infraco and **tie**.

Element	Qualifier	Comment	Unit	Comment	Desirable Value	Limiting Value	Exceptional Limiting Value
Speed	Shared running	Maximum	kph		**50**	**50**	**50**
Speed	Segregated running	Maximum	kph		**80**	**80**	**80**
Speed	Depot	Maximum	kph		**15**	**15**	**20**

Table 65 - Speed assumptions and normal limitations

Element	Qualifier	Comment	Unit	Comment	Desirable Value	Limiting Value	Exceptional Limiting Value
Geometric element	Minimum length		m		**15**	**12**	**6**

Table 66 - Geometric Elements - Element lengths are tied to the tram length, specifically distance between bogies

Element	Qualifier	Comment	Unit	Comment	Desirable Value	Limiting Value	Exceptional Limiting Value
Horizontal radius - Minimum	Running lines	Slab track	m		50	30	25
Horizontal radius - Minimum	Depot lines		m		50	40	20
Horizontal radius curves	Distance between opposite flexure	Radii dependant - no transition curves	m	Considered minima dependant upon tram data	15	10	6

Element	Qualifier	Comment	Unit	Comment	Desirable Value	Limiting Value	Exceptional Limiting Value
Horizontal radius curves	Distance between opposite flexure	With transitions on adjacent opposite flexure curves	m	Exceptional to be considered individually (also refer wheelbase)	10	86	60
Horizontal radius curves	Distance between curves of opposite flexure	Turnouts - theoretical tangent points at switch toe to next tangent pt (of opposite flexure)	m	Considered minimums dependant upon tram data (wheelbase)	10	8	6
Horizontal radius curves	Distance between curves of opposite flexure	Turnouts - theoretical tan.pt. at switch toe to tan.pt. (of similar flexure)	m	Considered minimums dependant upon tram data (bogie axle ctrs)	5	3	2
Horizontal radius curves	Tramstops		m	Absolute minimums	Infinity	2000	1000

Table 67 - Horizontal Curves: Minimum requirements for horizontal curves including distances between similar and opposite flexure. Similar requirements also for horizontal curvature up to turnouts and through Tramstops.

Element	Qualifier	Comment	Unit	Comment	Desirable Value	Limiting Value	Exceptional Limiting Value
Cant	Platforms		mm		0	0	0
Cant	Tangent track	Facilitate drainage	mm		0	15	15
Cant	Fixed Obtuse crossings		mm		0	150	3015
Cant	Curves		mm	Subject to Tram	75	75	100
Cant	Plain line track – depot		mm		0	0	15

Table 68 – Cant: Maximum cant values

Element	Qualifier	Comment	Unit	Comment	Desirable Value	Limiting Value	Exceptional Limiting Value
Negative cant	Plain line		mm		0	15	15
Negative cant	Turnouts	Turnouts - Only on the turnout routewhen turnout is facing downhill on a grade	mm		0	0	15
Negative cant	Turnouts	ElsewhereTurnouts and acute diamond crossings	mm		0	0	15
Negative cant	Turnouts	Obtuse crossings in diamonds	mm		0	0	0

Table 69 - Negative Cant: Maximum allowable values which are particularly important with regard to turnouts and obtuse crossings.

Element	Qualifier	Comment	Unit	Comment	Desirable Value	Limiting Value	Exceptional Limiting Value
Cant excess			mm	Subject to Tram	0	25	50

Table 70 - Cant Excess - Normally applied where slow speed running may be encountered, but does have some bearing in this concept.

Element	Qualifier	Comment	Unit	Comment	Desirable Value	Limiting Value	Exceptional Limiting Value
Cant deficiency	Plain line		mm	Maximum	40	60	75
Cant deficiency	Plain line - Depot		mm		40	75	100
Cant deficiency	Through route of turnout	On tangent or curved track-	mm		0	40	60
Cant deficiency	Turnout route		mm		40	60	75
Cant deficiency	Based on theoretical radius at switch toe	Cant deficiency based on theoretical radius formed by shortest wheel-base placed centrally at switch toe	mm		4025	4025	5025
Cant deficiency - jerk	At switch toes Consider shortest wheelbase	Maximum permitted jerk rate at switch toes using theoretical radius formed by shortest wheel-base	m/s3	jerk = 0.2 m/s3	0.30.2	0.30.4	0.50.4
Cant deficiency - jerk	Plain line Consider shortest wheelbase	Maximum permitted jerk rate as a result of the geometry change and shortest wheel-base	m/s3		0.250.2	0.350.25	0.450.3

Table 71 - Cant Deficiency: Deficiency at the switch toe will require careful consideration, effectively setting speed restrictions. Particular impact on the criteria will be to assess jerk with reference to the shortest wheelbase.

Element	Qualifier	Comment	Unit	Comment	Desirable Value	Limiting Value	Exceptional Limiting Value
Transition curves	Virtual Transition	Length basis	m	Subject to Tram	No use	1.810	1.810
Transition curves	Clothoid	Minimum length	m	Subject to Tram	15	10	6

Table 72 - Transition Curves - Dimensional requirements with some relationship to the tram dimensions

Element	Qualifier	Comment	Unit	Comment	Desirable Value	Limiting Value	Exceptional Limiting Value
Cant gradient	Cant gradient - Maximum permitted	RoCC may be overwritten by other minimums		Consider RoCC	RoCC	600	300
Cant gradient	Cant gradient - Minimum permitted				1500	2000	3000
Cant gradient	Switch toes				0	0	0
Cant gradient	Crossings and diamonds				0	0	0

Table 73 - Cant Gradient: Permitted maximums which, in effect, define twist parameters (dealt with later). Note: All the following apply only in the cases of applied cant on track on zero grade. For track on a grade or a vertical curve, where a twist in the track will arise from a horizontal curve, the maximum gradient that arises from applied cant must be less than the following limits (i.e. one in (value greater than following limits)) because an element of effective cant gradient will result from the combinations of horizontal curve and grade / vertical curve. In the latter cases the gradients that arise from applied cant are governed by the overall twist limits which are specified in table [78] below.

Element	Qualifier	Comment	Unit	Comment	Desirable Value	Limiting Value	Exceptional Limiting Value
Rates of change – cant		Rate of change of cant	mm/s	Subject to Tram	35	55	68
Rates of change - cant def		Rate of change of cant deficiency - plain line	mm/s	Subject to Tram	35	55	68
Rates of change - cant def		Rate of change of cant deficiency - S&C	mm/s	Subject to Tram	35	55	80

Table 74 - Rates of change of cant (RoCC) & Rates of change of cant deficiency (RoCCD) - Rate of change in lateral acceleration.

Element	Qualifier	Comment	Unit	Comment	Desirable Value	Limiting Value	Exceptional Limiting Value
Vertical alignment	Sag	Vertical curve radius - minimum	m	Subject to Tram	1000	625	500
Vertical alignment	Hog	Vertical curve radius - minimum	m	Subject to Tram	1000	625	500
Vertical alignment	Vertical acceleration		% of g		2	2	4
Vertical alignment	Turnouts and diamonds	Vertical curve radius. Proximity of vertical curve tangent point to switch toe and crossing of turnouts and diamonds.	m		150	100	60
Vertical alignment	Advance sws - xng & sws	Vertical curve radius	m		0	0	0
Vertical alignment		Minimum curve element length	m		20	15	10

Element	Qualifier	Comment	Unit	Comment	Desirable Value	Limiting Value	Exceptional Limiting Value
Vertical alignment	Instantaeneous change in grade		%		None	0.1	0.2
Vertical alignment	Grade distance between adjacent curves (similar flexure)	Preferred situation	m		None	None	None
Vertical alignment	Grade distance between vertical curves of opposite flexure	With combined average radius ***less than*** 3125m	m		15	10	6
Vertical alignment	Grade distance between vertical curves of opposite flexure	~~Grade distance between vertical curves~~With combined average radius ***greater than*** 3125m.	m		15	10	06

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Table 75 - Vertical Alignment - Some elements require consideration from the tram supplier, others refer again to element lengths

Element	Qualifier	Comment	Unit	Comment	Desirable Value	Limiting Value	Exceptional Limiting Value
Vertical geometry	Tramstops	Radius through tramstops (without exceeding gradient criteria)	m		Infinity	2000	1000

Table 76 - Vertical Geometry: Tramstop requirements

Element	Qualifier	Comment	Unit	Comment	Desirable Value	Limiting Value	Exceptional Limiting Value

Element	Qualifier	Comment	Unit	Comment	Desirable Value	Limiting Value	Exceptional Limiting Value
Gradients			%		5.0	6.7	8.08.5
Gradients	Tramstops		%		1.0	2.0	2.54.0
Gradients	Stabling	Maximum – includes locations where tram driver is routinely required to leave driving position	%		0.0	0.1	0.2
Gradients	Turnouts and junctions	Dependant upon twist and negative cant	%		0.2	3.0	6.55.0

Table 77 – Gradients: Maximum gradients in various locations

Element	Qualifier	Comment	Unit	Comment	Desirable Value	Limiting Value	Exceptional Limiting Value
Twist (as part of the design)	Short wave (over bogies)		$^0/_{00}$	Subject to Tram	1.51.2	2.0	3.3
Twist (as part of the design)	Long wave over length of vehicle	Project Tram geometric capability 10m @ 3mm $^0/_{00}$ + 10mm -- i.e. 30+10 = 40 (or 4 $^0/_{00}$)	$^0/_{00}$	Subject to Tram	1.5	2.0	3.33.0

Table 78 – Twist

The above represents the limits on the overall twist in the track that is a summation of: any gradient arising from applied cant; effective combinations of horizontal curves and grades / vertical curves; and other twisting effects (e.g. resulting from induced crossfalls for road drainage).

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Twist is introduced into the track whenever cant is applied and when track with zero cross-level has a combination of horizontal curvature and vertical curvature or gradient.

Such geometry creates a twist, which has to be negotiated by the tram vehicle. Clearly the tram has to be capable of handling such geometric situations. Certain manufacturers may define these criteria in their own way, an interpretation of which is indicated below.

Twist in the long wave is measured over the wheelbase (bogie centres); short wave being measured over the axle centres of the bogie. Short wave twist also leads to wheel un-loading, not, as yet, defined here.

Element	Qualifier	Comment	Unit	Comment	Desirable Value	Limiting Value	Exceptional Limiting Value
Vert / Horiz alignment	Horizontal radius - 25	Vertical curve radius - minimum (product rule)	m	40k,30k,25k	1600	1200	1000
Vert / Horiz alignment	Horizontal radius - 30	Vertical curve radius - minimum (product rule)	m	40k,30k,25k	1333	1000	833
Vert / Horiz alignment	Horizontal radius - 40	Vertical curve radius - minimum (product rule)	m	40k,30k,25k	1000	750	625
Vert / Horiz alignment	Horizontal radius - 50	Vertical curve radius - minimum (product rule)	m	40k,30k,25k	800	600	500

Element	Qualifier	Comment	Unit	Comment	Desirable Value	Limiting Value	Exceptional Limiting Value
Vert / Horiz alignment	Horizontal radius - 60	Vertical curve radius - minimum (product rule)	m	40k,30k,25k	667	500	n/a
Vert / Horiz alignment	Horizontal radius - 80	Vertical curve radius - minimum (product rule)	m	40k,30k,25k	500	n/a	n/a

Table 79 - Vertical/horizontal alignment combinations

Taking the comments above regarding twist, it can be seen the certain combinations of vertical and horizontal alignment can cause undesirable geometric situations. The tables below define, using a simple product rule, the limitations.

Element	Qualifier	Comment	Unit	Comment	Desirable Value	Limiting Value	Exceptional Limiting Value
Track spacing	Plus allowance for DKE	Double track main line - track centres - side poles	mm	~~Subject to Tram~~ - 31003150			mm
Track spacing	Plus allowance for DKE	Double track main line - track centres - centre poles	mm	~~Subject to Tram~~ - 36003650			~~mm~~
Track spacing	Plus allowance for DKE	Depot tracks and sidings - track centres		TBA Subject to Tram			
Track spacing	Plus allowance for DKE	Depot tracks and sidings - track centres - working space		TBA Subject to Tram			

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Table 80 - Track Spacing: ~~Requires further definition~~. Note: straight track on radii larger than 350 metres on fixed non-ballasted trackform

Element	Qualifier	Comment	Unit	Comment	Desirable Value	Limiting Value	Exceptional Limiting Value
Gauge	Track gauge				1435	1435	1435
Gauge	Track gauge widening				0	0	0
Gauge	Track gauge-flange-running			TBA Subject to Tram			
Gauge	Check flangeway			TBA Subject to Tram			

Table 81 – Gauge: Standard data that requires further review/approval

Element	Qualifier	Comment	Unit	Comment	Desirable Value	Limiting Value	Exceptional Limiting Value
Rail inclination		Inclination - Vertical street grooved rail		TBAVertical			mm
Rail inclination		Inclination - Non grooved rail		TBA Subject to Tram			

Table 82 - Rail Inclination

27 Roads and Utilities

This Section of the Employer's Requirements defines the roads and utilities requirements applicable to the Edinburgh Tram Network with which the Infraco must comply.

27.1 General

The roads works and utilities shall consist of all the necessary road works and associated accommodation works required to fully integrate the Edinburgh Tram Network into the urban road environment, including those relevant areas that are not trafficked.

The road works, utilities and associated accommodation works shall be provided in accordance with the Design Manual for Roads and Bridges (DMRB), except as amended by the requirements of, or otherwise agreed with, the relevant authority including where such requirements are more onerous.

The roads and utility works shall include but not be limited to the following:

- Road and junctions (including all necessary off-alignment works);
- Site clearance;
- Safety barriers and fencing;
- Drainage works including track drainage;
- Earthworks;
- Surfacing;
- Road lighting;
- Traffic signage and road markings;
- Traffic signals and tram signals;
- Landscaping;
- Temporary and permanent traffic measures;
- All associated cable ducting required for the works;

- Depot access and utilities, including within the Depot;

- Utility diversion works where not carried out by MUDFA; and
- Removal of all redundant services and apparatus affecting the works.

The works shall take account of MUDFA.

27.2 System-Wide Requirements

The tram network shall be segregated from the road wherever feasible using a variety of means as appropriate to the features and constraints of the individual locations. These include the use of road markings and varying surface types for visual or textural delineation. The design of the segregation details shall optimise their effectiveness without significantly compromising safety and operational factors, including the operation of junctions and emergency and maintenance access.

27.3 General Requirements

All works shall be carried out in accordance with the provisions of the Tram Legislation. All works on adopted roads shall be to a standard to allow subsequent re- adoption by the Roads Authority.

Wide-area modelling of traffic impacts consequent to the design shall be provided as a pre-requisite to approval, and prior agreement with the City of Edinburgh Council on the Traffic Regulation Orders and Temporary Traffic Regulation Orders necessary to implement the design and complete the works.

In addition to roads that have been adopted by the Roads Authority, the route for the tramway also uses roads that are currently in private ownership. In all cases the owners of private roads shall be consulted and their input and approval sought during the design process. Road works within these areas shall be to the same standard as that used for the roads adopted by City of Edinburgh Council (similarly, new and extended roads shall follow the same process). Where third parties are affected by a new or extended road their inputs and approvals where necessary shall be sought during the consultation process.

27.4 Stray Current

Refer to Stray Current of these Employer's Requirements at section [32]

27.5 Roads

27.5.1 General

The general requirements for the design of the roadworks shall meet the relevant Standards set out in Section 3.6 of these Employer's Requirements with emphasis on the following:

- Design Manual for Roads and Bridges (DfT);
- City Development Transport – Development Quality Handbook – Movement and Development (CEC);
- Edinburgh Standards for Streets (CEC); and
- Tram Design Manual (CEC).

27.5.2 Roads Design

The roads and track alignment shall be integrated in a manner that best uses the available space and optimises the alignment of both systems. Horizontal clearances between kerb lines of roads and tram network structures shall be not less than those set out in the relevant Department for Transport technical memoranda and the Department for Transport publication "Roads and Traffic in Urban Areas" and shall meet the guidance in ORR RSP2.

The requirements for geographical sections of the design and construction shall be discussed and agreed with **tie** and the City of Edinburgh Council to determine the extent of the proposed re-modelling, roadworks and (temporary and/or permanent) traffic management.

All surfacing materials shall comply with the DMRB requirements and consider City of Edinburgh Council's preferences. The integration of the Edinburgh Tram Network alignment, road design and road markings shall minimise the risk of road vehicles skidding on the rails. The finished works shall meet the serviceability requirements, balanced with commercial, social and environmental considerations. In particular, the following factors shall be taken into account:

- Make the best use of existing infrastructure;
- Meet the requirements of the promoter (**tie** and CEC);

- Minimise the disruption to traffic;
- Minimise the public perception of waste and unnecessary disruption;
- Minimise the construction cost;
- Maximise the maintainability;
- Minimise the construction time;
- Minimise the excavation, material usage and hence vehicle movements; and
- Meet the needs of properties fronting onto the route of the tramway.

The Roads Design shall include but not be limited to:

- Identification of constraints and provision of typical sections;
- Tram / road interface review in the light of outputs from the design process;
- Provision of integrated tram/road design model;
- Assessment of the impact of the track alignment on the road design and layout;
- Assessment of the impact of the OLE design on the road design and layout;
- Layout drawings including extent of the works;
- Drawings detailing discrete locations where the vertical track alignment deviates from existing ground levels, this will include cross-sections and contoured plans as required;
- Standard details;
- Drawings to show changes to existing car parking provisions along the route, for example at Rosebery House, Haymarket including new access;
- Access and general arrangement layout to the Depot at Gogar;

- Consultation with City of Edinburgh Council, Scottish Environment Protection Agency and Scottish Water during the initial drainage design process identifying potential outfall locations and surface water treatment requirements for both roads and tram;
- Location of existing surface water drainage networks and outline routing of surface water from track and road drainage over the entire route;
- Standard details of drainage connections, sand traps, manholes, etc.;
- Pedestrian guardrails and boundary fencing;
- Interpretation of outputs from the traffic modelling process;
- Identification of junctions where existing traffic signals may need modification. Identification of locations where new traffic signals may require to be installed;
- Preparation of information to support the Traffic Regulation Orders and Temporary Traffic Regulation Orders. This will be based on the roads design, or the latest road design available. Prior to submission for the Statutory Process the TROs will be reviewed against the latest design;
- Safety audits for all stages;
- Compliance with the approvals process;
- Layout drawings for tram / road interface at 1:500 scale;
- Final junction register;
- Integration of traffic and tram signalling systems determined by the traffic model and tram run-time simulation;
- Three-dimensional MX model for all roads design;
- Details including any special measures at specific locations;
- Detailed General Arrangement of new access to car park at Haymarket including any modifications to car park layout;

- General Arrangement and vertical alignment for new access road to the Depot at Gogar;
- 1:200 scale drawings for each junction;
- Detailed design of surface water drainage networks modelled using appropriate software;
- Detailed design of site clearance layout, boundary fencing, safety barrier and pedestrian guardrail, pavement, earthworks, signs and markings, kerbing, footways, traffic signal layouts and road lighting;
- Determination of the extent of modifications to existing traffic signals and new installation requirements. Preparation of a traffic signal equipment performance specification; and
- Links with the CEC UTC;
- Compliance with all side agreements entered into by CEC (whether final or in draft) with respect to the Parliamentary Tram Acts.

27.5.3 Road User Safety Audit

Road User Safety Audits shall be carried out as required by The City of Edinburgh Council and sufficient to demonstrate the integrity of the design process to HMRI (or the appropriate regime in force).

27.5.4 Cycleways

Where it is required that cycleways are provided as part of the Infraco Works these shall be designed and constructed in accordance with the relevant guidelines including:

- Design Manual for Roads and Bridges;
- City of Edinburgh Council "Roads Development Guidelines";
- Scottish Executive's "Cycle by Design"; and
- SUSTRANS "Cycle Friendly Infrastructure Guidelines for Planning and Design".

27.6 Drainage Including Track Drainage

All roads drainage shall be designed and constructed in accordance with The Design Manual for Roads and Bridges, Volume 4 and comply with The City of Edinburgh Council's requirements and the Scottish Environment Protection Agency standards. Where appropriate during the design process Scottish Water shall be consulted. The design parameters defined by these design codes and agreed by **tie** / CEC / SEPA / Scottish Water as being appropriate for the area and system shall be accommodated within the finished works.

At locations where the tramway drainage is connected to any other drainage system measures shall be taken to ensure that any by-products of the tram system are accounted for (e.g. provision of sand interceptors). Where necessary early involvement of the Scottish Environmental Protection Agency (SEPA) shall be sought to define and agree surface water outfall locations.

Provisions shall be included for the proper and effective drainage of grooved rails and point machine pits in road running track – See **Error! Reference source not found.Error! Reference source not found.** of these Employer's Requirements.

Provision shall be made in trackwork for the interception of entrained debris in the system that drains surface water from grooved rails, to enable the easy collection and removal of detritus by means of planned maintenance.

Outlets from the grooved rail and point machine pit drains shall be connected directly to the roads drainage system. For on-street track, the track drainage system shall incorporate an insulated break from the storm water system.

Provision shall be made in trackwork for the effective drainage of the track structure on grass track, ballasted and other off-road running sections (except on bridges, viaducts and the like). Outlets from these drainage systems shall be connected to collector drains running alongside the track. Chambers for access to clean and maintain the collector drain pipes and for the interception and removal of entrained debris and detritus shall be incorporated in the collector system. Collector drain systems shall be connected to other systems or outfalls as appropriate for the local regime and existing drainage systems, and in accordance with the requirements of the relevant water utility, the Scottish Environmental Protection Agency, the roads authorities and all other authorities as appropriate.

The drainage of all new bridge structures shall be positive and, unless otherwise required by the relevant local authority, all surface water shall be piped to the local storm water sewer systems by a defined drainage path.

Particular attention shall be paid to ensure that surface water drainage systems in the vicinity of traction substations and cable ducts are routed to avoid any risk of flooding of electrical equipment areas, point machine chambers, and the ducts themselves.

27.7 Road Signs, Traffic Signals and Urban Traffic Control

Road signs shall comply with the Traffic Signs Regulations and General Directions 2002 and the Traffic Signs Manual. The works shall be consistent with the requirements stated in the Edinburgh Standards for Streets (CEC). The signage provided for the tramway and the mandatory road signs shall be considered holistically and measures shall be taken to avoid clutter that could lead to a confusing environment for road users.

The traffic and tram signalling systems shall support the run-time of the tramway whilst minimising the impact on other road users. It shall be fully integrated with the City of Edinburgh Council's urban traffic control system. A protocol will require to be developed with the City of Edinburgh Council regarding the installation and integration of the traffic and tram signals. The signalling system shall incorporate recent/current technological developments, as appropriate, to optimise the combined efficiency of the tram and traffic signals.

The traffic management system shall accommodate the direct and consequential impacts of the Tram system and will be subject to approval by **tie** and CEC Wide-area modelling of traffic impacts consequent to the design shall be provided as a pre-requisite to approval, and prior agreement with the City of Edinburgh Council to implement the design and complete the works.

27.8 Road Lighting and Road Furniture

The road lighting shall conform to the Council strategy on lighting applying current street lighting standards and the Tram Design Manual. The lighting columns and Overhead Line Equipment (OLE) poles shall be rationalised to minimise road clutter and ensure safety of all users. Similarly, the quantity and disposition of road furniture shall also be rationalised for visual and safety reasons. OLE is subject to prior approval of the CEC planning authority and is to be obtained through the design process.

Lighting and road furniture will require to conform with safety guidelines and pass all relevant stages of road safety audit which are to be undertaken within the road design for tram implementation.

27.9 Utilities

The Edinburgh Tram Network shall be designed and constructed such that there is a minimal requirement to divert existing public utilities.

The final alignment shall take cognisance of the need to avoid the diversion of utilities' system-critical apparatus such as high-voltage oil-filled cables, fibre-optic communication cables, and high-pressure gas mains, wherever possible. Any protection required to such utilities shall form part of the Works.

Utility diversions that are not covered under the advance Multi Utilities Diversion Framework Agreement (MUDFA) including unknown apparatus that is found during the Infraco Works shall form part of the Infraco Works in accordance with Schedule 21 and will follow the principles detailed below.

The MUDFA Utility Diversion Design Phase will have identified the following:

- Definition of the utility diversion design parameters (to include details on how the utilities are relocated and any protection requirements);
- Identification of all known potential conflicts within 2.0m from edge of running rail;
- Schedule and drawings of conflicts;
- Categorisation of each conflict as either:
  - Under the Developed Kinematic Envelope (DKE);
  - Within 450mm horizontally of the edge of running rail to any excavation for relocation of the utility apparatus; or
  - Excavations between the tedge of running rail and 450mm to 2000mm horizontally from the DKE.
- Identification of potential environmental/archaeological 'hot spots';
- Cross referencing against original utilities interface report;
- Integration of ground penetrating radar etc. survey information and update to base information;

- Liaison with each utility owner to obtain actual details (where they exist) on size, material and invert level of all identified conflicts;
- Assess potential future utility maintenance work problems (safe working widths and traffic management implications);
- Design for utilities protection;
- Design development with the MUDFA contractor, SUC's and **tie**;
- Obtain utilities approvals;
- Cross check against latest Tram and roads design.

27.10 OLE Poles

Location of Overhead Line Equipment poles will be designed so as to minimise the risk of traffic impact. Collision barriers shall be provided where there is a reasonably foreseeable risk of a collision between a road vehicle and an OLE pole. However, collision barriers are not the preferred solution and all reasonable mitigation efforts shall be made, and careful consideration given, in the location of poles to avoid the necessity for collision barriers. Should this not be achievable, the collision barriers shall be functional, practical and maintenance free with anti-climbing measures to prevent the public from climbing and standing on top of barriers. Details of such barriers shall be approved by the City of Edinburgh Council in their capacity as Roads Authority as well as for visual impact through the prior approvals process.

28 Structures

28.1 General

The Edinburgh Tram Network requires the construction, or modification to, a number of structures throughout its length. The work involved in the Edinburgh Tram Network will impact on bridges and retaining structures. This Section 28 sets out the requirements which the Infraco must comply with in relation to structures.

28.2 Structures List

The following is a list of the principal structures along the Edinburgh Tram Network.

Table 83 - Structures Schedule

Structure Ref.	Section	Structure Name	Description
S19	2A	Haymarket Station Viaduct	New underbridge
S18	1D	Leith Walk Railway Bridge	Existing underbridge over single railway line
S1	3A	Roseburn Terrace Bridge	Existing single span plate girder underbridge.
S2	3A	Coltbridge Viaduct	Existing three span masonry arch underbridge
S3	3A	St George's School Access Bridge	Existing single span masonry arch overbridge.
S4	3A	St George's School Footbridge	Single span steel truss footbridge
S5	3A	Ravelston Dykes Bridge	Existing single span masonry arch overbridge.
S6	3A	Craigleith Drive Bridge	Existing single span masonry arch underbridge.
S7	3A	Holiday Inn Access Bridge	Existing three span composite overbridge
S8	3A	Queensferry Road Bridge	Existing single span masonry arch overbridge.

Structure Ref.	Section	Structure Name	Description
S9	3A	Groathill Road South Bridge	Existing single span masonry arch underbridge.
S10	3A	Telford Road Bridge	Existing single span overbridge.
S12	3B	Crewe Road Gardens Bridge	Existing single span RC structure
S20	2A	Russell Road Bridge	New underbridge at Russell Road delta
W3	5A	Russell Road Retaining Wall One	New retaining wall required due to level difference.
W4	5A	Russell Road Retaining Wall Two	New retaining wall required due to level difference.
W18	5A	Murrayfield Tramstop Retaining Wall	
S21A	5A	Roseburn Street Bridge	New underbridge
S21B	5A	Murrayfield Stadium Retaining Wall	New retaining wall required due to level difference.
S21C	5A	Murrayfield Stadium Underpass	New underbridge
S21D	5A	Murrayfield Training Pitches Retaining Wall	New retaining wall required due to level difference.
S21E	5A	Water of Leith Bridge	New underbridge
S23	5B	Carrick Knowe Underbridge	New underbridge (Intersection Bridge)
S24	5B	Existing Saughton Road Bridge	Existing WEBS structure
S25	5B	Existing Broomhouse Road Bridge	Existing WEBS structure

Structure Ref.	Section	Structure Name	Description
S26	5B	South Gyle Access Road Bridge	New underbridge
W11	5B	Bankhead Drive Retaining Wall	New retaining wall required due to level difference.
S27	5C	Edinburgh Park Station Bridge	New underbridge (Intersection Bridge)
S28	5C	A8 Underpass	New underpass
W16	5C	A8 Retaining Wall	Now replaced by a slope.
W19	5C	Gyle Stop Retaining Wall	New retaining wall required due to level difference.
S32	6	Depot Access Bridge	New structure required to provide vehicular access from Gogar Burn roundabout to the new depot.
S29	7A	Gogar Burn Bridge	New underbridge
S33	7A	EARL Underbridge	No longer required.
W14	7A	Gogar Burn Retaining Wall One	New retaining wall required due to level difference.
W15	7A	Gogar Burn Retaining Wall Two	New retaining wall required due to level difference.
W100	3A	Roseburn Corridor Retaining Walls	
S17	1D	Tower Place Bridge	Existing underbridge at Leith Docks

Structure Ref.	Section	Structure Name	Description
S16	1D	Victoria Dock Entrance Bridge	Existing underbridge at Leith Docks
W1	1D	Lindsay Road Retaining Wall	Existing modular retaining wall adjacent to Lindsay Road.
S30	7A	Gogar Culvert One	New culvert
S31	7A	Gogar Culvert Two	New culvert
S34	7A	Gogar Culvert Three	New culvert
W8	5A	Baird Drive Retaining Wall	New retaining wall required due to level difference.
S22	5A	Balgreen Road Bridge	New underbridge
W9	5A	Balgreen Road Retaining Wall One	New retaining wall required due to level difference.

28.3 Proposed Structural Form

The approval for all structures and civil engineering works shall be in accordance with the Approvals and Consents Management Plan The proposals at all structures listed above shall be subject to review/acceptance by **tie** prior to application for consent being made to the City of Edinburgh Council, or Approval to Network Rail as appropriate.

28.4 Listed Structures

Due cognisance shall be taken by the Infraco of the historical status of any of the structures affected by the Infraco Works. Work on such structures will be subject to the relevant approval process, as described in the Approvals and Consents Management Plan.

28.5 Vibration and Noise

Structures and civil engineering works shall be designed in accordance with **tie**'s Noise and Vibration Policy at 10.1.5.

28.6 Bearings and Movement Joints

The design shall minimise the need for bearings and movement joints within all the structures. Integral structures shall be adopted where feasible.

Where bearings are required, either elastomeric or pot type bearings shall be used to accommodate the longitudinal and transverse translations and rotations while minimising lateral loads on sub-structures.

All bearings shall be replaceable under full live loading.

The use of movement joints shall be minimised, but where proposed they shall be easily maintainable and replaceable.

28.7 Design Life

The design life of all structures is set out in Section 6 (Design Life) of these Employer's Requirements.

28.8 Design Standards

All structures shall be designed in accordance with the appropriate design standards – See Section 8 (Standards) of these Employer's Requirements. Adopted design standards should be listed by the Infraco in the Approval in Principle Form 'A', or equivalent, submitted to **tie** for individual structures.

28.9 Structure Loading

Structures supporting the ETN shall be designed to carry 0.5RL loading as defined in the Design Manual for Roads and Bridges (DMRB and BS5400 Part 2). The maximum allowable tram axle load is determined in 24.12 of these Employer's Requirements.

During the design of structures due cognisance shall be given to the loadings imposed by construction and maintenance vehicles. Any constraints upon the operation of construction and maintenance vehicles shall be identified and advised to **tie**.

28.10 Rail Break

All elements shall be designed and provided to cater for tensile breakage of one rail at any location at ultimate limit state only. The other unbroken rails and the supporting structure shall resist the unbalanced force from a broken rail. The force resisted by any element shall be the lesser of:

- The force resulting from the rail and concrete deck temperatures and shrinkage, or
- The sum of the clip resistances between the movement joints bounding the break.

The effect of rail break shall be considered in conjunction with rail tensile temperature effects and the tram dynamic weight, centrifugal, nosing and braking and/or traction effects. The partial load factor shall be taken as 1.0.

28.11 Clearances

As a minimum, clearances shall be to RSPG 2 Tramways requirements.

Structural designs shall take due cognisance of the potential developed kinematic envelope of Trams that may be operated on the ETN.

28.12 Finishes

Finishes to all concrete components of the Infraco Works shall comply with the following:

▪ All buried and permanently submerged surfaces	F1, U1
▪ Pier tops, bearing shelves and hidden surfaces	F2, U2
▪ Parapet Coping, Exposed surfaces	F3, U3
▪ Main bridge deck	U4
▪ Special finishes – where deemed appropriate these are to be agreed with **tie** and all relevant authorities (e.g. CEC structures department) taking cognisance of all cost and construction impacts.	Note

Table 84 - Finishes

28.13 Protection

Steel surface preparation and the application of high performance paint coatings shall provide a design life to the first maintenance intervention in excess of twenty years.

The top surface of the any bridge deck shall be protected with a proprietary sprayed waterproofing system in accordance with BD 47/99.

All buried concrete surfaces shall receive two coats of bitumen; and Pavix (or equivalent) is to be applied to all concrete surfaces exposed to salt spray. A risk based assessment is to be undertaken for approval by **tie** to identify the extent of anti-graffiti treatment to be applied to exposed concrete surfaces.

Deck and arch steelwork shall be protected by a paint system in accordance with the Specification for Highway Works.

[xx] check final para for consistency with first para. Lindsay Murphy

28.14 Infrastructure Maintainability

The infrastructure shall be designed to minimise maintenance requirements. In particular the design should allow access which will not adversely impact systems operation of the Edinburgh Tram Network for the completion of routine work.

Structures will be subject to regular general inspections and a principal inspection at a frequency of every six years. The principal inspection shall entail amongst others a close visual inspection of all

elements of a structure. Details of the inspection and maintenance regimes are to be developed by Infraco and approved by **tie**. Maintenance Requirements are detailed further in Table 95 – Structures at Section 40 of these Employer's Requirements.

28.15 Provision for Inspection and Maintenance

Access to the underside of decks for inspection and maintenance shall be via vehicular-mounted inspection platforms operating from ground level, where access is feasible within contracted design parameters. For maintenance of metal parapets, for example, access shall be from the walkways. For bridges across Network Rail infrastructure it will be necessary to undertake such inspections in accordance with Network Rail requirements.

28.16 Bearings

Mechanical bearings shall be replaceable by jacking up the structure's deck a nominal amount, which minimises disruption and physical works. Where this is required, track will be designed such that only the bridge track is displaced. The bearings shall not require replacement for at least 50 years. Where bearings are provided, suitable inspection and maintenance galleries shall be provided.

Unauthorised access to these galleries shall be prevented through the incorporation of suitable measures.

No specific provisions shall be made for inspection and maintenance of the bearings on piers. Access to these bearings will be via a hydraulic access platform.

28.17 Expansion Joints

Bridge expansion joints shall be of the sealed type and provision shall be made to carry any water seeping through the joint into the deck drainage system. Expansion joints shall be easily maintained and replaced.

28.18 Earthing and Bonding

Structures shall be designed to comply with the Earthing and Bonding Policy at Earthing and Bonding of these Employer's Requirements.

28.19 Protection against Stray Current

Where trackform is an integral part of the structures, it shall be designed to comply with Stray Current [section 32] of these Employer's Requirements.

28.20 Third Party Relationships

28.20.1 Road Closure and Traffic Management

All Infraco Works affecting road traffic will be subject to the granting of permissions from relevant parties and may involve road closures or traffic management measures approved by CEC or the owner of the affected road. All such approvals are to be in place in advance of of any traffic impacts and comply with the requirements of Project Management Processes

In particular, the following works are expected to have a significant effect on traffic movements and may require particular consideration:

- Groathill Road Bridge and Craigleith Drive Bridge may require road closures for the duration of the Infraco Works;
- Construction of the abutments and new deck for Roseburn Terrace Bridge will require temporary closure of the A8 and partial workings within the carriageway;
- The construction of a structure, passing under the A8 to the east of Gogar roundabout, shall require significant traffic management to minimise disruption to traffic during construction. Additionally consideration will be required for the traffic impacts to the construction of the Depot Access Bridge and A8 retaining wall structures;
- Ocean Drive Bridge widening may require road closure for the duration of the Infraco Works;
- Roseburn Corridor Structures will be impacted an may require temporary traffic constraints (Ravelston Dykes Bridge, Holiday Inn Access Bridge, Queensferry Road Bridge, Telford Road Bridge, Crew Road Gardens Bridge;
- Tram bridges to be constructed over live roads may require some traffic constraints including Haymarket Station viaduct, Russell Road Bridge, Roseburn Street Viaduct, Balgreen Road Bridge, South Gyle Access Bridge.

28.20.2 Other Interested Parties

All relevant third parties shall be consulted by Infraco as required during the course of. In particular, this will include in relation to structures:

- Network Rail – noting particularly the Carricknowe and Edinburgh Park Bridges;
- Forth Ports;
- Edinburgh Airport Limited;
- Edinburgh Park Management Limited / New Edinburgh Limited; and
- Scottish Rugby Union.

28.20.3 Landscaping and Boundary Treatment

The Design Manual sets out the parameters of the design elements of the environmental mitigation measures to be implemented. The design guidance and requirements contained within the Design Manual shall be considered by the Infraco taking into account the CEC's own Development Quality Guidelines. (They include: Quality of Landscaping in New Developments, Biodiversity, Tree protection and Urban Forestry.)

A Landscape and Habitat Management Plan (LHMP) shall also be identified and prepared for the approval of **tie** and subsequent presentation to the CEC. It should be noted that there is a requirement for the LHMP applicable to the Roseburn Corridor to be specifically approved by the CEC Planning Committee.

A Boundaries Treatment Management Plan shall be created and updated by the Infraco to reflect emerging issues regarding boundary interface design matters between the track and adjoining ownerships. In general, all landscaping and boundary measures shall be in keeping with the surrounding environment and shall be consistent with the local character of the relevant area.

Where it is determined that fencing is required either to physically segregate the tram track or to separate the tram from other parties (for example Network Rail) the fencing shall be of a type and standard that provides the necessary separation and satisfy the requirements of the other party. In the case of Network Rail it must conform to their Group and Company Standards. The design will take into account concerns with respect to an individual having safety space in a fenced route.

Boundary treatments shall take cognisance of the need for appropriate noise mitigation measures, as well as other appropriate ecological works (e.g. badger mitigation) ensuring all Infraco Works have achieved all relevant approvals. In particular it is required that such boundary treatment and noise mitigation measures meet with the requirement to provide an end result which is no worse than the environmental impact assessment and presented in the Environmental Statement which was presented as part of the parliamentary submission.

29 Depot

29.1 Scope

This Section of the Employer's Requirements defines the Depot requirements applicable to the Edinburgh Tram Network (ETN) which the Infraco must comply with.

29.2 Depot, Buildings and Associated External Works

The Depot shall be of an economical design which reflects economy of use and maintenance in providing all the functionality required by **tie**.

The Depot shall provide the facilities to operate, service, repair and maintain a reliable passenger service.

29.3 The Site

The Depot site in Gogar is located in the vicinity of Edinburgh International Airport and has constraints imposed upon its design by the Civil Aviation Authority due to the proximity of the emergency runway at the airport. Factors to be accommodated in the design and construction of the Depot include height restrictions that shall necessitate detailed discussions with the aviation authorities.

29.4 Staff Halt

At a location to be agreed by **tie**, shelters shall be provided for the sole use of tram crew and other staff working on the Edinburgh Tram Network so as they can board the Trams. The staff halt shall comprise of shelters not less than 2.5m x 2m which shall provide weather protection. The staff halt will be linked to the Depot by a designated walking route leading to a controlled gate in the Depot boundary fence. The shelters shall be monitored by CCTV cameras, if they are not visible from the Depot Control Centre. The shelters will be provided with telephones providing a dedicated link to the Depot Control Centre.

The staff halt shall not introduce any speed restriction to the passage of Trams.

29.5 Drainage

The general site area shall be lowered to ensure that all structures are below the flight path. As a result of this excavation, both foul and surface water drainage may need to be pumped from the permanent works to off-site outfalls.

29.6 Access

Road access from the A8 Gogar roundabout link road shall provide both entry and exit for normal Depot operations traffic and also for delivery and egress of Trams with the minimum of impact on other facilities. Height restrictions on vehicle loads shall be verified in relation to the Airport operations. The link road giving access to the Depot may be extended by others and will cross the Tram route to the Airport, and the Depot entry track.

29.7 Utilities

Existing utilities and sewers crossing the Depot Site site shall be protected or re-located as appropriate

29.8 Depot Site Layout

The configuration of the Depot and the use of the equipment contained therein shall minimise disturbance to neighbours.

Allowance shall be made in the site layout adjacent to the Depot building to accommodate temporary office facilities that may be needed during the construction, testing and commissioning phases of the Infraco Works. This shall include the provision of temporary electricity and water services.

The Depot site shall accommodate a zone within which the required accommodation can be located.

The Depot shall be secure and be provided with security systems as appropriate.

- The Depot shall have a suitably robust security fence 2.4m high shall enclose the Depot site with controlled entry points for Trams, vehicles and pedestrians. The security entry points shall be unmanned with security control systems providing the means of operation. These shall be centred on the Depot reception during normal office hours with transfer to the Control Centre at other times.

- The Depot shall incorporate two separate access points to the running lines.

- The entire Depot external operating area within the perimeter fence shall be provided with a comprehensive CCTV surveillance system, the images from which shall be displayed in real-time in the Control Centre. The cameras shall form part of the network CCTV system (refer to Section 35 (Supervisory Control and Communications Systems) of these Employer's Requirements. In particular a CCTV system shall be provided to view the Depot vehicular and

pedestrian entrances. It shall be integrated with the entry systems and shall be centred on the Depot reception during normal office hours with transfer to the Control Centre at other times.

The current reference design sets the Depot site below existing ground level and retaining structures shall be constructed as necessary along the A8 site boundary. These structures shall also form the ramp for the through track of the tram system to the Airport.

- The stabling area and its configuration shall be established by the combination of track requirements and the Depot building footprint. The Depot layout shall accommodate a minimum of 36 berths. The stabling facility shall be built to accommodate an initial 27 x 44m Trams. Adequate provision shall be made to allow cleaning personnel to move around berthed Trams.

- Set between the stabling roads shall be access paths alternately at least 1.0m and 2.0m wide with service points to provide facilities for Tram cleaning and minor maintenance on the 2.0m width paths.

- The desirable longitudinal gradient of all tracks within the Depot shall be zero. The absolute maximum longitudinal gradient shall be 0.4%. Cross-level gradient (cant) of all tracks shall be zero (see Section 26 (Track) of these Employer's Requirements).

- At the ends of any tracks that terminate, a Tram-arresting device shall be provided.

- A track shall be provided to enable Trams to be loaded and off loaded onto/from road transportation.

- A servicing track shall be provided complete with a tram wash plant and hand windscreen cleaning points. Road access shall be provided for detergent deliveries to the wash plant.

- The wash plant shall be located inside a shelter (the shelter need not extend the full length of the Tram being washed) – see Table 86 - Depot Plant and Equipment to be Provided of these Employer's Requirements, where the operating temperature range is set out. The facility will be provided with suitable devices to remove excess moisture from the washed vehicles. High quality results, at least as good as those achieved by Lothian Buses on their fleet, shall be delivered by this facility.

- Sand filling points within an enclosed structure shall be installed on the servicing track. The bulk sand silo (capacity at least 30t) and associated feeder equipment shall be located close by, along with the provision of road access for sand deliveries.

- A suitably drained bogie wash point shall be provided in the apron at the front of a Tram entry point to the workshop which allows demounted bogies to be easily manoeuvred in and out of the workshop. Plant used for this operation shall be transportable and housed within the main workshop. Power and water shall be provided to allow the tram pressure washer to be utilised at this location. Treatment of wastewater, to meet appropriate standards prior to connecting to the site drainage system, shall be provided.

- Car parking shall be provided for one third of the personnel employed on the Depot site. Within this provision, visitor car parking shall be provided close to the Depot entrance for no less than six vehicles.

- Servicing areas for external stores and containment of waste shall be provided.

- A sub-station for both traction power (main line and depot feeds) and domestic Depot supplies shall be provided.

- Due to the proximity of the Airport runway, planting and landscaping within the Depot site shall be restricted and consistent with CAA guidance to prevent bird strikes. Native species of plants shall be used where possible and shall be compatible with Tram operations.

- The Depot site shall be appropriately lit.

29.9 Depot Building

The following identify the principal features of the Depot building:

- The main Tram workshop, other workshops, stores, management, administration, operations and maintenance offices, staff welfare facilities (support accommodation) and the Control Centre for the complete Edinburgh Tram Network, shall be contained within a steel framed building clad in an insulated panel cladding system. The roof of the building shall be insulated to a suitable standard with the minimum number of penetrations.

- The building workshop shall accommodate a minimum of two tram maintenance roads, a wheel lathe road and a further tram service road.

- The support accommodation shall be arranged on two floors set to one side of the main tram maintenance workshop. The Control Centre shall be located at first floor level with the equipment room set below. A view of the depot external stabling area and tram entry/exit point shall be provided to Control Centre staff from within the Control Centre.

- The Depot shall be provided with the appropriate electricity supplies including 400V for individual items of workshop equipment both inside and outside the building, 230V for internal domestic use and 110V for small tools.

- Natural light in offices shall be maximised and all rooms shall be placed within the building in locations appropriate to their function. This shall be supplemented by artificial lighting consistent with the tasks undertaken and the hours of operation of the facility.

- Additional service space shall be provided for the accommodation of domestic services as well as for the accommodation and systems directly linked to the Tram operations.

- Full heating and ventilation will be provided throughout the building with air conditioning to the cControl Centre, equipment room, training and meeting rooms.

- Fire alarms and fire extinguishing systems shall be provided throughout the Depot building. Fire suppression shall be provided in the technical equipment room(s).

- Suitable office furniture shall be provided for all areas within the Depot building.

The following schedule of accommodation shall form the basis of the design for the office and welfare facilities attached to the Depot.

29.10 Schedule of Staff Numbers

The Depot shall accommodate the number of staff identified in the "Establishment with Expansion" column set out below.

Note: The locker rooms should have sufficient capacity for approximately 5% spare capacity on these numbers to cope with staff turnover and associated training overlap.			**Max Number on duty in the Depot at one time**	
Anticipated Job Title	**Establishment for Phase 1a/1b**	**Establishment with Expansion**	**Phase 1a/1b**	**With Expansion ratioed up**
OPERATIONS				
CORPORATE MANAGEMENT				
General Manager	1	1	1	1
Operations Manager	1	1	1	1
Commercial Manager	1	1	1	1
OPERATIONS				
Duty Managers	11	12	4	4
Operations Supervisor	9	9	2	2
Operations Assistant	1	1	1	1
Drivers	112	126	11	12

Anticipated Job Title	Establishment for Phase 1a/1b	Establishment with Expansion	Phase 1a/1b	With Expansion ratioed up
OPERATIONS				
Engineering Manager	1	1	1	1
Vehicle Engineer	1	1	1	1
Infrastructure Engineer	3	3	3	3
Safety and Standards Manager	1	1	1	1
Performance Regime Manager	1	1	1	1
Clerk	1	1	1	1
FINANCE				
Finance Manager	1	1	1	1
Accounts Assistant	2	2	2	2
Administration				
Secretaries	1	1	1	1
Admin. Staff	2	2	2	2

Anticipated Job Title	Establishment for Phase 1a/1b	Establishment with Expansion	Phase 1a/1b	With Expansion ratioed up
REVENUE PROTECTION STAFF				
Inspectors	112	126	11	11
Cashiers	1	1	1	1
Revenue Protection Manager	1	1	1	1
INFRASTRUCTURE / VEHICLE CLEANING				
Cleaning Manager	1	1	1	1
Cleaners	20	23	10	11
SUB TOTAL	**285**	**318**	**59**	**67**
TRAM MAINTENANCE				
Office Staff	3	3	3	3
Storeman	1	1	1	1
Technicians	30	34	15	16

Anticipated Job Title	Establishment for Phase 1a/1b	Establishment with Expansion	Phase 1a/1b	With Expansion ratioed up
SUB TOTAL	**34**	**38**	**19**	**21**
INFRASTRUCTURE MAINTENANCE				
Office Staff	4	4	4	4
Storeman	1	1	1	1
Technicians	37	42	18	20
SUB TOTAL	**42**	**47**	**23**	**25**
SUMMARY				
Operations	285	318	59	67
Tram Maintenance	34	38	19	21
Infrastructure Maintenance	42	47	23	25

Table 85 – Schedule of Staff Numbers

29.11 Accommodation (First floor)

The first floor is to be occupied by the Operator. The accommodation set out below is required as a minimum and must be related in all respects to the numbers of staff to be employed and based at the Depot as set out in Table 85 – Schedule of Staff Numbers, where not otherwise specified. Appropriate account is also to be taken by the Infraco of the maximum numbers of staff indicated as being on the premises at any one time in sizing toilets, messing facilities etc.

- A Control Centre to include the equipment as defined in paragraph 35.13 and allow a good ergonomic layout for the functions carried out therein.
- A room adjacent to the Control Centre, with sufficient space for the incorporation of the necessary furniture and technical equipment used to store and manage the handheld radios and ticketing equipment and their batteries, together with one desk space.
- A cash office adjacent to the Control Centre, with adequate space for two staff members and the associated equipment for cash counting and sorting, as well as a safe of an appropriate size.
- A viewing area shall be provided for visitors to view the Control Centre without disrupting the activity within.
- Windows shall be provided to provide a view into the tram workshop from the first floor. Suggested locations are adjacent to the Control Centre (if not inside, then integrated with the viewing area referred to above), adjacent to the engineering office, and in the viewing area.
- Adequate toilets and showers (Male, Female, Disabled).
- Access from the ground floor with at least two staircases and one lift (for disabled access and, unless other arrangements are available, for the lifting of equipment and furniture required on the first floor).
- One set of stairs is to give direct access between an external door (itself adjacent to the visitor's parking spaces) and the first floor. A reception area is to be provided at the first floor landing including an allowance for a reception desk and a minimum of four waiting chairs. A second set of stairs is to be adjacent to the Control Centre and provide a direct link, to a route from the staff parking/external access gate and the locker rooms, and to the walking routes onwards into the stabling sidings and to the access gate in the Depot fence to the staff halt on the main line.

- Office for the General Manager, sized for one person with meeting table for six people.
- Office for the Operations Manager, sized for two people. To be situated close to the Control Centre.
- Office for the Safety and Performance Managers, sized for two people.
- Engineering office, sized for three people, with meeting area for four people.
- Office for the Duty Manager and Supervisors, sized for three people.
- Office for the Finance and Commercial Managers, sized for two people.
- General office, sized for eight people.
- Messing facility, including limited self-service kitchen facility.
- Cleaning office and store.
- Interview room, close to the office of the Operations Manager.
- Meeting room for 10 people, close to the Reception.
- Two training rooms, one sized for 30 people and one for 15 people. The larger should be able to be subdivided, broadly in half. Note that this may be required to be on a permanent basis once the complete system is open for service.
- Space to locate the PABX and a computer server for the Operator.
- Locker Rooms, male and female in suitable proportion for the total relevant staff numbers and with an allowance for flexibility in recruitment. The design shall allow for flexibility in the division to allow for long-term changes in the proportions. The locker rooms should be placed conveniently for the Control Centre and messing facility. The space allowance for lockers should be based on two-thirds height/interleaved lockers.
- A store for uniforms and other small operational equipment.
- A records store.

- A location for photocopying.

29.12 Workshop General Requirements

- In the main workshop, all roads shall have traction power. The wheel lathe shall be placed in a central position to enable the workshop doors to be closed whilst the lathe is in operation;
- Gantry structures, for access to the Tram roof area from both sides, shall be provided for a minimum of two berths;
- Under-track pits shall be provided on no fewer than four tram maintenance berths incorporating access and egress stairs. Pits shall have adequate lighting, drainage and power tool sockets;
- 'Built-in' jacking points (i.e. lifting under the Tram bogies) shall be provided to one of the roads, which shall be provided with traction power, the pits containing this equipment shall be adequately drained;
- Battery charging equipment shall be provided for Tram batteries, fork lift trucks and all other battery powered equipment with associated ventilation equipment, in a dedicated area off the main workshop;
- Hydraulic and electronic workshop facilities, including bespoke test benches, shall be provided appropriate to the Trams. Fixed equipment, for the servicing and testing of hydraulic and electronic equipment shall be provided. The areas shall be capable of being separated from the main workshop area by closure of an industrial door; and
- Both heavy and light stores areas shall be provided complete with the necessary racking systems to suit the storage requirements of the spare parts required for all systems, equipment and Trams being supplied. Forklift truck access to these areas shall be provided. Stores are to be segregated between those required for the Tram Maintainer and those for Infraco.

29.13 Accommodation on Ground Floor

29.13.1 General Facilities

The ground floor is to be principally occupied by the Infraco. The accommodation requirements set out below is required as a minimum.

The design of the accommodation must be related in all respects to the numbers of relevant staff to be employed and based at the Depot as set out in Table 85 – Schedule of Staff Numbers, where not

otherwise specified. Appropriate account is also to be taken by the Infraco of the maximum numbers of staff indicated as being on the premises at any one time in sizing toilets, messing facilities etc.

The different spaces should be arranged grouped logically together and with respect to accesses etc. The workshop areas must also accommodate all relevant equipment listed in the Plant and Equipment Schedule – see Table 86 - Depot Plant and Equipment to be Provided.

- The equipment room shall be underneath the Control Centre. Necessary domestic plant rooms.
- A store for tram and infrastructure cleaning equipment.
- First aid room (suitable for all staff at the depot, accessible from the first floor and to an external vehicle access).

29.13.2 Facilities

- Staff access shall be arranged preferably, adjacent to the locker rooms and convenient for external access and with appropriate security.
- Adequate toilets and showers shall be provided (Male, Female, Disabled) serving both contractors.
- A messing facility, including limited self-service kitchen facility.
- Locker rooms, male and female in suitable proportion for the total relevant staff numbers and with an allowance for flexibility in recruitment. The design shall allow for flexibility in the division to allow for long-term changes in the proportions. The space allowance for lockers should be based on a full-height lockers for each relevant person. There should be dry locker rooms, sufficient for all Infraco staff, based on full-height lockers, and a drying room to include additional full-height lockers for all of the Infrastructure and Tram Maintenance staff.
- machine tool area, open to the tram workshop. This might be linked to the dirty workshop.

29.13.3 Tram Maintainer Specific Facilities

- A small store for workshop cleaning equipment.
- A location for a computer server for the Tram Maintainer.
- Tram Maintenance Managers Office, sized for one person with meeting area for four persons.

- Tram Maintenance General Office, sized for five persons.
- Tram Stores including office, small items store and large items store with access for fork-lift truck. The size of these shall be agreed with the relevant contractor.
- Battery store and charging area
- Clean workshop(s) for electronics and hydraulics
- Dirty workshop for bogie, with cross access track from the main vehicle workshop underneath the travelling crane; area could be linked with machine tool area

29.13.4 Infrastructure Maintainer Specific Facilities

- A location for a computer server for the Infrastructure Maintainer.
- Infrastructure Maintenance Manager's office, sized for one person with meeting area for four persons.
- Infrastructure Maintenance general office, sized for five persons.
- Infrastructure stores including small office, small items store and large items store with access for fork-lift truck. The size of these shall be agreed with the relevant contractor.
- Clean workshop for electronics
- Dirty workshop which could be the machine tool area.

29.14 Provisional Schedule of the Plant and Equipment

The plant and equipment to be provided and installed shall include, but not be limited to, the following:

Table 86 - Depot Plant and Equipment to be Provided

	No	Description	Function	Features	Fixed/Mobile/ Portable	Location used	Supplier	User	Maintainer	Access Control	Cleaned	Quantity
1		Cleaning Equipment										
	1.1	Tram Cleaning Equipment	Equipment for cleaning of tram interiors	110V Industrial vacuum cleaning equipment, ≥ 2kW power Equipment to allow removal Floor polishing equipment	P	Generally used in stabling areas However can be used throughout the Depot	T	O	O	O	O	6

	No	Description	Function	Features	Fixed/Mobile/ Portable	Location used	Supplier	User	Maintainer	Access Control	Cleaned	Quantity
	1.2	Tram pressure washer	Industrial washer for general tram cleaning within the Depot including bogie washing	Self powered Hot water/steam - self heating Pressure variable up to ≥200 bar Flow rate ≥12 l/min Lance and hose ≥10m Detergents compatible with Tram external finishes	M	Throughout Depot	T	T	T	T	T	1
	1.3	Infraco pressure washer	Removal Removal of fly posters General cleaning	Features as per Tram pressure washer Mobile towable bowser with capacity for up to one shift of cleaning Infraco to ensure	M	Across the ETN	I	I	I	I	I	1

	No	Description	Function	Features	Fixed/Mobile/ Portable	Location used	Supplier	User	Maintainer	Access Control	Cleaned	Quantity
				interchangability with tram pressure washer Readily transportable on back of road-rail and other road vehicles								

	No	Description	Function	Features	Fixed/Mobile/ Portable	Location used	Supplier	User	Maintainer	Access Control	Cleaned	Quantity
	1.4	Tram Washing Plant	Fixed plant for cleaning of Tram exterior	Unidirectional >15 tph continuously Minimised water consumption, maximised water recirculation controllable and monitored from Control Centre via SCADA system Self contained Pre-wet One pair application brushes Automatic end wash Two pair water wash brushes	F	Alongside main workshop	I	O	O	O	O	1

	No	Description	Function	Features	Fixed/Mobile/ Portable	Location used	Supplier	User	Maintainer	Access Control	Cleaned	Quantity
				Dryer Operates from -5°C ambient external temperature within shelter Final details TBD with tram supplier ≥70% water recycling Backflow prevention devices shall be installed. Treatment of wastewater to meet appropriate standards prior to connecting to site drainage system shall be provided.								

	No	Description	Function	Features	Fixed/Mobile/ Portable	Location used	Supplier	User	Maintainer	Access Control	Cleaned	Quantity
	1.5	Rail Groove Cleaning Equipment	P-way cleaning	Vacuum equipment to remove detritus/debris from grooved track including drain boxes and points Able to clean drains and gullies employing water jets Transportable on road/rail vehicle, lifted with crane or fork lift truck Self powered for full shift Easy collection/disposal of detritus/debris	M	Across the ETN	I	I	I	I	I	1

	No	Description	Function	Features	Fixed/Mobile/ Portable	Location used	Supplier	User	Maintainer	Access Control	Cleaned	Quantity
	1.6	Parts washer	Infrastructure/Tram component cleaning & degreasing in dirty workshop	Able to wash components ≤100kg, ≤750mm diameter	F	Within dirty workshop	I	I/T	I	I	User	1
	1.7	Floor scrubber	Depot floor cleaning	Industrial vacuum/brush scrubber equipment Compatible with floor finishes	M	Within Depot building	T	T	T	T	T	1
2		Mechanical Handling										
	2.1	Shunter	Manouveuring Trams within workshop	Battery powered Road/rail capability Capable of towing/propelling single Trams Speed up to 3 km/h	M	Throughout Depot tracks Road capability to move	T	O/T	I/T	O	User	1

	No	Description	Function	Features	Fixed/Mobile/ Portable	Location used	Supplier	User	Maintainer	Access Control	Cleaned	Quantity
				Local and remote control Charging facilities Coupler at each end		between tracks on hardstanding						
	2.2	Tram lifting system and stands	Lifting Trams to allow routine maintenance and removal of bogie(s)	Fixed underfloor system providing flush floor when not in use. Ability to lift fully functional, unladen tram. Synchronised lift from single control panel. Ability to stop and lock lift at any vertical positionInterlocking to	F	Main workshop	T	T	T	T	T	1 set

	No	Description	Function	Features	Fixed/Mobile/ Portable	Location used	Supplier	User	Maintainer	Access Control	Cleaned	Quantity
				protect Tram in event of system/component failure. Manually positioned stands to be provided Interlocking with OLE if required.								
	2.3	Fixed high level access platforms	To allow access to all equipment mounted on Tram roof	Capable of providing access to all roof mounted equipment on tram Decking to prevent tools or small to components falling through Handrails and toeboards to prevent	F	Main workshop	I	T	I	T	T	2 sets

	No	Description	Function	Features	Fixed/Mobile/ Portable	Location used	Supplier	User	Maintainer	Access Control	Cleaned	Quantity
				personnel/material falling Access/egress gates interlocked with OLE End protection								
	2.4	Overhead crane	Bridge type crane spanning 2 roads within the workshop to allow all material within main workshop to be transported up to and including size/weight of motor bogie	≥6.3 tonne capacity Vertical clearance <960 mm from hook (fully raised) to top of crane Traverses below OLE Interlocked with OLE Remote control using hand held device Multi-speed faciltiy - lift, traverse and travel	F	Main workshop	I	T/I	T	T	User	1

	No	Description	Function	Features	Fixed/Mobile/ Portable	Location used	Supplier	User	Maintainer	Access Control	Cleaned	Quantity
				Long and cross travel to cover all areas over the two roads								
	2.5	Mobile crane	Facilitate removal of miscellaneous equipment including bogie components within the dirty workshop	≥2t capacity Powered operation	M	Throughout workshops	T	T/I	T	T	User	1
	2.6	Bogie workstands	To allow dismounted bogies to be maintained	Allows bogie to be manoeuvred along the stub track in the dirty workshop Wheel locks Capable of supporting	M	Dirty workshop	T	T	T	T	T	1

	No	Description	Function	Features	Fixed/Mobile/ Portable	Location used	Supplier	User	Maintainer	Access Control	Cleaned	Quantity
				both trailer and motor bogie								
	2.7	Other tram equipment stands	Various stands to allow items of equipment to be stored and readily maintained when dismounted from the Tram	Infraco to propose depending on tram design Expected to include stands for doors, windows, body panels etc…	M	Throughout Depot	T	T	T	T	T	
	2.8	Accommodation bogies	To allow Trams to be moved within workshop once bogies have been removed or the Tram has been split at any articulation	Allows Tram to be manoeuvred throughout the depot once any combination of bogies has been replaced Allows entire tram to	M	Throughout Depot	T	T	T	T	T	

	No	Description	Function	Features	Fixed/Mobile/ Portable	Location used	Supplier	User	Maintainer	Access Control	Cleaned	Quantity
				be manoeuvred throughout the depot once any articulation has been split								
	2.9	Fork lift truck	Lifting and transporting miscellaneous equipment	Battery powered Charging facilities Road wheels >3 t lifting capacity Drum handling equipment Crane arm Capable of accessing all shelving and racking in stores- Infraco to demonstrate	M	Throughout the Depot but limited to hard standing areas when outside	T	T/I	T/I	T	User	1

	No	Description	Function	Features	Fixed/Mobile/ Portable	Location used	Supplier	User	Maintainer	Access Control	Cleaned	Quantity
	2.10	Pallet truck	Lifting & Transporting equipment particularly in stores	Manually manoeuvred, hydraulic lifting the Infraco to propose requirements. Infraco to provide integrated solution	M	Throughout the Depot but limited to hard standing areas when outside	I	T/I	T/I	T	User	The Infraco to propose
	2.11	Hand trolleys	Transporting tools and spares	Unpowered the Infraco to propose requirements. Infraco to provide integrated solution	M	Throughout the Depot but limited to hard standing areas when outside	I	T/I	T/I	T	User	The Infraco to propose

	No	Description	Function	Features	Fixed/Mobile/ Portable	Location used	Supplier	User	Maintainer	Access Control	Cleaned	Quantity
	2.12	Infraco lifting slings	General slings for lifting infrastructure heavy components on system and in Depot building	Infraco to propose. Stand for storage	P	Use on system infrastructure	I	I	I	I	I	The Infraco to propose
	2.13	Tram lifting slings	Specific lifting gear to allow all equipment to be removed and replaced.	Raised hook on overhead crane can be no more than 5390 mm ARL the Infraco to propose Stand for storage	M	Use in Depot building only	T	T	T	T	T	Tramco to propose
	2.14	Windscreen/window removal equipment	For use in replacing tram windscreens and side windows	Mobile stand capable to being used to access both windscreen and side windows Electrically powered vacuum beam with	M	Use in Depot building only	T	T	T	T	T	1

	No	Description	Function	Features	Fixed/Mobile/ Portable	Location used	Supplier	User	Maintainer	Access Control	Cleaned	Quantity
				suckers adapted to windscreen design Audio/visual alarm in the event of suction loss								
	2.15	Re-railing equipment	For use in rerailing trams out on the System	Variety of jacks/beams/slides to be proposed by the Infraco Airbags Slew locking devices Capable of being readily transported on the road/rail vehicle	M	Used any where on system including Tramstops	T	T	T	T	T	1 set
	2.15	Stop boards	To indicate the presence of equipment/personnel/tram	The Infraco to propose requirements. Infraco	P	Throughout System	I	T/I	I	T/I	User	≥20

	No	Description	Function	Features	Fixed/Mobile/ Portable	Location used	Supplier	User	Maintainer	Access Control	Cleaned	Quantity
			s on the tracks	to develop integrated solution								
3		Workshop & Stores Furniture										
	3.1	Shelving and racking	Storage of spares and other material	Heavy duty The Infraco to propose requirements. The Infraco to develop integrated solution	F	Stores	I	T/I	I	T/I	User	The Infraco to propose
	3.2	Tram staging	for Tram inspections/repairs	The Infraco to propose any additional staging required	M	Used within Depot building	T	T	T	T	T	The Infraco to propose
	3.3	General staging	For infrastructure inspections/repairs	The Infraco to propose any additional staging	M	Across Edinburgh Tram	I	I	I	I	I	The Infraco to propose

	No	Description	Function	Features	Fixed/Mobile/ Portable	Location used	Supplier	User	Maintainer	Access Control	Cleaned	Quantity
				required		Network						
	3.4	Shelving	Storage of minor items/documents	The Infraco to propose requirements. The Infraco to develop integrated solution	F	Throughout workshops	I	T/I	I	T/I	User	The Infraco to propose
	3.5	Workbenches	Equipment maintenance	The Infraco to propose requirements. The Infraco to develop integrated solution	F	Throughout workshops	I	T/I	I	T/I	User	The Infraco to propose
	3.6	Cupboards	Storage of minor items/documents	The Infraco to propose requirements. The Infraco to develop integrated solution	F	Throughout workshops	I	T/I	I	T/I	User	The Infraco to propose

	No	Description	Function	Features	Fixed/Mobile/ Portable	Location used	Supplier	User	Maintainer	Access Control	Cleaned	Quantity
	3.7	COSHH cupboard	Storage of COSHH items	The Infraco to propose requirements. The Infraco to develop integrated solution	F	Dirty workshop	I	T/I	I	T/I	use r	The Infraco to propose
	3.8	Workshop stools	Personnel comfort when working	The Infraco to propose requirements. The Infraco to develop integrated solution	F	Throughout workshops	I	T/I	I	T/I	Us er	The Infraco to propose
4		Fixed Plant										
	4.1	Air conditioning maintenance equipment	Specialist tools for filling/emptying refrigerant	The Infraco to propose	F	Anywhere in Depot building	T/I	T/I	T/I	T/I	T/I	The Infraco to propose
	4.2	Tyre replacement equipment	Specialist tools for tyre splitting/removal/balancing /bearing replacement	The Infraco to propose	F	Dirty workshop	T	T	T	T	T	1

	No	Description	Function	Features	Fixed/Mobile/ Portable	Location used	Supplier	User	Maintainer	Access Control	Cleaned	Quantity
	4.3	Underfloor wheel lathe	In-situ reprofiling of Tram tyres	Capable of producing a range of wheel profiles. Tolerances to be agreed between the Infraco Swarf conveyed to skip for removal by means of forklift truck capable of turning all wheels on one Tram within eight hour shift	F	Within Depot building.	T	T	T	T	T	1
	4.4	Sand Plant	Refilling of Tram sanding equipment	Minimum silo capacity 30 tonnes Capable of receiving sand delivery directly from road vehicle Allows Tram driver to	F	Dedicated facility	T	O	O	O	I	1

	No	Description	Function	Features	Fixed/Mobile/ Portable	Location used	Supplier	User	Maintainer	Access Control	Cleaned	Quantity
				fill an empty tram within 5 minutes Rate of fill to be sustainable for 30 minutes. In no circumstances shall the interval between the filling of two Trams exceed 10 minutes The physical condition of the sand shall not deteriorate when stored Sand deliveries to a Tram shall stop automatically when								

	No	Description	Function	Features	Fixed/Mobile/ Portable	Location used	Supplier	User	Maintainer	Access Control	Cleaned	Quantity
				the tram sand box is full Sand filling nozzles to be compatible with the sand filling inlets on the trams Signal interlocking to inhibit the movement of a tram if the sand filling nozzles are not returned to their correct storage position.								
	4.5	Machine tools	General machine tools required for maintenance	The Infraco to propose requirements. The Infraco to develop	F	Dirty workshop	I	T/I	T/I	T/I	User	The Infraco to propose

	No	Description	Function	Features	Fixed/Mobile/ Portable	Location used	Supplier	User	Maintainer	Access Control	Cleaned	Quantity
				integrated solution								
	4.6	Paint booth	Respraying of removable Tram panels	For use with water based paints integrated compressor	F	Outside workshop	I	T/I	T/I	T	User	1
	4.7	Pantograph maintenance & load test jig	to calibrates and align tram pantograph off Tram roof	The Infraco to propose	F	Throughout workshops	T	T	T	T	T	1
	4.8	Suspension setting equipment	To allow suspension to be set/shimmed without using tram lift	The Infraco to propose	M	Throughout workshops	T	T	T	T	T	1
	4.9	Diesel generator	Back up power source	Capable of connection to the depot LV switchboard and other plant requiring an external	M	Across network	I	I	I	I		

	No	Description	Function	Features	Fixed/Mobile/ Portable	Location used	Supplier	User	Maintainer	Access Control	Cleaned	Quantity
				energy source. Capable of providing at least three day continuous operation.								
5		Hand & Mobile Tools										
	5.1	Infrastructure tools	Hand tools	The Infraco to propose	P	Across ETN	I	I	I	I	I	The Infraco to propose
	5.2	Tram tools	Hand tools	The Infraco to propose	P	Across ETN	T	T	T	T	T	Tramco to propose
6		Welding Shop Equipment										
	6.1	Ferrous welding equipment	General infrastructure repairs	The Infraco to propose requirements. Infraco to develop integrated solution	F	Dirty workshop	I	T/I	I	T/I	User	The Infraco to propose

	No	Description	Function	Features	Fixed/Mobile/ Portable	Location used	Supplier	User	Maintainer	Access Control	Cleaned	Quantity
	6.2	Aluminium welding equipment	Specialist Tram and Tram shelter repairs	The Infraco to propose requirements. The Infraco to develop integrated solution	F	Dirty workshop	I	T/I	I	T/I	User	The Infraco to propose
7		Battery Shop Equipment										
	7.1	Tram battery charger	To recharge Tram Batteries	The Infraco to propose	P	Battery room	T	T	T	T	T	The Infraco to propose
	7.2	Infrastructure battery chargers	To recharge various batteries used in power supply, control and comms equipment	The Infraco to propose and develop solution compatible with tram battery charger	P	Battery room	I	T	T	T	T	The Infraco to propose
8		Instrumentation and Test Equipment										

	No	Description	Function	Features	Fixed/Mobile/ Portable	Location used	Supplier	User	Maintainer	Access Control	Cleaned	Quantity
	8.1	Tram test equipment	To allow testing of measurement and testing of tram equipment	The Infraco to propose. Note any overlap with "Special Tools" to be highlighted. As a minimum, proposal to include; headlight tester, tools to allow event recorder to be downloaded and interrogated, tools to allow CCTV systems to be downloaded and interrogated, tools to allow PA and PID announcements to be re-configured.	M/P	The Infraco to propose	T	T	T	T	T	The Infraco to propose

	No	Description	Function	Features	Fixed/Mobile/ Portable	Location used	Supplier	User	Maintainer	Access Control	Cleaned	Quantity
	8.2	Infrastructure and Fixed systems test equipment	To allow measurement and testing of infrastructure and fixed systems	The Infraco to propose. Note any overlap with "Special Tools" to be highlighted as a minimum, proposal to include; OLE height and stagger gauge, stray current data loggers, noise measurement equipment, ride measurement equipment, point setting detection equipment, ≥3 sets of live line testing	M/P	The Infraco to propose	I	I	I	I	I	The Infraco to propose

	No	Description	Function	Features	Fixed/Mobile/ Portable	Location used	Supplier	User	Maintainer	Access Control	Cleaned	Quantity
				equipment								
9		Infrastructure Maintenance Equipment										
	9.1	Portable P&C grinders	To dress points and crossings	The Infraco to propose	M	On Site	I	I	I	I	I	1 set
	9.2	Track welding equipment	to build up profiles/replace sections of track	The Infraco to propose	M	On Site	I	I	I	I	I	1 set
	9.3	Portable tamping equipment	To build up track ballast to realign track	The Infraco to propose	M	On Site	I	I	I	I	I	1 set
	9.3	Portable lighting equipment	To illuminate work/collision sites	The Infraco to propose	M	On Site	I	I	I	I	I	1 set
	9.4	Portable generators	To power site tools/lights	The Infraco to	P	On Site	I	I	I	I	I	2

	No	Description	Function	Features	Fixed/Mobile/ Portable	Location used	Supplier	User	Maintainer	Access Control	Cleaned	Quantity
				propose								
	9.5	Track measuring Equipment	To allow track line and levels to be measured	The Infraco to propose	P	On site	I	I	I	I	I	1 set
10		Road Vehicles										
	10.1	Road - rail vehicle	To move about the system carrying mobile equipment and personnel	Able to operate on UK roads Able to operate on all parts of the ETN To be equipped with demountable ≥2 man-basket to enable OLE inspection throughout the ETN Capable of towing a tram including ability to apply tram brakes from cab of road-rail	M	Mobile throughout ETN and road network	I	I	I	I	I	1

	No	Description	Function	Features	Fixed/Mobile/ Portable	Location used	Supplier	User	Maintainer	Access Control	Cleaned	Quantity
				vehicle Capable of having snow plough attached in both road and rail mode Crane with capacity ≥6t and a reach (reduced capacity) of at least 4m. Able to transport other equipment items as set out elsewhere in this list Able to transport ≥3 personnel in cab Payload capability ≥10t								

	No	Description	Function	Features	Fixed/Mobile/ Portable	Location used	Supplier	User	Maintainer	Access Control	Cleaned	Quantity
				This will make it a requirement that the driver has a LGV driving license. Powered winch with ≥8t pulling capacity								
	10.2	Other road vehicles	Miscellaneous vehicles to be proposed by Infraco	The Infraco to propose	M	Throughout road network	I	I	I	I	I	The Infraco to propose
	10.3	Road/rail trailer	Trailer with large man lift for OLE inspection/repairs	Capable of being towed to site by	M	Throughout road	I	I	I	I	I	1

	No	Description	Function	Features	Fixed/Mobile/ Portable	Location used	Supplier	User	Maintainer	Access Control	Cleaned	Quantity
				road/rail vehicle or truck		network						

29.15 Overhead Line Equipment

The Depot tracks shall be equipped with overhead line equipment. This will be in compliance with the Employer's Requirements for Overhead Line Equipment in Section [31].

Electrical and safety interlocking with the craneage and other plant and equipment shall be provided.

29.16 Depot Substation Buildings and Associated External Works

The requirements for the Depot substation building and associated external works are as follows:

- The Depot sub-station requirements and facilities shall accommodate the needs of the traction power loads within the Depot and to service the adjacent sections of main line, the Depot domestic supplies and the requirements of the Distribution Network Operator.
- A separate 11kV/400V LV transformer and distribution switchgear shall be accommodated fed from the main 11kV supply located in the Depot substation.
- The depot LV switchboard shall be capable of being energised from an external / mobile generator via socket and plug with an interlocked isolator. This shall provide 400 V ac supplies to essential services within the Depot complex.
- Provision shall be made for the switchboard generator apron and clear access to the connection point.

29.17 Depot Systems

29.17.1 Electrical Supplies

The power supply to the traction sub-station is described in Section 30 (Traction Power) of these Employer's Requirements.

Scope

The requirements on the Infraco shall include but not be limited to:

- Main (11kV) power transformer and LV switchboard;
- Sub-mains distribution and main equipment;
- Small power distribution;
- Power supply to mechanical plant and controls;
- Back-up supplies (fixed standby generator);
- Uninterruptible power supplies;
- Data distribution and information technology systems supplies (including operations IT systems);
- Fire protection system supplies;
- Power supplies to CCTV, security and access control systems supplies;
- Power supplies to lighting – internal and external, emergency lighting supplies;
- Cable containment;
- Lightning protection and Depot equipment earthing; and
- Commissioning of systems and training.

Auxiliary Power Supplies

Auxiliary supplies shall be provided with a suitably sized uninterruptible power supply. The uninterruptible power supply room shall be provided with cooling in order to maintain battery life (along with ventilation to offset hydrogen build-up if required).

110 Volt Power Supplies

Appropriate networks of 110 V shall be provided:

- 110 V power shall be distributed within the stabling area;
- 230 V/110 V transformers shall provide 110 V supplies throughout the workshops, the main LV switchroom, the plantroom, the wash plant and the sand filling plant.

Control Centre

Electrical supplies shall be configured such that in the event of a single failure there shall be no loss of data and no requirement for excessive actions on the part of the Control Centre staff.

A dual supply changeover arrangement, with high integrity circuit breakers is preferred to a single large uninterrupted power supply. The power changeover function shall not in itself cause the failure of any system so powered, the loss of information or an interruption to the availability to any sub-system for more than 20 seconds.

- Two, suitably sized uninterrupted power supplies shall be connected in parallel and supplied from the Depot substation to provide supplies to critical loads, i.e. Control Centre and equipment room supplies;
- The equipment room electrical systems to provide heating, ventilation, air conditioning, lighting, power and other building services to provide effective habitation for the centralised terminals of all sub systems deployed upon the Edinburgh Tram Network and the human/computer interfaces thereof shall be provided; and
- Lighting to equipment room shall be provided in accordance to CIBSE Codes. Emergency lighting within equipment room shall be at least 50% of normal to allow operations to be carried out even during mains failure.

An appropriate means of facilitating uninterrupted data and voice communication between the equipment room and Control Centre shall be provided for those sub-systems that are present at the operator workplaces, mimic diagrams, display banks and any emergency override facilities. Dedicated containment (and riser, depending on the room's orientation) for cabling between the two rooms shall be provided.

29.17.2 Specific Sub-System Technical Requirements

Access Control

A complete access control system shall be provided to relevant standards with a clearly defined access control strategy.

Controlled entry for pedestrians, Trams and road vehicles shall be provided with appropriate access control for each. Access control shall be switchable between a reception area (for daytime use) and the Control Centre. The Depot road entrance shall have two separate vehicle gates for entry and exit, and additionally a pedestrian gate on the footway. The vehicle gate shall be capable of being opened, and the pedestrian gate released, from either the Control Centre or the Depot reception, or by a member of staff presenting a security card to a reader at the gate.

The vehicle gate shall re-close once a vehicle has passed through. The pedestrian gate shall close automatically and re-lock when it closes. The vehicle exit gate shall open automatically when a vehicle approaches it from within the Depot.

Tram entry / exit locations shall be provided with manual gates, which shall normally be left open. At these gateways, there shall be a microwave or equivalent detector, which shall sound a single brief distinct audible warning in the Control Centre whenever the beam is interrupted by a person or larger object.

Intercoms shall be provided from each of the two entry gates (pedestrian and vehicle) to reception and Control Centre. There shall be two intercom positions on the same pole, one at convenient height for car drivers and one for heavy goods vehicle drivers, who shall be able to use them whilst in the driving seats of their vehicles. here shall be one security card reader at the lower position and one with the intercom at the pedestrian gate. Any equipment in centre of the road shall be removable if required to allow tram movement by road if designed to be through the same access. An intercom system shall operate in line with the access control system.

IT Systems

IT Systems including network cabling containment throughout the Depot building for the independent supply of IT systems shall be provided in accordance with Good Industry Practice.

- Data cabling shall be provided to appropriate standards;
- All equipment finishes shall be appropriate to area and type of use within the Depot building and shall be in materials with a long life in an environment that is in continuous use;
- All accessories used shall be from approved suppliers/manufacturers. Lifespan of finishes / accessories shall be verified with relevant supplier. Correctly (IP) rated items shall be installed as appropriate to the environment; and
- All materials used shall comply with their appropriate standards. Where necessary, finishes / accessories to carry the appropriate 'test pass' mark.

Data collection facilities shall be provided for the management of information provided by all relevant equipment including the underfloor wheel lathe, SCADA, wash plant etc.

Adequate data points shall be provided to enable data collection facilities to be connected.

Lighting

Natural light in offices shall be maximised and all rooms shall be placed within the building in locations appropriate to their function.

Office lighting shall be to CIBSE document 'Lighting Guide 7: Office Lighting'. The document encourages the maximum use of daylight in offices. Use of lighting controls (i.e. daylight sensing, presence detection) shall also be provided, hence saving energy by utilising daylight wherever and whenever possible.

Lighting in main workshop and other areas shall be placed such that light is given where required for work to take place, including when Trams are present. Each lighting element shall also be safely accessible for maintenance during the continuous operating hours with the OLE over one Tram berth isolated.

- Lighting shall be provided so as to provide the required lighting levels (to CIBSE Guides) even when Trams are occupying the workshop. Task lighting shall be provided by luminaires placed close to the task, also supported by portable lamps connected to local supplies;

- Appropriate switching and control strategies shall be implemented; and

- Verification of lighting levels shall be supported by lighting calculations and also by taking post-installation light meter readings.

29.17.3 Workshop Doors

Workshop Tram access doors shall be bi-parting, bi-folding with clear panels for through visibility. The doors shall be power-operated with push-button controls both inside and outside. The open and close button shall be press and hold whilst the door moves, rather than press and walk away to ensure door does not open or close onto an obstruction or person.

- A top-hung door with a bottom track shall be provided and allowed for when sizing the electric motor;

- The actuating mechanism shall be such that it can be maintained without the need to isolate the overhead line equipment;

- In the event of power or door operating equipment failure, it shall be possible for one person to operate the doors manually from ground level;

- The doors shall be provided with a suitably located insulated aperture to accommodate the live overhead line;

- Overdoor heaters, if proposed, shall operate only when doors open via interlinks and integral thermostats.

Door leaves shall be bonded to earth so that should they inadvertently come into contact with the overhead line equipment, the fault resistance shall be sufficiently low to ensure immediate circuit breaker trip without damage to doors or equipment.

29.17.4 Hazardous Material Storage

Facilities for the storage of hazardous materials and road access for their delivery and off loading shall be provided.

29.18 Equipment Room

29.18.1 Fire Alarms / Fire Extinguishing System

The equipment room shall have a means of locally activating the fire alarm via a wall-mounted panel.

The equipment room shall be fitted with smoke and temperature alarms.

The equipment room shall also be fitted with an automatic and manually operated extinguishing system, which shall not damage the equipment when activated. The extinguishing system chosen shall be designed subject to a risk assessment based on criticality etc.

In the event of the loss of the primary power supply, the alarm system shall function for a minimum of six hours. This system shall be integrated with the durations and functionality of all other UPS systems.

29.18.2 Heating and Ventilation

The equipment room shall be environmentally controlled to minimise the effects of room heating due to equipment dissipation.

The heat exchanger vents shall not be positioned over the work area of the maintainers nor directly above equipment cubicles, and shall be placed in position to minimise localised chilling effects.

The room shall be positively ventilated to prevent dust ingress.

All equipment fitted with fans shall ensure that fan failure shall not compromise system functionality.

29.18.3 Lighting

Lighting within the equipment room shall be either incandescent or fluorescent type fittings.

In the event of power failure, emergency lighting shall be fitted which shall operate for four hours and maintain the level of illumination in the room.

The lighting shall be positioned to illuminate the front and rear of the equipment cubicles, but not directly above equipment cubicles.

29.18.4 Cable / Conduit Entry

Cable routing shall be primarily through floor-recessed conduit.

The main cable entry / exit shall be via an aperture located in the floor, which provides entry or access for cables external to the Depot.

Cable access shall be through the equipment room ceiling.

Particular care shall be taken to ensure that electro-magnetic compatibility is not degraded when cables are closely located.

Cables shall be continuously screened through the wall / floor / ceiling apertures.

Appropriate strain relief or clamping shall be provided.

All cables and conduits shall be clearly marked with cable identifiers or suitable permanent marking which shall last for the expected lifespan of the cable or conduit.

29.18.5 Architectural Requirements

Equipment shall be laid out in the equipment room to afford easy accessibility.

Cubicle doors, when opened shall not impinge on access.

Appropriate 'safe' walkways shall be clearly identified on the floor of the room.

Equipment shall be placed such that cabling runs are minimised.

Antenna, low signal or high frequency cable runs shall be minimised and the equipment positioning optimised to ensure a majority of these runs are compliant.

The equipment room floor shall be sealed to minimise dust ingress into the equipment and the surface shall ensure that no static build-up occurs.

29.18.6 Security Requirements

In the event of security and access control system failure, this shall be logged accordingly and displayed to the Control Centre staff.

29.18.7 Equipment Room Furniture

The equipment room shall be furnished with modern ergonomic furniture to assist the maintainers and reduce fatigue.

There shall be two maintainer's desk positions in the room.

The design of the equipment room furniture shall include provision for the effective management of cabling, and equipment and maintenance power supply distribution.

Each desk position shall have personal storage of a minimum of three lockable drawers.

Positioning of storage shall not inhibit the work-envelope of the maintainer.

Additional tool storage locations shall be located in appropriate areas of the equipment room

29.19 Mechanical and Public Health

29.19.1 General

The mechanical and public health services works to be provided shall include the main Depot, and comprise heating, fresh air ventilation, toilet accommodation extract ventilation, specialist extract ventilation, comfort cooling systems, control systems, incoming natural gas supplies and distribution, fire alarm systems, fire suppression system, incoming mains water supplies, domestic hot water generation, domestic hot and mains water distribution, rainwater collection, waste and soil pipework systems, and underground surface water and foul drainage immediately local to the main Depot (connecting into main services systems).

29.19.2 Water

Cold water shall be provided to each stabling road.

Mains water shall be supplied to areas such as the vehicle workshop (and other special purpose workshops), plant room and wash plant. Backflow prevention devices shall be employed.

Domestic hot water shall be centrally generated and stored. The calorifiers and circulation plant shall be housed in the appropriate plant room.

29.19.3 Air Conditioning

Air conditioning shall be provided in the Control Centre, and all administration areas.

A 'free-cooling' system shall be provided for the equipment room.

Duplicate cooling systems, each capable of 100% duty, shall be installed to serve the Control Centre and equipment room.

29.19.4 Ventilation

Dedicated extractor systems shall be provided to suit specific items of equipment (i.e., lathes, paint spraying booths. vehicle battery charging and uninterrupted power supply system).

29.19.5 Drainage Pad

A drainage pad shall be provided adjacent to the pressure washer with a water and power supply for a pressure washer.

Treatment of wastewater to meet appropriate standards prior to connecting to site drainage system shall be provided.

29.19.6 Mechanical Systems

The systems shall be configured such that in the event of a single failure there shall be no loss of data and no requirement for excessive actions on the part of the Control Centre staff.

All centralised mechanical services plant shall be located in the plant room with sufficient space allocation for maintenance and / or plant removal. The only exception to this may be the heat rejection plant necessary for the air conditioning/comfort cooling installations, which are likely to located externally. Should equipment be required to be located externally the impact on the overall visual appearance of the Depot shall be considered.

30 Traction Power

The scope of this Section of the Employer's Requirements is to define the traction power (substations) requirements applicable to the Edinburgh Tram Network which the Infraco must comply with.

30.1 General Requirements

The provision of traction power shall be derived from a number of suitably located traction substations distributed around the Edinburgh Tram Network.

Each Edinburgh tram traction power substation shall include:

- The traction substation enclosure;
- The associated Scottish Power HV (11 kV) three-phase power supplies with associated HV switchboard, metering and local emergency tripping facility;
- 230V LV services with associated metering and distribution equipment for substation services i.e. lighting, small power etc;
- Traction substation transformer-rectifier/s and equipment;
- Traction dc switchboards;
- Feeder and bypass isolators;
- Substation earthing;
- Negative busbars;
- Batteries / charger;
- SCADA interface marshalling panels or agreed equivalent;
- Associated internal power and control cabling; and
- Miscellaneous items to complete.

Substations shall be containerised at all locations where this is practicable.

Provision shall also be made for a 11 kV supply to the Depot services transformer.

30.2 Traction Substations

30.2.1 General

A sufficient number of traction substations (including a separate substation for the Depot) shall be provided, as described later in this Section 30.

The equipment to be provided for each of the eight traction substations for Phase 1a shall comprise:

- Appropriate HV supply arrangements from a Scottish Power circuit breaker (as part of their HV switchboard to be located in a separate section of the substation building);
- A single indoor transformer-rectifier unit;
- A 750 V dc switchboard with direct acting overload protection, impedance protection, earth fault protection and transfer tripping;
- A negative busbar cubicle;
- A tripping and closing battery and charger; and
- All associated internal power and control cabling, and earthing.

The layout and disposition of all equipment contained within all substations shall be identical where this is practical.

Separate personnel access shall be provided to the compartment housing LV control, protection and instrumentation equipment and associated multicore cabling terminations. This compartment shall be fully segregated from the HV / traction voltage compartments by means of a cage or similar. An access door shall be provided between the two compartments, with a locking system that is to be agreed with **tie**.

Two track feeder isolators with earthing function and a motorised bypass isolator shall be provided.

At all substations, control and indication information shall be provided to SCADA by suitable remote communication interface.

30.2.2 Russell Road Track Paralleling Hut (applicable to Phase 1b only)

Consideration shall be given to the provision of a Russell Road track paralleling hut, which shall be provided with similar equipment as all other substations, however an HV supply from Scottish Power will not be provided and the substation shall be used as a track paralleling hut in the first instance.

The design shall consider the future detailed provision for the installation of such an HV Supply, in configuration of the substation which shall be identical, as far as practicable, to all other substations to be provided within the Edinburgh Tram Network.

Cable ducts into the building shall be provided to enable the future installation of a HV Supply with the minimum of disturbance to the ongoing operation of the location.

30.2.3 Gogar Depot Substation

The equipment at the Depot traction and services substation shall comprise three HV supply cables from three Scottish Power circuit breakers, or ring main units feeding two indoor transformer-rectifier units for depot stabling traction and main line traction, and the other to the services transformer in the Depot building.

One four-panel 750V dc switchboard with direct acting overcurrent protection, relay overcurrent protection, thermal image, earth fault protection on three (two for the yard and one for the workshop) track feeder circuit breakers and direct acting reverse current protection on the rectifier circuit breaker. (Alternatively, a fused rectifier may be used, whereby no direct acting reverse current protection on the rectifier circuit breaker is needed at all. An isolator may be offered in place of a rectifier circuit breaker. If the fused rectifier option is chosen, then this will be fed from one rectifier transformer; a three panel 750V dc switchboard feeds the main line in the usual way as described above.

The whole of the Depot yard shall be earthed on the negative side including the workshop traction supplies.

The enclosure of the yard and workshop circuit breaker shall be solidly earthed, and also connected to the rectifier negative pole.

Two negative busbar cubicles (one for the yard rectifier and the other for the main line rectifier), a tripping and closing battery and charger, all associated internal power and control cabling, and earthing shall be provided.

In an annex segregated from the main enclosure for fire detection, two motorised track feeder isolators with motorised earthing function and a motorised load break bypass isolator with over-current detection and tripping relay shall be provided.

30.3 System Protection Settings

As well as complying with the **tie** requirements for as built documentation, all calculations used to determine protection settings shall be provided by the Infraco in a format allowing complete checking of methodology results without any additional sources of information.

30.4 Power System Design Principles

The 11 kV feeds to each traction substation shall be derived from and form part of the local Distribution Network Providers (Scottish Power) Network ring with a dedicated ring main unit or switchboard feeding the Edinburgh Tram Network the traction substation.

HV switchgear shall be provided to meet the requirements of the DNO (Scottish Power).

The 750 V dc traction power system shall provide a very high degree of reliability. Thus, small single-rectifier, substations shall be provided at close spacing, arranged to feed the 'in' and 'out' lines in permanent cross-connection between substations.

The OLE feeding shall be arranged so that the use of locally operated manual feeder isolators can facilitate the remote isolation and earthing of the overhead line; alternative solutions may also be offered.

Each traction substation shall also be configured so it can be isolated from the main line and bypassed without an impact on the Tram service.

The auxiliary switches of the bypass isolator shall, on the bypass isolator closing, re-configure the hard wire inter-tripping pilots to bypass the isolated substation. In the event of a fault, the over-current relay of the bypass isolator shall trip the feeding circuit breakers at both ends of the extended section, and give SCADA indication of the direction in which the fault current flow was detected. Other procedures for indication of fault location may also be offered.

Equipment located within the substations and the remote motorised isolators, including the earthing function, shall be controlled and monitored over the SCADA system.

11 kV supplies at the Depot and control centre will be taken from two 11 kV Scottish Power feeders, via a Scottish Power switchboard affording three 11 kV feeds to the Edinburgh Tram Network.

One feed shall supply the traction transformer-rectifier for the Depot yard, workshop and stabling area roads that have the track solidly earthed.

The second feed shall supply the traction transformer-rectifier for a normal main line feeding configuration.

The third feed shall supply the transformer, adequately-sized for the Depot and control centre LV ac services.

Maximum use of the standard traction transformer rectifier unit shall be achieved for the System by providing a high degree of reliability. This will be afforded by deriving traction supplies from two separate Scottish Power feeders at each substation.

In the particular case of the Depot, in the event of loss of the 400 V ac supply, essential equipment (principally the Control Centre) shall continue to function on UPS supplies and from a separate generator (see Section 29 (*Depot*) of these Employer's Requirements).

The 11 kV incoming supply to all traction substations shall be able to be individually tripped by the system controller located in the Control Centre via SCADA, and by staff locally by means of a dedicated 11kV trip push button to be located in each substation lobby.

The OLE shall also be able to be tripped in either direction by the system controller from the Control Centre via SCADA.

The OLE shall be able to be tripped in both directions simultaneously via a hard wire emergency mass trip button to be located in the Control Centre that shall trip all substations in the designed groups.

The OLE shall be able to be tripped locally in both directions simultaneously by means of an emergency push button located in each substation lobby.

The substations are named, referenced and located as shown below:

Table 87 - Substation Abbreviations

Substations	Nomenclature
Phase 1a	

Leith Sands Substation	LSE
Leith Walk Substation	LWE
Cathedral Substation	CAE
Haymarket Terrace Substation	HTE
Jenner's Depository Substation	JDE
Bankhead Drive Substation	BDE
Gogar Depot Substation	GDE
Ingliston Park and Ride Substation	IPE
Phase 1b	
Craigleith Substation	CGE
Granton Mains East Substation	GME
Granton Road Substation	GRE

The 750 V dc feeder circuit breakers at each substation shall be arranged to feed the OLE locally through manual feeder isolator / earth switches located in their own compartment of the traction substation. Motorised load break bypass isolators shall be provided in these compartments or at suitable location to link adjacent OLE sections in an emergency.

Intermediate sub-sectioning points shall be provided, comprising section isolators in trackside pillars (depot: pole mounted will be acceptable) to give operational flexibility during emergencies. With the exception of 'tail end' feeds, most sections of OLE shall be double end fed, and provided as second level protection with transfer tripping through private pilot cables.

30.5 Scottish Power Interface (DNO)

All Scottish Power 11 kV supplies connections, together with all associated protection, emergency tripping and tariff metering equipment shall be procured by the Infraco.

The provision of a separate Scottish Power LV supply connection for lighting and auxiliary services within the traction substation buildings, excluding the depot traction substation shall be procured by the Infraco.

The ratings and protection of the Scottish Power supplies shall be suitably co-ordinated with the characteristics of the power conversion equipment.

SCADA indications shall be made available and SCADA cable tails shall be provided for Scottish Power to wire into their equipment. A maximum number of up to 5 in-/output connections are to be considered as sufficient.

30.6 Multicore and Control Cabling

All necessary multicore and control cables within the substation, and LV ac supplies to the substation equipment, shall be provided.

Each substation LV ac supply shall be drawn from a suitably rated LV ac consumer unit.

The provision and installation of all the necessary intertripping pilot cables to and from the dc switchgear located within each substation shall be included.

Cables for all LV ac and LV dc protection, control, alarm and indications shall have copper conductor with XLPE or PVC insulation and an overall PVC oversheath and galvanized steel wire armour where cables are to be installed without armoured conduit or trunking or other adequate mechanical protection.

The conductors shall be plain annealed copper wire complying with BS EN 60447 – 2007 as applicable or equivalent and all cores shall be clearly identified by printed numbers at regular intervals.

The minimum conductor size shall be not less than seven strands of 0.67 mm diameter wire, or in the case of single wire conductors the minimum cross-sectional area shall be not normally be less than 2.5 mm^2. In special cases for light current installations single strand, annealed copper conductors with a cross-section of 1.5 mm^2 may be used but only with the specific written approval of **tie**.

All cable sheaths shall be free from defects and impervious to water.

Multicore and control cables shall be terminated in accordance with the manufacturer's recommendations and the cable cores shall be left long enough to be terminated without the addition of separate tails.

All detail diagrams shall be cross-referenced and shall show multicore cable schedule reference numbers to facilitate cable identification.

30.7 Transformer Rectifiers

30.7.1 General Arrangement

Each unit shall consist of a dry type, Class F AN cooled transformer to BS EN 60726. Each unit shall be suitable for environmental conditions E1 and ambient temperatures C1. The rectifier shall

comprise silicon diodes mounted on heat sinks, the whole to BS EN 60146, and cooled by natural circulation of air, enclosed in a cubicle with a rigidly constructed fabricated steel framework. The steel framework shall be completely clad in sheet steel to the extent as shall be consistent, by the provision of screened openings, with the requirements of natural cooling and ability to assess readily by direct vision from outside the cubicle any unhealthy condition of the major internally mounted components. Drip-proof top covers shall be fitted. The outer surfaces of the cubicles shall be Grey Shade 631 Semi Gloss to BS 381C 1996 or similar, e.g. RAL 7047. Adequate ventilation provision shall be made in the substation buildings without jeopardising the security of the building to ensure the equipment is able to perform correctly.

Alternatively, a separate close-coupled transformer cubicle may be offered. Substation floor area shall be considered at a premium, so an important consideration is compactness of layout without jeopardising operating and maintenance requirements.

All equipment shall comply with the requirements of BS EN 60076 and BS EN 60146, and the degree of enclosure shall be IP31 of BS EN 60529.

30.7.2 Rating

The rating of the transformer-rectifiers shall be declared as the 100 per cent continuous rated output at 750 V dc on all transformer tappings. Each combined unit shall have an overload rating according to the rating class of BS EN 60146 stated in the Schedules. The impulse voltage withstand rating shall be 75 kV for the nominal system voltage of 11 kV.

30.7.3 Voltage Regulation

The overall voltage regulation of each combined transformer - rectifier shall be 5 per cent with a tolerance of ±5 per cent of the regulation from 5 to 100 per cent rated load.

30.7.4 Voltage Ratio & Connections

The HV primary winding shall be delta connected, and two secondary windings, one star and one delta, arranged for series bridge rectifier operation in accordance with circuit diagram 12 of BS EN 60146 to produce 750 V dc at 100 per cent rated load and nominal tapping.

30.7.5 Voltage & Phase Tapping

Tappings shall be provided on the HV windings in order to make an off-circuit HV voltage selection, by means of bolted links.

30.7.6 Transformer Cores

The cores shall be built up of cold rolled grain oriented silicon steel sheets in accordance with the guaranteed maximum total loss stated in BS EN 10107. When a transformer is connected on the nominal tapping, and operating at rated voltage and frequency, the flux density at any point in the magnetic circuit shall not exceed 1.6 Tesla.

The magnetic circuit shall be insulated from all structural parts and be capable of withstanding a test voltage to the frame of 2 kV rms for one minute. A link shall be provided for earthing the magnetic circuit to the enclosure.

30.7.7 Performance Under External Short Circuit

The performance of the rectifier transformer under external short circuit conditions shall be in accordance with BS EN 60076 (BS 171 is withdrawn). In applying the values stated therein it is to be assumed that the voltage at the terminals of one side of the transformer is maintained at the full rated value for the duration of the short circuit when there is a short circuit between the phases or to earth on the other side of the transformer, or between poles on the rectifier output.

30.7.8 Losses

The no-load and load losses shall be as low as is consistent with reliability and economical use of materials.

30.7.9 HV Cable Terminations

A cable termination chamber for top or bottom entry shall be provided suitable for dry type terminations and the HV cable.

30.7.10 Diodes

The type of diode used shall have been proved in service and have an assessed reliability generally in accordance with valid and current European Standards ((actual BS 9300 seems not to standardise diodes for traction rectifiers)). A fuse-less design of diode bridge shall be provided. Alternatively fused diode bridges with monitored fuses in combination with fuse-less, but short circuit proof resistor/capacitor circuits may also be offered (refer to section30.7.11).

Each diode shall be capable of withstanding voltages having a peak value not less than 2.5 times the peak working reverse voltage rating.

Particular attention shall be paid to the method used for mounting the diodes, and it shall be possible to replace easily any individual diode without disturbing other components.

30.7.11 Surge Protection

Each rectifier shall be fitted with surge protection to ensure that the reverse voltage is shared equally across series connected diodes and bridges and that the voltage across individual diodes is limited to the peak transient reverse voltage rating of the diode.

In order to attenuate surge voltages caused by lightning strikes, pantograph arcing or similar effects, a surge protection circuit comprising two separately fused resistor/capacitor networks shall be provided. The design of the surge circuit shall be such that resonant effects with significant

harmonics present in the open circuit voltage are minimised. . Alternatively, a non-fused short-circuit proof resistor/capacitor circuit may also be offered.

Adequate protection against lightning and over-voltages, however caused shall be afforded to the substation equipment. The characteristics of all surge diverters to be used on the Edinburgh Tram Network shall be correctly co-ordinated with those of the rectifier surge circuits, so as to limit over-voltages to acceptable levels and minimise resonance effects.

30.7.12 Temperature Rise

The rectifier transformer temperature rise shall be limited to 800 K at rated output. The maximum operating temperature of any rectifier component, including busbars and connections, shall not exceed the limits permitted by BS EN 60146.

30.7.13 Protective Services

The following devices shall be provided:

- Diode heat sink and transformer winding over-temperature alarm and trip, with alarm contacts for SCADA indication and local alarm lamp indication (amber) or, alternatively, indicated on substation control & protection display;

- Surge circuit fuse failure alarm, operating for the failure of either or both circuits, with alarm contacts for SCADA indication and local alarm lamp indication (amber) or alternatively indicated on the substation control & protection display; if a non fused solution is provided (refer to section [30.7.11] Surge Protection then no indication is required.

- A supply supervision device shall be provided to monitor the presence of the main supply to the transformer-rectifier and to give a supply failure alarm through the SCADA system; and

- An extreme inverse over-current/earth fault relay protection on the 11 kV incoming circuit for tripping the Scottish Power rectifier feeder circuit breaker, with alarm contacts for SCADA indication.

30.7.14 Instrumentation

Each rectifier shall be fitted with a shunt or dc current transducer with connection to an ammeter mounted on the front of the cubicle. Each rectifier shall be fitted with a fused voltage divider connected to a rectifier output voltmeter mounted alongside the ammeter.

The overall accuracy of the shunt / dc current transducer and ammeter, and of the voltage divider and voltmeter, shall be to Class Index 1.3.

Alternatively, this instrumentation may be located in the rectifier feeder cubicle of the DC switchgear or the values may be shown on substation control & protection displays.

All 750 V dc connections, relays and instruments and any stray current monitoring instruments shall be capable of withstanding the test voltage stipulated in BS EN 50124-1 2001.

30.7.15 Negative Isolation

The negative connection from each rectifier shall include a disconnection facility by means of an isolator, either as part of the rectifier or part of the negative busbar cubicle.

30.8 A.C. HV Switchgear

Provision is to be made for a 'Scottish Power' emergency trip facility (located in each substation lobby) to allow mobile tramway staff, who may not be authorised for access to the traction substations, to trip the Scottish Power in-feed to a substation in the event of a failure of the SCADA system.

30.9 D.C. Traction Supply Switchgear

30.9.1 General

The switchgear shall be of the high-speed air break type in accordance with BS EN 50123-2, suitable for use on a 750 V dc traction overhead line system, with floating track negative return circuit.

Circuit breakers shall be of the carriage-mounted 'withdrawable' type, within cubicles.

The switchboard shall comply with BS EN 50123 Part 6 and be capable of sustaining without damage, the electrical and mechanical stresses produced by fault conditions up to the prospective system short circuit rating.

The entire switchboard enclosure shall be insulated from earth and there shall be no inadvertent earthing of the switchboard other than via the main earth bar passing through the low impedance earth fault sensor.

Each cubicle shall be of rigid folded sheet steel construction suitable for all normal and fault conditions, and withstand repeatedly without distortion or failure, shocks caused by closing and opening impacts. Enclosures shall have a degree of protection to IP 31.

Removal of covers on any cubicle to permit access to components shall not cause exposure of live conductors in the adjacent cubicles.

The design of the cubicles shall ensure complete dispersion of ionised effluent from the circuit breaker to atmosphere without hazard to personnel or the possibility of establishing a conducting path to the switchboard frame.

The switchgear assembly shall be designed in compliance with, and have certified test reports to demonstrate compliance with clause 6.6.3 of BS EN 50123-6 1998. Front access doors to compartments with exposed metalwork connected to the primary circuit shall be insulated against arcing to the door (3 mm polycarbonate screen or equivalent) and have a fault rated flexible earth strap at the top of the door between door and cubicle frame. Hinges and door latches shall be substantial and keep engaging on door closure.

Outgoing cable boxes shall be suitably sized to accommodate the DC cables. Feeder cable boxes shall be furnished with a surge arrester coordinated with the OLE and rectifier surge protection ratings.

Other DC switchgear, proved and tested in similar applications providing same or similar functionality in compliance with relevant, current and valid European Standards may also be provided.

30.9.2 Busbars

The busbars shall be rigidly supported and fully insulated throughout their length, including tee-off connections and joints between adjacent chambers.

The busbars shall be completely enclosed in an earthed metal chamber, access to which shall be by means of bolted panels. Removal of these panels shall not give access to outgoing circuits. No small wiring or other equipment shall be mounted in busbar chambers.

Other solutions providing same or similar functionality and electrical safety may also be provided.

30.9.3 System Voltage and Fault Level

The normal system traction working voltage shall be taken as 750 V DC, with a tolerance in accordance with BS EN 50163.

The switchgear shall be capable of withstanding the electrical and mechanical stresses when clearing short circuit currents up to the maximum prospective level of the system, assuming that normal voltage will be maintained at the primary terminals of the rectifier transformer.

The switchgear shall be capable of interrupting the following currents:

- Terminal short circuits;
- Overhead line faults adjacent to a substation;
- Overhead line faults remote from substations, and including faults at the most distant point fed under the most onerous outage conditions tolerable;
- All values of traction load currents likely to be encountered in service, passing through the switchgear in either the forward or reverse direction; and
- Load currents of tramcar auxiliaries, under both starting and running conditions, passing through the switchgear in either the forward or reverse directions.

All electrical clearances in air and insulator creepage distances shall be adequate to withstand all specified steady state voltages and all transient voltages likely to arise in service.

30.9.4 Temperature Rise

Each current carrying component of the equipment supplied shall be capable of continuous operation at the specified ratings without exceeding the maximum temperature rises stated in the appropriate European Standard.

30.9.5 Circuit Breaker Isolation

Each complete circuit breaker together with its auxiliary switches and operating mechanism shall be arranged on a 'withdrawable' carriage to permit full accessibility for maintenance purposes and as a means of isolating the circuit.

Indication of circuit breaker `open/closed' status, and circuit breaker position, shall be visible through a window in the cubicle access door or by other suitable means (e.g. after opening the cubicle access door and, in addition, on substation protection and control display)..

The circuit breaker carriage shall remain within the confines of the cubicle when in the service or isolated positions.

A positive stop shall be provided to indicate when the circuit breaker has been fully moved into the service position.

Mechanical interlocks shall be provided so that it is neither possible to withdraw the circuit breaker without having first tripped the operating mechanism, nor to replace the circuit breaker if in the closed position. Means shall also be provided to enable the circuit breaker to be operated electrically or by hand when in the isolated position. A padlocking facility shall be provided on the isolating handle aperture. The main isolating contacts of the fixed portion shall be equipped with shutters arranged automatically to cover all live parts on both busbar and outgoing circuits. Provision shall be made for padlocking each individual shutter in the closed position.

Secondary isolating contacts shall be provided as necessary and arranged so that when in the isolated position all auxiliary supplies to the circuit breaker carriage are still connected.

Facilities shall also be provided so that the circuit breaker and its associated electrical auxiliary circuits can be operated electrically when the carriage is completely withdrawn from the cubicle enclosure.

The circuit breaker carriage shall be equipped with suitable wheels for movement on normal floor surfaces and also to act as guides in conjunction with suitable alignment rails, pins and sockets to ensure correct and accurate engagement of the plug and socket contacts.

Steel ramps and tracks of suitable section and robust construction shall be provided for the movement of the carriage into and out of the stationary portion of the cubicle. The arrangement shall positively and accurately align the main and secondary plugs of the carriage with the respective stationary portion plugging contacts and during all movements under service conditions maintain such alignment and earthing contact. The ramps shall be designed to permit easy movement of the carriage between cubicle and floor without shock or damage to the equipment or floor.

Plugging or scraping contacts with copper current paths shall be provided to ensure a satisfactory and positive connection of the metalwork of the circuit breaker carriage to the switchboard earth bar established in the isolated position before any 750 V connections are made.

30.9.6 Circuit Breakers

All circuit breakers shall have a continuous current rating in accordance with BS EN 50123 and BS EN 60439 where applicable, shall be identical in arrangement and fully interchangeable with each other, where appropriate. Rectifier and feeder circuit breakers shall not be interchangeable, in -case Rectifier circuit breakers are provided (in case of Fused Rectifier diodes, Rectifier disconnectors are sufficient and to be provided).

The closing circuit shall contain an anti-pumping feature which shall prevent automatic re-closure should the closing signal be retained indefinitely either by operator action or resulting from a failure on the supervisory control system. The circuit breaker shall not respond to a close signal when open and a trip signal is present.

Closing and tripping circuits shall be capable of satisfactory operation within the limits of 70 per cent (tripping of feeder circuit breaker trip coils) 80 per cent (closing) and 120 per cent, of the rated dc auxiliary supply voltage.

The 'trip' coils of the dc rectifier circuit breakers shall, if needed (see above), take the form of 'under voltage release' coils after Network Rail practice, so that loss of auxiliary voltage will cause the rectifier circuit breaker to drop out, leaving the feeder breakers closed up as a track paralleling hut (TPH).

The circuit breaker shall be capable of being closed and tripped manually in the service position while still retaining its full fault making and breaking capacity. Under such manual operation it shall be possible to disconnect the auxiliary dc supply without interfering with the operation of the breaker.

Provision shall also be made for the slow manual closing of circuit breakers when withdrawn for maintenance purposes and one device for this purpose shall be provided per switchboard. The slow closing device shall be such that the moving portion of the circuit breaker can be halted at any point in the travel, to enable checks to be made at all points of the closing stroke.

Mechanical indicators shall be provided to show whether the circuit breaker is open or closed. An operations counter shall be fitted.

Shunt tripping coils shall be wired in series with circuit breaker auxiliary contacts arranged so that the supply to these coils is automatically cut off on completion of a successful operation.

All contacts shall be easily and quickly replaceable.

The arc chutes shall be so arranged that any emission of flame, hot gases or metal particles during operation of the circuit breaker will be contained within the cubicle and not cause damage. Arc-chutes shall be designed for convenient handling and removal during inspection and maintenance.

The design of the arc control chutes shall be such that erosion caused by the arc and emission of ionised effluent during operation of the circuit breaker is minimal. The materials used in them shall be non-hygroscopic.

Each circuit breaker carriage shall be fitted with a label holder and an easily removable blank white sandwich plastic label.

The front and rear of each cubicle shall display a prominent label showing the circuit identification by name and approved reference number.

30.9.7 Interlocks

A system of mechanical or electronic interlocks (substation control and protection) shall be provided which automatically imposes a fixed sequence of events designed to prevent mal-operation of the circuit breaker unit as a whole.

30.9.8 Protection Devices

Each feeder circuit breaker shall be fitted with a uni-directional series instantaneous overload device, with a calibration range chosen to be a standard for the system. It shall also be fitted with a multi-functional device to afford instantaneous, programmable and thermal image protection. Rate of rise protection is disallowed (may be a standard part of the multi function relay, provided it can be disabled) but impedance protection will be considered.

Each feeder circuit breaker shall be fitted with a line proving device to prove the circuit onto which the circuit breaker has been instructed to close is not faulted. The maximum current that may flow due to the 'line proving', in the event of a short circuit shall not exceed 40 amps. The relay that measures the residual resistance in the circuit and blocks the circuit breaker against closing shall have a setting range of 2 to 50 ohms as a minimum. In addition to blocking the circuit breaker from closing a SCADA indication shall also be given that the closing has been blocked.

A combined intertripping and earth fault protection scheme shall be provided. Each switchboard shall be equipped with a low impedance earth fault detector, arranged to initiate a local mass trip of all dc circuit breakers and to intertrip corresponding feeder breakers at adjacent substations for all causes of feeder CB tripping. 'Intertrip receive' protection relays or related control equipment shall be fitted with a manual reset flag or similar (e.g. display), showing when the protection is operated. Intertrip by-pass facilities shall be provided, by means of auxiliary switches in the substation bypass isolators reconfiguring automatically when the isolator is closed. Inter-trip, in/out of service, switches shall be provided in order to inhibit the intertripping when OLE is sub-sectioned. Provision shall be made for SCADA 'opening' of the feeder circuit breakers without causing a mass trip or intertrip.

Contacts shall be provided to give individual trip alarms from main and back-up protections through the SCADA system.

The SCADA system will include a remote trip facility. In order to maximise reliability, the incoming SCADA control signal for this facility shall be arranged not only to trip the appropriate local feeder circuit breaker but also to trip the corresponding feeder circuit breaker at the remote end of the OLE section via the intertripping pilot wire system.

Each circuit breaker shall be fitted with a push button and lamp (white) to provide a local trip 'circuit healthy' indication on demand with the breaker closed. The current path for this feature shall include the actual circuit breaker trip or actuation coil.

Additionally, a voltage operated relay fitted with a self reset flag indicator shall be provided to supervise the tripping supplies to the switchboard. Contacts shall be provided to give an alarm through the SCADA system.

Each outgoing d.c. feeder cable box shall be equipped with a surge diverter.

30.9.9 Control and Instrumentation

All equipment shall comply with relevant and valid European Standards.

Auxiliary control supply shall be from a floating LV d.c. supply. Individual panels shall have both polarities of the supply fused, or protected by magnetic circuit breakers.

Current measuring devices shall be fed from either shunts or transducers. All 750 V connections and associated relays and instruments shall be capable of withstanding the test voltages according to relevant and valid European Standards.

Main items to be included on each panel shall include:

- Circuit breaker control switch (open/close);
- Circuit breaker control selector switch (local/supervisory); and
- Indication lamps (open/closed - green/red).

All control and control selector switches shall be suitable for locking by means of a padlock. Indication lamps shall be of the LED type to ensure long life.

Each feeder circuit breaker panel shall be provided with an ammeter, of overall accuracy including the shunt to Class Index 1.5.

Each rectifier panel shall be provided with a voltmeter fed from the rectifier side of the circuit breaker, or the rectifier voltage transducer.

Alternatively, listed control and indication elements may also be provided by means of the substation protection and control units (e.g. display). In this case, therefore, padlocking is not applicable.

30.9.10 Overhead Line Emergency Trip

A facility to ensure the fail-safe hard wire emergency mass trip of traction substation dc circuit breakers by the system controllers shall be provided within the Control Centre.

Separate emergency trip push buttons shall be provided for the following two groups:

- Haymarket to Newhaven
- The rest of the Edinburgh Tram Network including the Depot,

This facility shall take the form of a suitably located and identified wall mounted box containing all equipment and push buttons necessary to provide this function.

The equipment to be provided in each traction substation and TP hut for this feature shall comprise a hold-in relay energised from the tripping batteries of the traction substation and a remote normally-closed contact in the Control Centre or other substation. The system shall be provided with trimming resistances to keep the relay current within limits for varying distances to the remote contact. The system is envisaged to be stable at up to 15 km with 1.5 sq mm pilot cores. The mass

trip relay shall have sufficient circuits to trip all feeder circuit breakers and dc rectifier circuit breakers. It is not envisaged to use the rectifier circuit breaker trip and an open link shall be provided in this circuit. Two further normally-open and normally-closed contacts shall be provided for use in cascading the trip to other traction substations in a similar manner.

Provision shall be made for an overhead line emergency trip facility (located in each substation lobby) to allow mobile tramway staff, who may not be authorised for access to the traction substations, to trip the overhead lines in both directions from a substation in the event of a failure of the SCADA system. The logic of this trip facility will be integrated in the central station controller of each substation.

30.9.11 Circuit and Busbar Earthing

Means shall be provided at each panel for applying a safety earthing device to busbar or circuit connections in order to comply with safety legislation. A dedicated earthing truck or other suitable earthing equipment, as needed for the installed equipment, shall be provided at each substation for such purposes.

30.9.12 Isolator Motorised Operation

Where motorised isolators are provided, operation of the feeder isolator and earth switch functions shall be from the substation tripping battery.

Operational commands shall be via SCADA signals hard wired from the SCADA outstation within the substation to relays in the isolator panel.

Both OLE feeder terminals shall have 'live line' detection arranged to inhibit opening of the feeder isolator and this detection shall be brought back to the Control Centre via SCADA.

It shall not be possible to earth a feeder unless the bypass and feeder isolator are both open.

It shall not be possible to close a feeder isolator unless both the earth has been removed and the adjacent bypass isolator is open.

It shall not be possible to close the bypass isolator unless both adjacent feeder isolators are open. SCADA position indication shall be provided for all switching elements in all positions.

In the event of loss of rectified Scottish Power LV supply the operation shall auto change over to a battery supply.

For isolators located in the Depot, this section is not applicable, because of manual operation.

30.9.13 Bypass Isolator Over-current Feature

The bypass isolator when closed shall reconfigure the 'pilot wire' inter-tripping between adjacent substations to bypass the substation in which the bypass isolator is accommodated.

In case protection of contact line cannot be provided by adjacent substations when bypass-isolator is closed, the bypass isolator shall have a 'line current' trip feature where the current passing through the bypass isolator is measured and operates one of two relays depending on the direction of current flow through the isolator to trip both remote substations in the event of detecting a current in excess of setting.

The setting range to be approved by **tie**.

The relays shall be powered from a dedicated battery with a minimum of four hours standby time.

This battery shall be supplied from the substation tripping battery supply. There shall be SCADA indication of loss of battery voltage.

30.10 Batteries and Chargers

30.10.1 Scope and System Voltage

One 100 per cent duty battery, 100 per cent duty charger and dc distribution board unit shall be provided for each traction substation, for the purposes of providing tripping, closing and control supplies for the 750 V dc and ac switchgear. The battery charger will be supplied from the Scottish Power LV ac supplies in the substation. Neither polarity shall be deliberately earthed and the supply shall function unaffected with either pole inadvertently earthed.

It is to be noted that such supplies for the Scottish Power 11 kV switchgear will be derived from a battery and charger to be supplied and installed by Scottish Power themselves (Electricity Supply Regulations requirement).

The nominal battery voltage, suitable for the switchgear, shall be in accordance with BS 2618. The charger supply shall be 230 V, single phase, 50 Hz, and the complete equipment shall be a manufacturer's standard product.

30.10.2 Batteries

The batteries shall be of the high performance type, and shall be designed for a life expectancy of at least ten years under the conditions of service likely to be encountered. Battery cases shall be of high impact polystyrene translucent plastic. The batteries shall be such that maintenance shall be required at not less than twelve month intervals.

30.10.3 Battery Duties

The rating of each battery shall be sufficient to meet the requirements of the most arduous duty cycle at any one of the substations including:

- The continuous standing load; and
- On the assumption the battery is charged to 80 per cent of its rated capacity and the charger supply is then lost, the battery shall then be able to supply the standing load for twenty-four hours and then have sufficient capacity to carry out the closure and tripping of a 750 V circuit breaker twelve times in quick succession.

30.10.4 Battery Accommodation

Each battery together with its associated charger and dc distribution load shall be accommodated in a single, self-contained, ventilated, sheet steel cubicle of rigid construction.

The cells shall be so mounted that ready access is provided to the tops of all cells for maintenance purposes. The battery enclosure internal metalwork shall be treated with electrolyte-resisting paint.

30.10.5 Battery Chargers

Each battery charger shall be of the automatic constant voltage type and shall be suitable for supplying the constant load and at the same time maintaining the battery in a fully charged condition while floating across the load and charger.

Arrangements shall be made such that, in the event of the battery becoming discharged, the rate at which recharging commences is as high as possible consistent with maintaining the automatic charging constant voltage feature and with the connections remaining undisturbed, as for normal service.

Each charger shall also incorporate a boost charge feature, which shall, after having been started, provide an automatically controlled high charge rate sufficient to restore a fully discharged battery to the fully charged state within twelve hours without excessive gassing or any form of damage to the

battery. The boost charge shall be initiated manually but reset to float automatically, and shall not cause damage to any connected equipment. Each charger shall be capable of automatically and continuously supply the constant load with the battery disconnected. Under such conditions, the charger shall still maintain the nominal system voltage without any damage to itself, and the ripple of dc output shall not exceed ±15 per cent.

30.10.6 Alarm Devices

The following shall be provided:

- Undervoltage detection equipment to give local indication (amber lamp) and supervisory alarm when the system voltage falls to below 80 per cent nominal. A time delay shall be incorporated to prevent initiation during temporary voltage dips;
- Charge fail detection equipment to give local indication (amber lamp) and supervisory alarm if the voltage from the charger falls below the nominal floating charge voltage. Blocking diodes shall be provided to prevent the battery voltage being supplied to the equipment, so that only the charger voltage is effective in causing the alarm. The device shall not operate on switching surges or transient loss of ac supply; and
- Earth fault detection equipment to give local indication (amber lamp) and supervisory alarm of the occurrence of an earth fault, and to give local discrimination between positive and negative faults.

The above alarms shall be given separate SCADA alarm channels.

30.10.7 Instrumentation

The following shall be provided:

- Charger output/output voltmeter;
- Output dc load ammeter; and
- Centre zero battery ammeter.

30.10.8 Battery Distribution Board

The following shall be provided:

- Provision for isolating the battery (withdrawing the main fuses);

- Main and subsidiary fuses in both polarities; and
- Subsidiary fuses to dc switchboards (three in Depot traction substation, one in each of the other substations), ac switchgear transformer rectifier units, feeder and bypass isolators, two spare circuits.

30.11 Earthing, Bonding, Surge Protection & Ancillary Equipment

30.11.1 Earthing Systems

Each substation shall be equipped by Scottish Power with an earth system for their equipment which may be available for connection to the Edinburgh Tram Network substation earthing system and equipment, but only by agreement between the parties.

A earthing installation at each traction substation shall also be provided capable of specified performance alone, without recourse to connection to the Scottish Power earth system. Where Scottish Power allows interconnection, the Edinburgh Tram Network earth system shall connect to the Scottish Power earth terminal via a disconnectable link.

The Edinburgh Tram Network earthing systems shall be constructed employing copper conductors, including all necessary junctions, connectors and supports. The installation shall comply with relevant, current and valid European Standards.

The earth systems shall comprise a continuous main earth bar installation, located where possible in the cable trench, and around the inside walls of the substation, with branch connections to equipment and metalwork.

Each earthing conductor shall either be solid copper with a minimum cross-sectional area of 80 mm2 or stranded PVC sheathed copper with a minimum cross-sectional area of 70 mm^2.

All joints and bonds shall be made by proven methods to the current carrying ability of the earth conductor and full details shall be submitted for **tie**'s approval.

Attention is drawn to manufacturers' instructions on the earthing of traction dc switchgear via to low impedance earth fault protection equipment.

An Edinburgh Tram Network local earth rod system, of resistance to earth less than 2 ohm, shall be provided at each traction substation and connected to the substation earth system through a

disconnection link by means of stranded PVC sheathed copper cable with a minimum cross-sectional area of 70 mm^2 per cable. The earth rod system shall be in a minimum of two near equal sections (~4 Ohm) each connected back to the substation earth system as described. The resistance between any point of the earth system and a group of earth rods shall not exceed 0.1 ohm. This assumes earth interconnection with the Scottish Power system.

30.11.2 Traction Negative Busbar System

A negative busbar, insulated from earth and mounted within a sheet steel enclosure, shall be provided at each traction substation. The enclosure shall also incorporate an off-load isolator for the connection cables to the rectifier negative terminal. The negative busbar shall provide the connection point for the outgoing negative feeder cables to the tram track. The enclosure shall be able to accommodate four 1000 square millimetre section aluminium cables to the running rails. The enclosure shall be arranged to facilitate visual inspection of the connections inside. The enclosure shall be provided with robust insulated terminals adjacent to the negative busbar for terminating the stray current monitoring cables. Alternative stray current monitoring system can also be provided whereas no stray current monitoring cables may be necessary.

In order to minimise the flow of stray return currents in the earth and buried services, the negative pole of the traction supply, comprising rectifiers, negative busbars, feeder cables and tram track, shall not be deliberately earthed at any point.

The traction negative busbar of each traction substation shall be connected to the substation earth bar either via a minimum of one BB HVL and two Alstom 'Interval of discharge' (Soule 2 RAY's) in parallel, or via an equivalent circuit (e.g. Siemens Sitras® SCD), to control the touch voltage of the traction negative circuit and provide a fault return path. These shall be accommodated within the sheet steel negative busbar enclosure or in a separate cubicle.

The metalwork of the negative busbar enclosure shall be connected to the substation earth system.

30.11.3 Surge Diverters

Adequate protection against lightning and atmospheric overvoltages shall be afforded to the substation equipment. The characteristics of all surge diverters shall be correctly co-ordinate with those of the rectifier surge circuits, so as to limit overvoltages to acceptable levels and minimise resonance effects.

The equipment connected to the OLE shall be protected against surges by surge diverters.

Each feeder isolator shall be equipped with a non-linear resistor gapless surge diverter connected positive pole to earth at the cable terminations in the substation. The surge diverters shall be of the zinc oxide type, enclosed in the dc feeder circuit breaker cable box.

The surge diverters shall be so designed and constructed to combine a high discharge capacity and low residual voltage with mechanical robustness.

30.11.4 Substation Ancillary Equipment

The following ancillary equipment shall be provided in each substation:

- 2 No. suitable sized and rated fire extinguishers of approved type and size;
- 1 No. fully-stocked first aid cabinet of approved type;
- 2 No. `Electric Shock' wall-mounted framed safety instruction cards;
- 1 No. substation operation diagram printed on a plastic medium and framed;
- 6 No. double-sided rigid plastic notices 100 mm x 600 mm with cord loop attachment, "Danger-Live";
- 12 No. double-sided rigid plastic notices 100 mm x 60 mm with cord loop attachment, "Caution - do not interfere with this apparatus"; and
- 4 No. key safes, approximately 150 mm x 250 mm of approved type.

Sufficient padlocks for all switchgear shall be provided. The structured key security system shall be agreed with **tie**.

All substation door access keys shall be in accordance with the structured key security system set out in Section 22 of these Employer's Requirements.

30.12 Cables & Accessories

30.12.1 General

All cables shall comply with the current applicable specifications of the relevant European Standard and the supplementary requirements of these Employer's Requirements.

30.12.2 Types of Cables

Categories of cables shall be allocated series of reference numbers as follows:

- HV supply cables (1000 series)
- 750 V dc traction cables (positive) (2000 series)
- 750 V dc traction cables ((negative) (3000 series)
- Stray current monitoring cables (4000 series)
- LV supply cables (5000 series)
- Pilot cables (dc transfer trip) (6000 series)
- Telecoms multipair cables (7000 series)
- Fibre optic cables (8000 series)

30.12.3 11kV A.C. Cable

AC cables shall be provided for the interconnection of the Scottish Power HV switchgear, the a.c. circuit breaker, and the transformer rectifier units.

The cables shall be in compliance with Scottish Power standard and may be three phase or single phase with sheaths connected also in accordance with Scottish Power standards.

30.12.4 Traction Supply Cables

Single core 750 V DC copper cables shall be used for the connection of rectifier (positive) to dc switchgear, and rectifier (negative) to negative busbars.

Cables from rectifiers to DC switchgear positive and negative busbars shall be dimensioned taking into account the rating of the transformer/ rectifier unit, including their overload class.

Negative cables may have a reduced insulation level commensurate with the reduced voltage withstand required.

The cables shall be manufactured in accordance with appropriate European Standards.

Conductors shall be stranded tinned copper wires to BS EN 60228.

The insulation shall be butyl rubber (BR) or ethylene propylene rubber (EPR) to BS 6899 type GP2.

Alternatively XLPE may be considered by **tie** with adequate reference application and justification.

Cables shall be anchored at terminations by mechanical plastic glands, where gland plates must be traversed, and if necessary supported by non-hygroscopic resin-bonded laminated wood, hardwood or similar non-metallic approved clamps.

Conductor terminations shall be by means of indented or annular-compressed tinned copper lugs, with heat-shrinkable tube oversheath.

Cable conductors shall be jointed with indented or annular compressed ferrules with an approved compression tool, the joint made up by an approved jointing kit and sheathed by an approved heat-shrinkable tube.

Compression tools shall be certified as calibrated, and shall only be used when within the calibration period.

Cables to be utilised within the permanent works shall be drummed up and provided to site to ensure maximum cable lengths are installed throughout to minimise the necessity for through joints.

30.12.5 Low Voltage Supply and Multicore Control Cables

The cable construction shall comply with European standards.

Cables shall have copper conductor with XLPE insulation, PVC oversheath and, where not installed with mechanical protection, galvanized steel wire armour.

The conductors shall be plain annealed copper wire complying with BS EN 60447 circular or shaped conductors. All cores shall be identified by phase colours, or in case of control cables, by printed numbers.

All sheaths shall be free from defects and impervious to water.

LV supply cables shall be terminated in accordance with the manufacturer's recommendations and the cable cores shall be left long enough to be terminated without the addition of separate tails.

Cables to be utilised within the permanent works shall be drummed up and provided to site to ensure maximum cable lengths are installed throughout to minimise the necessity for through joints.

31 Overhead Line Equipment

31.1 Scope

This Section of the Employer's Requirements defines the overhead line equipment (OLE) requirements that are applicable to the Edinburgh Tram Network which the Infraco must comply with.

31.2 General Requirements

The information provided in this section supplements any information provided in the Tram Design Manual and other documentation provided by **tie**.

Unless otherwise stipulated, all requirements pertaining to overhead line equipment shall be compliant with BS EN 50119.

31.3 Equipment Overview

Appearance of the overhead line equipment is of paramount importance throughout the Edinburgh Tram Network. The appearance must be appropriate to the location, and visual intrusion shall be minimised.

The type of equipment provided (including, for example, auto-tensioned, fixed termination, catenary support; central mast with balanced bracket arms, side masts with cantilever arms, span wire construction etc.) over each section of the Edinburgh Tram Network shall be appropriate to the area and to the tramway operating speed requirement in that location. The use of building fixings shall be maximised.

31.4 Electrical Power Characteristics

The overhead line equipment shall be energised at a nominal 750V in accordance with BS EN 50163: 2005: Railway Applications - Supply Voltages of Traction Systems.

The overhead line equipment system shall comply with the following electrical and operational parameters:

- System voltage;
- Conductor of suitable cross sectional area;

- Traction buried reinforcing DC cables;
- The required operational speeds; and
- All in-service loading conditions.

31.5 Environmental Considerations

The overhead line equipment system shall fully comply with the environmental criteria as set out in these Employer's Requirements.

31.5.1 Ice Loading

The conventional ice loading of 10mm radial shall be used when assessing the ice-loading on overhead conductors.

31.5.2 Pollution

The creepage path and creepage distance of insulators shall accommodate the implications of atmospheric pollution in accordance with EN 50119:2001, pollution level "medium", and for areas close to the sea, "heavy"..

31.6 Material for Equipment

Standard materials shall be used with the exception of the route sections from Newhaven Road to Ocean Drive and Caroline Park to Granton Square Tramstops, where stainless steel or aluminium material (for tubes and fittings) shall be provided.

If 'parafil' or an equivalent material is to be considered, rigorous quality control fully documented and certified measures for the application, installation and long-term maintenance of the material shall be implemented. These measures are subject to specific approval by **tie**.

31.7 Pole and Cantilever Tube Deflection Criteria

The deflection of poles, cantilever tubes and other structural elements under normal and transient loading conditions shall be such as to not detract from the minimum safety functionality or appearance of the overhead line equipment system.

31.8 Mechanical and Electrical Clearances

Mechanical and electrical clearances shall, as a minimum, be in accordance with BS EN 50119 and the guidelines specified in ORR's publication "Guidance on Tramways", Railway Safety Publication 2 (**"RSP 2"**). In addition, a 'safe working zone', shall be incorporated.

31.9 Contact Wire Gradient and Geometry

Contact wire gradients adopted shall take account of the planned tram operating speed in the area and shall follow BS EN 50119 requirements. The contact wire gradient shall be such that at all times and under all environmental and operating conditions, contact with the pantograph is maintained.

The overhead line equipment horizontal geometry shall be arranged so that the contact wire is always in contact with the working width of the pantograph under all environmental and operational conditions.

31.9.1 Contact Wire Height

The governing requirement for the establishment of rules for contact wire heights shall be as clause 5.2.8 of BS EN 50119. For safety considerations, in areas where tram path is shared with the public traffic the contact wire height and the profiling of the wire shall take into account:

- ORR's RSP2 requirement for minimum wire heights where a support has failed;
- Minimise the risk of contact with wire from people and/or objects on open top double decker buses, over-height road vehicles, window cleaners carrying ladders and any third party work;
- Activities associated with the Edinburgh festival, Christmas fun-fair on Princes Street, and similar public events; and
- Provide the necessary clearance for designated high-load routes.

31.10 Structural Integrity

All proposed structures within the overhead line equipment system shall be designed to comply fully with the design parameters and codes of practice specified for the project.

31.11 Electromagnetic Compatibility

The overhead line equipment shall comply with Electromagnetic Compatibility Section of these Employer's Requirements.

31.12 Dynamic Performance

The dynamic performance of the overhead line equipment/pantograph interface shall be in accordance with the requirements of Clause 5.2.1 of BS EN 50119.

The performance of the overhead line equipment/pantograph interface shall be validated by a full dynamic simulation study undertaken during the design phase. The governing specification for all design activities is BS EN 50119.

The study method shall be validated in accordance with the requirements of BS EN 50317 and BS EN 50318.

31.13 Design Life

The design life of the overhead line equipment is set out in Design Life of these Employer's Requirements.

31.14 Auto-Tensioned Equipment Types

31.14.1 Form of Equipment

Low visual impact equipment is required throughout the Edinburgh Tram Network. Thus, anywhere along the route of the Edinburgh Tram Network, where line speed and/or pantograph interaction with the overhead line equipment demands, auto tensioned trolley wire equipment will generally be the appropriate solution.

31.14.2 Conductors and Tensioning Devices

The overhead line equipment shall utilise a single contact wire system, with additional parallel (buried) feeders or catenary system outside the city centre where the messenger wire replaces the parallel feeders..

The contact wire size shall be confirmed by electrical modelling studies and by pantograph/ overhead line equipment dynamic modelling.

Should mechanically tensioned balance weight system be proposed, the tensioning device shall comprise a counterweights and pulleys system of discrete and compact design. For example, the counterweight stack must be incorporated inside the pole structure. The system shall utilise a fail-safe mechanism with vandal proof features.

31.14.3 Tension Lengths

The maximum tension length between anchor locations shall be chosen so as to minimise the number of anchor points but without undue drag, localised hard spots and overloading of the equipment.

31.14.4 Span Length

The pole positioning, and hence span length along the track, shall be chosen:

- To maximise the structure spacing to achieve economy;
- To maintain the technical parameters referred to elsewhere in this document, e.g. geometry, clearance, dynamic performance, etc;
- For visual and aesthetic appearance issues, in accordance with the Tram Design Manual, and
- The achievement of all relevant consents and approvals.

31.14.5 Parallel Feeders

Aerial parallel feeders shall not be permitted. All parallel feeders shall be buried, located in suitable ducts running along the tracks and with cross feeding to the overhead line equipment conductors at suitable intervals. Outside Edinburgh city centre other options, like catenary system may also be offered by the Infraco for approval by **tie**.

31.15 Fixed Termination Equipment Types

31.15.1 Form of Equipment

Fixed termination trolley wire equipment shall be considered as an appropriate and cost effective solution for highly sensitive areas and/or where lower operational running speeds are required.

31.15.2 Reduced Conductor Tension System

At junctions and sharp corners, where the operational speeds are limited by the track geometry, a variant of the fixed termination unsupported wire shall be considered which utilises a reduced conductor tension system.

31.16 Depot Equipment Type

In the Depot area, a fixed termination single contact wire system (supported or unsupported) shall be provided which shall accommodate the wire height constraints.

31.16.1 Equipment Support and Registration

Cantilevers

For both auto-tensioned and fixed termination systems the cantilevers shall consist of a horizontal registration tube insulated and hinged at the face of the pole, and supported by a tie wire.

As an option, fully insulated tubes and steady arms (glass fibre plastic or equivalent) may be proposed and offered for review by **tie**.

Cross Span Wire Supports

In Edinburgh city centre areas, as an alternative to cantilever on pole equipment option, the simple cross span wire support assembly may be considered. These can be constructed between poles or attached to suitable buildings, along the route of the Edinburgh Tram Network. The choice of material and the method of construction of cross span wires shall be subjected to the approval of the planning authority.

All fittings, clamps and accessories shall be standard proprietary items, capable of being sourced freely from the market.

For minimising the visual impact of the equipment the use of non-corroding material (particularly stainless steel) shall be considered by the Infraco.

Jumpers and Feeders

All feeders and jumpers shall be electrically and mechanically compatible with the environmental and operational conditions. The visual impact due to connecting buried feeder cables to overhead conductors shall be considered when selecting appropriate feeder pole locations.

Insulation

All overhead line equipment support and registration assemblies shall be double insulated or equivalent. Failure of any single insulator shall not create an unsafe condition.

Section Insulators

Apart from the entrance to the Depot maintenance workshop, all section insulators shall be of the 'make before break' type.

31.17 Overhead Line Equipment Poles and Equipment Enhancement

Where poles are provided, the shape and colour shall be considered as part of the visual approach. The objective shall be to minimise their overall visual impact. It should be noted that the Tram Design Manual identifies a preference for circular poles.

Consideration shall be given to individual replacement of building fixings by poles in the future, should building alterations require their removal on a temporary or permanent basis.

The appearance around the base of support poles is of importance in certain areas. Consideration shall be given to minimise the impact to and ease of replacement of poles if damaged, e.g., by errant road vehicles.

The paint finish, if painting is required, shall be fully applied at the manufacturers works. However, following installation on site, the paint finish may have to be re-applied in some areas. The paint system to be used shall be offered for approval by **tie**.

Special attention shall be given to avoid damage to painted surfaces during delivery and installation. Specific approval shall be sought to make good any damage to paint work, following installation on site and **tie** reserves the right to reject equipment on the grounds of damaged paintwork alone.

31.17.1 Combined OLE / Lighting Poles

An integrated design of overhead line equipment poles and street lighting is required. This shall seek to optimise the spacing of support poles and minimise visual intrusion of the OLE and road lighting as a whole. An appropriate electrical feeding and earthing scheme shall be provided. This shall minimise the additional components required to be attached to support poles and shall take account of the maintenance approach to be adopted for the road lighting. The general requirements

for bonding and earthing of the system are contained in Earthing and Bonding of these Employer's Requirements.

Poles carrying overhead wiring along Princes Street shall not interrupt axial views down the streets connecting to Princes Street, shall be located between tram lines and shall be placed at regular intervals.

It should be noted that the Tram Design Manual prohibits fixings for wiring to buildings or structures on the north side of Princes Street.

31.17.2 Anchor Bolts, Foundations and Ties

Tie-back anchors shall be permitted in the off-street sections of the Edinburgh Tram Network with adequate anti-climbing protection, the design of which shall be subject to specific approval by **tie**.

Any anchor bolt connections and fasteners shall be fully secured and vandal proofed.

31.17.3 Foundations

For the ease of construction and where applicable the preferred type of foundations shall be of side bearing concrete, cast in-situ. These shall be either mechanically or hand dug, depending on the access and limited space availability for plant and equipment. This type of foundation shall be provided in Edinburgh city centre and populated areas, particularly where underground utilities are closely spaced or not easily detectable.

In certain areas within the Edinburgh Tram Network where the track alignment and construction of the track slab permits, the overhead line equipment foundations may be incorporated within the track slab design.

31.17.4 Fixing to Masonry and Concrete Structures

There are a significant number of buildings, particularly within the World Heritage Site categorised for their architectural or heritage values.

Fixings to buildings listed in schedule 10 of each of the Edinburgh Tram (Line One) Act 2006 and Edinburgh Tram (Line Two) Act 2006 require full listed building consent.

31.18 Safe Working On The System

The configuration of the overhead line equipment shall take into account the project requirements for a safe working zone of 2.0m (measured horizontally from the near rail and also vertically above

the ground). All electrical and mechanical clearances shall comply BS EN 50119 and with the recommendations and guidance provided by HMRI RSP2.

31.19 Switching and Sectioning Requirements

31.19.1 Sectioning

The overhead line shall be divided by means of OLE section insulators into separate electrical sections and subsections, the lengths of which are determined by the locations of the traction substations and operational requirements.

31.19.2 Isolation Facilities

At substation feeder points, off-load, positive polarity, SCADA controlled, motor operated isolator/earth switches (termed 'feeder isolators') shall be provided to isolate and earth each overhead line section from its respective feeder cable. Additionally, positive polarity, SCADA controlled, motor operated load brake isolators (termed 'bypass isolators') shall be provided to interconnect adjacent overhead line sections when the intervening substation is out of service. These shall be connected across the line side of the two feeder isolators, and will normally be open. At key overhead line sectioning points, positive polarity manually operated isolator/earth switches (termed "section isolators") shall be provided to isolate sub-sections from other sub divisions of the section and (in some cases) earth the isolated section.

At the section insulator and the insulated rail joint between Depot and main line, a mechanically coupled double pole section isolator is to be provided to bypass the section insulator and insulated rail joint. The isolator is intended to be used solely to power the Depot and stabling and fans from the main line in the event of failure of the depot traction power supply. It is not intended to be used to power the main line from the depot stabling traction power supply.

31.20 Isolator Enclosures

Feeder isolators and bypass isolators shall be provided.

Section isolators shall be provided. For on-street sections these 'section isolators' shall be totally enclosed in trackside cubicles, referred to as 'section pillars'.

Section pillars shall be of stainless steel construction to IP 65, free-standing with a base set on a concrete foundation. The pillars shall be factory-built assemblies, of rationalised widths to suit the range of isolator numbers required per unit.

The enclosure shall be bonded to the tram track via an insulated 'earth' cable from an internal stainless steel stud, and the arrangements of which shall comply with Earthing and Bonding of these Employer's Requirements.

The isolator/earth switch 'earth' bar shall be bonded to the section pillar and connected to the tram track via suitable cable(s) additional to the above.

The dimensions of the pillars shall be the minimum compatible with standard creepage and clearance distances because physical clearances on the tramway are restricted.

An A4 size document holder shall be provided on the inside of the enclosure door.

The doors shall be outward opening through 180 degrees, hinged internally and fitted with stays. The doors shall be fitted with heavy-duty stainless steel locks operated by dedicated keys, which shall be provided in accordance with the operation and maintenance requirements for the **tie** structured key security system described in Section 22 of these Employer's Requirements.

It shall be possible to view the status of the isolator and any locking without opening the doors.

31.20.1 Paint Finish

The paint finish, if painting is required, shall be fully applied at the manufacturers works. However, following installation on site, the paint finish may have to be re-applied in some areas. The paint system to be used shall be offered for approval by **tie**.

Special attention shall be given to avoid damage to painted surfaces during delivery and installation. Specific approval shall be sought from **tie** to make good any damage to paint work, following installation on site and **tie** reserves the right to reject equipment on the grounds of damaged paintwork alone.

31.20.2 Labelling

Front panel legends, fitted centrally to the door consisting of approved 'Danger 750 V' - labels (black letters on a yellow background), and 'pillar description - reference number labels' with black letters on a polished stainless background, shall be provided on each pillar door.

31.20.3 Isolators

Isolators within an enclosure shall be arranged in groups where possible. The physical position of each isolator within each group shall correspond with the actual direction of the overhead line connected to it, and a standard layout shall be adopted throughout the system.

The isolator blades shall be of copper, and the isolator assembly and its insulation shall be suitable for the required current carrying capacity within the environment of the enclosure.

Feeder and section isolators and operating mechanisms shall be suitable for off-load breaking and fault making in respect of both 'closing' and 'earthing' operations. The operating mechanism for manual operation shall have a firm distinct stop in the operation at each stage of operation. It shall not be possible to move from closed to earth positions, or the reverse, without the operator coming to a definite halt at the 'open' position before moving to the earth position by a separate operator movement.

Bypass isolators and their operating mechanisms shall be suitable for on-load breaking and fault making in respect of 'closing' operations.

The construction of the isolator shall be such that live parts are fully shrouded from the operator, by 8 mm of polycarbonate or equivalent arc resistant material, whilst allowing the position of the isolator contacts to be clearly visible with the enclosure door open.

The isolator mechanism shall be such that it can be locked by means of a padlock in the closed, open or earthed position.

Each isolator mechanism shall be clearly labelled with its unique identifier reference code in accordance with the electrical nomenclature scheme.

31.21 Power Feeder, Reinforcing and Bonding Cables

31.21.1 Feeder Cables

Single core 750 V dc cables shall be used for:

- The connection of substations (positive) to the OLE;
- OLE parallel reinforcing cables;
- Negative cables from substation negative busbars to the track; and
- Negative track parallel cables and rail and track cross bonding cables.

OLE parallel reinforcing cables shall be sized in accordance with the design of the overall traction system.

Feeder cables shall be sized to match the rating of the OLE / reinforcing cable combination of each section.

Feeder cables from the traction substation feeder isolators to the OLE parallel reinforcing cable junctions shall be buried cable ducts running track side. A maximum of two cables may be carried per 150 mm diameter duct.

Cables for different circuits shall not share a common duct. The choice of cable material shall also minimise the number of bi-metallic cable joints.

Positive and negative cables shall not share a common duct.

Reinforcing cables shall be installed in buried ducts along the track. They shall run from OLE feeder point to feeder point with connections to the OLE via single core suitably rated copper cables to 'inbound' and 'outbound' lines. These feeds shall be at traction substations and maximum intervals of 450 m. Cables shall be drummed and supplied at maximum lengths to avoid and/or minimize cable through joints. Where joints cannot be avoided they shall be located in suitable cable drawpits or in neat, small dimension pillars of minimum intrusion on the streetscape. Joints between drum lengths of reinforcing cable, where no OLE connection is involved, may be in pillars or drawpits at the discretion and agreement as to specific installation method statements by **tie**. The insulation system employed at connection points shall meet the requirements of EN 50124-1 2001 to level 0.9 kV and OV4.

At nominal mid points between the OLE feeds and a maximum 250m from an OLE feed point there shall be suitably rated copper cross connections between the 'inbound' and 'outbound' OLE contact wires via the shortest practicable visually acceptable cable route. There shall be no joints in these cables.

Positive reinforcing and feeder cables shall be terminated in compression cable lugs of proprietary appropriate size and material for the cable used. Proprietary crimping tools designated for the cable lug to be crimped shall be used. Such crimping tools shall be under quality assurance control and within their calibration period. The appropriate flat stainless washer shall be used between cable lug and fixing bolt head. At all bi-metallic connections a suitable bi-metal connector piece shall be employed such that dissimilar metals are not connected other than by molecular fusion.

Feeder cables to the OLE shall be copper cored flexible, where required, installed in the OLE support poles in a neat and unobtrusive manner. As installed the cables shall meet the requirements for double insulation such that two distinct insulation layers can be identified to the

satisfaction of HMRI (or the appropriate regime in force). There shall be no joints between connection to the contact wire and the connection to the reinforcing cable(s).

The bi-polar section isolator at the eastern Depot entrance shall have one side of the positive pole cabled to the main line OLE parallel reinforcing cable by duplicate suitably rated cables. The other side of the positive pole shall be cabled to the Depot east isolator panel by duplicate suitably rated cables. The negative pole shall have suitable cables to each side of the isolator, one to each rail either side of the insulated rail joints.

Negative cables may have a reduced insulation level commensurate with the reduced voltage withstand required.

31.21.2 Track to Traction Substation (TSS) Negative Return Cables

Each of the four running rails in the vicinity of the TSS shall have a cable brought back to the negative busbar of the TSS.

A nominal one metre from the position on the running rails of the connections mentioned in the above, the cess running rail of each track shall be connected to the six-foot rail of the other track by a single cable. These are also classed as 'return' cables.

31.21.3 Rail to Rail and Track to Track Traction Cross Bonds

The rails of each track shall be connected together with a single suitably rated cable at suitable intervals.

At every second connection in the above, the six-foot rails of each track shall be connected together with a single suitably rated cable.

31.21.4 Running Rail Continuity Cables

Where 'along track continuity bonding' is required for negative return traction current return, 'along track' bonding cables shall be installed. Places requiring such bonding are:- Insulated rail joints to be normally bonded out, fishplated rail joints, rail sliding expansion joints (breathers), points and crossings, or other designated places.

'Along track bonding' shall comprise duplicate copper or steel cables as a minimum for each running rail to be so bonded.

31.21.5 General Requirements for Cables

All cables shall be terminated in compression cable lugs of proprietary appropriate size and material for the cable used. Proprietary crimping tools designated for the cable lug to be crimped shall be used. Such crimping tools shall be under quality assurance control and within their calibration period. The appropriate flat stainless washer shall be used between cable lug and fixing bolt head.
All return cables shall be connected to the running rails via proprietary connector plates to connect with the running rails using duplicate 'Cembre' or equivalent connectors, by milled holes in the rail web with connector thimbles expanded into the holes on a spacing not less than that allowed by the track designer. Bolt and connection sizes shall be coordinated with the rating of the cable size to be connected. Simpler single 'Cembre' type connections (or similar approved) may be used for cross bonding cables and duplicated continuity cables mentioned in the above.

The cables shall be manufactured to European standards, appropriate to their application.

Cables shall be anchored at terminations by mechanical plastic glands, where gland plates must be traversed, and if necessary supported by non-hygroscopic resin-bonded laminated wood, hardwood or similar non-metallic approved clamps. Conductor terminations shall be by means of indented or annular-compressed lugs to suit the cable, with heat-shrinkable tube over-sheath.

Cable conductors shall be jointed with indented or annular compressed ferrules with an approved compression tool, the joint made up by an approved jointing kit and sheathed by an approved heat-shrinkable tube. Compression tools shall be certified as calibrated, and within the calibration period.

31.21.6 Cable Ducts

Power cables shall be laid in suitably sized UPVC/polyethylene cable ducts. Parallel reinforcing cables for the OLE will require a minimum of 200 mm diameter ducts.

Draw pits shall be sized to suit the particular cables installed within the cable run and shall facilitate the installation of the cables without damage to the cable. Particular attention shall be made to ensure the cable loop can be installed without damage to the cable when installing at mid point.

Suitable draw wires shall be installed in each of the ducts when they are laid, and the draw wires shall remain in the ducts after the installation of the cables to aid any future modification or repair work.

31.21.7 Installation of Cables

The arrangement of cables and all methods of laying and installation, including any special methods that may be necessary, shall be submitted by the Infraco for approval by **tie**.

Unless it has been agreed that the construction of cables is such as to permit laying at sub-zero temperatures, cable laying shall take place only when the ambient temperature is above 0°C and has been at this temperature for at least 24 hours, and approved special precautions have been taken to maintain the cable above this temperature to avoid risk of damage during handling. The recommendations of the cable manufacturer must also be taken into account.

All cables shall be installed with a bending radius not less than that recommended by the cable manufacturer.

Cable installation shall take account of the physical properties of the cables and the manufacturer's recommendations shall be clearly detailed on all cable pulling schedules.

All joints and terminations shall be made by proven methods to the current carrying ability of the cable and full details shall be provided to **tie**.

31.21.8 Surge Diverters

Surge diverters shall be positioned at the junction of each feed point and the OLE at traction substations on the OLE side of the isolator, and at over-bridges.

Surge diverters shall be of the gapless, metal oxide type with a rated discharge current of at least 10kA. The earthing terminal of the arrester will be connected to buried rods to provide an earthing resistance of less than 5 ohms. Surge arrestors' design, material and performance shall conform to the requirements of power supply specified standards for the Edinburgh Tram Network.

31.21.9 Bonding

The earthing and bonding requirements shall comply with **tie**'s Earthing and Bonding Policy (see Section 34 of these Employer's Requirements).

32 Stray Current

The ETN shall be designed in accordance with BS EN 50122-2.

In order to keep the stray currents caused by the traction return current as low as possible, permanent conductive connections between the return circuit and earth, including drainage diodes, are disallowed. The rail insulation against earth shall be at least five times better than recommended in BS EN 50122-2 before commencement of the Testing and Commissioning Phase.

Voltage limiting devices between return circuit and earth shall be dimensioned such, that they do not short-circuit the return circuit and earth during normal operation of the ETN, but ensure that accessible voltages do not exceed 60 V limit stated in RSP2 clause 183.

Where track substructures are steel-reinforced in longitudinal direction, a sufficient amount of reinforcement bars, i.e. at least four per track, shall be longitudinally interconnected by welding. At both sides of expansion gaps in the substructure, these bars shall have welded cross-connections and shall be interconnected in longitudinal direction by means of a conductor with suitable mechanical flexibility. This interconnected system shall not be connected to the return circuit at any point.

The Infraco must produce an Edinburgh Tram Network specific Stray Current Mitigation Strategy document that clearly defines its strategy for achieving as low as reasonably practicable protection requirements for the stray current effects and must submit such strategy to **tie** for their approval. Additionally, as part of that Stray Current Mitigation Strategy, the Infraco must produce a "Code of Practice for Stray Current Corrosion Control" and submit it to **tie** for their approval.

33 Low Voltage Architecture

The LV supplies shall be arranged by the Infraco with the DNO, and this shall also include all necessary metering equipment or agreements for provision of unmetered supplies. The LV supplies shall include all those required for illuminated road signs, other road furniture, street lighting, traffic signal controllers, points actuation, tram signals, communications equipment, and Tramstop equipment.

The LV supplies shall provide the necessary security of supply to achieve the overall ETN reliability requirements, for individual elements and as a whole.

The LV supplies shall allow cabinet sizes in areas of visual concern to be minimised.

Provision shall be made by the Infraco for the attachment of local generators at critical points in the ETNin the case of local supply outages (e.g. at Tramstops).

The system architecture provided by the Infraco shall take account of the known statistical history of local power outages such that the overall ETN system and subsystems availability is achieved.

In establishing the capacity and duration of any UPSs provided, the time that the Infraco maintenance staff may need to mobilise and install a temporary generator shall be considered by the Infraco and advised to **tie**. This time shall be demonstrated by the Infraco to **tie** during the commissioning period. **tie** shall give at least two weeks notice that the test may be required. **tie** may then require the test to be undertaken by the Infraco immediately with no further prior notice at a time and location to be determined by **tie**. This time shall be appropriately included in the overall availability analysis for the ETN.

LV power design by the Infraco shall take account of local system requirements e.g. for additional lighting and for specific loads, such as the passenger lift at Murrayfield Tramstop and drainage pumps where installed.

The LV architecture shall reflect the fact that isolated supplies will be required trackside and remote from Tramstops or substations at such as pointwork and signals at tramway junctions, and isolated TPDS cabinets.

Particular attention must be given by the Infraco to suitable redundancy for critical equipment such as drainage pumps and the communications systems.

LV supplies to substations shall be provided as part of the Infraco's arrangements with the DNO unless these supplies are provided from elsewhere.

Where UPSs are to be provided by the Infraco, careful consideration of appropriate loads to be supplied should be given by the Infraco. Automatic load-shedding schemes shall be considered where appropriate to support the required overall System availability.

Proposals for remote metering of substations shall be provided by the Infraco for the approval of **tie**.

34 Earthing and Bonding

The requirements for earthing and bonding are set out in the latest version of the document "System Earthing Policy", reference ULE90130-SW-REP-00071 and the Infraco shall comply with such requirements in respect of carrying out the Infraco Works.

35 Supervisory Control and Communications Systems

35.1 Scope

The scope of this section of the document is to define the Supervisory Control & Communications requirements that are applicable to the Edinburgh Tram Network (ETN).

It is split into three parts:

- Specific technical requirements of the various telecommunication subsystems;
- Components of those subsystems located at the Control Centre;
- Common considerations applying to these subsystems.

35.2 Specific Technical Requirements

This describes the various subsystems of the Supervisory Control and Communications System:

- The Tram Position and Detection Subsystem;
- The Passenger Information Display System;
- The Telephone Network;
- Operational Radio System;
- Passenger Help / Passenger Emergency Help Points;
- Closed Circuit Television (CCTV) System;
- Supervisory Control and Data Acquisition;
- Operational Data Network.

1.3 sets out considerations that apply to all Communications Subsystems that are included in 1.2.

The detailed interfaces between Infraco and Tramco shall be developed. Consequently the statements made in the ERs concerning the scope split between Infraco and Tramco may be subject to change.

35.3 Tram Position and Detection System

35.3.1 Overview

The Tram Position and Detection System shall provide the information needed to monitor the efficient and effective movement and to implement the overall regulation of trams running on the Edinburgh Tram Network. The Tram Position and Detection System shall include both tram borne and trackside equipment.

Each tram driver shall be responsible for safe tram operation using 'Line Of Sight' principles, with the Tram Position and Detection System identifying and setting the correct route ahead of the tram and providing tram signals.

The Tram Position and Detection System shall provide monitoring facilities to the Control Centre staff.

The Tram Position and Detection System shall collect the following data from each tram as is passes over the loops for transmission to the Control Centre in real time:

- Tram number;
- Tram run number;
- Tram destination;
- Driver staff identity number;
- Driver duty number; and
- Whether the Tram is in service or out of service.

The Tram Position and Detection System shall provide a number of functions which shall include:

- Tram identification;
- Tram position on network (outside of depot);

- Tram progress monitoring;
- Route setting;
- Processing of manual 'Tram ready to start' and automatic advance signal demand requests from trams;
- Provide demands to the Points Controllers to permit trams to safely traverse points junctions;
- Provide demands to the local Traffic Signal Controller(s) to permit trams to safely traverse tram/road crossings; and
- Tram signals to provide controlled entry to and exit from the depot berthing and maintenance facilities;
- Store data concerning the times each tram arrives at and departs from all of the Tramstops. This will be passed to the Central Data Recorder to allow the daily performance of the system to be calculated by the Performance Monitoring System.

The Tram Position and Detection System shall convert relevant Tram Position and Detection System data into a format to update the Real Time Passenger Information Display system.

On the approach of a tram to each Tramstop and at the termini, the Tram Position and Detection System shall provide updates to the Passenger Information Display system such that the Tramstop Passenger Information Displays are updated and display information as stated in 35.4.1.

On each day, the TPDS shall enter the details of journeys for the particular tram for each entire operating day into the tram on-board computer at the commencement of service. The tram driver shall input his own driver code and the tram diagram number for the day. Alternatively, the TPDS may transmit this data to the tram. Any change to this data e.g. as the result of an incident affecting the service shall be initiated by the driver.

The Tram Position and Detection System will include the ability to:

- Display to the Driver how early or late he/she is at each stop;
- Allow the Driver to issue 'Tram Ready-to-Start' commands at selected Tramstops;
- Allow the Driver, when his/her tram is on the approach to a diverging junction, to manually demand that the points move left or right by operating controls in the cab.

35.3.2 Technical Requirements

Key locations where Tram Position, Route Setting and Detection Equipment shall be provided shall include:

- At the approach to, and exit from, tramway/ road junctions;
- Entry to, and exit from, the Depot;
- At the approach to, and at, all Tramstops;
- At the approach to, and exit from, points and crossings.

Trackside Equipment at each of these locations shall be connected to the Edinburgh Tram Operational Data Network.

In the event that this Operational Data Network fails, the Trackside Tram Position and Detection System Equipment at each of these locations shall continue to operate autonomously until network connections are restored, at which point normal operations shall resume without Control Centre staff intervention.

The TPDS shall pass the times at which each tram arrives and leaves each Tramstop to the Performance Monitoring System (PMS), so that the PMS can calculate the operational performance of the Tram System according to specified algorithms.

Tramway signal heads shall be positioned at all signal controlled Track and Road Junctions and Pedestrian Crossings to allow optimum sighting for the tram driver. Local environmental conditions and the requirements of all interested parties, including that of HMRI (or the appropriate regime in place), shall be taken into consideration when choosing the positions of these signals.

Tramway signal heads shall display different proceed aspects for different routes if they are signalled separately. In such cases the Tram Position and Detection System shall pass the appropriate direction request to the road traffic signal controller as well as the point controller.
Tramway signal heads shall indicate the acceptance of the signal demand by the system to the tram drivers.

The lie of all facing points shall be detected and displayed by point indicators. These are in the scope of the Points Control System, and are described in the section of this document dealing with the Track. However, although Signals and Points Indicators shall be clearly distinguishable, they should also be in similar style, and it will require some co-ordination with the Points Controller supplier to ensure compatibility.

Tramway signal heads shall utilise Light Emitting Diodes (LED's) and not incandescent lamps.

At all signal controlled tram and road junctions there shall be an interface installed between the Edinburgh Tram Network Tram Position and Detection System and the local traffic Signal Controllers. All tram signals at signalled controlled tram and road junctions shall be driven directly by the Traffic Signal Controller, through demands from the Tram Position, Route Setting and Detection System. The Tram Position and Detection System/Urban Traffic Control System interface shall implement an agreed Tram Priority at each signal controlled junction.

Each Tram Position and Detection System/Urban Traffic Control System interface shall incorporate the facility for the initiation of a "tram proceed" signal in the event of either tram detection failure or local Urban Traffic Control System interface failure. This facility shall be available at all times for use by the Control Centre Staff. Trackside facilities for tram drivers to make manual requests of the UTC are not required. A foreseeable single point failure shall not cause a tram to be presented with a tram stop signal on the street that causes the tram to stop for more than 5 minutes. A FMEA analysis shall be produces within 8 months of contract close that satisfactorily demonstrates that the proposed solution meets this requirement.

The failure of the Tram Position and Detection System equipment at any signal-controlled road crossing shall initiate the immediate operation of the junction into a predetermined (adjustable) priority cycle sequence. All such failures shall be monitored, reported and logged to the Tram Control Centre via SCADA and passed to the PMS System.

The implementation of the detection system at Tramstops and other trackside locations will be permitted to use the Tram Position and Detection System hardware in lieu of a Supervisory Control and Data Acquisition Remote Termination Unit for the passage of alarms and indications, should this prove a more efficient use of hardware resources.

35.3.3 Tram-Borne Equipment

The Tram Position and Detection System shall include equipment to be installed on the trams. This equipment shall include:

- A Driver's Panel and keypad, to be installed in each cab;
- Communications equipment, to provide transmission of messages between the tram and the trackside equipment;
- Vehicle fault / maintenance indications / alarms transmission interface.

This equipment shall utilise the on-tram power supply.

All operations data messages etc. to or from the tram-borne Tram Position and Detection System shall be monitored and recorded in the equipment room for future reference or fault investigation.

35.4 Passenger Information Display System (PIDS)

35.4.1 Overview

Each Tramstop platform shall be equipped with a real time passenger information display system that shall be connected to the Control Centre by the Operational Data Network.

PIDs shall allow a limited selection of messages and free-form text to be displayed, at selected individual, selected groups or at all Tramstops on command from the Control Centre.

Each platform shall be equipped with at least one double-sided display; the display shall be in the form of a dynamic three line display.

Each display shall conform to the requirements of "DfT Inclusive Mobility - Guide to best practice in access to transport infrastructure". They shall each have the following characteristics:

- It shall be double sided;
- It shall be based on LED technology;
- Each side shall have three dynamic information lines, the third of which shall also provide a time display;

- Each line shall have at least 32 characters;
- Each character shall be at least 50 mm high;
- Characters shall be bright yellow on a black background;
- The PID shall adjust to ambient light levels making it legible in all weather and lighting conditions.

Each Passenger Information Display shall be sited so that it is visible to anyone standing within the Tramstop shelter, and from as much of the platform area as possible.

Passenger Information Displays shall also be provided at the following locations:

- Ingliston Park and Ride facility;
- Edinburgh Airport passenger terminal;
- Ocean Terminal Shopping Centre; and
- Haymarket Railway Station.

Alternative types of display may be used at these locations subject to agreement with **tie**.

At termini, the Passenger Information Displays shall display a departure time, which shall be the later of the scheduled departure time and the arrival time plus one minute. At other Tramstops, the Passenger Information Displays shall show variable messages including the destination and time to arrival (in minutes) of the next three tram service arrivals, or arrivals within the next 30 minutes, which ever is the less at the particular platform.

Tramstop Passenger Information Displays shall be able to display Lothian Buses 'BUSTRACKER' information as an overall capability. Real-Time data shall be provided over an internet connection by the client in an agreed format.

The following Tramstops shall have Passenger Information Displays that display the arrivals of both buses and trams at the Tramstop:

- Ocean Terminal
- Foot of the Walk
- Picardy Place
- Saint Andrew Square
- Princes Street
- Haymarket
- Edinburgh Park Station
- Airport
- Crewe Toll
- Granton

Passenger Information Displays on Tramstops, including those with bus/tram interchange facilities, shall be capable of prefacing the destination of the tram service being displayed by a two or three digit 'trip number' and of any required bus service by a three digit route number.

Each Passenger Information Display shall incorporate a digital time display (synchronised to the Edinburgh Tram Network time server derived from the Rugby Radio Clock or its successor or similar) as part of the display.

The colour and contrast of the lettering that is displayed by the Passenger Information Display shall fully take into account the requirements of the visually impaired. In particular DfT guidelines e.g. 'Inclusive Mobility - relating to provision for the visually impaired' and the requirements of Mobility and Access Committee for Scotland (MACS) shall be considered.

The Passenger Information Display System shall incorporate the necessary degree of redundancy and duplication to enable the systems availability targets to be achieved without losing the ability to handle faults and accept necessary upgrades.

The equipment shall be consistent with the design of the structural elements of the Tramstop.

The Passenger Information Displays shall have 3 line LEDs and configured as lines, scrolling functionality should be possible.

35.5 Telephone Network

35.5.1 Overview

The Edinburgh Tram Network shall be provided with a Telephone Network that shall provide two-way voice communications between all staff at fixed locations throughout the Edinburgh Tram Network. The main Operator interface with the Telephone Network shall be provided by an integrated workstation at each Control Centre staff position.

The Operator's interface shall be designed to carry out control functions in an ergonomically efficient manner.

The Telephone Network shall comprise of the following sub-systems:

- A central Private Automatic Branch Exchange (PABX):
- Public Switched Telephone Network;
- Depot extensions (via the Depot structured cabling scheme);
- Passenger Help / Emergency Help Points (via the Operational Data Network);
- Public Address System (via the Operational Data Network);
- Substation extensions (via the Operational Data Network); and
- A Voice Recorder;
- Control Centre Human Computer Interface (HCI) for the telephony services; and
- Call logging and maintenance facilities.

To facilitate management and maintenance of the PABX, it shall be provided with a maintainer's workstation, located in close proximity to the equipment.

The PABX shall provide:

- Digital call recording;
- Digital call logging;
- Maintenance and subscriber management; and
- All recording of the Telephone Network is to be digital to the current best medium.

All recording as described above should be carried out to the data recorders.

The Telephone Network shall include all PABX equipment, all necessary interfaces, configuration of the system elements, the connecting cables and management and diagnostic facilities.

The Telephone Network shall provide voice communications to external agencies including the emergency services and the urban traffic controllers.

The Telephone Network shall provide maintenance and administrative staff within the depot and substations telephone communications facilities appropriate to their needs.

35.5.2 Technical Requirements

The Telephone Network shall provide voice communication with all internal Edinburgh Tram Network organisation members and external parties but not with trams.

The Telephone Network and all associated components shall be of sufficient capacity to meet the current and future needs of the Edinburgh Tram Network.

All elements of the Telephone Network shall be designed to operate in an integrated manner.

The Telephone Network shall use the Operational Data Network for call routing to remote locations, e.g. Tramstops and traction power substations.

Suitable operator equipment shall be provided for the depot receptionist.

Suitable telephone handset equipment shall be provided for depot operational, administrative and maintenance staff.

Suitable telephone handset equipment shall be provided for traction power substations.

Access to the Public Switched Telephone Network shall be configurable at all telephones, including those within the depot and substations, in order to change call barring and security measures.

PABX equipment shall be located in the Equipment Room. A multi-pair tie cable shall be provided to interconnect the PABX with the depot structured cabling patch panel.

The Telephone Network shall be equipped with a Maintainers' Workstation, also situated in the Equipment Room, for network management and diagnostics.

The Maintainers' Workstation shall allow the:

- Display of system status and alarms;
- Download of call and system logs to removable media;
- Configuration of the Telephone Network;
- Management of subscribers;
- Provision for updating system software; and
- Reporting of real time status and alarms to external equipment.

35.6 Public Address System

35.6.1 Overview

Loudspeakers and Audio Loops located at each Tramstop platform shall form part of the Edinburgh Tram Network Public Address System. The Operational Data Network, details of which are contained in Section [35.6.1] shall connect the associated amplifiers/controllers to the Control Centre.

35.6.2 Technical Requirements

Each Tramstop shall constitute a zone.

An appropriate number of low output speakers shall be provided at each platform to prevent the possibility of announcement intrusion into adjoining properties, yet clearly audible without distortion on all areas of the platform. The speakers and their mountings shall be visually unobtrusive.

The Control Centre shall have the ability to make direct announcements to any Tramstop or groups of Tramstops, or turn off individual Tramstops or groups of Tramstops.

There shall be automatic switching between the volume setting for day / night time for each day of the week at the appropriate time of day.

Each Tramstop platform shall also be equipped with an audio loop to provide Public Address facilities for those who use hearing aids. The messages conveyed by these audio loops shall be identical to those issued by the standard Public Address equipment.

Park and Ride facilities shall be considered as a single Tramstop for Public Address purposes.

A 'library' of pre-recorded Public Address announcements shall be available to the Control Centre. Facilities shall be provided in the Control Centre for suitably trained operational staff to record additional announcements.

The approach and passing of 'Out of Service' trams shall be capable of initiating an automatic announcement at the stop advising passengers of the approach of the 'Out of Service' tram as it passes through the network.

35.7 Operational Radio System (ORS)

35.7.1 Overview

The ORS shall meet the mobile communications requirements for operation and maintenance requirements of the trams, and the tram network, and have sufficient capacity to meet the known future needs as defined in these Employer's Requirements.

An ORS shall be provided to enable safe and effective two-way communication enabling voice and data exchanges between the Control Centre staff and:

- Drivers on board an individual Tram, groups of Trams and/or all trams;
- Drivers of road and other support vehicles for the Edinburgh Tram Network; and
- Individually, or in groups, other mobile Edinburgh Tram Network operations and/or maintenance staff using hand portable equipment along the Edinburgh Tram Network and in the Depot.

Reliable voice communications shall be available throughout the length of the route, and to all areas used by operations or maintenance staff in the course of their duty so that messages of normal, priority or emergency status can be conveyed with high reliability.

The main operator interface with the ORS shall be provided by workstations installed in the Control Centre (for Control Centre staff), and tram mounted mobiles (for tram crews), road vehicle mounted mobiles and hand portable equipment for other mobile staff. Infraco shall supply 130 sets of radios with two spare batteries each and carrying cases. These sets will be supported by suitable re-charge racking and storage facilities.

The ORS shall comprise:

- A trunking controller;
- Sufficient base-stations to provide acceptable and reliable coverage to the satisfaction of **tie**;
- Integrated Control Centre operators' equipment;
- Mobile equipments for tram, road vehicle or hand-portable operation; and
- All communications links and configuration of the system.

35.7.2 General Requirements

The ORS shall use trunking technology capable of group and broadcast calls with normal or emergency priority.

Base-station equipment in close proximity to the Edinburgh Tram Network shall connect to the trunking controller via the Operational Data Network.

The radio system or two-way communication shall not be affected by the failure of the Control Centre systems or supplies.

The ORS shall operate within allocated frequencies administered by OfCom. Operating licences and consents for the ORS shall be obtained from OfCom and any other relevant authorities, e.g. Civil Aviation Authority (CAA). The Operator shall be required to hold all such licences and permits obtained.

Communication shall be reliable, continuous and free from interference as set out in the RAMsS section of this document.

The Operational Radio System shall have all voice communications digitally recorded by the central voice recorder. Recording of the Operational Radio System voice communications shall be integrated with recording of the Telephone Network.

All recording of the Operational Radio System is to be digital to the current best medium.

35.7.3 Short Codes

The Operational Radio System shall be able to send 'short codes' to Trams. It shall be possible to send such short codes to individual trams, groups of trams or to all trams and shall be configurable by the Operator's administrator.

The short codes shall be:

Table 88 - Radio Short Codes

Status Message	Status Meaning	Control to Tram	Tram to Control
CHANGE	Change Active Unit		✓
ACK MESS	Status message acknowledge		✓
ACK CALL	Group Voice Call Acknowledge		✓
###-DEP	Departure from departure points, where ### is the three letter code for each departure Tramstop.		✓
DELAY	Delay to Report		✓
FAULT	Defect to Report		✓
NEWCREW	Crew Change Complete		✓
HELP	Police Required		✓ (see notes below)
EXIT	Depot Exit Request		✓
ENTRY	Depot Entry Request		✓
RELIEF	Crew Relief Request		✓
XO-DONE	Crossover / Turnback complete		✓
STABLED	Tram Stabled		✓
CREWGONE	Driver Leaving Tram – will report back		✓

ALL-STOP	Stop Immediately	✓	
STOPNEXT	Wait Next Stop	✓	
FIREMEN	Beware Fire Engines	✓	
FIREGONE	Fire Engines Clear	✓	

Notes

The 'HELP' code shall also be able to be sent from the hand portable and from the road vehicle radios; and

The emergency call functionality shall also require the use of short codes.

There shall be at least 30 codes.

The Operational Radio System including all mobiles radios and hand-portables shall be capable of being reconfigured by the Operator to operate with amended or additional status messages.

35.7.4 Physical Considerations

The Radio System Trunking Controller shall be installed in the Equipment Room. It shall communicate with either the maintainer's workstation or as a separate dedicated workstation, located in close proximity to the equipment.

All base station antennae shall be fitted with adequate surge protection measures.

Provision shall be made for charging racks sufficient for the for hand-portable radio equipment. Charging racks are to be located in the Control Centre.

All masts required to support base station equipment shall be capable of withstanding all foreseeable wind loading. They shall be fitted with anti-climb protection.

35.7.5 Radio Maintainers' Workstation

The Operational Radio System shall be equipped with a Radio Maintainers' Workstation for network management and diagnostics.

The Maintainers' Workstation shall allow the:

- Display of system status and alarms;
- Download of system logs to removable media;
- Configuration of the Operational Radio System;
- Subscriber management;
- Provision for updating system software;
- Reporting of real time status and alarms to external equipment; and

The Operational Radio System maintainers' workstation shall be situated in the Equipment Room.

Fault and downtime information shall be transmitted to the PMS system.

35.7.6 Road Vehicle Mobile Radio Equipment

The Operator and Maintainers will operate road vehicles requiring Operational Radio System mobile radio equipment. As a minimum all road vehicles shall be equipped with:

- Mobile transceiver;
- Cable harness, feeder and antenna;
- Display, keypad, speaker & microphone; and
- Necessary power supplies.

All road vehicle mobile equipment shall be equipped with a keypad and alphanumeric display unit and be capable of displaying and storing short data messages.

Road vehicle mobiles shall translate status codes into meaningful textural messages.

All vehicle mobiles shall be equipped with an emergency call facility.

35.7.7 Hand-Held Mobile Radio Equipment

Certain Operational and Maintenance staff will be mobile and require hand portable mobile radio equipment. As a minimum the equipment shall include one hundred and thirty sets of:

- Hand-held radios with battery;
- Carrying cases for the hand-held radios;
- Two spare batteries for each radio;
- All necessary operational accessories, such as lapel microphones; and
- Sufficient charging racks suitable for 230VAC 50Hz operation to ensure availability of fully charged radios.

As a minimum the handportable radio shall use batteries with a life of 10 hours when used with a 90%rx / 10%tx duty Cycle.

Battery chargers shall fully charge a battery in less than 4 hours.

All hand portable radios shall be weatherproof and suitable for continuous use on or about the person in the outdoor environment.

All hand portable mobile equipment shall be equipped with a keypad and alphanumeric display unit and be capable of displaying and storing short data messages.

Hand portable mobiles shall translate status codes into meaningful textural messages.

All hand portable mobiles shall be equipped with an emergency call facility. The hand portables shall operate effectively and clearly within the trams and along the route of the Edinburgh Tram Network.

35.7.8 Tram borne Radio Equipment

Radio equipment shall be fitted to each driver's cab to enable two-way voice communications between drivers and controllers at the depot.

The Operational Radio Network equipment fitted to the tram shall include, as a minimum:

- Mobile transceiver;
- Keypad and display compatible with MAP27 interface protocol;
- Radio antenna, to be mounted on the tram roof.

The above equipment shall be free issued to the Tram Supplier for installation.
This radio equipment will utilise equipment supplied by the Tram Supplier, including:

- Gooseneck microphone;
- Emergency call button or kick switch and interface to the ORS;
- All necessary interconnections between Operational Radio Equipment in both cabs provided; and
- All necessary interconnections to other on-tram systems including power supply.

All voice communications involving the tram driver shall be via a hands-free method incorporating the touch-screen console and the gooseneck microphone so as to minimise distraction of the driver from his/her driving responsibilities. The integration of these functions shall be undertaken by Infraco.

When the tram is required to change direction of travel; e.g. after arrival at a terminus, the tram driver shall not be required to make any input to the Operational Radio System as he/she takes up occupation of the 'now leading' cab and the 'Change' status message shall be automatically generated.

Tram radios shall translate status codes into meaningful textual messages and display these to the driver.

All radio calls received during on-board Public Address announcements shall be clearly indicated to the driver at the time of receipt.

All tram-borne radios shall be equipped with an emergency call facility.

35.7.9 Tram-Borne Interfaces

The interfaces for tram-borne Operational Radio Network equipment with other tram-borne systems shall include:

- Passenger Emergency Help Points;
- Public Address System; where the tram driver instigates an on-board Public Address, this shall take precedence over any incoming radio calls received during the duration of public address. The tram driver shall be alerted to the presence of an incoming radio call;
- Radio voice communications and an attack alarm shall be provided between the tram drivers and the inspectors on board each tram.

35.8 Passenger Help / Passenger Emergency Help Points

35.8.1 Overview

Each Tramstop platform shall be equipped with at least one Passenger Help / Passenger Emergency Help Point that shall be connected to the Control Centre by the Operational Data Network.

Each Passenger Help / Passenger Emergency Help Point shall be sited so that it is visible by the platform Closed Circuit Television camera.

Provision shall be provided for the connection of future additional Passenger Help/Passenger Emergency Help Points, as a minimum, at Ingliston Park and Ride facility.

All Passenger Help / Passenger Emergency Help Points System Equipment shall comply with the latest disability advice from the Department for Transport.

35.8.2 Technical Requirements

Each Passenger Help / Passenger Emergency Help Point shall be provided with a two-way speech connection between the user on the Tramstop platform and the Control Centre Staff.

Each Passenger Help / Passenger Emergency Help Point shall be clearly visible and signed, and mounted in a manner that restricts its vulnerability to vandalism.

Each Passenger Help / Passenger Emergency Help Point shall be capable of being activated in two modes, normal and emergency, and there shall be a clearly marked and separate activation button for each function. Initiation of a call at the Passenger Help / Passenger Emergency Help Point shall be by pushing the appropriate call button.

Initiation of a call shall initiate the immediate recording of the subsequent voice communication that shall be time and date related.

Initiation of a call at the Passenger Emergency Help Point shall also cause the relevant Closed Circuit Television camera to focus on the Passenger Help / Passenger Emergency Help Point, overriding any sequential scanning for that camera. The recording rate of the CCTV camera will be increased during the PEHP conversation to the rate specified at section 35.14.13 of these Employer's Requirements.

35.9 Closed Circuit Television

35.9.1 Overview

The Edinburgh Tram Network shall be provided with a digital colour Closed Circuit Television (CCTV) System.

The tram CCTV system shall interface to the City of Edinburgh Council citywide CCTV system as 35.9.2.

Each Tramstop platform shall be equipped with at least one Closed Circuit Television camera. Additional Closed Circuit Television cameras shall be provided if adequate coverage of the access and egress routes at Tramstops and park and ride facilities cannot be achieved using the platform Closed Circuit Television cameras. Additional Closed Circuit Television cameras shall be provided to give full coverage of Park and Ride facilities.

Images from the CCTV cameras shall be transmitted to a Digital Video Recorder where they shall be recorded and time-stamped.

The Closed Circuit Television System shall comply with the requirements outlined in the Home Office guidelines for digital CCTV and the related UK Police Guidance notes and shall provide clear images of 'evidential quality' under all weather and lighting conditions to be made available at the Control Centre for operational purposes and for the recording for evidential purposes.

The Edinburgh Tram Network Depot complex will be equipped with a digital CCTV System as part of the Depot Security System. This CCTV System shall be interfaced to the Passenger CCTV System detailed in this Section. The requirements for the Depot CCTV System are described in 29.8 - Depot Site Layout.

(Please note: As of 11/12/2007, the calculation of the number of CCTV cameras and the bandwidth required on the ODN – See 35.11 for a definition – is based on two cameras per Tramstop, plus ten cameras at the depot and none at Sub-stations. This gives a requirement for 54 new cameras. The ODN also needs to allow for 7 existing, plus two new, cameras at the Ingliston Park & Ride.

35.9.2 Technical Requirements

Cameras shall be of the dome type, vandal resistant and mounted on Tramstop infrastructure or special CCTV poles. The mounting arrangements for each camera shall ensure stability and limit any vibration to acceptable limits so as not to interfere with image quality.

CCTV cameras located at the Park and Ride facilities shall be positioned to cover all of the car park paths, locations identified for Ticket Vending Machines, shelters, buildings, any other structures and both pedestrian and vehicle access points.

The CCTV System at Park and Ride facilities shall provide a clear image of vehicles including the ability for operators to read their registration plates.

The CCTV viewing system shall normally cycle through a pre-defined list of camera images and carry this out over a pre-programmed time period.

All CCTV cameras shall be provided with pan, tilt and zoom facilities both automatically within preset limits and under manual control, and be programmed to zoom in on the Passenger Help / Passenger Emergency Help Point when they are used and to a Ticket Vending Machine location when a TVM alarm is initiated. The Control Centre Staff shall be able to override automatic operation and control the cameras.

The CCTV cameras shall incorporate configurable 'no-dwell' zones to ensure the privacy of adjacent buildings and shall be suitably adjusted at the time of camera installation.

The CCTV System shall be provided with appropriate electrical / electronic interfaces to facilitate the presentation of images to an Edinburgh Tram Network display located within the Lothian & Borders Police Centre, the Lothian Buses Control Centre (Annandale Street) and one located at the Edinburgh in View CCTV Centre. This interface will also enable the transmission of images from the CEC's CCTV system to the ETN such that an appropriate subset of the CEC's CCTV images can be viewed in the Control Centre.

These interfaces shall be physically located in the Equipment Room. They shall include the provision and installation of the necessary connections and extensions to the Tram communication system to provide the necessary interfaces to third parties, and shall remain under the control of the Edinburgh Tram Network.

The selection of individual images by any of the above mentioned third parties for their further interrogation on their local monitors shall only be provided following telephone authority being obtained by them from the Control Centre Operator and shall not inhibit the continued use or availability of images to the Control Centre Operator.

Facilities shall be provided to enable any images generated by cameras that are part of the other interconnected CCTV systems to be selected by the Control Centre Operator and displayed within the Control Centre. Facilities shall be provided to "screen print" images for expediency.

35.10 Supervisory Control and Data Acquisition

35.10.1 Overview

A Supervisory Control and Data Acquisition (SCADA) System shall be provided to monitor and control remote equipment.

The SCADA System shall comprise of a central host, which is used to scan the outlying equipment that is connected to Remote Terminal Units (RTUs) or "Intelligent Relays" shall regularly scan the attached equipment for status or to set/reset the associated controls and, in turn, will be scanned periodically by the central system. Alternatively, electronic subsystems like e.g. traction substation control & protection systems can be directly connected to overall SCADA by means of e.g. a databus or network connection.

The primary interface to the SCADA System shall be a diagram displayed to the Control Centre operators. The SCADA System shall transmit system data received, in real-time, from the RTUs to the mimic display.

The SCADA System will comprise four main functional elements as follows:

- Traction Power SCADA;
- Tramstop SCADA;
- Trackside SCADA; and
- Ticket Vending Machine alarm indications shall be transmitted via the SCADA system. Further details are contained in Employer's Requirements Integrated Fare Collection Section.

The current status of the Traction Power System as presented by the SCADA System shall be available as a display to the Control Centre Staff at all times.

35.10.2 General Requirements

The SCADA itself shall not be a safety critical system, however, it shall provide the facility for the Control Centre staff to make requests of remote equipment to execute actions on behalf of the Control Centre staff, and provide indications for sub-systems.

These sub-systems are:

- Safety related - the traction power control system and remote terminal at each substation;
- Security related - the Passenger Help / Passenger Emergency Help Points at each Tramstop together with the associated Closed Circuit Television camera; and
- Security related - The transmission of Intruder Alarms.

The SCADA system shall pass data relating to equipment failure to the Performance Monitoring System (PMS), to allow the PMS to calculate operational performance relating to equipment availability.

The implementation of the SCADA System at Tramstops and other trackside locations may use the Tram Position and Detection System hardware in lieu of a SCADA RTU for the passage of alarms and indications, should this prove to be more efficient option.

Each SCADA System RTU shall contain a minimum of 30% spare capacity for the future in addition to those specified in the sections below, for the addition of further controls and indications across the Edinburgh Tram Network.

At Tramstops the SCADA Remote Termination Units shall be housed in the Tramstop equipment cabinet with the other Tramstop Supervision, Control and Communication Equipment.

Within Substations the SCADA Control and Monitoring Modules shall be wall or cabinet mounted. SCADA Remote Termination Units shall also be installed within the Points Controller cabinet at all electrically heated points. Further details are contained in 26.11.2 of these Employer's Requirements.

It shall be assumed that the signals to be monitored and controlled by the SCADA system will be concentrated into an interface rack. Connection shall be made from the SCADA Modules to the interface rack.

Individual Tramstop systems control and communications equipments shall be designed to integrate with the Tramstop furniture wherever possible.

35.10.3 Traction Power SCADA

The Edinburgh Tram Network Traction Power Supply System has substations placed along the Edinburgh Tram Network as detailed in Employer's Requirements Traction Power (Substations) Section.

Each Traction Power Control Unit should provide as a minimum:

- 128 Digital Inputs;
- 16 Digital Outputs;
- 16 Analogue Inputs.

It shall be possible to put each substation into a bypass mode remotely by using SCADA, in order to guard against equipment and power failures or to allow maintenance.

The SCADA System shall contain a series of 'macros' that shall enable the Control Centre staff to isolate and earth all electrical sections between adjacent sub-stations or between a sub-station and the end of the Edinburgh Tram Network route by making no more than two mouse clicks, or equivalent, from the SCADA Human Computer Interface power diagram. This operation will initiate a sequence of switching operations, the progress and completion of which shall be indicated to the Control Centre staff via the SCADA Human Computer Interface power diagram. Should any operation in this sequence 'time out', or fail, a visual and audible alarm shall be generated to the Control Centre staff and the sequence be suspended by the system.

Facilities shall be provided to enable the switching sequences to be created, edited and deleted by a person with the appropriate rights of SCADA access to the system shall be provided.

The following SCADA System controls and indications provided for each substation shall include, but not be limited to:

- Fire Alarms;
- Equipment Over Temperature Alarms;
- Intruder Alarms;

- Low Voltage Power Supply Fault indication;
- DC power fault indication (e.g. output circuit failure, etc.);
- Over Voltage Trip Alarms;
- Under Voltage Trip Alarms (if Under Voltage Trips are generated);
- Line Live;
- Line Earthed;
- Stray current monitoring, if provided;
- Power data, volts and amps in real time;
- 'UPS status for communications equipment;
- Battery and Battery Charger Status;
- DNO indications;
- Status of all isolators; and
- Status of all circuit breakers and control of them.

The Edinburgh Tram Overhead Line Equipment shall be arranged such that it is possible to isolate all or parts of the overhead traction supply. Feeder and Bypass Isolators are located at the line side in electrical cabinets or within the nearest substation. Further details are available in Employer's Requirements Overhead Line and Pantograph Section.

The SCADA System controls and indications to and from these Isolators shall include:

- Control command for opening and closing of individual Bypass Feeders at each substation;
- Indication of all individual Feeder Isolator position (open / closed / earthed / indeterminate); and
- Indication and Control of all individual Bypass Isolators.

Where a Control Command is instigated by an Operator, the display shall ask him / her to confirm the action before proceeding. In any case, each Control Command shall be handled at the protocol level by a Request – Check – Confirm sequence to ensure that the possibility of the wrong control being performed is minimised. SW and HW interlocking may be realised in the traction power station by means of the substation control and protection system in each substation, which may also be required for local operation.

Information presented to the Operator shall be accurate under all feasible circumstances and shall include the status of all sub-section isolators. Manual input of the status of sub-section isolators may be proposed by Infraco with the appropriate risk analysis.

35.10.4 Tramstop SCADA

Tramstop Equipment shall be monitored by the Control Centre Operating staff via the SCADA System.

Such equipments shall include, but not be limited to:

- Operation of Passenger Help / Passenger Emergency Help Point and status;
- 'No-Break' Power Supply failure alarms;
- Communications Systems Status & Alarms;
- CCTV fault status;
- Public Address System volume level control, fault status and controls;
- Passenger Information Display fault status;
- Passenger Help/Passenger Emergency Help Point activation;
- Passenger Help/Passenger Emergency Help Point fault status;
- Tramstop equipment intruder alarms (including Fare Collection System Alarms – see below);
- Tramstop electrical supply status (including Tramstop lighting supplies).

Each Tramstop RTU should provide as a minimum:

- 64 Digital Inputs;
- 16 Digital Outputs;
- 4 Analogue Inputs.

35.10.5 Trackside SCADA

The SCADA System shall monitor trackside equipment as follows:

- Point Controls and Indications;
- Failure of Points to move within a given time of the request;
- Point Heater Controls and Indications (The Operator shall be able to command the heating of points in the event of the thermostatic control failing);
- Tram Wash equipment; and
- Sand replenishment equipment - inclusive of sand levels etc;
- Status of lift(s);
- Pumps.

It is possible that the Trackside SCADA system will share an RTU with the Tramstop SCADA system, and the trackside SCADA requirements will vary at different points along the alignment. The I/O counts are included within the Tramstop I/O count. However, note that an extra RTU will be necessary in the Depot for the specialised equipment there, for which the allowance below should be made:

- 64 Digital Inputs;
- 4 Analogue Inputs.

35.10.6 Fare Collection SCADA

Ticket Vending Machine Alarms shall be brought to the attention of the Control Centre Operating staff via the SCADA System.

The TVMs provided by **tie** shall contain normally closed relay contacts (contacts open on occurrence of fault) for the following alarms to the SCADA system, and shall include:

- TVM Vandal Alarm;
- TVM coin jam;
- TVM printer malfunction;
- TVM card unit malfunction;
- TVM tickets low;
- TVM Cash Vault(s) ¾ full;
- TVM doors open.

TVMs shall be procured by TEL and issued to Infraco for installation.

The I/O for the TVMs is already included in the count in the Tramstop SCADA.

35.11 Operational Data Network

35.11.1 Overview

An Operational Data Network (ODN) shall be provided to ensure two-way voice and data transmission to fixed locations along the entire Edinburgh Tram Network, with high reliability, availability and low latency.

The ODN shall provide the communications 'backbone' between Tramstops, substations, other remote equipment and the Depot, and shall convey data for a variety of applications including:

- Tram Positioning, Routing and Detection System;
- Passenger Information Displays;
- Telephone Network;
- Public Address;
- Operational Radio Network (optional);
- Passenger Help / Passenger Emergency Help Points;
- Closed Circuit Television;
- Point Control and Indication;
- Point Heating Control and Indication;
- Supervisory Control And Data Acquisition; and
- Ticket Vending Machines (separation of data shall be provided, one secure encoded stream for revenue, ticketing and fare collection data and the other for Ticket Vending Machine alarms, administration and management).

The ODN shall use a fibre optic transmission system. A multi-core fibre shall connect all ODN nodes.

The ODN shall include all master and outstation node equipment, interface cards, configuration of the system elements, the connecting cables and management and diagnostic facilities. Fibre optic repeaters between nodes shall not be employed.

The ODN Control Centre Node shall be equipped with sufficient communications capacity to allow the interconnection of all traction power substation nodes, Tramstop nodes point control nodes and Depot equipment.

Where appropriate, Depot subsystems shall be connected to the ODN via the secure Local Area Network.

The ODN shall support the emergency relocation of Control Centre staff to alternative location(s) served by the ODN following a Control Centre evacuation, where they will be able to continue operation of the Edinburgh Tram Network albeit in a degraded mode.

The ODN shall not be a safety critical system. However it shall convey safety or security related messages to and from the following sub-systems:

- Safety related - Traction Power Supervisory Control And Data Acquisition; and
- Security related - Passenger Help / Passenger Emergency Help Points and the associated Closed Circuit Television images;
- Security related - The transmission of Intruder Alarms.

The ODN shall provide a bandwidth sufficient for the satisfactory transfer of all data, telephone and other signals required for controlling, monitoring and communicating with equipment distributed throughout the Edinburgh Tram Network.

In addition, the associated ODN communications paths and power supplies shall themselves incorporate similar levels of redundancy / diversity.

The ODN shall be configured such that in the event of single failure there shall be no loss of data and no requirement for any immediate actions on the part of the Control Centre staff. It shall be configured so as to provide automatic re-routing in the event of failures such that any loss of facility is confined to that given locality and does not affect the operation of the transmission system and facilities at any other location.

The ODN shall incorporate the necessary degree of redundancy and duplication to enable the commitment to be achieved without losing the ability to handle faults and accept necessary upgrades.

Where there are connections or any exchange of data between subsystems, each system shall be such that any failure in another system shall not cause a failure of the system, (except in the functionality between the two systems concerned).

There shall be commonality of design between all types of ODN nodes.

The transmission latency of the ODN shall be such that it does not contribute any appreciable delay to any voice or data applications.

The ODN shall provide an expansion capability of 200% to allow for system growth or to enable further interfaces to be added or an increase in the bandwidth requirements of existing applications or known future enhancements of the Edinburgh Tram Network.

35.11.2 Location of Nodes

Remote ODN Nodes shall be located so that together they serve all locations along the alignment which require communications with the Control Centre, including Tramstops, substations, and points control and points heating cabinets. ODN nodes shall be provided at all Tramstops. Nodes shall also be provided at other locations if it not within the immediate vicinity of a Tramstop node.

Tramstop Nodes

Each Tramstop Node shall be equipped with communications interfaces to allow the interconnection of the following two-way voice or data services throughout the Edinburgh Tram Network:

- Digital Closed Circuit Television cameras and associated controls;
- Passenger Help / Passenger Emergency Help Points;
- Public Address;
- Ticket Vending Machines;
- Passenger Information Displays;
- Supervisory Control And Data Acquisition Remote Telemetry Units;
- Tram Position and Detection System Equipment; and
- Edinburgh Tram Network timeserver.

Where appropriate, a Tramstop Node shall be equipped with additional communications interfaces to allow the interconnection of the following two-way voice or data services throughout the Edinburgh Tram Network:

- Radio base station equipment or
- Other Control Centres e.g. Police. Fire, Ambulance and other Emergency Services, Traffic Control Centre.

Traction Power Substation Node

If required separately, a Substation Node shall be equipped with communications interfaces to allow the interconnection of the following two-way voice and data services throughout the Edinburgh Tram Network:

- Supervisory Control And Data Acquisition Remote Telemetry Units;
- Private Automatic Branch Exchanges extensions; and
- Edinburgh Tram Network timeserver.

Where appropriate, an ODN Substation Node shall be equipped with additional communications interfaces to allow the interconnection of the following two-way voice or data services throughout the Edinburgh Tram Network

- Digital Closed Circuit TV cameras and associated controls;
- Tram Position and Detection System equipment;
- Radio base station equipment or
- Other Control Centres e.g. Police.

Points Control Node

If required separately, a Points Cabinet Node shall be equipped with communications interfaces to allow the interconnection of the following two-way voice or data services throughout the Edinburgh Tram Network:

- Supervisory Control And Data Acquisition Remote Telemetry Units; and

- Tram Position and Detection System equipment.

Where appropriate, a Points Cabinet Node shall be equipped with additional communications interfaces to allow the interconnection of the following two-way voice or data services throughout the Edinburgh Tram Network:

- Radio base station equipment or
- Other Control Centres e.g. Police.

35.11.3 General Requirements

For all ODN nodes, the multi-core fibre shall be terminated at a fibre patch panel situated adjacent to the node.

Tramstop node equipment shall be mounted in the Tramstop Equipment Cabinet. Traction Power Substation node equipment shall be either rack or wall mounted dependent upon its location. Control Centre Node equipment shall be fitted within an equipment rack located in the Equipment Room.

The ODN shall be equipped with a Maintainers' Workstation (which may be shared with other subsystems) running a Network Management System for network management and diagnostics.

The Maintainers' Workstation shall allow the:

- Display of system status and alarms;
- Download of system logs to removable media;
- Configuration of the Operational Data Network;
- Provision for updating system software; and
- Reporting of real time status and alarms to external equipment.

The ODN maintainers' workstation shall be situated in the Equipment Room at the Control Centre.

35.12 Considerations applying to all Communications Subsystems

This sub-section details those considerations which apply to all the subsystems these are:

- Electrical Connections;
- Cabinets;
- Alarming of Faults.

35.12.1 Electrical Connections

All powered equipment described above, with the exception of the Passenger Information Display System and Ticket Vending Machine, shall be provided with a 'No-Break' power supply, via a UPS system, located in the nearest Tramstop Cabinet or Substation, as appropriate. LV Supplies will be in accordance with 33 these Employer's Requirements.

All electrical connections shall be made in such a way that the public shall not have access to any cabling. All cabling and wiring must comply with the Cabling and Ducting section of these Employer's Requirements.

The cable routes shall avoid close contact with, or interference from, high voltage electrical supplies and for this reason a 3.0 metre separation shall be achieved in any plane between any communication cable routes and high voltage electrical supplies.

Wherever practicable, communication between two or more items of trackside equipment and from trackside equipment to the Control Centre shall be by such means that permits minimal trackside cabling and an acceptable level of system integrity.

All powered equipment described in this section shall be provided with a connection to an earth. The earthing and bonding requirements are described in **tie**'s Earthing and Bonding Policy Document.

35.12.2 Cabinets

All Tramstop control equipment, forming part of the subsystems, as described above, shall be mounted in cabinets located on or adjacent to the Tramstop platforms. Within substations, cabinets may be wall or floor-mounted as appropriate. The requirements on cabinets in general are detailed in 19 of these Employer's Requirements.

35.12.3 Alarming of Faults

It is essential that malfunctioning of equipment is brought to the attention of the operators, in a unified manner, as quickly as possible. This shall be achieved through the medium of the SCADA System.

Where possible, this may be achieved through network monitoring of the subsystems, and a connection between the network monitoring system and the SCADA system. Where this is not possible, it shall be achieved through a contact connected into an RTU connected in turn to the appropriate SCADA system.

35.13 Control Centre

This describes the components of the various subsystems described above are located in the Control centre. It divides those systems into:

- Those components within the Control Centre;
- Those components within the Equipment Room.

35.13.1 Control Centre - Overview

The Control Centre shall be the focal point for the control and operation of the Edinburgh Tram Network. Its purpose shall be to provide a working place for the operational employees to manage and coordinate day-to-day activities associated with system operations. The Control Centre shall be located on the first floor of the Depot building.

The Control Centre comprises of a number of workstations, at which Control Centre staff sit and use equipment to remotely control or retrieve data from the system. The operator interface shall be designed to carry out control functions in an ergonomically efficient manner.

These workstations are:

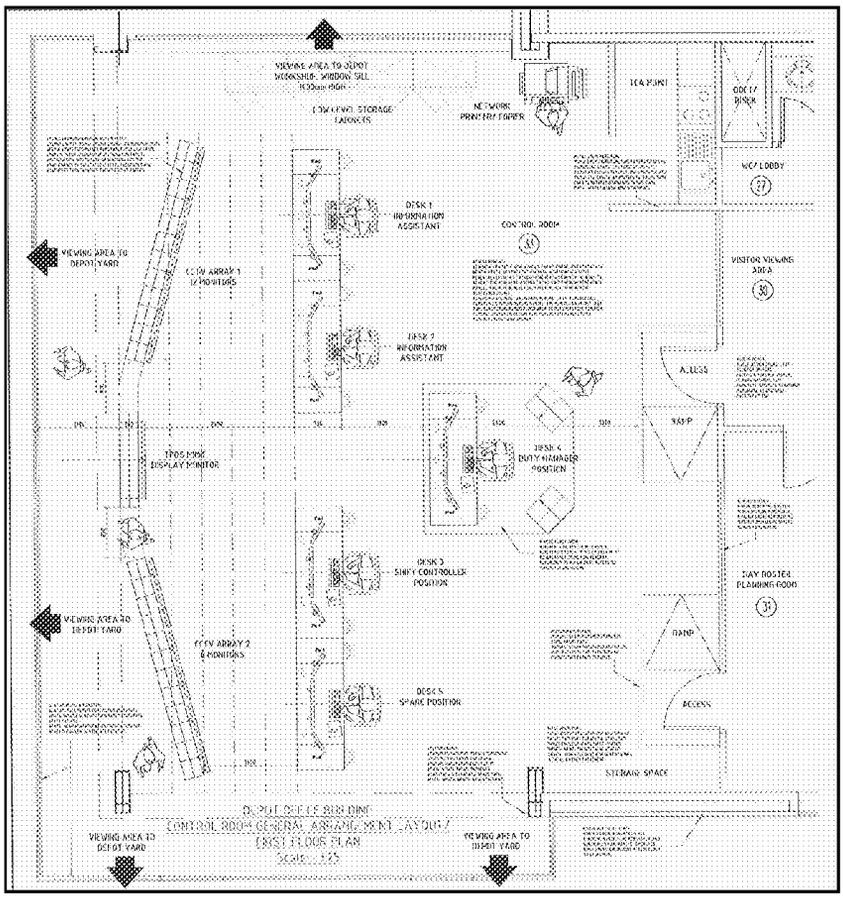
- The Duty Manager;
- The Shift Controller;
- The Information and Security Supervisor;

- There are also two workstations that have been identified for future expansion of the system.

A Monitor Matrix shall be provided, to be positioned either on the front wall or in close vicinity to the Control Centre desks. The matrix shall be of sufficient size to be viewed by all Control Centre staff.

A typical Control Centre Layout is shown in the diagram below. This shows the Control Centre with the addition of the two workstations that have been identified for future expansion.

Figure 12 - Typical Control Centre Layout



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35.13.2 Workstation Capabilities

Each Control Centre Workstation shall have the capability to provide indication and control of all subsystems and services: however, it will normally be restricted by logon status to the duties normally associated with the position. The various control and monitoring capabilities are described by subsystem:

- Tram Position and Detection Subsystem;
- SCADA System;
- Operational Radio System;
- Passenger Information Displays;
- Public Address;
- Closed Circuit Television;
- Passenger Help / Passenger Emergency Help Point System;
- Telephone System.

There shall be at least three screens attached to each workstation. The three screens shall be able to form a continuous display. The status of the dynamic data shall be regularly updated, at a frequency of not less than once every five seconds.

Through the top-level diagram it shall be possible to access additional nested menus or screens to gain additional information from the subsystems and facilities.

The presentation of the menus and 'human computer interface', to the Control Centre operators, shall be subject to the approval of **tie**.

Each workstation shall be equipped with at least one keyboard, and some or all of a mouse, joystick, or touch screen capability to navigate around the screens. The keyboard (s) shall be retractable when not in use.

Differential alarm tones shall be provided for each of:

- Operational Radio Network normal calls;
- Operational Radio Network emergency calls;
- Passenger Help Point activation;
- Passenger Emergency Help Point activation;
- Internal and external telephones; and
- Emergency Telephone lines

Tram Position and Detection Subsystem

The Workstation shall present a diagrammatic representation of the entire Edinburgh Tram Network both as an overview display and a series of overlapping sectional displays

Each display shall provide the following as a minimum:

- Last known position of each tram;
- Run / Route number of each tram;
- Number of each tram;
- Punctuality of each tram;
- Driver staff identity for each tram;
- Tram in service / out of service;
- Tram destination; and
- Status of each tramway signal;
- Lie of points;
- Input a tram signal demand via the UTC system;

The Control Centre Workstation(s) controls are only intended for use when the system is disrupted, in emergencies, engineering works, equipment failure conditions, or at the run out and run in of trams to/form the depot. Under normal operating conditions the Tram Position and Detection System will automatically control signals, points and routing of the trams and without the intervention of Control Centre staff. They shall be designed in such a way as to not compromise the safe running of the tram system at any time.

SCADA System

The Workstation shall present a diagrammatic representation of the entire Edinburgh Tram Network both as an overview display and a series of overlapping sectional displays, upon which shall be displayed the control, monitoring and alarm functions associated with the following:

- Electrical Power Substation Equipment for each Electrical Supply Point, the actual position and status of circuit breakers and motorised section isolators;
- Tramstop Equipment;
- Trackside Equipment; and
- Vending Machine Alarms. Details available in Employer's Requirements, Integrated Fare Collection.

The controls and indications shall be displayed in real time and synchronised with the Edinburgh Tram Network Time system.

SCADA Alarms

All alarm events shall generate an alarm message, which shall be electronically logged and displayed to the targeted Control Centre operator.

Each alarm message shall identify the system that has generated it.

Each alarm message shall be assigned a priority level.

High priority alarms shall generate an audible tone.

Alarms shall be presented in a hierarchical manner, with sufficient gradation to ease handover between Control Centre staff.

The Control Centre staff shall have the facility to accept alarms individually or as a 'page' of alarms.

The alarm list shall have the facility to display alarms in chronological order, with the latest alarm first.

Each alarm entry shall include the date and time of occurrence, location and plant identity.

The silencing of alarms shall not inhibit the annunciation of further alarms nor constitute an acknowledgement of the alarm.

Alarm Sequence

Onset of Alarm

This shall be indicated by a flashing alarm message and sounding an audible alarm at the Workstation. There is also a simultaneous logging in the fault log and printing of the alarm on a printer situated in the equipment room.

Acknowledgement of the Alarm by the Control Centre Staff

The alarm message shall be steady, the audible alarms shall revert to a low level, and the acknowledgement shall be logged in the fault log and printed on a printer situated in the equipment room.

Acknowledgement of Reset of the Alarm by the Control Centre Staff

The reset alarm message shall be steady, the low level audible alarms shall cease, and the acknowledgement shall be logged in the fault log and printed on the Supervisory Control and Data Acquisition System printer situated in the Equipment Room.

Operational Radio System

The Workstation shall permit (preferably via a touch screen interface):

- Initiation / receipt of radio calls to any/all tram(s) and other vehicles fitted with the Operational Radio System;
- Initiation / receipt of radio calls to any/all portable radio handsets;

- Provides audible and visual alarms for emergency radio calls received. Such alarms shall be displayed so as to clearly differentiate between normal events and emergency events; and

- Use of 'short radio codes'.

Primary means of initiating radio calls to individual trams from the Control Centre staff shall be achieved by mouse click(s) on the relevant tram represented on the Tram Position Detection System display.

The attention of Control Centre staff to a tram making a radio call to the Control Centre shall be achieved by appropriate graphics symbols on both the Tram Position Detection System and Operational Radio System Human Computer Interfaces accompanied by an audible signal.

All Operational Radio System communications shall be via the Control Centre: direct calling between outstation radios is not required and shall not be available.

When an outstation user wishes to call the Control Centre, they shall insert a call request message. The Control Centre staff will then call them back.

When Control Centre staff call an outstation, the outstation radio shall 'ring' and the outstation operator shall answer the call and speak first.

All radio calls shall also be capable of being made and received via the Control Centre Workstations.
When an emergency call is received at the Control Centre, a distinct audible and visual alarm shall appear on the Workstation. It shall not be possible for a Control Centre member of staff to cancel an emergency call without answering it.

Nomenclature for tram radio call signs shall be the same as the tram number.

When Control Centre staff send a single voice message to all trams and request the tram drivers to acknowledge receipt, the radio system shall present a list of all trams and their status to the Control Centre staff via the Operational Radio System Human Computer Interface.

The status shall be coloured to identify:

- Trams that have acknowledged the message, in green;

- Trams that do not have active radios, in amber;

- Trams that have not acknowledged the message in red.

This will enable the Control Centre staff to identify any trams that have not acknowledged the call. A similar arrangement shall apply to status codes sent to trams.

The Operational Radio System shall support the emergency relocation of Control Centre staff to alternative location(s) served by the Operational Data Network following a Control Centre evacuation, where they will be able to continue operation of the Edinburgh Tram Network albeit in a degraded mode.

The system shall digitally record all outgoing and incoming radio messages.

Passenger Information Displays

The Passenger Information Display System shall be accessible to the Control Centre staff via the Control Centre Workstations.

Normally, the Platform Information Display System shall be automatically updated from the Tram Position Detection System. However, the Control Centre staff shall have the ability to display a selection of pre-recorded messages and free form text on individual Platform Information Displays or groups of displays.

Details and times of the application of pre-recorded messages and free form text shall be logged by the Central Data Recording System.

Public Address

The Control Centre staff shall have the ability to initiate and transmit direct announcements to individual Public Address System Platforms, zones or groups of zones via the Control Centre telecommunications console.

The Control Centre staff shall be able to alter the volume setting of individual Public Address System zones or groups of zones.

Details of all Control Centre staff interventions and direct announcements shall be logged by the Central Data Recording System.

Closed Circuit Television

Colour pictures shall be transmitted to the Control Centre from the Tramstops, substations, park & ride facility and surrounding areas.

The system shall normally display a continuous cycle of Closed Circuit Television. The system shall interrupt this cycle to automatically display the image of the location where a Passenger Help Point / Passenger Emergency Help Point is activated: this shall cause the relevant camera image to be transferred to the Control Centre Staff's local Closed Circuit Television display. This should be able to be overridden by the Control Centre staff. After termination of a Passenger Help / Passenger Emergency Help Point call, the associated Close Circuit Television Camera shall revert to the normal scanning sequence.

The Operator shall be able to select those images that are required to be displayed in predetermined viewing patterns on the Monitor Matrix at the front on the Control Centre near that of the support workplace. Priority of selection shall be adjustable, to be governed by the current Edinburgh Tram Network operating procedures. This shall be adjustable and the system shall allow new viewing patterns to be created, amended and deleted as required by the Control Centre staff to suit individual operational circumstances.

Operation of a Ticket Vending Machine alarm shall similarly cause the local Closed Circuit Television image to be automatically displayed on a pre-selected monitor in the Control Centre.

The selection of the camera for control shall cause the image to be transferred to the Control Centre Staff's local Closed Circuit Television display.

The Control Centre Staff shall have a joystick that shall allow control of the pan, tilt, zoom and focus camera attributes.

The Closed Circuit Television Graphical User Interface shall allow the Control Centre operator to switch any camera image to be recorded at high rate to the central data recorder, to be viewed on any monitor or his own workstation.

The control of the video switching shall be completely transparent to the user.

Location, time and date stamped recording facilities shall be activated if the emergency button is activated on a Passenger Help / Passenger Emergency Help Point, the image from the relevant camera shall be automatically routed to a designated screen in the Control Centre.

Video and textual information shall be displayed on the local display when swapped from the monitor matrix display and shall maintain camera identity, status and location.

All characters overlaid on a Closed Circuit Television image shall provide clearly legible letters and characters on a dark background. Character generation shall be separate from the video image such that the location of a camera failure can be clearly identified.

The Control Centre shall provide facilities to capture a video image displayed on the Control Centre operator's display and print the image via a high quality video printer.

Passenger Help / Passenger Emergency Help Point System

The Passenger Help / Passenger Emergency Help Points System shall be accessible to the Control Centre staff via the Control Centre Workstations for alarm presentation, and via the Control Centre telecommunications console for communication with the person initiating the alarm or help request. Activation of a Passenger Help / Passenger Emergency Help Point shall give an immediate flashing indication and associated audible alarm on all Control Centre staff workstations and the Control Centre Overview Display. If this is an Emergency Help point activation, the image of the associated CCTV camera shall be automatically called to the Monitor Matrix.

The alarm message shall be steady and the audible alarm shall be silenced upon acknowledgement by the Control Centre staff.

Upon termination by the Control Centre staff of a Passenger Help / Passenger Emergency Help Point call, the reset alarm message shall be steady.

Telephone System

There shall be a touch screen interface to the Telephone, (and Public Address and Passenger Help Point / Passenger Emergency Help Point sub-systems if not provided for otherwise) that provides for:

- Initiation / receipt of telephone calls to any / all users on the exchange provided;
- Priority and high integrity initiation / receipt of telephone calls to / from emergency services;
- Audible and visual alarms for Passenger Help Point / Passenger Emergency Help Point calls received; and
- Making of public address announcements at individual, grouped or all Tramstops and / or park & ride sites.

All Control Centre staff positions shall be identical, with functionality determined by user 'log-in'.
All voice communications to and from the Control Centre shall be recorded and be capable of being played back.

Recorded voice communications shall be stored as detailed in 35.14.14.

Emergency telephone lines shall be provided to allow contact with and from the organisations detailed in 35.13.4, regardless of any failure of the main Private Automatic Branch Exchange.

Such facilities need not necessitate individual handsets but may consider a single handset (on the relevant operator workplaces) with priority displays and call buttons.

The Workstation shall incorporate:

- Information displays: (Supervision of extensions and exchange lines);
- Call processing and routing: Traffic and console status; and
- Ability to provide user input via keyboard entry.

The Workstation shall provide:

- Interactive voice greetings and messaging;
- Advanced call monitoring;
- Line engaged signal;
- Waiting time or queuing status;
- Called / calling parties identity;
- Pre-programmed numbers;
- Hands-free / wireless operation;
- Time display, synchronised by the Time Server;
- Conference calling;
- Audio control;
- Programmable functions;
- A local loudspeaker;

- An adjustable ring tone;
- Public Address System Interface; and
- Number ID

35.13.3 Control Centre Philosophy

The Control Centre shall provide Control Centre staff, and especially the shift controller and duty manager, with clear visibility of the entrance and exit tracks and associated infrastructure of the Depot complex with the main tramway and at least one end of Depot shed tracks and stabling apron tracks.

All Workstations shall be of similar design to maintain the aesthetics of the Control Centre.

Each Control Centre Staff position shall be able to control the local lighting, so that screen light reflections shall be reduced.

The Control Centre shall provide positions for the following operations personnel:

Operations Duty Manager

The Duty Manager will be responsible for overall control of the Edinburgh Tram Network and the safety of its operation.

The Operations Duty Manager is required to 'book' Tramcrew on / off duty and needs to see crew before they take their turn of duty in order to be convinced that they are in an appropriate condition to commence duty. The Control Centre shall provide for this without the need for Tramcrew to enter the Control Centre.

The Duty Manager's workstation will be identical to all other workstations.

Operations Shift Controller

The shift controller is responsible for the minute by minute operation of the Edinburgh Tram Network ensuring service perturbation risks are minimised and Tramcrew are aware of the current state of the Edinburgh Tram Network.

Operations Information & Security Supervisor

The information & security supervisor provides support to the duty manager and shift controller by monitoring the positions of trams, monitoring and editing of Passenger Information Displays, monitoring of Closed Circuit Television and Passenger Help / Passenger Emergency Help Points. This post will also take the primary role in ensuring passenger information and security.

Duty Manager

The duty manager's work place shall be located such that he can clearly see and interact with all the operations of the Control Centre.

The duty manager's workplace shall provide facilities to monitor and control the following subsystems:

- Tram Position and Detection;
- Supervisory Control and Data Acquisition;
- Operational Radio System;
- Closed Circuit Television;
- Telephones.

Shift Controller

The operator workplace provided for the shift controller shall be a complete replica of that provided for the duty manager.

In addition, the shift controller shall be given clear visibility of the mimic display and the bank of CCTV displays located at the front of the Control Centre.

Information & Security Supervisor

The information and security supervisor workplace shall be identical to the other workstations.

Monitor Matrix

A monitor matrix shall be mounted either on the front wall or in close vicinity to the Control Centre desks. The matrix shall be of sufficient size to be viewed by all Control Centre staff.

It shall display CCTV images. Textual information shall be displayed on the displays to provide camera identity, status and location. Characters shall provide clearly legible letters and characters on a dark background. Character generation shall be separate from the video image such that the location of a camera failure can be clearly identified, and shall not be generated by the camera itself.

The Monitor Matrix shall cycle through a user-definable set of images over a period of time.

Positioning of the images or sequencing in the matrix shall reflect the geographical layout of the Edinburgh Tram Network. The sequencing and display time of these images shall be user configurable.

The Information and Security Operator shall be able to select those images that are required to be displayed in specified viewing patterns on Monitor Matrix. Priority of selection shall be adjustable, to be governed by the current Edinburgh Tram Network operating procedures. This shall be adjustable and the system shall allow new viewing patters to be created, amended and deleted as required by the Control Centre staff to suit individual operational circumstances.

When activated by the Passenger Help / Passenger Emergency Help Points System interface, the Monitor Matrix shall display the associated CCTV image for that Passenger Help/Passenger Emergency Help Point.

35.13.4 Emergency Telephone Lines

The Control Centre shall have dedicated 'direct' lines between itself and the following locations as a minimum:

- Fire Brigade Control Centre;
- Lothian & Borders Police Control Centre;
- Lothian Buses Control Centre (Annandale Street);
- Edinburgh in View CCTV Centre;

- Ambulance Control Centre;
- Airport Control Centre;
- Network Rail Edinburgh Waverley Power Signal Box;
- Network Rail Electrical Control Centre at Cathcart; and
- City of Edinburgh Urban Traffic Control.

The primary telephone interface providing these facilities shall be through the single integrated audio telecommunications device at each desk, with a secondary hand-held unit for back up. Multi facilities will not be acceptable.

Any incoming calls from emergency services shall be brought to the attention of the Control Centre staff, via messages on the display, audible alarms and / or indicators on the handsets.

All voice communications and messages critical to safe operation shall be recorded on the central data recording system.

All Control Centre communications between control-room staff shall also be recorded and stored for at least thirty-one days.

35.13.5 Local Area Network

All of the Workstations situated within the Control Centre shall be connected to a dual redundant Local Area Network, which shall in turn be connected to the Servers and Systems in the Equipment Room and thence to the Operational Data Network.

The Local Area Network cabling standard shall be category 5/5e or higher.

Each Control Centre staff position shall have two Local Area Network connections per Local Area Network and these shall be accessible through the floor mounted recessed sockets.

The Local Area Network shall accommodate the connection of further terminals for the requirements of future expansion of the Edinburgh Tram Network.

35.13.6 Control Centre Time Display

The Control Centre shall have one or more wall-mounted digital display clocks, mounted so that all Control Centre operators have full view of the displayed time.

These clocks shall show the day, date, hours, minutes and seconds.

The clocks shall be synchronised with the Rugby time signal or its successor or similar.

35.13.7 Safety Requirements

The Control Centre will not house safety critical systems, however, it will provide controls and indications for sub-systems that can be considered to be safety or security related.

These sub-systems are:

- Safety related - the Traction Power Control System and Supervisory Control and Data Acquisition at each substation;
- Security related - the Passenger Help / Passenger Emergency Help Point communications to each Tramstop; together with the associated Closed Circuit Television equipment; and
- Safety related - the Tram Position, Route Setting and Detection System.

35.13.8 Electrical Requirements

The equipment located in the Control Centre shall run from 230/240VAC 50Hz electrical supplies.

Appropriate switched mains sockets shall be located on the walls and in the floor area close to each Control Desk locations for miscellaneous mains powered equipment.

There shall be no 110VAC or 415VAC 50 Hz available in this room. Power tools which require 110VAC 50Hz shall utilise a step-down / isolation transformer to achieve this.

Each mains socket shall be rated for a current of 13A.

The Control Centre equipment shall be supported by the provision of Uninterruptible Power Supply / diverse electrical supplies, further details are available in the Employer's Requirements Depot Section. An Uninterruptible Power Supply mains distribution panel shall be available in the Control Centre to provide a fault tolerant supply for all the equipment in the room. The connection of the

equipment to the Uninterruptible Power Supply distribution panel shall be through a system which has the same standard three-pin plug and sockets as normal 240v supplies, but is differentiated from the normal supply by means of appropriate labels and/of colour.

The design shall include full details of the future capacity that shall be provided for Edinburgh Tram Network expansion, and the method proposed for the work necessary to incorporate, install and commission future extensions.

All Control Centre cables and equipment shall be identified by permanent labelling in an approved format as detailed in the overall system-wide requirements.

The system wiring shall be sized to permit a minimum of 35% increase in power consumption for any additional equipment added as part of future Edinburgh Tram Network enhancements.

The main cable entry shall be via an aperture located in the floor, which provides entry or access for cables into the equipment room.

Particular care shall be taken to ensure that Electro-Magnetic Compatibility is not degraded when cables are closely located.

Cables shall be continuously screened through the aperture in the floor.

Appropriate strain relief or clamping shall be provided.

All cables and conduits shall be clearly marked with cable identifiers or suitable permanent marking which shall last for the expected system lifespan.

Local cabling between the Control Centre and the Equipment Room ducts shall be such that new cabling shall be capable of being installed without disruption to the operations including impact on the connections to the workstations.

35.13.9 Logging

In addition to voice image and message recording, there are two additional log facilities:

- Fault log; and
- Day log.

Fault Log

An electronic fault log shall be created which shall log status messages from Supervisory Control and Data Acquisition and communications systems.

The fault log records all system faults for further investigation.

Data storage shall be provided which shall record data on a 'first in-first out' basis.

Data shall be backed up on a removable storage medium and the system shall automatically do this or notify the Control Centre operator that backup is required before overwriting.

Data shall be backed up on a removable storage medium and the system shall automatically do this or notify the Control Centre operator that backup is required before overwriting.

Fault reports shall be automatically generated.

Day Log

An electronic log of day-to-day operations shall be implemented, from which a hard copy can be generated.

35.13.10 Central Data Recording

The Control Centre shall have a means of digitally recording/replaying the following information:

- All Operational Radio System voice communications;
- All Telephone Network calls to or from the Control Centre;
- All calls via the emergency telephone lines;
- Public Address announcements;
- Closed Circuit Television images, (at variable speed controlled by the viewer);
- Textual changes to Passenger Information Display; and
- The data shall be stored on non-volatile memory storage for the purposes of review or incident investigation.

The Control Centre staff shall be able to replay the data recorder from each desk position.

Information shall be recorded in a tamper-proof manner to evidential standards and be retained for a minimum period of one month.

35.13.11 Printers

The Control Centre shall house local printers for the printing of logs of maintenance or diagnostic data or colour prints of Closed Circuit Television frames.

35.13.12 Control Centre Furniture

The Control Centre shall be furnished with modern ergonomic furniture to assist the Control Centre staff and reduce fatigue.

Each desk position shall have personal storage of a minimum of three lockable drawers. Positioning of storage shall not inhibit the work-envelopes of the Control Centre Staff.

Additional storage equipment shall be located to the sides of the Control Centre.

The design of the Control Centre furniture shall include provision for the effective management of cabling, and equipment and maintenance power supply distribution.

Each of the Control Centre staff shall have the following functionality:

- Computer / workstation with dual flat screen displays, plus retractable keyboard;
- Integrated audio communications device comprising of handset and headset for (Public Address, Operational Radio, Telephones and Passenger Help / Passenger Emergency Help Points). The Telephone System (PABX) and the Operational Radio System shall be provided separately;
- Emergency telephones;
- Local light dimming control;
- Joystick control, (movement zoom and focus of Closed Circuit Television Cameras;
- Pointing device such as a mouse or tracker ball and keyboard; and
- Passenger Help / Passenger Emergency Help Point identification display.

The integrity of Controls and Indications shall be commensurate with the extent to which safety depends upon their correct operation, in both normal and degraded modes.

35.13.13 Spare Capacity / System Expansion

Following installation of the initial Edinburgh Tram Network Control Centre System:

- All conduits, troughing, trunking, and apertures shall be only 50% full of cables;
- All multi-pin connectors shall have a minimum of 10% capacity available for expansion; and
- All multi-way termination blocks shall provide a minimum of 20% capacity for expansion.

35.14 Equipment Room

35.14.1 Overview

The Equipment Room shall be situated either directly adjacent to, or directly below the Control Centre. The primary purpose of the Equipment Room is to provide a location to house the bulk of equipment, which supports the operational monitoring, management and operation of the Edinburgh Tram Network.

The equipment shall primarily be contained in freestanding cabinets located in the Equipment Room. Cabling from the equipment exits from the cabinets and shall be routed to sub-systems located outside the Depot or routed through an aperture into the Control Centre.

Within the Equipment Room will be maintainer desks, which shall be used for maintaining equipment associated with the running of the system.

It is proposed that the Equipment Room shall house the servers which host the following systems (subject to the required performance, reliability, safety and maintainability characteristics):

- Tram Position and Detection subsystem;
- Passenger Information Display subsystem;
- Telephone Network Private Automatic Branch Exchange;
- Public Address subsystem;
- Operation Radio Network Trunking Controller and base station (if required);

- Passenger Help / Passenger Emergency Help Point subsystem;
- Closed Circuit Television subsystem;
- Matrix controller;
- Supervisory Control and Data Acquisition subsystem;
- Operational Data Network Control Central Node;
- Performance Monitoring System;
- Central Data Recording and Storage;
- Radio Clock;
- Security and Access Controller;
- Fire alarm system;
- Voice recording and playback;
- Printers (if required).

35.14.2 Maintainer's Positions

Where appropriate, a Maintainer's Workstation shall be provided for a subsystem, along with any printer. The maintainer's position shall be supplied with any additional diagnostic equipment that cannot be integrated into the maintainer's workstation as part of the suite of software. Any additional special adapters or cables and connectors shall also be provided.

35.14.3 Security and Access Control

The security and access control system shall be housed in the Equipment Room.

The security and access control system shall also monitor the entry and exit to the Equipment Room.

Abnormal or illegal entry messages shall be sent to the Control Centre. These actions shall also be logged in the central data recorder.

35.14.4 Layout

The layout of the Equipment Room shall not be detrimental to maintenance and movement of equipment.

The positioning of cabinets and equipment shall take into consideration the cable and conduit entries and exits into the room.

The maintainer's workstations shall be situated with a full view of the equipment.

35.14.5 Equipment Housings and Mounting

Where possible, the equipment shall be placed in sealed, lockable cabinets, which provide a minimum of IP34 sealing.

Where indicators or diagnostic light emitting diodes/displays are used on equipment the cabinets shall have a glass door to assist in easy viewing from the maintainer's workstation.

Wherever possible, equipment shall be rack mounted or modular to aid replacement and maintenance.

To assist with installation all cabinets and equipment shall be fitted with suitable craneage or lifting points.

35.14.6 Diagnostic, Maintenance or Offline Mode Indications

If the equipment in the Equipment Room is placed into a diagnostic, maintenance or offline mode, this shall be communicated to the Control Centre staff and shall not compromise system safety or the performance of other systems.

35.14.7 Equipment Power Supplies

All powered equipment shall be connected to an Uninterruptible Power Supply in an adjacent room. This shall deliver 230V a.c. 50 Hz or 400 V a.c. 50 Hz.

Switched mains sockets shall be located on the walls and in the floor area close to the equipment locations. Further details are available in the Employer's Requirements - Depot. There shall be provision for 110V a.c. 50Hz in this room to enable the connection of power tools and the sockets shall be clearly marked accordingly.

Each 230V ac 50Hz mains socket shall be rated for a current of 13A.

A Supply distribution panel shall be mounted to the wall to enable disconnection of supplies in the event of an emergency.

The system wiring shall be sized to permit a minimum of 25% increase in power consumption to accommodate additional equipment required for Edinburgh Tram Network expansion.

The power loading and performance characteristics of equipment shall be stated at the extremes of temperature, normal running and transient conditions.

35.14.8 Storage

The Equipment Room shall provide storage for both personal and vocational items. This shall be in the form of lockable cupboards and units.

All main data storage shall be carried out on servers or equipment located in the equipment room where access is restricted. All system or program data must be shown to be retrievable in the instance of a system re-build.

Adequate shelving and filing cabinets etc shall be provided to locate equipment, handbooks, files and storage of electronic data.

Printers and miscellaneous equipment shall be sited in the locale of the maintainers in order to afford easy access.

35.14.9 Spare Capacity / System Expansion

All conduits, troughing, trunking, or apertures shall be only 50% full of cables. All multi-way termination blocks shall provide a minimum of 20% capacity for expansion. All multi-pin connectors shall have a minimum of 10% capacity available for expansion.

Each cabinet shall only be populated up to 75% to provide additional space for system enhancements.

Cabinets containing equipment which may be affected by the future Edinburgh Tram Network enhancements shall have enough spare capacity to accommodate those changes or demonstrate that the expansion or upgrade can be achieved with the minimum amount of changes or use of personnel.

All patch panels and terminals shall have the capacity for equipment used by the future Edinburgh Tram Network enhancements.

35.14.10 Master Clock and System Clocks

Within the Equipment Room, a Master Clock System shall be installed.

The Master Clock shall source a time signal from the standard Rugby clock signal (or its successor) or similar and broadcast the time signal to all systems that require accurate time synchronisation.

The Master Clock shall broadcast the time signal over the Local Area Network or directly via wired connections to the appropriate equipment.

In the event of Rugby time signal failure the system shall continue to generate time signals based on an accurate battery-backed clock. In the event of Master Clock failure, each of the systems that require the Rugby time signal shall continue operating using their own local clock signal. The failure of the Master Clock shall be logged accordingly and displayed to the Control Centre staff.

The time shall be sent to each of the systems to allow logging to resolution of 10ms or better.

A digital display clock shall be situated in a position, which can be easily seen by the maintainers at their workstation position. The clock shall source its time from the master clock. It shall show the day, date, hours, minutes and seconds.

35.14.11 Performance Monitoring System

The Performance Monitoring System shall be connected to the equipment room Local Area Network and be accessible by all designated users with appropriate user group login and password protection.

It shall receive data from the Tram Position and Detection Subsystems and the SCADA systems, which will allow it automatically to calculate those measures of performance of the Tram Network that can be calculated automatically. The relevant Performance Measures are all of those measures that form Performance Measurement System, as set out in Schedule 6 to the Infraco Agreement. This system shall produce appropriate daily and other periodical reports in both paper and software format. The reports shall to provide a suitable audit trail for the calculation of the PMS. The detailed specification for this system shall be subject to further development with **tie** and subject to **tie**'s approval.

The Performance Monitoring System shall also be accessible remotely through a Local Area Network firewall, via the Internet.

35.14.12 Monitor Matrix Display Driver

The Monitor Matrix Controller shall receive data from the Closed Circuit Television System cameras and display the images onto the Matrix of displays in the Control Centre.

It shall be connected to the dual redundant Local Area Network and / or Closed Circuit Television System.

It shall have the capability of being expanded to accommodate the expansion of the Edinburgh Tram Network closed circuit television system.

35.14.13 Central Data Recording

The Central Data Recorder shall be housed in a cabinet separate to all other equipment. The cabinet shall be sealed and locked and have suitable tamperproof fittings. The door shall be fitted with an alarm to indicate when it has been opened, which shall be logged, printed, and displayed to the Control Centre staff.

The data shall be stored in secure manner such that no tampering can be achieved. The maintainers shall have easy access to the system in order to backup/archive data. The system shall have the capability of supporting connections to a Local Area Network based digital recording system held in the Equipment Room.

The system shall provide playback facilities within both the Control Centre and one of the administration offices.

All recorded Control Centre communications shall be time stamped to the nearest second, updated from the Edinburgh Tram Network Time Server in the Equipment Room. Recordings shall be archived to transportable media.

The archiving process shall not interrupt the recording process. The viewing of recorded Closed Circuit Television images shall not interrupt the recording of further Closed Circuit Television images.

The quality of data stored shall be suitable for legal interpretation and proceedings.

The data shall be stored on a system, which shall have the capacity to store at least thirty-one days worth of system communications, Closed Circuit Television images and text information.

Each camera shall be recorded at a minimum rate of 16 frames per second (fps): however, the images shall be recorded at a higher frame rate of 25 fps when:

- An Emergency Help point has been activated;
- A TVM alarm is detected;
- A designated zone has been entered;
- The Control Centre staff manually command the Closed Circuit Television image to be recorded.

The data shall be recorded in a circular buffer where the oldest data is overwritten by the latest data ('first in-first out') and is subject to the storage capacity of 31 days referred to above.

The data shall be stored in secure manner such that no tampering can occur.

The images shall be overlaid by security coding of time/date and location.

Freeze frame facilities shall be provided.

In the above cases, the system will interrogate the Operator at the end of every three minutes to determine whether or not the high recording rate should be continued.

The central data recorder shall provide conversion facilities to adjust the optimisation of the images but not the pictorial content.

The storage device shall provide an audible warning that the storage capacity is within 5% of capacity and that the Control Centre staff are required to archive data to a non-volatile medium.

The status of the data recorder shall be conveyed to Control Centre staff.

Each DVR shall be connected to the Operational Data Network, to allow images to be transferred between locations to allow remote viewing.

35.14.14 Voice Recording

The Equipment Room shall house a Local Area Network based digital recording system that shall record all voice communications both into and out of the Control Centre.

The Central Voice Recorder shall be housed in a cabinet separate to all other equipment.

The cabinet shall be sealed and locked and have suitable tamperproof fittings.

The door shall be fitted with an alarm to indicate when it has been opened, which shall be logged, printed, and displayed to the Control Centre staff.

The voice recordings shall be stored in a secure manner such that no tampering can be achieved. The maintainers shall have easy access to the system in order to backup / archive data.

The system shall provide playback facilities within both the Control Centre and in one of the administration offices.

All recorded Control Centre communications shall be time stamped to the nearest second, updated from the Time Server in the Equipment Room.

Recordings shall be archived to removable media.

The archiving process shall not interrupt the recording process.

The quality of data stored shall be suitable for legal interpretation and proceedings.

The voice recordings shall be stored on a system, which shall have the capacity to store at least thirty-one days worth of voice communications.

The data shall be recorded in a circular buffer where the oldest data is overwritten by the latest data ('first in-first out').

The data shall be stored in secure manner such that no tampering can be achieved.

The storage device shall provide an audible warning that the storage capacity is within 5% of capacity and that the Control Centre staff are required to archive data to a non-volatile medium.

The status of the voice recorder shall be conveyed to Control Centre staff.

35.14.15 Equipment Room Maintainer Desks

Two workstations shall be provided for the maintainers, which comprise a local display, 'man-machine interface' and keyboard to enable the interrogation of the server or other related equipment for diagnostic or maintenance purposes.

The Workstations in the Equipment Room shall be of similar design to their equivalents in the Control Centre but their users shall require a greater level of more detailed access. Such access shall be governed by password and user group membership.

The Equipment Room workstations shall comprise:

- Display, mouse and keyboard for interaction with the Tram Position and Detection System and Passenger Information Display sub-system, the Operational Radio System and the UTC sub-system, the latter via the Tram Position, Route Setting and Detection System;
- Touch screen interface to the Telephone Network, Public Address system, and Passenger Help/Passenger Emergency Help Point systems;
- Touch screen interface to the Operational Radio System;
- Displays and console for the selection and monitoring of Closed Circuit Television images from remotely located cameras;
- Display, mouse and keyboard for interaction with the Supervisory Control and Data Acquisition System; and
- Human computer interfaces for the purpose of archiving and retrieving logged data.

Each maintainer's position shall have two-off Local Area Network connections per Local Area Network and these shall be accessible through recessed sockets.

Each maintainer's position shall have a Telephone Network handset.

35.14.16 Equipment Room Local Area Network Requirements

Each of the maintainer's workstation computers situated within the Equipment Room shall be connected to a Local Area Network.

The Local Area Network cabling standard shall be category 5/5e or higher.

Each Equipment Room maintainer's positions shall have two Local Area Network connections that shall be accessible through recessed sockets.

The Equipment Room Local Area Network shall accommodate the connection of further terminals for the requirements of future Edinburgh tram Network expansion.

35.14.17 Other Systems

A repeat of the 'System Overview' display that is located in the Control Centre staff shall be made available on the Operator's Local area network, updated at least every 5 seconds. This is to enable **tie** to use this image for purposes such as for onward transmission to the TEL /Lothian Bus information centres and in the depot mess room to assist staff with timing crew changes.

36 Integrated Fare Collection

36.1 Scope

The scope of this Section of these Employer's Requirements is to define the integrated fare collection requirements that are applicable to the Edinburgh Tram Network.

36.2 Procurement

Ticket Vending Machines (TVMs) and Ticket Validators for installation at Tramstops will be 'free issued' by **tie** to the Infraco at the Depot. The Infraco shall be required to provide the necessary foundations, ducting, power supply and communications linkage to the TVM and Ticket Validator locations at the Tramstops. The Infraco shall be responsible for the installation of agreed quantities of TVMs and Ticket Validators at the agreed locations.

36.3 General Technical Specification

The hand held TVM docking stations shall be 'free issued' by **tie** to the Infraco at the Depot and the Infraco shall provide appropriate power and comms interface connections, together with appropriate racking to store and charge.

36.4 Integrated Fare Collection

tie/TEL shall be responsible for the Edinburgh Tram integrated fare collection system which shall provide passengers with tickets and ticket validation on and/or off Trams for multi modal seamless bus and Tram journeys within the confines of the Lothian Bus operational area for ticket sales and throughout the SESTRAN area for validation.

Static Ticket Vending Machines will be provided at Tramstops, and hand held ticket vending machines that can also validate tickets will be carried by an Inspector on board each Tram. The fare collection system shall consist of a number of items of equipment each providing elements of the overall System functionality.

These shall include:

- Ticket Vending Machines providing ticket purchasing facilities – these are to be provided separately to the Infraco by **tie** and 'free issued' for installation by the Infraco;
- Tramstop ticket Validators – these are to be provided separately to the Infraco by **tie** and 'free issued' for installation by the Infraco;

- Docking stations for hand-held ticket issuing and smart-card validation machines and associated support apparatus (including docking stations) – these are to be provided separately to the Infraco by **tie** and 'free issued' to the Infraco. The Infraco shall provide power and communications interface connections to the Depot local area network, together with appropriate racking to store and charge the hand held ticket machines.

The elements of the IFC system shall use the system wide communications backbone that shall be provided by Infraco to provide the wide area connections for data transfer and equipment control.

The Infraco shall provide connections for the Ticket Vending Machines and Ticket Validators to be connected locally to the communications network at Tramstops.

The Infraco shall provide a connection for the ticketing central management system to be connected to the communications network and local area operational network at the depot / operational control centre.

The Infraco shall provide for the ticketing central management system to be connected to the outside world by means of a secure IP address.

36.5 Ticket Vending Machines and Validators

36.5.1 General

There shall be a minimum of two TVMs per Tramstop. Exact numbers of TVMs and Ticket Validators are to be agreed for each Tramstop.

The Infraco shall include in the design of the Tramstops suitable foundations for the TVMs and the Ticket Validators and provide 230 volt ac power and communications links to the units as appropriate.

36.5.2 Docking Stations for Hand-Held Ticket Machines

Docking stations and chargers shall be 'free issued' by **tie** to the Infraco. The Infraco shall provide power and communications interface connections to the depot local area network, together with appropriate racking to store and charge the hand held ticket machines. These will be connected to the Central Management System.

Table 89 - Hand Held Ticket Machine Quantities

Equipment	Quantity	Comments
Docking Stations	*35*	As determined in the design and implementation phases

36.5.3 Equipment Interfaces

The following equipment interfaces are required to be provided by the Infraco:

Table 90 - System Interfaces

Interface	Interface with Discipline	Interface Definition	Interface Management
Central Management System	System wide	Integrated Fare Collection	Individual sub systems
Ticket Vending Machine	Tramstop / Buildings	Integration Fare Collection	Buildings
Ticket Vending Machine	Supervisory, Control and Communications System	Integrated Fare Collection	Supervisory, Control and Communications System
Smart Card Validators	Tramstop / Buildings	Integration Fare Collection	Buildings
Smart Card Validators	Supervisory, Control and Communications System	Integrated Fare Collection	Supervisory, Control and Communications System
Hand Held Ticket Machines	Central Internal Financial Control system and SC&C	Integrated Fare Collection	Integrated Fare Collection

The interfaces identified above will be further developed by the Infraco to include details of programme requirements for interface resolution. The detailed interfaces and management thereof will be carried out according to the system integration process for the Edinburgh Tram Network.

37 System Integration

37.1 Introduction

A tramway has many constituent parts and therefore integration is a crucial factor when designing, implementing and operating a successful tramway.

tie shall be provided by the Infraco with a totally integrated Edinburgh Tram Network with all systems, subsystems and interfaces working efficiently and harmoniously together as one and able to be operated and maintained in full compliance with the requirements of the Edinburgh Tram Network and appropriate Consents. To achieve this, the Infraco shall be responsible for successfully undertaking comprehensive co-ordination and system integration roles within the Infraco Works. The system integration responsibility shall exist throughout all phases of the Infraco Works.

This Section of the Employer's Requirements outlines these responsibilities and provides details of the extent of co-ordination and system integration.

37.2 Definitions

System Integration shall include the collation, identification, recording and management of all elements of the Infraco Works, including but not limited to, the project management, design, procurement, manufacturing, factory testing, delivery, offloading, erection, construction, equipping, testing, commissioning, system acceptance testing, shadow running, operation and maintenance of the ETN.

Such integration shall include both the 'hard' integration elements in terms of system and sub-system functionality etc and 'soft' integration elements associated with approvals and Consents, people interfaces, plans, processes and procedures, and land/property agreements.

Also included shall be the production and delivery of all associated documentation (training and maintenance manuals and "As Built" documentation), all spare parts and special tools etc to allow the safe and efficient fulfilment of all operation and maintenance obligations, including dependability criteria, for the projected life time of the Edinburgh Tram Network.

System interfaces shall mean where two or more main elements or subsystems meet or interact or are intended to meet or interact in a manner which is necessary for the expedient and necessary progress of the Infraco Works and the safe and efficient operation and maintenance of the Edinburgh Tram Network.

37.3 Principle

System Integration is a fundamental project requirement and shall include the efficient and effective leadership of the system engineering and associated processes, coordination of the processes for the design, implementation and bringing the Edinburgh Tram Network into public service, complete technical direction and configuration management of the existing system design and system and subsystem interfaces to facilitate the Infraco Works.

37.4 Inter-contract Integration, Integration of third party and free issue equipment

The Infraco shall be responsible for managing all activities required to ensure that the Edinburgh Tram Network is successfully integrated with the equipment and subsystems being provided by the Infraco Parties and others. This over-arching integration role shall include as a minimum the following activities:

- undertaking a design co-ordination system and subsystem development function between contracts;
- lead in the system integration of the ticketing machines, ticket validators and bus passenger information displays;
- lead in the system integration of the subsystems and equipment being provided under the ETN project together with, systems and equipment, such as the "free issue components" or as indicated by **tie**;
- provision of an integrated testing and commissioning plan; and
- implementation of an integrated testing and commissioning programme.

37.5 Formal Roles to be undertaken by the Infraco

37.5.1 System Design Authority

The Infraco shall be responsible for the management of the design and interface processes in respect of systems and equipment being provided under or supplied pursuant to this Agreement. The system design authority role shall be deemed to include leadership of the System engineering process, co-ordination of the design process, configuration management of the System design, System and subsystem interfaces and all associated documentation including general technical direction.

37.5.2 System Integrator

The Infraco shall perform the system integrator role with the aim of meeting the objectives of system integration as set out in this Section. This responsibility shall exist in all phases of the contract from initial requirements analysis, final sign-off of the ETN for operational use and during maintenance.

The Infraco shall be responsible for the practicalities of how the role of system integrator shall be executed, however as a minimum the role is deemed to include the management of the following activities:

- Systems assurance;
- Electromagnetic compatibility including stray current;
- Electromagnetic interference and any associated immunisation of Network Rail signalling systems or assets;
- Environmental issues – noise and vibration;
- System acceptance inclusive of testing and commissioning and training;
- Inter-contract integration;
- Third party issues and consents;
- System safety; and
- Verification and validation.

The Infraco shall:

- Produce a comprehensive system integration management plan, to be implemented and regularly updated by the Infraco throughout the duration of the Infraco Works. Such a plan shall form a fundamental part of the Infraco's overall operational & maintenance plan and design & implementation plan.
- Establish and document appropriate arrangements for the identification, management and monitoring of system integration at the scheme, system, and sub-system levels;

- Provide demonstrable assurance throughout the technical development, procurement and implementation of the ETN that the system and sub-systems form an integrated whole (both in terms of physical, functional and organisational fit, and the operation performance and dependability)

- Identify and integrate the System and all systems as defined in these Employer's Requirements. and equipment being provided under for the ETN project together with, subsystems and equipment provided by others as detailed in 37.4.

- Maintain the integrity of the scheme configuration; and

- Provide and demonstrate compliance and traceability between the scheme requirements and the design and implemented solution and evidence to support the phased and final cases for safety.

All Deliverables shall be:

- submitted in soft copy as required by **tie**;

- Produced in accordance with the ISO 9000 series and in a format approved by **tie**;

- Clearly written, without jargon, with terminology defined; figures, data, calculations and information used shall be clearly traceable and justified; all assumptions shall be stated and justified; and

- Be updated as necessary throughout the Term or as requested by **tie**.

38 Location Specific Requirements

The requirements set out in this section of the Employer's Requirements are mostly applied either system wide or common to particular elements throughout the ETN. The principal exceptions are in relation to the Depot, the Specific Agreements made during the Parliamentary process and the Third Party Agreements as detailed in Schedule 13 (Third Party Agreements). Specific requirements have been identified through the design process. These have been developed by the SDS Provider through the design process over the past years, in particular the following processes:

- The SDS design process, preliminary and detailed (still ongoing) including (in no specific order and not limited to;
- Initial briefing from **tie** and their designers from the Parliamentary stage on issues within the STAG drawings and that had arisen subsequently, either during or in parallel with the Parliamentary process;
- Consultation with CEC as Promoter/Undertaker, as Planning Authority and with their Transport function, including as Roads Authority;
- Consultation with Stakeholders, including major bodies such as BAA, RBS, New Edinburgh Limited, Network Rail and First Scotrail, Historic Scotland, the World Heritage Trust, Forth Ports, and the emergency services. Note that some of these have Agreements as referred to above, but that further consultation and the passage of time has identified additional, changed and/or more detailed requirements to those set out in the Agreements;
- Consultation with other affected landowners, who may not have specific design requirements built into Agreements, as referred to above;
- Consultation with the Operator and with TEL (including Lothian Buses);
- Consultation with HMRI;
- Consultation with other affected bodies such as SEPA, Scottish Power, and the other Utilities;
- Specific consultation with frontagers;
- Specific consultation with general interest groups, relating to e.g. environmental matters, disability issues and cycling;

- Consultations with those submitting planning applications along the tram route;
- Public consultation.

39 Project Programme

39.1 Introduction

This Section of the Employer's Requirements provides an account of the programme restrictions that will impact on the Programme. The Section also contains details of the format in which programmes should be submitted and how costs should be broken down in the Work Breakdown Sheet.

39.2 Key Dates

- Key dates in respect of the Edinburgh Tram Network and the provision of the works, services and supplies by the Infraco are set out below. The tram depot at Gogar shall be complete and commissioned ready to accept first tram delivery by the end of November 2009.

Delivery into service for Phase 1a shall be 3rd March 2011 and 1b 26th December 2011 respectively.

In addition to the Programme dates included above, there are further Programme restrictions within which Infraco must work. These are constraint dates which shall not necessarily affect the whole Works but may do so. Infraco shall take due cognisance of these and the Programme dates outlined above. The constraint dates are as listed below:

- Table of overall Programme Constraints;

Constraint	Dates
Embargos	August Embargo – from the first Sunday in August until the first Sunday in September Christmas Embargo – from the Thursday preceding the first Sunday in December until the first working day of the New Year annually
MUDFA	Latest revision of programme as agreed with **tie** through formal progress meetings.
Design	Latest revision of programme as agreed with **tie** through formal progress meetings.
Others	All other Constraints as shown in Schedule 13 – Third Party Agreements, Code of Construction Practice and Network Rail Possessions

Table 91 – Table of overall Programme Constraints

- Further working time restrictions are imposed on the Infraco by the Construction Code of Practice;
- Network Rail potential possession dates..

39.3 Basis for Programme

- Infraco shall base its programme on the project management requirements at 12 of these Employer's Requirements;

- The Work Breakdown Structure (WBS) for building and coding the programme that is to be used to develop the Infraco programme is that used in **tie**'s master programme;

- The P3e Activity Code Dictionary (Mandatory Codes as below); and

39.4 Third Party Agreements

Infraco shall include these constraints and obligations resulting from Schedule 13 – Third Party Agreements. Infraco shall demonstrate to **tie** that these constraints and obligations have been considered and resolved in the programme.

tie acknowledge their supporting role in the delivery of the obligations contained within these Third Party Agreements.

DOC.NO.	VERSION	STATUS	DATE	SHEET
PRO-INFRACO-1399	3.6	DRAFT	14/03/2008	597

39.5 P3e Activity Code Dictionary (Mandatory Codes)

The following codes shall be used by the Infraco in the preparation and development of their programme. These codes can only be modified with the express permission of **tie**.

Activity Code		Description
Geographical Sections		
01	Section 01	Newhaven Road to Haymarket
02	Section 02	Haymarket Corridor
03	Section 03	Haymarket to Granton Square
04	Section 04	Granton Square to Newhaven Road – (Future Development)
05	Section 05	Roseburn Junction to Gogar
06	Section 06	Gogar Depot
07	Section 07	Gogar to Edinburgh Airport
08	Section 08	Ingliston Park & Ride to Newbridge – (Future Development)
Intermediate Geographical Sections		
01A		Newhaven Road (inclusive) to Foot of the Walk (exclusive)
01B		Foot of the Walk (inclusive) to McDonald Road (exclusive)
01C		McDonald Road (inclusive) to Princes Street West (exclusive)
01D		Princes Street West (inclusive) to Haymarket (exclusive)
02A		Haymarket (inclusive) - Roseburn Junction (inclusive)
03A		Roseburn Junction (exclusive) to Crewe Toll (inclusive)
03B		Crewe Toll (exclusive) to Caroline Park (inclusive)
03C		Caroline Park (exclusive) to Granton (inclusive)
04A		Granton (exclusive) to Lower Granton Road (inclusive) - Future Development
04B		Lower Granton Road (exclusive) to Newhaven Road (exclusive) - Future Development
05A		Roseburn Junction (exclusive) to Balgreen Road (inclusive)
05B		Balgreen Road (exclusive) to Edinburgh Park (inclusive)
05C		Edinburgh Park (exclusive) to Gogarburn (inclusive)
06A		Gogar Depot
07A		Gogarburn (exclusive) to Edinburgh Airport (inclusive)
08A		Ingliston Park & Ride to Newbridge North - Future Development

Sub-Section (Tram Stop)

00	Intermediate Section Wide
01	Depot
02	Depot Stop (exclusive) - Gogarburn (inclusive)
03	Gyle (exclusive) - Depot Stop (inclusive)
04	Gogarburn (exclusive) to Ingliston Park & Ride (inclusive)
05	Ingliston Park & Ride (exclusive) to Edinburgh Airport (inclusive)
06	Edinburgh Park Central (exclusive) - Gyle (inclusive)
07	Edinburgh Park Station (exclusive) - Edinburgh Park Central (inclusive)
08	Bankhead (exclusive) - Edinburgh Park Station (inclusive)
09	Saughton Road North (exclusive) - Bankhead (inclusive)
10	Balgreen Road (exclusive) - Saughton Road North (inclusive)
11	Murrayfield Stadium (exclusive) - Balgreen Road (inclusive)
12	Roseburn Junction (exclusive) to Murrayfield Stadium (inclusive)
13	Haymarket (inclusive) - Roseburn Junction (inclusive)
14	Shandwick Place (inclusive) - Haymarket (exclusive)
15	Princes Street West (inclusive) - Shandwick Place (exclusive)
16	St. Andrew's Square (exclusive) - Princes Street West (exclusive)
17	Picardy Place (inclusive) - St. Andrew's Square (exclusive)
18	McDonald Road (inclusive) - Picardy Place (exclusive)
19	Balfour Street (inclusive) - McDonald Road (exclusive)
20	Foot of the Walk (inclusive) - Balfour Street (exclusive)
21	Bernard Street (inclusive) - Foot of the Walk (exclusive)
22	Port of Leith (inclusive) - Bernard Street (exclusive)
23	Ocean Terminal (inclusive) – Port of Leith (exclusive)
24	Newhaven Road (inclusive) - Ocean Terminal (exclusive)
25	Roseburn Junction (exclusive) to Roseburn (inclusive)
26	Roseburn (exclusive) - Ravelston Dykes (inclusive)
27	Ravelston Dykes (exclusive) - Craigleith (inclusive)
28	Craigleith (exclusive) - Telford Road (inclusive)
29	Telford Road (exclusive) - Crewe Toll (inclusive)
30	Crewe Toll (exclusive) - West Pilton (inclusive)
31	West Pilton (exclusive) - Caroline Park (inclusive)
32	Caroline Park (exclusive) - Saltire Square (inclusive)
33	Saltire Square (exclusive) - Granton Square (inclusive)
34	St. Andrew's Square

Discipline Codes

ACCB	Accommodation and Boundary Works
APPR	Approvals
APPP	Prior Approvals – Detail Design
APPT	Technical Approvals – Detail Design
ARCH	Architecture
AUXI	Auxilliary Power
BLDS	Buildings
BRDG	Bridges
CECS	CEC Services
CHAR	Charette Changes
COMM	Commissioning
DASB	Design – As Builts
DEMO	Demolition
DEPO	Depot
DRAN	Drainage
EART	Earthworks / Embankments
ELEC	Electricity
ENVI	Environmental
GASS	Gas
GEOT	Geotechnical
HIGH	Highways
HMRI	Railway Inspectorate
JNCS	Junctions
LAND	Landscaping
LIGH	Lighting
MANA	Management
MECH	Mechanical
MILE	Milestones
MISC	Miscellaneous
MODL	Modelling
MULT	Multi-Discipline
NETR	Network Rail
OHLE	OHLE
OTHW	Other Works
PLAT	Platforms
POWR	Power (Traction)
ROAD	Roads / Paths / External Works

SEWR	Sewerage
SIGN	Signalling
STAK	Stakeholder
STRL	Street Lighting
STRU	Structures / Retaining Structures
SUBM	Submissions
SUBS	Sub-Stations
SURV	Surveys
SYSC	Systems Communications
SYSE	Systems Engineering
TELC	Telecoms (Including Data)
TRAM	Tram Vehicles
TRCK	Track
TRMS	Tram Stops
TROS	Traffic Order
TTRO	Temporary Traffic Order
TUNN	Underpasses / Tunnels
UTIL	Utilities
WATR	Water Supply

Phase Codes

D	DEVELOPMENT (Management)
L	LAND & PROPERTY (Management)
J	JRC (Management)
S	SDS DESIGN
ID	INFRACO DESIGN
M	MUDFA (Utilities - Construction)
A	ADVANCED WORKS (Construction)
I	INFRACO (Construction)
T	TRAMCO (Construction)
W	SYSTEM WIDE As Built Design
P	PROJECT WIDE

Scope Type Codes

O	Original Scope
A	Approved Change to Original Scope
U	Unapproved Change to Original Scope

Line Codes

00	Common
1a	Phase 1a - Airport to Newhaven Road
1b	Phase 1b - Roseburn Junction to Granton Square
02	Phase 02 - Granton Square to Newhaven Road
03	Phase 03 - Ingliston Park & Ride to Newbridge North - Future Development

40 Maintenance

40.1 Scope

The scope of this section is to define the maintenance requirements with which the Infraco must comply.

It is anticipated that the Edinburgh Tram Network will have been delivered, tested and commissioned and taken into operation in accordance with the other parts of these Employers Requirements.

The maintenance scope is to maintain the delivered Edinburgh Tram Network functionality for the Term according to this Section of the Employer's Requirements and the Agreement.

40.1.1 General

The Infraco maintenance responsibilities during the Term are detailed here and apply to both the Edinburgh Tram Network infrastructure and Trams. This section also details the Infraco's obligation to develop a maintenance strategy and plan for the Edinburgh Tram Network as a whole, for delivering a maintenance service. The strategy and plan shall include planned inspections and interventions, lifecycle replacement and response to unplanned equipment failures and damage for whatever reason. For the avoidance of doubt, in accordance with the Infraco Agreement, repair of damage due to accidents, vandalism, graffiti, theft, derailments, external influences, force majeure, and repair of damages due to improper handling or operation of the system, where this is not the responsibility of Infraco, entitles Infraco to payment for additional labour and material required in accordance with the Schedule of Agreed Prices.

In response to these requirements the Infraco shall develop a maintenance strategy to support and enable the Edinburgh Tram Network to maintain the performance standards, and a Maintenance Plan for all Infrastructure and Tram systems and elements under their responsibility, that make up the Edinburgh Tram Network. The Maintenance Plan shall be submitted to **tie** and reviewed and agreed in accordance with the Review Procedure.

The Infraco's performance in delivering effective maintenance will be measured, monitored and managed through a combination of the key performance indicators and availability criteria, and assessed by **tie** through a series of qualitative tests in accordance with the Agreement.

40.1.2 Overall Objectives

The main objective of the Edinburgh Tram Network is to provide a safe, reliable, punctual, clean, easily accessible, comfortable and environmentally friendly transport service.

The Maintenance Plan shall form part of the Infraco integrated management system. This shall also include the following objectives, procedures and processes:

- The Parties shall co-operate to achieve the aims under the Agreement;
- The Infraco shall demonstrate how it will meet the Employer's specific requirements under the Infraco Agreement, particularly the requirements for the availability of the ETN and defined sub-systems;
- The Infraco shall manage all their Infraco Parties to ensure they fulfil the requirements of their contracts;
- The Infraco shall ensure that the activities of all Infraco Parties do not compromise the operations, safety and life expectancy of the ETN;
- The Infraco shall set up and adhere to schedules and programmes for all planned work, including adherence to the relevant Operations & Maintenance Specifications and Manuals provided by Infraco;
- The Infraco shall in discharging its obligations minimise any downtime on the system for the Operator;
- The Infraco shall co-operate with **tie** and interfacing parties including the Operator, CEC, Network Rail shall co-operate and, in particular, shall support any obligations they respectively have under their safety management system;
- The Infraco shall be aware of, and be compliant with Law and standards governing operation and maintenance of tram network infrastructure, systems, equipment, and any changes thereto; and
- The Infraco shall establish and maintain lines of communication with all interfacing and affected parties by means of scheduled meetings, consultation, notices, and when required by tie publicity, in regard to maintenance works.

Each year the Infraco shall plan and undertake programmes to review and improve the levels of system availability, safety, performance, and delivery of the infrastructure and trams. The Infraco shall develop a performance improvement plan which shall be developed in conjunction with the Operator and shall be included in future issues of the infrastructure maintenance plan. Infraco shall update the Maintenance Plan in the light of operational experience and resubmit for approval in accordance with the Review Procedure in Schedule [14] of the Agreement.

The Infraco performance payment regime set out in Schedule [7] of the Agreement shall provide a financial incentive for Infraco to provide reliable systems and assets for operation and to undertake effective maintenance of the Edinburgh Tram Network.

40.2 Infrastructure Maintenance Requirements

40.2.1 Purpose

This Infrastructure Maintenance Requirements section identifies the output specification that the Infraco shall meet. This includes delivering planned preventative (cyclical), life cycle and corrective maintenance to the infrastructure of the Edinburgh Tram Network and all relevant plant and equipment for which Infraco is responsible. The Infrastructure Maintenance Plan, which shall be developed by Infraco in response to these Requirements, shall specify objective plans and specifications for maintenance from the pre-operational period and over the Term and shall contain a strategy complying with 40.2.4 of this Section. These Employer's Requirements may be reviewed as necessary during the operational period by agreement with **tie**. The Infrastructure Maintenance Requirements shall be read in conjunction with the other sections of these Employer's Requirements and with such 'as-built' technical documentation, design standards and Operation & Maintenance standards and manuals as are developed by the Infraco.

The Infrastructure Maintenance Plan shall be a fully controlled issue document. Updates shall be shown as a draft version until these are agreed by **tie**. It shall take into account all statutory, regulatory and contractual requirements in force at the time of issue.

40.2.2 Scope

The Infrastructure Maintenance Plan shall cover all maintenance activities, including but not exclusively, the response to unplanned equipment failures and damage for whatever reason, to the infrastructure, plant and equipment that make up the Edinburgh Tram Network. The following responsibilities matrix identifies the general scope for which the Infraco is responsible. The Infraco responsibility for Depot Plant and Equipment maintenance is identified in Table 86 - Depot Plant and Equipment to be Provided.

The Infraco detailed responsibilities in respect of road related obligations are contained in table [93] – Roads, structures in table [95] – Structures (as carried out by the Infraco or others) and landscaping (trees and vegetation).

Table 92 – Infrastructure and Equipment Responsibilities Allocation Matrix

Description	User Competence Assessor	Used by			Cleaned by				Maintained by				Access Controlled by			
		Infraco	Tram Maintainer	Transdev	Infraco	Tram Maintainer	CEC	Transdev	Infraco	Tram Maintainer	CEC	Transdev	Infraco	Tram Maintainer	CEC	Transdev
Tram Stop Structure																
Platform surfaces		N/A	N/A	N/A	✗	✗	✗	✔	✔	✗	✗	✗	✗	✗	✗	✔
Platform Inclined Approach		N/A	N/A	N/A	✗	✗	✗	✔	✔	✗	✗	✗	✗	✗	✗	✔
Canopy		N/A	N/A	N/A	✗	✗	✗	✔	✔	✗	✗	✗	✗	✗	✗	✔
Inside surfaces		N/A	N/A	N/A	✗	✗	✗	✔	✔	✗	✗	✗	✗	✗	✗	✔
External surfaces		N/A	N/A	N/A	✗	✗	✗	✔	✔	✗	✗	✗	✗	✗	✗	✔
Internal Roof surfaces		N/A	N/A	N/A	✗	✗	✗	✔	✔	✗	✗	✗	✗	✗	✗	✔
External Roof surfaces		N/A	N/A	N/A	✗	✗	✗	✔	✔	✗	✗	✗	✗	✗	✗	✔
Integral Lighting		N/A	N/A	N/A	✗	✗	✗	✔	✔	✗	✗	✗	✗	✗	✗	✔
Internal seating		N/A	N/A	N/A	✗	✗	✗	✔	✔	✗	✗	✗	✗	✗	✗	✔

Description	User Competence Assessor	Used by			Cleaned by				Maintained by				Access Controlled by			
		Infraco	Tram Maintainer	Transdev	Infraco	Tram Maintainer	CEC	Transdev	Infraco	Tram Maintainer	CEC	Transdev	Infraco	Tram Maintainer	CEC	Transdev
Tram Stop Furnishings																
Stop Name Signage		N/A	N/A	N/A	✗	✗	✗	✔	✔	✗	✗	✗	✗	✗	✗	✔
Static Information Signage		N/A	N/A	N/A	✗	✗	✗	✔	✔	✗	✗	✗	✗	✗	✗	✔
Guard Rails/Barriers (as applicable)		N/A	N/A	N/A	✗	✗	✗	✔	✔	✗	✗	✗	✗	✗	✗	✔
Lighting Columns		N/A	N/A	N/A	✗	✗	✗	✔	✗	✗	✔	✗	✗	✗	✗	✔
Lighting Lanterns		N/A	N/A	N/A	✗	✗	✔	✗	✗	✗	✔	✗	✗	✗	✗	✔
Litter Bins		N/A	N/A	N/A	✗	✗	✗	✔	✔	✗	✗	✗	✗	✗	✗	✔
External seating		N/A	N/A	N/A	✗	✗	✗	✔	✔	✗	✗	✗	✗	✗	✗	✔
Platform Edge White Line		N/A	N/A	N/A	✗	✗	✗	✔	✔	✗	✗	✗	✗	✗	✗	✔
Advertising Signage		N/A	N/A	N/A	✗	✗	✗	✔	✔	✗	✗	✗	✗	✗	✗	✔
Tram Stop Equipment																
CCTV Cameras		N/A	N/A	N/A	✔	✗	✗	✗	✔	✗	✗	✗	✗	✗	✗	✔
Public Address Loudspeakers		N/A	N/A	N/A	✔	✗	✗	✗	✔	✗	✗	✗	✗	✗	✗	✔
Hearing Loops		N/A	N/A	N/A	✗	✗	✗	✗	✔	✗	✗	✗	✗	✗	✗	✔
Passenger Information Displays		N/A	N/A	N/A	✔	✗	✗	✗	✔	✗	✗	✗	✗	✗	✗	✔
Passenger Alarm/Help points		N/A	N/A	N/A	✗	✗	✗	✔	✔	✗	✗	✗	✗	✗	✗	✔
Ticket Vending Machines (maintained & serviced by TEL)		N/A	N/A	N/A	✗	✗	✗	✔	✗	✗	✗	✗	✗	✗	✗	✔
Drainage (Interface defined in Table 93)		N/A	N/A	N/A	✔	✗	✔	✗	✔	✗	✔	✗	✗	✗	✗	✔

Description	User Competence Assessor	Used by			Cleaned by				Maintained by				Access Controlled by			
		Infraco	Tram Maintainer	Transdev	Infraco	Tram Maintainer	CEC	Transdev	Infraco	Tram Maintainer	CEC	Transdev	Infraco	Tram Maintainer	CEC	Transdev
Trackside Equipments																
Stop Equipment Cabinets		N/A	N/A	N/A	✔	✘	✘	✘	✔	✘	✘	✘	✘	✘	✘	✔
Stop Equipment Cabinet Equipment		N/A	N/A	N/A	✔	✘	✘	✘	✔	✘	✘	✘	✘	✘	✘	✔
Traction Isolator Cabinets		N/A	N/A	N/A	✔	✘	✘	✘	✔	✘	✘	✘	✘	✘	✘	✔
Traction Isolator Cabinet Equipment		N/A	N/A	N/A	✔	✘	✘	✘	✔	✘	✘	✘	✘	✘	✘	✔
Point Control Cabinets		N/A	N/A	N/A	✔	✘	✘	✘	✔	✘	✘	✘	✘	✘	✘	✔
Point Control Cabinet Equipment		N/A	N/A	N/A	✔	✘	✘	✘	✔	✘	✘	✘	✘	✘	✘	✔
Point Heater Cabinets, Point Heaters & Controls		N/A	N/A	N/A	✔	✘	✘	✘	✔	✘	✘	✘	✘	✘	✘	✔
Road Junction Cabinets		N/A	N/A	N/A	✘	✘	✔	✘	✘	✘	✘	✘	✘	✘	✔	✘
Road Junction Cabinet Equipment		N/A	N/A	N/A	✘	✘	✔	✘	✘	✘	✘	✘	✘	✘	✔	✘
Point Machines (including Manual Control)		N/A	N/A	N/A	✔	✘	✘	✘	✔	✘	✘	✘	✘	✘	✘	✔
OLE Contact Wire & Supports		N/A	N/A	N/A	✔	✘	✘	✘	✔	✘	✘	✘	✘	✘	✘	✔
OLE Poles		N/A	N/A	N/A	✔	✘	✘	✘	✔	✘	✘	✘	✘	✘	✘	✔
OLE Pole mounted Equipments		N/A	N/A	N/A	✔	✘	✘	✘	✔	✘	✘	✘	✘	✘	✘	✔
OLE Wall Fixings		N/A	N/A	N/A	✔	✘	✘	✘	✔	✘	✘	✘	✘	✘	✘	✔
OLE Wall fixed Equipment		N/A	N/A	N/A	✔	✘	✘	✘	✔	✘	✘	✘	✘	✘	✘	✔

Description	Used Competence Assessor	Used by			Cleaned by				Maintained by				Access Controlled by			
		Infraco	Tram Maintainer	Transdev	Infraco	Tram Maintainer	CEC	Transdev	Infraco	Tram Maintainer	CEC	Transdev	Infraco	Tram Maintainer	CEC	Transdev
Tram Signal Heads (Roadside)		N/A	N/A	N/A	✗	✗	✔	✗	✗	✗	✗	✗	✗	✗	✗	✔
Tram Signal Posts (Trackside)		N/A	N/A	N/A	✗	✗	✗	✔	✔	✗	✗	✗	✗	✗	✗	✔
Tram Signals Posts		N/A	N/A	N/A	✗	✗	✗	✔	✔	✗	✗	✗	✗	✗	✗	✔
Tram Detector Loops		N/A	N/A	N/A	✗	✗	✗	✗	✔	✗	✗	✗	✗	✗	✗	✔
Lighting on OLE Masts		N/A	N/A	N/A	✗	✗	✔	✗	✔	✗	✗	✗	✗	✗	✗	✔
Trackside cable ducts		N/A	N/A	N/A	✔	✗	✗	✗	✔	✗	✗	✗	✗	✗	✗	✔
Trackside cables		N/A	N/A	N/A	✔	✗	✗	✗	✔	✗	✗	✗	✗	✗	✗	✔
Cable drawpits		N/A	N/A	N/A	✔	✗	✗	✗	✔	✗	✗	✗	✗	✗	✗	✔
Structures (Bridges, Retaining Walls etc)																
Over Bridges See Table 95 for split		N/A	N/A	N/A	✔	✗	✔	✗	✔	✗	✔	✗	✗	✗	✗	✔
Under bridges See Table 95 for split		N/A	N/A	N/A	✔	✗	✔	✗	✔	✗	✔	✗	✗	✗	✗	✔
Retaining walls		N/A	N/A	N/A	✔	✗	✗	✗	✔	✗	✗	✗	✗	✗	✗	✔
Misc Structures		N/A	N/A	N/A	✔	✗	✗	✗	✔	✗	✗	✗	✗	✗	✗	✔
Swept Path		N/A	N/A	N/A	✗	✗	✔	✗	✗	✗	✔	✗	✗	✗	✗	✔
Swept Path Markings		N/A	N/A	N/A	✗	✗	✔	✗	✗	✗	✔	✗	✗	✗	✗	✔
Track																
Trackwork		N/A	N/A	N/A	✔	✗	✗	✗	✔	✗	✗	✗	✗	✗	✗	✔
Points & Crossings		N/A	N/A	N/A	✔	✗	✗	✗	✔	✗	✗	✗	✗	✗	✗	✔
Track Drainage		N/A	N/A	N/A	✔	✗	✗	✗	✔	✗	✗	✗	✗	✗	✗	✔
Field' Stray Current Equipments		N/A	N/A	N/A	✔	✗	✗	✗	✔	✗	✗	✗	✗	✗	✗	✔

Description	User Competence Assessor	Used by			Cleaned by				Maintained by				Access Controlled by			
		Infraco	Tram Maintainer	Transdev	Infraco	Tram Maintainer	CEC	Transdev	Infraco	Tram Maintainer	CEC	Transdev	Infraco	Tram Maintainer	CEC	Transdev
Sub Stations																
Sub Station Buildings		N/A	N/A	N/A	✔	✘	✘	✘	✔	✘	✘	✘	✘	✘	✘	✔
Sub Station Equipments		N/A	N/A	N/A	✔	✘	✘	✘	✔	✘	✘	✘	✘	✘	✘	✔
Sub Station Compounds		N/A	N/A	N/A	✔	✘	✘	✘	✔	✘	✘	✘	✘	✘	✘	✔
Sub Station Parking Facilities		N/A	N/A	N/A	✔	✘	✘	✘	✔	✘	✘	✘	✘	✘	✘	✔
Stray Current Monitoring Points		N/A	N/A	N/A	✔	✘	✘	✘	✔	✘	✘	✘	✘	✘	✘	✔
Stray Current Equipments		N/A	N/A	N/A	✔	✘	✘	✘	✔	✘	✘	✘	✘	✘	✘	✔
Earthing Equipments		N/A	N/A	N/A	✔	✘	✘	✘	✔	✘	✘	✘	✘	✘	✘	✔
Trams																
Free issue' tram mounted equipments		N/A	N/A	N/A	✔	✘	✘	✘	✔	✘	✘	✘	✘	✘	✘	✔
Trams		N/A	N/A	N/A	✘	✘	✘	✔	✘	✔	✘	✘	✘	✘	✘	✔
Tram saloon & Drivers cabs		N/A	N/A	N/A	✘	✘	✘	✔	✘	✔	✘	✘	✘	✘	✘	✔
Radio																
Portable radios		N/A	N/A	N/A	✘	✘	✘	✔	✔	✘	✘	✘	✘	✘	✘	✔
Radio Base stations		N/A	N/A	N/A	✔	✘	✘	✘	✔	✘	✘	✘	✘	✘	✘	✔
Landscaping																
Soft landscaping		N/A	N/A	N/A	✘	✘	✘	✔	✔	✘	✘	✘	✘	✘	✘	✔
Hard Landscaping		N/A	N/A	N/A	✘	✘	✘	✔	✔	✘	✘	✘	✘	✘	✘	✔

Description	User Competence Assessor	Used by			Cleaned by				Maintained by				Access Controlled by			
		Infraco	Tram Maintainer	Transdev	Infraco	Tram Maintainer	CEC	Transdev	Infraco	Tram Maintainer	CEC	Transdev	Infraco	Tram Maintainer	CEC	Transdev
Miscellaneous																
Communication & Control links		N/A	N/A	N/A	✗	✗	✗	✗	✔	✗	✗	✗	✗	✗	✗	✔

LEGEND	
	Provided by Tram Maintainer
	Provided by the Infraco
✔	Responsible
✗	Not Responsible

Floor	Room No.	Description	User Competence Assessor	Used by			Cleaned by			Maintained by			Access Controlled by		
				Infraco	Tram Maintainer	**Transdev**	Infraco	Tram Maintainer	**Transdev**	Infraco	Tram Maintainer	**Transdev**	Infraco	Tram Maintainer	**Transdev**
Stores, Workshops and Maintenance Area															
Ground Floor Level		Stores Office Centrally located	n.a	✓	✓	✗	✓	✓	✗	✓	✗	✗	✓	✓	✗
		Heavy Store (Infraco)		✓	✗	✗	✓	✗	✗	✓	✗	✗	✓	✗	✗
		Heavy store (Tramco)		✗	✓	✗	✗	✓	✗	✓	✗	✗	✗	✓	✗
		Visitors Entrance Hall	n.a	✓	✓	✓	✓	✓	✓	✓	✗	✗	✗	✗	✓
		Workshop Cleaners Room	n.a	✓	✓	✗	✓	✓	✗	✓	✗	✗	✓	✓	✗
		Light Store (Infraco)		✓	✗	✗	✓	✗	✗	✓	✗	✗	✓	✗	✗
		Light Store (Tramco)		✗	✓	✗	✗	✓	✗	✓	✗	✗	✗	✓	✗
		Infrastructure Workshop		✓	✗	✗	✓	✗	✗	✓	✗	✗	✓	✗	✗
		Dirty Workshop / Machine Shop		✗	✓	✗	✗	✓	✗	✓	✗	✗	✗	✓	✗
		Clean Workshop (Infraco)		✓	✗	✗	✓	✗	✗	✓	✗	✗	✓	✗	✗
		Clean workshop (Tramco)		✗	✓	✗	✗	✓	✗	✓	✗	✗	✗	✓	✗
		Lobby	n.a	✓	✓	✗	✓	✓	✗	✓	✗	✗	✓	✗	✗
		Male Toilets	n.a	✓	✓	✗	✓	✓	✗	✓	✗	✗	✓	✗	✗
		Male Showers	n.a	✓	✓	✗	✓	✓	✗	✓	✗	✗	✓	✗	✗
		Female Toilets	n.a	✓	✓	✗	✓	✓	✗	✓	✗	✗	✓	✗	✗
		Female Showers	n.a	✓	✓	✗	✓	✓	✗	✓	✗	✗	✓	✗	✗
		Staff Corridor	n.a	✓	✓	✓	✓	✓	✓	✓	✗	✗	✗	✗	✗
		Infrastructure Admin	n.a	✓	✗	✗	✓	✗	✗	✓	✗	✗	✓	✗	✗
		Maintenance (Tramco) Admin	n.a	✗	✓	✗	✗	✓	✗	✓	✗	✗	✗	✓	✗
		First Aid	n.a	✓	✓	✓	✓	✓	✓	✓	✗	✗	✗	✗	✓
		Switchroom		✓	✗	✗	✓	✗	✗	✓	✗	✗	✓	✗	✗
		Infrastructure Manager	n.a	✓	✗	✗	✓	✗	✗	✓	✗	✗	✓	✗	✗
		Maintenance (Tramco) Manager	n.a	✗	✓	✗	✗	✓	✗	✓	✗	✗	✗	✓	✗
		Store Room (Cleaners?)	n.a	✓	✓	✗	✓	✓	✗	✓	✗	✗	✗	✗	✗
		Staff Entrance Hall	n.a	✓	✓	✓	✓	✓	✓	✓	✗	✗	✗	✗	✓
		Drying Room	n.a	✓	✓	✗	✓	✗	✗	✓	✗	✗	✓	✓	✗
		Tram Batteries		✗	✓	✗	✗	✓	✗	✓	✗	✗	✗	✓	✗
		Equipment Room		✓	✗	✗	✓	✗	✗	✓	✗	✗	✓	✗	✗
		UPS Room		✓	✗	✗	✓	✗	✗	✓	✗	✗	✓	✗	✗
		Compressor Room - Air tools		✓	✗	✗	✓	✗	✗	✓	✗	✗	✓	✗	✗
		Tram Maintenance Area		✗	✓	✓	✗	✓	✗	✓	✗	✗	✗	✓	✗
		Maintenance Area Transit Zone		✓	✓	✓	✓	✓	✓	✓	✗	✗	✗	✓	✗
		Inspection Pits		✗	✓	✗	✗	✓	✗	✗	✓	✗	✗	✓	✗
First Floor office accommodation			n.a	✗	✗	✓	✗	✗	✓	✓	✗	✗	✗	✗	✓
Furnishings - Used, Cleaned, Maintained and Controlled as appropriate															
Chairs, Desks, Tables, Filing cabinets etc			As Appropriate	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Kitchen and Catering Equipment				✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Reception Desk & Furnishings				✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Control Room Furnishings				✗	✗	✓	✗	✗	✓	✓	✗	✓	✗	✗	✓
Lockers, Coat Rails etc				✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Training Room furnishings (Projector, Screen etc)				✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
External															
Depot Yard				✓	✓	✓	✓	✓	✓	✓	✗	✗	✗	✗	✓
Depot Stabling Area				✓	✓	✓	✓	✓	✓	✓	✗	✗	✗	✗	✓

Table 93 – Roads

Task or Activity	Sub-heading	Maintenance Works to be undertaken by:	Frequency	Minimum Response Time	Comments
Defects reporting CLARENCE, walking surveys, etc	Rail and rail containment	Infraco			Sharing of information between CEC & Infraco call centres.
	Tram Stops	Infraco			
	Overhead Line Equipment	Infraco			
	Tram duct access chambers	Infraco			
	Tram vehicle detection loops	Infraco	-	-	All part of the routine 28 day inspection, work arising dealt with below
	Non-tram vehicle detection loops	CEC	1 working hour		
	Temporary tram signs	CEC	28 days	-	
	Coloured/textured surfacing for tram	CEC	28 days	-	
	All other road related defects	CEC	28 days	-	
Defect repairs	Rail and rail containment	Infraco			
	Tram Stops	Infraco			
	Overhead Line Equipment	Infraco			
	Tram duct access chambers	Infraco			
	Tram vehicle detection loops	Infraco			
	Temporary tram signs	Infraco			
	Coloured/textured surfacing for tram	CEC		3 months	Resurfacing only to be undertaken when it is agreed that it is required.
	All other road related defects	CEC	-	Emergency* (7 days) Non Emergency (3 months)	* Likely to result in injury (CEC liability, conscious decision by CEC on timescale)
Signals	Tram detection loops and cable to the UTC controller	Infraco		1hr	
	Traffic and tram signal equipment	CEC		4hrs	24 hr response already contracted by CEC.

Task or Activity	Sub-heading	Maintenance Works to be undertaken by:	Frequency	Minimum Response Time	Comments
	Traffic detection	CEC		4hrs	
	CEC Traffic Control Centre	CEC		5mins	Telephone contact with CEC Control Centre except when this is unmanned when Tram control will be able to make a junction call themselves.
Lighting	On OLE poles	Infraco		* 2hr	Response required when 6 or more adjacent lights fail.
	Platforms	Infraco		* 1hr	Response required when 2 or more adjacent lights fail.
	Street Lighting	CEC		* 2hr	Response required when 6 or more adjacent lights fail.
	All other illuminated road signs and bollards	CEC		28 days	
Winter Maintenance	Roads	CEC		* 2hrs	
	Cycleways/footways	CEC		* 2hrs	
	Platforms on-street	CEC		* 2hrs	
	Platforms off-street	Infraco		* 2hrs	
Removal of obstructions	On road/footway including non-segregated tramway path, platforms and platform ramps	CEC		* 1hr	May involve Lothian and Borders Police
	On tramway (segregated sections)	CEC		*1hr	
	On platform (segregated sections)	CEC		*1hr	
CCTV	For roads	CEC		28 days	
	For tram	Infraco		2 days	

Table 94 – Roseburn Corridor

Task or Activity	Sub-heading	Maintenance Works to be undertaken by:	Frequency	Minimum Response Time	Comments
Defects reporting CLARENCE, walking surveys, etc	Cycleway/footway	CEC	28 days		
	Retaining walls	CEC	28 days		
	Lighting	CEC	28 days		
	Embankment/cutting and its vegetation	CEC	28 days		
	Kick-rail	Infraco			Demarcation between areas
	Fencing – between cycleway/footway and tramway	Infraco			
	- all other fencing	CEC			
	Noise Barriers	Infraco			If required and do not form a part of the perimeter fencing.
	Grass track	Infraco			
	Drainage	Infraco			
	Tram Stops	Infraco			
	Overhead Line Equipment	Infraco			
	Tram duct access chambers	Infraco			
	Tram vehicle detection loops	Infraco			
	Temporary tram signs	Infraco			
	Coloured/textured surfacing for tram	Infraco			
Defect repairs	Cycleway/footway	CEC		Emergency* (7 days) Non Emergency (3 months)	
	Retaining walls	CEC			
	Lighting	CEC			

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	Embankment/cutting and its vegetation	CEC			
	Kick-rail	Infraco			
	Fencing	Infraco			
	Noise Barriers	Infraco			
	Grass track	Infraco			
	Drainage	Infraco			
	Tram Stops	Infraco			
	Overhead Line Equipment	Infraco			
	Tram duct access chambers	Infraco			
	Tram vehicle detection loops	Infraco			
	Temporary tram signs	Infraco			
	Coloured/textured surfacing for tram	Infraco			
Winter Maintenance	Cycleways/footways	CEC		* 2hrs	
	Platforms	Infraco		* 2hrs	
Removal of obstructions	On cycleway/footway	CEC		* 1hr	May involve Lothian and Borders Police
	On tramway and platform	Infraco		* 1hr	
CCTV	At Tramstops	Infraco		2 days	

Table 95 – Structures

Task or Activity	Sub-heading	Maintenance Works to be undertaken by	Frequency	Minimum Response Time	Comments
Structures	S01 Roseburn Terrace Bridge Existing structure to carry trams and cycles	CEC			CEC to be responsible for the ongoing structural maintenance. Infraco will be responsible for day-to-day maintenance (see Definitions below). Existing deck to be removed by the Infraco and fascia to be incorporated within new structure. The existing abutments will be retained to support the embankments but will not support the new bridge deck. Inspection report available. No major defects noted that would present a future maintenance liability.
	S02 Coltbridge Viaduct Existing structure to carry trams and cycleway	CEC			CEC to be responsible for the ongoing structural maintenance. Infraco will be responsible for day-to-day maintenance. Existing structure has been inspected (inspection report available) and assessed. The existing structure will carry the proposed tramway with a new steel walkway attached to the western elevation. Any defects noted during the inspection will be rectified by the Infraco during the construction of the walkway and new deck slab.

Task or Activity	Sub-heading	Maintenance Works to be undertaken by:	Frequency	Minimum Response Time	Comments
	S03 St George School Access Bridge Existing road bridge over tram	CEC			CEC to be responsible for the ongoing structural maintenance (if CEC own it). Infraco will be responsible for day-to-day maintenance. Existing structure has been inspected (inspection report available) but no assessment has been undertaken as the structure provides vehicular access over the proposed tramway.
	S04 St George School footbridge Existing footbridge over tram	CEC			CEC to be responsible for the ongoing structural maintenance (if CEC own it). CEC to be responsible for polycarbonate sheets. Existing structure has been inspected (inspection report available) but no assessment has been undertaken as the structure provides pedestrian access over the proposed tramway.
	S05 Ravelston Dykes Bridge Existing bridge over tram	CEC			CEC to be responsible for the ongoing structural maintenance. TEL will be responsible for day-to-day maintenance. Existing structure has been inspected (inspection report available) but no assessment has been undertaken as the structure provides vehicular access over the proposed tramway.
	S06 Craigleith Drive Bridge Existing bridge to carry trams and cycles	CEC			CEC to be responsible for the ongoing structural maintenance. Infraco will be responsible for day-to-day maintenance. The structure have been inspected (report is available) and assessed. The structure has capacity to carry the proposed tramway. No major defects were noted.

Task or Activity	Sub-heading	Maintenance Works to be undertaken by:	Frequency	Minimum Response Time	Comments
	S07 Holiday Inn Access Bridge Existing road bridge over tram	CEC			CEC to be responsible for the ongoing structural maintenance. Infraco will be responsible for day-to-day maintenance. Existing structure has been inspected (inspection report available) but no assessment has been undertaken as the structure provides vehicular access over the proposed tramway.
	S08 Queensferry Road Bridge Existing road bridge over tram	CEC			CEC to be responsible for the ongoing structural maintenance. Infraco will be responsible for day-to-day maintenance. Existing structure has been inspected (inspection report available) but no assessment has been undertaken as the structure provides vehicular access over the proposed tramway.
	S09 Groathill road South Bridge Existing bridge to carry trams	CEC			CEC to be responsible for the ongoing structural maintenance. Infraco will be responsible for day-to-day maintenance. The structure have been inspected (report is available) and assessed. The structure has capacity to carry the proposed tramway. No major defects were noted.
	S10 Telford Road Bridge Existing road bridge over tram	CEC			CEC to be responsible for the ongoing structural maintenance. Infraco will be responsible for day-to-day maintenance. Existing structure has been inspected (inspection report available) but no assessment has been undertaken as the structure provides vehicular access over the proposed tramway.

Task or Activity	Sub-heading	Maintenance Works to be undertaken by:	Frequency	Minimum Response Time	Comments
	S11 Drylaw Drive Bridge Existing bridge to be demolished				Structure to be demolished by the Infraco.
	S12 Crewe Road Gardens Bridge Existing road bridge over tram	CEC			CEC to be responsible for the ongoing structural maintenance. Infraco will be responsible for day-to-day maintenance. Structure to be extended by the Infraco over the proposed tramway. No inspection or assessment has been undertaken. A full set of construction drawings for the structure were provided.
	S16 Victoria dock Entrance Bridge Existing bridge carrying to carry trams and general traffic	CEC			CEC to be responsible for the ongoing structural maintenance. Infraco will be responsible for day-to-day maintenance. An inspection of the structure was undertaken (inspection report is available), however, no assessment has been undertaken to date.
	S17 Tower Place Bridge Existing bridge carrying to carry trams and general traffic	CEC			CEC to be responsible for the ongoing structural maintenance. Infraco will be responsible for day-to-day maintenance. An inspection of the structure was undertaken (inspection report is available), however, no assessment has been undertaken to date.

Task or Activity	Sub-heading	Maintenance Works to be undertaken by:	Frequency	Minimum Response Time	Comments
	S18 Leith Walkway Railway Bridge Existing	Network Rail			The structure has been inspected and assessed (reports are available). The structure has capacity to carry the proposed tramway. The major defected noted during the inspection, leaking water main, has now been rectified. However, the next routine inspection should confirm that no adverse affects have occurred to the substructures.
	S19 Haymarket Station Viaduct New	CEC			CEC to be responsible for the ongoing structural maintenance. Infraco will be responsible for day-to-day maintenance.
	S20 Russell Road Bridge New	Infraco			Infraco to be responsible for all maintenance.
	S21A Roseburn Street Bridge New	Infraco			Infraco to be responsible for all maintenance.
	S21B Murrayfield Stadium Retaining Wall New	Infraco			Infraco to be responsible for all maintenance.
	S21C Murrayfield Stadium Underpass New	Infraco			Infraco to be responsible for all maintenance.
	S21D Murrayfield Training Pitches R/W New	Infraco			Infraco to be responsible for all maintenance.

Task or Activity	Sub-heading	Maintenance Works to be undertaken by:	Frequency	Minimum Response Time	Comments
	S21E Water of Leith Bridge New	Infraco			Infraco to be responsible for all maintenance.
	S22 Balgreen Road Bridge New	Infraco			Infraco to be responsible for all maintenance.
	S23 Carrick Knowe U/B New bridge carrying trams and cycles	CEC			CEC to be responsible for the ongoing structural maintenance. Infraco will be responsible for day-to-day maintenance.
	S24 Saughton Road Bridge Existing WEBS bridge	Infraco			Infraco to be responsible for all maintenance. This structure was constructed as part of the WEBS project. Full construction drawings were supplied to ensure that the structure is integrated into the tram system without any modification. An assessment report confirming this is available.
	S25 Broomhouse Road Bridge Existing WEBS bridge	Infraco			Infraco to be responsible for all maintenance. This structure was constructed as part of the WEBS project. Full construction drawings were supplied to ensure that the structure is integrated into the tram system without any modification. An assessment report confirming this is available.
	S26 South Gyle Access Bridge New tram only bridge	Infraco			Infraco to be responsible for all maintenance.

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Task or Activity	Sub-heading	Maintenance Works to be undertaken by:	Frequency	Minimum Response Time	Comments
	S27 Edinburgh Park Station Bridge New tram only bridge	Infraco			Infraco to be responsible for all maintenance.
	S28 A8 Underpass New	Infraco			Infraco to be responsible for all maintenance.
	S29 Gogar Burn Bridge New	Infraco			Infraco to be responsible for all maintenance.
	S30-31-34 Gogar Culverts New	Infraco			Infraco to be responsible for all maintenance.
	S32 Depot Access Bridge New road bridge over tram	CEC			CEC to be responsible for the ongoing structural maintenance. Infraco will be responsible for day-to-day maintenance.
	S33 No longer required				
	W01 Lindsay Road Retaining Wall New	CEC			CEC to be responsible for the ongoing structural maintenance. Infraco will be responsible for day-to-day maintenance.
	W02 Ferry Road Retaining Wall New	CEC			CEC to be responsible for the ongoing structural maintenance. Infraco will be responsible for day-to-day maintenance.
	W03-04 Russell Road Retaining walls 1&2 New	Infraco			Infraco to be responsible for all maintenance.

Task or Activity	Sub-heading	Maintenance Works to be undertaken by,	Frequency	Minimum Response Time	Comments
	W08 Baird Drive Retaining wall New	Infraco			Infraco to be responsible for all maintenance.
	W09 Balgreen Road Retaining wall 1 New	Infraco			Infraco to be responsible for all maintenance.
	W11 Bankhead Drive Retaining. Wall New	Infraco			Infraco to be responsible for all maintenance.
	W14 & W15 Gogar Burn Retaining Walls New	Infraco			Infraco to be responsible for all maintenance.
	W16 A8 Retaining Wall New	Infraco			Infraco to be responsible for all maintenance.
	W17 Depot Internal Retaining Walls New	Infraco			Infraco to be responsible for all maintenance.
	W18 Murrayfield Tramstop Retaining Wall New	Infraco			Infraco to be responsible for all maintenance.
	W19 Gyle Stop Retaining Wall New	Infraco			Infraco to be responsible for all maintenance.

Task or Activity	Sub-heading	Maintenance Works to be undertaken by:	Frequency	Minimum Response Time	Comments
	W100 Roseburn Corridor Retaining. Structures New	CEC			CEC to be responsible for the ongoing structural maintenance. Infraco will be responsible for day-to-day maintenance.

Clarification of terms used in Tables 89 to 91 inclusive of the Employers Requirements.

Tram Stop:
Shall comprise: shelters, lighting, passenger information, platform and ramps including the paving, kerbing/cope and soft landscaping, drainage, cleansing and waste removal, seats, cycle racks (where these are directly associated with the tramstop, ticket machines and waste bins).

Rail and Rail Containment

Shall comprise: the rail and rail drainage (up to the point where this ties in to existing road drainage), and the structural elements that contain its permanent placement, and any associated road repairs where these are a consequence of the tramway maintenance. In the case of Roseburn Corridor it shall also include the grass track, up to and including the kick-rail and fencing separating the tramway from the cycleway/footpath.

Overhead Line Equipment

Shall comprise: the pole, the overhead power line and any necessary equipment to allow the permanent placement of the overhead power line.

Tram duct access chambers

Shall comprise: chamber/manholes and permanent covers to access points to the tram related duct access points along the route.

Temporary tram signs

Shall comprise: traffic signs, including temporary speed restriction signs, which are erected from time to time for limited periods over and above permanent tram signs.

Coloured/textured surfacing for tram

Shall comprise: specialist coloured and textured surfacing, including skid-resistant and edge demarcation surfacing, which is laid specifically for hazards directly associated with the tram track over and above that required for general traffic.

Grass Track

Shall comprise: the rail and rail drainage and the structural elements that contain its permanent placement, and any associated repairs, all within the boundaries defined by kick-rails and/or fence/retaining walls.

Structures

"Day-to-day" maintenance of structures will comprise cosmetic treatments including cleaning, the removal of graffiti and localised repairs of paintwork where this is required as a result of graffiti removal.

"Structural maintenance" of any structures will comprise renewal of waterproofing and associated road surfacings; repairs to brickwork, masonry, concrete or steel; repairs to facings and cladding; repair and/or replacement of bearings; repairing 3rd party damage; and any other maintenance activity not mentioned in the "day-to-day" activities above. Where this will require the removal of the rails or its containment is required prior to the structural maintenance then this will be undertaken in all instances by Infraco and reinstated upon completion of the works.

Where activities are the obligation of the Infraco or the Infraco's Sub-contractors, or the Infraco is supporting other parties' roads, structures and Roseburn Corridor obligations, Infraco shall ensure that such obligations are fulfilled, to ensure the safety of the Edinburgh Tram Network is not degraded and that the ability of Infraco, Tram Maintainer, **tie** and the Operator to achieve their objectives is not frustrated.

40.2.3 Maintenance Approach

The approach to maintenance of the Edinburgh Tram Network (**"ETN"**) shall be as follows:

- All day to day maintenance and inspection activities and planned life cycle renewals and refurbishments shall be planned, organised, undertaken and safely handed back to the Operator in an operational condition as required by the Infrastructure Maintenance Plan and the specifications (against which the ETN is built) and procedures;

- All activities carried out under the scope of the Infrastructure Maintenance Plan shall be the responsibility of the Infraco manager responsible for the maintenance obligations;

- All day to day maintenance, inspection activities and life-cycle replacement works shall be carried out in accordance with agreed procedures and method statements, in the knowledge of, and in liaison with, the Operator;

- Infraco will maintain system interfaces (e.g. Wheel / Rail or Pantograph / OLE), to the best effect for the ETN as a whole.

- Maintenance and life-cycle replacement works shall be classified as planned or unplanned activities arising from condition assessment which has been determined by planned inspection and testing;

- Unplanned maintenance activities shall include rapid response to unplanned equipment failure and damage from whatever cause, and shall be monitored in accordance with the fault rectification times. The approach to each of these categories will be different but there shall be two managers (the Tram Maintainer and the Infraco, with one to be designated as the lead manager) liaising with the Operator's engineering manager, who are responsible for undertaking works in their area of responsibility. These managers shall be able to call upon the services of contractors to carry out all or part of these works.

40.2.4 Maintenance Strategy

Preventative Maintenance

The Infraco shall schedule interventions such that all components that make up the infrastructure shall be subject to checks, repairs and conditioning treatments in order to maximise the asset and component lives, and in advance of critical tolerances being reached which would have affected operation, or have reduced their performance in the service for which they were designed.

Two types of preventative maintenance shall be undertaken:

- Systematic preventative maintenance that follows a predetermined schedule based upon time, usage and data gained through operational and maintenance experience such as:
  - Condition inspection and safety checks; for example, grooves for excessive wear, damage, or debris;
  - Cleaning of equipment and drains;
  - Functional tests to reveal faults; and
  - Adjustments to enable optimum operation.
- Conditional preventive maintenance including carrying out planned inspections to establish if the performance or operation of infrastructure sub systems are within pre-determined measurable parameters such as:
  - Vibration and noise levels ;

- Temperature thresholds in substation transformers etc.;
- Wear limits on rail, and wire height and stagger, etc.;
- Including non-destructive testing as appropriate; and
- Points operation times and geometric limits.

The Infraco shall take the necessary corrective maintenance action arising as a consequence of the conditions where these are out of tolerance.

Reactive and Fault Correction Maintenance

The Infraco shall repair or change damaged or faulty equipment, following the observation of any failures and/or the occurence of incidents. This involves two kinds of intervention:

- Breakdown in service requiring specific intervention shall be limited to re-establishing safe, robust and sound operating conditions. This shall require a specific intervention, to be carried out by Infraco staff within the limits of the equipment and operating rules and procedures agreed with the Operator and **tie**.
- Repairs: this covers interventions that shall be undertaken following incidents or failures that occur in operation, potentially involving a longer stoppage of equipment including overhauls of parts of a sub-system or section of the line. This is an intervention of lasting character, carried out by maintenance staff or contractors. After repair, if equipment has been replaced, then it shall conform to its original specifications or such alternative standards as agreed with **tie**; or in the event that the equipment is reconditioned then it shall conform with allowable tolerances.

Response times for reactive and fault correcting maintenance will be based on the potential impact of the incident or failure. A response to an incident is to be initiated within the time limits specified in Clause 52 of the Agreement. Fault Correction times are detailed in the table on the following page.

Table 96 - Fault Correction Requirements

Fault category	Correction Time Limit Between 06:01-22:00	Correction Time Limit Between 22:01-06:00	Description
1	1 hour to attend and make safe and functional. 2 hours to Breakdown Intervention	2 hours to attend and make safe and functional. Rectified by 07:30	Critical issue such as Health & Safety risk, or failure halting the operation of the tram network in whole or part thereof, failure of major system
2	2 hours	3 hours	Failure impacting the punctuality of the tram network, or having potential to impact.
3	8 hours	9 hours	Failure or incident not having immediate impact on network operation, but impacting the quality of the Transport Services as monitored by the Edqual Service elements in Schedule 7 of this Agreement
4	1 week	1 week	Failure or incident not impacting network operation, nor quality of the Transport Services as monitored by the Edqual Service elements in Schedule 7 of this Agreement
Tramstop equipment cleaning Fault - Offensive Graffiti and fly posting	2 hours	2 hours	
Tramstop equipment cleaning Fault - Graffiti	5 hours	5 hours	

Fault category	Correction Time Limit Between 06:01-22:00	Correction Time Limit Between 22:01-06:00	Description
Tramstop cleaning Fault – Other	24 hours	24 hours	
Tramstop lighting Fault	2 days	2 days	
Tramstop telephone Fault	3 days	3 days	
Fault causing the lift at Murrayfield Tramstop or depot to be out of operation	6 hours	6 hours	
Tramstop electronic passenger information display Fault	2 days	2 days	
Tramstop PA system Fault	24 hours	24 hours	
Tramstop CCTV Fault	2 days	2 days	
Defect, fault or other disrepair that restricts access to all or part of a Tramstop or otherwise interferes with its use	1 day	1 day	
Defect, fault or disrepair	24 hours	24 hours	

Fault category	Correction Time Limit Between 06:01-22:00	Correction Time Limit Between 22:01-06:00	Description
causing a trip hazard at an Tramstop (including unintended changes of floor levels or protrusions from the floor of more than 25mm)			
Defect degrading system access to below DDA requirements	6 days	6 days	
Broken glass at a Tramstop or the depot	2 hours	2 hours to attend, make safe and functional. Rectified by 07:30	
Overflowing / damaged gutter at a Tramstop or the depot	24 hours	24 hours	
Structural defect, fault or other disrepair at a Tramstop or the depot	28 days	28 days	
Any other defect, fault	5 days	5 days	

Fault category	Correction Time Limit Between 06:01-22:00	Correction Time Limit Between 22:01-06:00	Description
or other disrepair at a Tramstop or the depot (including in relation to shelters, seats, canopies, signage, cycle parking, litter bins and poster cases) but excluding blocked drains, overgrown vegetation and fencing faults.			
Blocked drain other than on a street running section of the Edinburgh Tram Network System	24 hours	24 hours	
Blocked drain on a street running section of the Edinburgh Tram Network System	2 hours	By 07:30 if notified between 22:01 and 05:30	
Overgrown	3 days	3 days	

Fault category	Correction Time Limit Between 06:01-22:00	Correction Time Limit Between 22:01-06:00	Description
vegetation			
Defect, fault or disrepair fencing such that access to the track or buildings and equipment is not prevented	6 hours	6 hours	
Defect, fault or disrepair in respect of a Monitoring Point or any other electronic monitoring equipment	24 hours	24 hours	
Structural defect, fault or disrepair other than at a Tramstop or the depot	28 days	28 days	
Any other defect, fault or disrepair other than at a Tramstop or the depot	2 days	2 days	

Note:

The foregoing table concentrates on elements not covered by the punctuality and qualitative criteria of the Performance Monitoring Regime set out in Schedule 6 to the Agreement.

The Infraco shall develop an electronic system for the management of reactive and faulting maintenance. The system shall be based upon the electronic Event Logger which will be situated in the Control Centre and shall enable the accurate analysis, reporting and logging of faults and other reactive maintenance requirements (including cleaning) including the time and date when they were reported and the time and date when they were cleared. Infraco shall manage all faults through to a satisfactory resolution and will provide a full record and audit trail including details of how the resolution was achieved and the time taken to achieve it. The full details of the system to be agreed with **tie** and shall form part of the asset management system as referred to in these Employer's Requirements.

Life Cycle Maintenance

The Infraco shall refurbish and replace elements of infrastructure before its performance deteriorates below the design, stated tolerances or equipment has become obsolete and/or is incurring disproportionately high maintenance costs as assessed by the Infraco and proposed to **tie**. The initial lifecycle replacement plan will be based upon the manufacturer's stated design life, Infraco's previous experience, and assumptions on the impact of designed use.

Subsequent annual updates will take into account condition and reliability data gathered during the inspection, maintenance and operational use.

Further Maintenance Activities

In respect of the ETN, the Infraco shall in addition to preventive, life cycle and reactive maintenance undertake the:

- Removal of graffiti;
- Repair vandalism and accident damage; and
- Cleaning.

Repair of vandalism and accident damage and removal of graffiti will be undertaken by the Infraco and, where this is not caused by the Infraco or any of the Infraco Parties, the Infraco shall be entitled to payment for additional labour and material required in accordance with the Schedule of Agreed Prices.

40.2.5 Organisation, Training and Competency

Staffing Plan, Recruitment and Training Plan

The description of the Infraco organisation for all aspects of maintenance and all management and administrative support shall be set out in Infraco human resources plans (staffing plan and recruitment and training plan). These documents shall contain all details of:

- Organisational structure;
- Job descriptions and required competencies;
- Standard training courses;
- Compliance with all appropriate Law and regulations;
- and the procedures required to:
  - Recruit staff to fulfil the various employee roles and maintain the required establishment;
  - List the scope of items to be sub-contracted by the Infraco;
  - Monitor the performance and competency of maintenance staff whether direct labour or contractors; and
  - Secure and review the required competencies and associated training courses.

The maintenance documents submitted in draft form with the Infraco Proposals shall subsequently be developed and agreed with **tie** and Operator as part of the Infraco Works. This will include the identification of key staff. These documents shall be reviewed and updated when necessary, and at least annually.

It is to be expected that there will be an element of staff turn-over during the contract period. The Infraco shall include in the plan their process of ensuring quality is maintained and knowledge is managed and maintained. The proposed replacement of any key staff member of Infraco shall be notified to **tie** and to the Operator.

40.2.6 Quality, Health, Safety and Environmental

Health and Safety

For all matters relating to Health and Safety, Infraco shall produce and maintain a Safety Management Plan, which shall comply with the requirements of ISO18001 and be certified by an ISO approved body. The Safety Management Plan shall be reviewed and updated when necessary, and at least annually.

Environmental and Sustainability Management

For all matters relating to environmental and sustainability management Infraco shall produce an Environmental Management Plan. This shall set out the various environmental legal and regulatory requirements that Infraco shall comply with and the Infraco standards, processes and procedures that will enable compliance with such environmental, legal and regulatory requirements, to also meet its obligations under the various agreements to which it is a party, the **tie** Environmental and Sustainability policy and shall in all respects comply to the requirements of ISO 14001 and be certified by an ISO approved body.

The Environmental Management Plan shall be submitted to **tie** prior to completion of Section A on Site, and shall be reviewed and updated when necessary, and at least annually.

Quality

The Infraco HSQE Manager shall be responsible for providing a Quality Management Plan within the Quality Management System which shall comply with the requirements of ISO 9001 and be certified by an ISO approved body. The Quality Management Plan shall be available at least three months in advance of any maintenance activities commencing. The Infraco HSQE Manager shall be responsible for auditing and inspecting the requirements of all Infraco plans, processes and procedures.

The Quality Management Plan shall be submitted to **tie**, and shall be reviewed and updated when necessary, and at least annually.

Safety

The Infraco shall develop, to the satisfaction of **tie**, the Independent Competent Person as defined under the ROGs regulations, HMRI and other Approval Bodies, a generic safety management system for the commissioning and operation of the ETN that complies with the ROGs regulations.

The generic safety management system shall be capable of development to a full and final version prior to commencement of commissioning of the ETN.

The preliminary work on the safety management system will include the production of a safety justification framework document that will indicate the likely format and some of the detail of the eventual Case for Safety that the Operator, Infraco and Tram Maintainer will be required to present to, and gain approval from, the Competent Person as defined under the ROGs Regulations.

The framework document will be drafted in conjunction with the Operator and **tie** and in consultation with the Competent Person, as defined under the ROGs Regulations and other relevant Approval Bodies describing how system safety is achieved through system design supported by system maintenance and system operation. It shall embrace the following subject areas:

- Description of system design, maintenance and operation: Introductory section giving general description of the ETN, identification of safety responsibilities and reporting mechanisms;
- Arrangements during construction and initial access to the lines: organisation and management of working staff, safety, emergency arrangements, identification of staff, insurance, safety audit, arrangements for keeping and distributing records;
- Arrangements for testing and staff training: organisation and management of staff, safety arrangements including staff working on the tramway, emergency arrangements, identification of staff, insurance, fault analysis, safety audit, arrangements for keeping and distributing records;
- Infrastructure management: track, speed limits, public crossings (surface and bridges), fencing, Tramstop infrastructure, monitoring and reporting systems;
- Tram operation arrangements: operating arrangements including fitness and training of staff, certification of staff, tram preparation, defect repair and breakdown procedures and communications;
- Tramstop arrangements: access for contractors, control of access and vandalism and security;
- Tram maintenance arrangements: engineering and operational acceptance of tram vehicles, competence of staff engaged on maintenance, quality assurance, technical audit, monitoring, reporting of defects, procedure for imposing operating restrictions, acceptance of trams for the transport services;
- Infrastructure maintenance: inspection procedures, accreditation, control and monitoring, reporting procedures, emergency arrangements, communications, signage and warnings in the operating environment;
- Interfaces with other organisations: liaison with emergency services, HMRI and Roads authorities;

- Risk assessment: assessment of the risks associated with all aspects of the project operations including groups of people most at risk, severity of failure event and likelihood of event occurring;

- Health and safety policy: policy statement, monitoring arrangements, alcohol and drug policy including testing and disciplinary action; and

- Code of practice for working on or near the line;

- Control of safety critical work.

40.2.7 Liaison with tie and Other Parties on Maintenance Related Issues

Infraco Communications Plan

The Infraco shall create a Communications Plan (which shall be agreed with **tie** as part of the finalisation of the Infrastructure Maintenance Agreement) for all matters related to communications between the Infraco, the Operator, Tram Maintainer, **tie**, TEL, CEC and if required by **tie** other third parties.

A Communications Plan shall be submitted to **tie** prior to commencement on Site, and shall be reviewed and updated when necessary and at least annually.

The Infraco shall establish effective lines of communication with the Operator and **tie**, through the control centre and planning staff in order to plan maintenance activities around tram service requirements. The Infraco shall pay particular attention to communication in respect of the planning and undertaking of works having a direct impact on the operation of the ETN, the return to full service following completion of the maintenance and unplanned maintenance activities or repairs covering day to day operations and tie/third party long-term contractual matters.

The Infraco shall provide details of how effective lines of communication with the Operator and **tie** will be set up and maintained throughout the Term. This will include details of how key staff and expertise will be provided "on call" at all times to the Operator in the event of unforeseen breakdowns etc. Infraco shall after liasing with the Operator propose a process for system / equipment handover after the completion of maintenance activity to be agreed with **tie** and a programme of daily meetings to discuss punctuality performance (and associated deductions) and infrastructure availability.

The Communications Plan shall be aligned with that of the Operator and Tram Maintainer to ensure communication in critical areas, such as health and safety management, access arrangements for maintenance and response, and permits to work, are coordinated.

40.2.8 Reporting

Annual Review

Infraco shall prepare an annual review report, "The Annual Review Report". The content of the Annual Review Report shall be agreed with **tie** and address the following, as a minimum:

- Health and safety, environmental and quality annual performance reports and proposals for improvement;
- Annual report on planned, reactive and lifecycle maintenance activities carried out against programme, together with impact of shortfalls and proposals for recovery;
- Overall system performance, trends in condition or failures and recommendations based on learning though the process of delivering maintenance; and
- Summary and classification of complaints and significant events, together with actions taken / recommended.
- Recommendations based on learning though the process of delivering maintenance.

Infraco shall be responsible for arranging each year's Annual Review Meeting, to take place, as nearly as possible, twelve months after the previous year's Annual Review Meeting.

Infraco shall issue the meeting agenda and all required management reports and papers, as agreed with **tie**, no later than five working days in advance of each meeting.

Reporting period review

The reporting period review report shall include comprehensive details to cover as a minimum the following information for the relevant Reporting Period:

- Output from performance measurement system with associated performance deduction calculations as Schedule 7;
- Details of all events after associated with failures to provide Available Infrastructure and Available Trams;
- Health and safety, environmental and quality reports;

- Maintenance report showing progress against Annual Maintenance Plan and detailing the programme for the upcoming eight weeks, including;
    - A statement on planned maintenance, including cleaning, performance during the Reporting Period and any backlog;
    - Report on reactive and fault correcting maintenance, including cleaning, required during the Reporting Period, impact on Tram service, and any wider implications to the service and the Maintenance;
    - Any planned future works to be carried out within the eight week period, howsoever arising, which have the potential to disrupt the operation of the Edinburgh Tram Network service; and
    - Infrastructure condition, failures in the Period and mitigation undertaken in Period and with recommendations and actions to be taken, complaints and any significant events.

Infraco shall schedule the Four weekly Review Meetings no less than one month in advance of each meeting.

Infraco shall issue the meeting agenda and all required management reports and papers, as agreed with **tie**, later than five working days in advance of each meeting.

Records

Infraco shall maintain all records necessary for the effective delivery of the maintenance services. All records shall to be up to date within ten Business Days of the end of the relevant Reporting Period relating to the specific record. Records are to be the property of **tie**, access to the records will be afforded to **tie** within five days of a request being made. Records will be kept for the longer of the Term or 6 years from the day the maintenance service was performed.

The record details, including format, storage medium, recovery procedure, administration and access, are to be proposed within the draft Communication Plan, and discussed and agreed with **tie** in conjunction with the final Communications Plan.

The agreed method of communicating a request will be included within the Communications Plan.

40.2.9 Infrastructure Maintenance Plan - Overview

Infraco shall develop and deliver a Maintenance Plan that ensures that all the Infrastructure assets and equipment safely continue to meet their designed operational performance or specification, meet the availability targets identified within the Contract, and support the achievement of the performance regime.

40.2.10 Development of the Plan

An Infrastructure Maintenance Plan shall be developed by Infraco and submitted to **tie** prior to commencement of maintenance activities. This shall detail how maintenance will be delivered in response to the infrastructure maintenance requirements; where it is not possible to include elements of detail at the time, a development plan will be included, identifying exactly what information is outstanding, and when it will be provided.

The completed Infrastructure Maintenance Plan will be submitted by the date identified in the development plan and agreed with **tie**.

During the operational phase Infraco shall submit to **tie** an annual infrastructure maintenance plan for review and approval three months before the anniversary of the Service Commencement Date of the Edinburgh Tram Network or part thereof. The new plan will detail the planned and life cycle maintenance for the following year in order to provisionally approve planned works. The process of approval is to be agreed with **tie** during the tender stage.

Life Cycle Requirements

A Lifecycle Replacement Plan shall be included within the Infrastructure Maintenance Plan. This will detail all planned lifecycle replacement works over the Term.

The annual updates to the Infrastructure Maintenance Plan will include an updated Lifecycle Maintenance Plan detailing life cycle replacement works until the end of the maintenance period.

The planned maintenance strategy (including cyclical and life-cycle maintenance) should be such that the performance of the Edinburgh Tram Network should never fall below that of the designed operational performance or specification, within the Term.

Reactive Maintenance Requirements

The Infraco Maintenance Plan shall detail Infraco's assumptions on the volume and type of reactive maintenance likely to be experienced in the relevant period, and should detail how their resource planning has been prepared to respond to it.

Frequencies

The Infraco Maintenance Plan shall indicate the frequency and sequence to which maintenance will be undertaken; based upon statutory obligations, manufacturer's and best practice recommendations, Contractor's experience and operational performance and availability requirements.

Maintenance Codes

A standard Work Breakdown Structure, consistent with that defined for the construction phase, shall be established to identify maintenance tasks to various infrastructure sub-systems.

40.2.11 Tools

The Infraco shall maintain and replace as appropriate, a full set of tools sufficient for the maintenance of the ETN in good condition and calibrated where necessary.

40.2.12 Availability and Warranty

The availability requirement for the Edinburgh Tram Network is contained within the performance regime.

Lack of availability of key systems or the late running of trams due to failures which are the Infraco responsibility will give rise to the imposition of performance deductions from the fee payable under Schedule 6. Details of the performance regime are set out in the Schedule 6.

During any warranty period or extended warranty period associated with any part and during the Term (as set out in the Agreement), a robust process shall be in place to manage the return and replacement of parts thus contributing to optimal operational service, whilst optimising the management of warranty claims under the Agreement.

40.2.13 Asset Management System

An integrated asset maintenance management and recording system shall be provided and utilised by Infraco in order for data obtained from the tram and infrastructure sub-systems or other sources to be collated and analysed. This will enable the Infraco to assess safety and performance issues and to facilitate modifications and changes, where necessary, to the maintenance plan and working practices including the asset management system itself.

A computerised asset management system shall be established, in a form to be agreed with **tie**, to facilitate maintenance of the assets and allow data obtained from the infrastructure sub-systems, trams or other sources to be collated and analysed. This will include development of an asset register.. This will enable technical staff to assess safety and performance issues and to facilitate modifications and changes, where necessary, to the maintenance plan and working practices.

In addition to recording all the assets as they arrive on site, the asset management system shall record against each discrete item provided with a serial number:

- Its date of registration;
- Its location(s), including transfers from one site or equipment to another;
- Its maintenance history, with references etc.;
- Its fault history;
- Its maintenance prognosis (when maintenance is next due etc.); and
- Overdue inspection / maintenance.

The functional details of the asset management system will be integrated with the hard copies of the suite of operation and maintenance manuals and comply with the requirements specification for an asset management system.

40.2.14 Work Instructions

Infraco shall verify that they and all sub-contractors have carried out the necessary planning to undertake all proposed maintenance activities in accordance with the Infrastructure Maintenance Plan and all necessary risk assessments, method statements and work instructions.

For each maintenance activity type, detailed work instructions will be broken down against equipment type and artisan skill set to facilitate planning of the work. Each work instruction will provide a step by step breakdown of the work involved including information about how any equipment to be worked on should be accessed and / or made safe.

40.2.15 Minimum Spare Parts Holdings

In order to cover all planned infrastructure maintenance and arising corrective maintenance, sufficient spares shall be held by the Infrastructure Maintainer throughout the duration of the Infrastructure Maintenance Agreement to ensure that delays in completing planned or corrective maintenance are not experienced due to parts unavailability.

Infraco will provide details of its planned spares holding within the Infrastructure Maintenance Plan.

The Infrastructure Maintainer shall be required to maintain, at all times, a minimum holding of certain spare parts. The schedule of minimum spare parts holding will be developed by **tie** and Infraco as part of the finalisation of the Infrastructure Maintenance Agreement. The level of minimum spare parts holding will also be reviewed every year to ensure that it is appropriate on the basis of operational experience and Infraco's ongoing requirements.

For the avoidance of doubt, the initial stock / holding of spares shall be provided as part of the initial capital expenditure by Infraco. The Infraco maintainer shall be responsible for the replacement of any spare part used and the stock / holding shall be maintained at the same level, subject to adjustments approved by **tie**, based upon experience, once the ETN is operational. Where repair is to be undertaken in-situ, information shall be provided of any special facilities or equipment required. Where equipment is to be returned to the original equipment manufacturer (or any other organisation) for repair, it shall be demonstrated that the holding is sufficient to allow for predicted turnaround times.

Wherever reasonably practicable and where cost efficient the Infrastructure Maintainer shall source as many consumable spare parts and as much repair work from approved local suppliers in the interests of cost efficiency and minimisation of lead times.

40.2.16 Maintenance Records

All maintenance work performed shall be logged for record, monitoring and audit purposes. This shall be recorded in a log book and in the asset management system.

40.2.17 Indicative Scope

Infraco shall develop their Infrastructure Maintenance Plan to include all fixed Infrastructure and mobile equipment under their responsibility; this includes, but is not limited to those identified in table below.

The maintenance of Infrastructure shall generally be based on the recommendations of the manufacturer or designer, and as set out in the operating and maintenance manual. Specific additional requirements are listed in the second column.

Table 97 - Infrastructure Maintenance Plan Scope

System, Element or Service	tie Specific Requirements
Overhead Line Electrification	
Control and Communications Systems	The common failure reporting of the SCADA system, the log files of computers and the recording devices shall be used for the detection of failures in addition to fault reports provided by the Operator. As the Closed Circuit Television (CCTV) and the Public Address System (PA) at the Tramstops and in the depot area are crucial for the security of the site, their proper functioning shall be monitored. CCTV cameras need to be cleaned regularly and recording media made available. Quick repair of any faulty or damaged CCTV equipment shall be conducted to maintain Tramstop security. It is equally essential that the information given over the PA system be clear and audible, taking into account ambient noise level at Tramstops.
Power Supplies and Sub-Stations	
Tramstops	Regular maintenance is essential to ensure that features, which were designed to prevent crime and improve the environment, do not deteriorate and present opportunities for crime and raise fears for personal security. It is also crucial to ensure that Help Points are clearly signed and well lit so that their location is clear to passengers on the Tramstop. Therefore, the quick repair of faulty or damaged equipment is essential.
Pest Control	Special planned maintenance shall be considered for vermin

System, Element or Service	tie Specific Requirements
	control, pigeon shoots and the removal/ cleaning of birds' droppings and nests. These activities shall be scheduled as required and every six months intervals maximum throughout the ETN.
Depot Building and Yard	Special planned maintenance shall be considered for vermin control, Pigeon shoots and the removal/cleaning of birds' droppings and nests. These activities shall be scheduled as necessary and every six months intervals maximum. Infraco will ensure that safe, secure, access and use of the facilities is not impeded by adverse weather conditions such as snow and ice.
Lighting for Depot Building, Depot Yard, Tramstops, P&R Site, Control Centre and Offices	
Track Work and Roads	
Landscaping	A landscape and vegetation plan shall be developed and adhered to by Infraco to summarise the responsibilities and frequency and scope of the management of trees on, or closely adjacent to, the System (see Third Party Agreements (Schedule 13) and the Code of Maintenance Practice).
Structures	Regular drain clearing
Internal Workshop Equipment	This equipment should be supplied to Infraco with the corresponding operating instructions, which also contain instructions for proper maintenance.
External Workshop Equipment	
Infraco Road Vehicles	Maintenance of vehicles shall be in line with best practice and legislative requirements

40.2.18 Cleaning Maintenance Plan

Within the Infrastructure Maintenance Plan Infraco shall include a cleaning plan which shall detail the cleaning schedule for all infrastructures and equipment for which Infraco have responsibility. In addition to scheduled cleaning, if required by **tie,** Infraco shall provide a reactive cleaning service to respond to specific incidents causing litter or hazards. Where this requires additional material or labour, the scope and costs shall be agreed in advance in writing in accordance with the Agreement.

40.2.19 Track and Infrastructure Cleaning

The Infraco shall ensure that all locations for which Infraco has responsibility are kept free of rubbish and litter. The locations shall be cleaned in accordance with the location categories defined in any Regulations made under the Environmental Protection Act 1990. These categories are:

- Category 1 Walkways linking to public rights of way or road;
- Category 9 Railway embankments in urban areas.

The complete ETN shall be litter picked once every six months on average with the area within the Tramstop being litter picked every month.

Infraco cleaning of Tramstops shall be limited to the following:

- CCTV cameras;
- Passenger Information Displays; and
- Public Address speakers.

40.2.20 Depot Building and Yard, Offices and Car Park

Infraco shall ensure that all locations for which Infraco has responsibility are kept free of rubbish and litter. The areas within the Depot shall be cleaned in accordance with the frequencies stipulated in the Infrastructure Maintenance Plan, but no less than the following:

- Toilets – once a day;
- Canteen areas – once a day;
- Offices – once a day;
- Corridors and communal areas – once a day;
- Workshop area – once a day; and
- Car Park and Depot Yard – once a week.

40.2.21 Cleaning Records

All cleaning work performed shall be logged for record, monitoring and audit purposes. This shall be recorded in a log book and in the CMS.

40.3 Tram Maintenance Strategy

40.3.1 Purpose

The purpose of this tram maintenance section is to describe how Infraco shall procure that Tram Maintainer shall meet its obligations under the Tram Maintenance Agreement and its obligations under the Operators safety justification document in respect of maintenance and all references to Tram Maintainer responsibilities in this section shall be read as Infraco responsibilities and the Infraco shall have overall responsibility for the compliance. This includes the fleet of trams supplied under the Tram Supply Agreement and any relevant plant and equipment for which the Tram Maintainer is responsible. The final version of the Tram Maintenance Plan, to be developed by Tram Maintainer in response to these Employer's Requirements, will set out the specific objectives for the pre-operational period and the first twelve years of operation, following which this document may be reviewed. This Tram Maintenance section should be read in conjunction with the Tram Maintenance Agreement, and with such 'as-built' technical documentation and operation and maintenance manuals as shall be provided by the Tram Supplier.

The Tram Maintenance Plan shall be a fully controlled document. The Infraco shall procure that Tram Maintainer will take into account all mandatory requirements in force at the time of issue. It shall be updated annually allowing a three month review period to take cognisance of operational experience.

40.3.2 Scope

This Tram Maintenance section covers the maintenance activities for the following:

- Tram servicing & maintenance (planned activities);
- Tram repairs (unplanned activities); and
- Cleaning of the trams (primarily the responsibility of the Operator).

Where certain activities are the obligation of parties other than Tram Maintainer, the Tram Maintenance section will describe how the Tram Maintainer shall ensure that such maintenance obligations are fulfilled, so as to ensure the safety of the ETN, is not degraded and that the ability of the Operator to achieve its objectives is not frustrated.

Table 92 – Infrastructure and Equipment Responsibilities Allocation Matrix and *Table 86 - Depot Plant and Equipment to be Provided* identifies the scope for which the Tram Maintainer is responsible.

Overall Objectives

The overriding objective is to operate a safe, reliable, punctual, clean, easily accessible, comfortable, and environmentally friendly transport service which meets **tie**'s expectations.

The Tram Maintenance Plan will be developed to deliver this objective by:

- Co-operation with Infraco to achieve the aims of the Tram Maintenance Agreement;
- Meeting the specific requirements under the Tram Maintenance Agreement, particularly the defined performance standards in respect of tram availability and reliability;
- Diligent management of subcontractors to ensure they fulfil the requirements of their subcontracts;
- Adherence to the relevant Operations and Maintenance Manuals;
- Setting up and adherence to schedules and programmes for all planned work;
- Co-operation with interfacing parties and in particular the support of any obligations they have under a 'Safety Case', 'Safety Management System' or Legislation;
- Awareness of, and compliance with, legislation, statutes, regulations, and standards governing the operation of the Tramway and any changes thereto. (This will include reviews to identify any necessary changes to any established operating procedures for Phases 1a and 1b); and
- Establishing and maintaining lines of communication with all interfacing and affected parties by means of scheduled meetings, public meetings and consultation. Each year the Tram Maintainer shall undertake programmes to improve the safety, performance, and delivery of the Tram service. These programmes shall be developed in the form of a performance improvement plan which shall be included in future issues of the Operations and/or Tram Maintenance Plan.

Maintenance Approach

The approach to maintenance of the Trams shall be as follows:

- All day to day maintenance and inspection activities and any "special works" are to be planned, organised, carried out and safely handed back to an operational status under the requirements of this Tram Maintenance section and Infraco and/or Operator procedures and regulations;

- All activities carried out under the control of the Tram maintenance plan are the responsibility of a named Tram Maintainer manager (or his named deputy) responsible for the maintenance obligation;

- Maintenance activities are classified as planned, or unplanned arising from condition determined from planned inspection and testing;

- The approach to each of these classifications will be different but essentially there will be two managers (Tram Maintainer and Infraco) liaising with the Operator's Engineering Manager, for carrying out the works in their area of responsibility with Infraco having overall responsibility. Subject to prior approval, these managers may call upon the services of approved sub-contractors to carry out some of these works; and

- Tram maintenance staff will have been trained to drive the Trams within the Depot and will do so when Operator drivers are unavailable to do so.

- The Tram Maintainer shall minimise the operational downtime of the tram vehicles or any other equipment under its control for maintenance.

Table 98 - Maintenance Plan

Maintenance Activity	Planned Frequency	Responsible Manager	Contracted out to External Supplier – Tenderer to complete
Inspection of Trams	Yes See Appendix 1	Tram Maintainer Manager	
Servicing of Trams	Yes See Appendix 1	Tram Maintainer Manager	
Maintenance & overhaul of Trams	Yes See Appendix 1	Tram Maintainer Manager	
Cleaning of trams Sanding, consumable replenishment	Yes See Appendix 1	Operator	N/A
Repairs as required to trams to deliver the timetable (including	Unplanned	Tram Maintainer Manager	

accident damage and vandalism repairs)			

40.3.3 Organisation, Training, and Competency

Staffing Plan, Recruitment & Training Plan

The description of the Tram Maintainer organisation for all aspects of the operation, maintenance, and all management and administrative support of Phases 1a and 1b shall be set out in the Tram Maintainer human resources plans, staffing plan and recruitment and training plan. These documents will contain details of:

- Job descriptions and required competencies; and
- Standard training courses;
- and the procedures required to:
  - effectively recruit staff to fulfil the various employee roles;
  - monitor their performance; and
  - secure and review the required competencies and associated training courses.

These documents shall be agreed with **tie** as part of the finalisation of the Tram Maintenance Agreement.

40.3.4 Quality, Health, Safety, & Environment

Health and Safety

For all matters relating to health and safety the Tram Maintainer shall produce a Safety Management Plan which shall be agreed with **tie** as part of the finalisation of the Tram Maintenance Agreement. This Plan shall set out all relevant or appropriate regulatory requirements that the Tram Maintainer has to comply with, and the Tram Maintainer standards and procedures that it will have to develop to comply with legislation. The Plan will also meet the obligations under the Tram Maintenance Agreement. The Safety Management Plan must not prejudice the Operator safety case. The Tram Maintainer shall operate complaint to ISO 18001.

Environment

For all matters relating to environmental management, the Tram Maintainer shall produce an Environmental Management Plan which shall be agreed with **tie** as part of the finalisation of the Tram Maintenance Agreement. This Plan shall set out all relevant and appropriate regulatory requirements that the Tram Maintainer shall comply with, and the Tram Maintainer Standards and Procedures that it will have to develop to comply with legislation. The Plan will also meet the obligations under the various Agreements. The Tram Maintainer shall operate in compliance within EN14001.

Quality

The Tram Maintainer shall be responsible for quality in so far as implementing the requirements of the above two plans in respect of auditing and inspecting the requirement of all Tram Maintainer plans and procedures. The Tram Maintainer shall operate to and achieve accreditation to ISO 9002.

40.3.5 Liaison with Promoter & Other Parties on Maintenance Related Issues

Communications Plan

The Tram Maintainer shall create a Communications Plan (which shall be agreed with **tie** as part of the finalisation of the Tram Maintenance Agreement) for all matters related to communications within Infraco, the Operator, and all relevant third parties and stakeholders.

It is critical that the Tram Maintainer establishes effective lines of communication with the Operator, through their Control Centre, in order to plan the maintenance activities around service requirements. This specifically relates to the withdrawal of Trams for planned preventative maintenance and returning of Trams for service following completion of these activities and unplanned maintenance activities or repairs.

The Tram maintainer will provide details of how effective lines of communication with the Tram Operator will be set up and maintained throughout the period of the Tram Maintenance Agreement. This will include details of how key staff and expertise will be provided 'on-call' at all times to the Operator in the event of unforeseen tram breakdowns etc. It will also include a system for Tram handover after the completion of Tram Maintenance activity and a programme of daily meetings to discuss punctuality performance (and associated deductions), tram defect status and future Tram utilisation.

40.3.6 Tram Servicing and Maintenance Plan

Fleet Overview

The Tram fleet for Phases 1a and 1b will consist initially of 27 Trams, each capable of carrying about 250 passengers.

The Trams will be maintained at a new purpose-built depot.

40.3.7 Maintenance Plan Overview

All planned and preventative inspection and maintenance shall be carried out using a programme that shall be agreed annually between **tie** and Infraco. A balanced programme is required for this type of rolling stock, enabling the most efficient use of Tram downtime.

Maintenance schedules and examination job titles in this document have been drawn from general experience of similar vehicle types, and do not relate to any particular vehicle. It should be noted that all exams, sequences and frequencies mentioned are indicative at this stage, and will be reviewed once further fleet and maintenance contractor details are known.

Unplanned repair activities are not included in this Tram Maintenance section but shall be provided by the Tram Maintainer in terms specified in the Tram Maintenance Agreement.

40.3.8 Maintenance Strategy

Tram Planned Preventative Maintenance

There are two types of preventative maintenance which are to be carried out:

- Systematic preventative maintenance which follows a predetermined schedule such as:
  - Condition inspection and safety checks;
  - Cleaning of equipment;
  - Functional tests to reveal faults; and
  - Adjustments to enable optimum operation.

- Conditional preventative maintenance consists of carrying out regular inspections to determine that the performance, or operation of, Tram sub-systems remain within pre-determined measurable parameters, such as:
  - Vibration and noise levels;
  - Temperature threshold; motors and cooling circuits, etc.;
  - Wear threshold; wheel diameter, suspension heights/clearances, and pantograph height, etc.; and
  - Door operation times.

Tram Corrective Maintenance

This type of maintenance entails repairing or changing faulty equipment, through observation of failures. It involves three kinds of intervention:

- Breakdown in service requiring specific intervention. Immediate repairs are to be carried out rapidly to clear the line as quickly as possible. This activity is limited to re-establishing sound operating conditions and assisting the Operator to re-establish operational headways. Unless a repair can be rapidly undertaken to ensure safe, normal operation of the affected Tram for the remainder of the day, the affected Tram should be withdrawn from service and returned to the Depot where a more permanent repair, under controlled conditions, may be carried out.

- Repairs. This covers interventions carried out following incidents or failures that occur in operation, or identified from routine maintenance activity, generally involving a longer stoppage of equipment including overhauls of an entire Tram or major Tram component or operating system. This is an intervention of lasting character, carried out by maintenance staff (or approved sub-contractors). After repair, the Tram must conform to its original specifications.

- Whilst not strictly a breakdown, the Tram Maintainer shall also be required to assist with the recovery of any Tram derailment occurring on the line and carry out the appropriate re-railing technique, irrespective of the cause of the derailment. The Tram Maintainer will advise the Operator of the safe condition, or otherwise, when re-railing of the Tram has been completed.

Further Maintenance Operations

Preventive maintenance and corrective maintenance must be complemented by:

- Operations that contribute to the good image of public transport (appearance and comfort) such as removal of graffiti and re-applying freshening up paintwork, that cannot be achieved by the Operator through routine cleaning methods; and

- Checks on wheel condition (profile and flats).

The final version of the Tram Maintenance Plan shall include the proposed programme for all Tram preventative maintenance and further maintenance operations.

The periodicity/interval and duration or all planned preventative maintenance activities shall be specified in the final version of the Tram maintenance plan. It is anticipated that most intervals will be fixed-time intervals based upon calculated scheduled service distances, to be specified by the Tram Supplier. If any activities are specifically based upon a kilometreage based interval, which cannot readily be related to elapsed time, this should be made clear in the proposal.

The various examination types, based on their interval shall be categorised by code letter and the activities to be undertaken shall be fully detailed. The information should be summarised in the form of a matrix or star/dot chart where the breakdown of exam type is shown labelled on one axis and equipment or sub-system to be worked on is labelled on the other axis.

The Tram Maintainer will also create a list of standard repair times for items that are susceptible to damage or failure in service, such as replacement of glazing, lower front skirts, pantograph etc. Where possible, standard durations for repair and fixed prices for these repairs shall be established.

Maintenance Codes

A standard set of maintenance codes should be established to identify maintenance tasks to various Tram sub-systems:

The following standard set of codes is proposed (and are used in the Star Charts) and should be developed further as the details of the Tram design and recommended maintenance approach are understood:

Table 99 - Star Charts

Code	Area
A	Sanding System
B	Brakes
C	Bodywork
E	Battery and Control Systems
F	Radio and communications systems
G	Pantograph
H	Heating and Ventilation
I	Interior Trim and Fittings
M	Electrical Machines
O	Doors
P	Electrical Traction Power Equipment
T	Mechanical Transmission
U	Underframe and Bogies
Z	Emergency Equipment

Maintenance star charts setting out the indicative periodicities for maintenance activities shall be developed as part of the Maintenance Plan.

These star charts are to be developed in line with the finalisation of the Tram Maintenance Agreement and Tram Supplier's recommendations.

40.3.9 Availability and Warranty

The availability requirement for phases 1a and 1b of the ETN will be established in detail during the tendering process. Where possible, at peak periods and for special events, all trams should be made available.

Any lack of availability will give rise to the imposition of availability deductions from the fee payable under the Tram Maintenance Agreement. Details of the availability performance regime are set out in the Tram Maintenance Agreement. This also sets out the requirement for a 'hot spare' Tram and for Trams to be available for training purposes outside of peak hours.

During the Warranty and Extended Warranty period (as set out in the Tram Supply Agreement) a robust process must be in place to manage the return and replacement of parts thus ensuring optimal operational service, whilst optimising the management of warranty claims under the Tram Supply Agreement.

40.3.10 Technical Management

An integrated, computer-based maintenance management and recording system (CMS) should be utilised in order for data obtained from the maintenance of the Trams or other sources to be collated and analysed. This will enable the technical team to assess safety and performance issues and to facilitate modifications and changes, where necessary, to the Tram Maintenance Plan and working practices.

The CMS shall also provide a real-time configuration management control system of the Trams by recording serial numbers of all components on the Trams. This record shall also be updated whenever components are exchanged or replaced during maintenance or repair of the Trams.

The CMS will need to be capable of interfacing with Infraco and/or **tie**'s systems to facilitate remote access to maintenance management data.

40.3.11 Work Instructions

In order for Infraco to be able to verify that the Tram Maintainer has carried out the necessary planning to undertake all proposed preventative maintenance activities in accordance with the Tram Maintenance Plan, details of the work activities shall be submitted for information only.

For each exam type detailed work instructions will be broken down against equipment type and artisan skill-set to facilitate planning of the work. Each work instruction will provide a step-by-step breakdown of the work involved including information about how any equipment to be worked on should be accessed and/or removed from the Tram.

Each work instruction should, as a minimum, include details of:

- Health and safety precautions;
- Key skills and competencies required to undertake the work;
- Consumable components to be replaced;
- Special tooling (if any);

- Particular Depot facilities required; and
- Agreed time to complete the task.

40.3.12 Minimum Spare Parts Holdings

In order to cover all planned Tram Preventative Maintenance and arising Corrective Maintenance, sufficient spares shall be held by the Tram maintainer throughout the duration of the Tram Maintenance Agreement to ensure that a Tram is seldom unavailable for service due to parts unavailability.

Spares fall into the following categories:

- Consumables (brake pads, filters, bulbs etc.);
- Line Replaceable Units (repair on site);
- Line Replaceable Units (return to OEM for repair); and
- All other equipment.

The Tram Maintainer shall provide details of its planned spares holding and into which of each of the above categories each item falls.

In order to facilitate a seamless transition of Tram Maintenance services from one Tram Maintainer to another on the expiry or earlier termination of the Tram Maintenance Agreement, the Tram Maintainer shall be required to maintain, at all times, a minimum holding of certain spare parts. The schedule of minimum spare parts holding will be developed by **tie** and the Tram Maintainer as part of the finalisation of the Tram Maintenance Agreement. The level of minimum spare parts holding will also be reviewed after three years to ensure that it is appropriate on the basis of operational experience and Infraco's ongoing requirements.
Failure to maintain the minimum spare parts holding will give rise to an availability deduction being made in respect of the maintenance fee.

Where repair is to be undertaken on site, information shall be provided of any special facilities or equipment required. Where equipment is to be returned to the original equipment manufacturer (or any other organisation) for repair, it shall be demonstrated that the holding is sufficient to allow for predicted turnaround times. Estimated lead times for all other spares shall also be provided.

Where line replaceable units (LRUs) are exchanged as part of normal Tram preventative maintenance (to be brought up to optimum condition off the vehicle), the appropriate work

instruction should be explicit regarding this fact and should also state the approved time for exchange of such components. The spares holding of LRUs should be sufficient to cater for this method of working.

Wherever possible the Tram maintainer shall source as many consumable spare parts and as much repair work from approved local suppliers in the interests of cost efficiency and minimisation of lead times.

40.3.13 Cleaning Maintenance Plan

Tram Cleaning

Internal and external cleaning of Trams is the responsibility of the Operator. This will also include the removal of graffiti, except where this cannot be removed by normal cleaning methods or requires replacement of the panel(s) concerned. In such cases the panels will be replaced or made good by the Tram Maintainer. This shall also include the replacement of window glazing due to damage by etching.

The Tram Maintainer must ensure that adequate quantities of interior and exterior body panels, glazing and window sealing materials are kept in stock to meet this obligation.

40.4 Maintainability, Maintenance and Spares

40.4.1 General

An asset register shall be produced by the Infraco and the Tram Maintainer and populated by them with equipment data, serial numbers etc. The asset register shall be available prior to the commencement of delivery of equipment and materials. All spares, tools and test equipment which are delivered as part of the Works, shall be entered in the asset register.

Performance, reliability, fault / failure data shall be available that enables analysis of the Edinburgh Tram Network for product improvement.

Data shall be presented to maintenance staff such that potential causes of faults / failures are clearly identified.

Hardware components shall be easily accessible and not require specialist equipment for their removal or replacement.

Connectors shall be used which permit fast and easy disconnection and replacement of faulty / failed components and prevent dirt and moisture ingress and are suitably supported and specified for the operating environment in which they are used.

Maintenance regimes, component replacement programmes and spares holding levels shall be determined through fault tree, cause-consequence and Markov analysis, as appropriate, and ratified through the verification and validation process.

Spares that have potential long lead times, or minimum order quantities, shall be identified and adequate quantities held on site in order to achieve the performance requirements of the system including repair times.

The Edinburgh Tram Network shall be designed to facilitate inspection, repair, maintenance and fault finding without interruption to the ETN operations and performance.

Spares provided shall be sufficient to ensure the continuous operation of the system from the date of the Edinburgh Tram Network handover to **tie**. These spares shall include provision for damage and vandalism. The Edinburgh Tram Network design shall be underwritten such that all equipment / system suppliers shall warrant that all equipment in the design shall be available for the design lives specified and that they shall give **tie** a minimum of twelve months notice where after that period they intend to cease supply of that component.

Equipment housings / enclosures and their contents, e.g. racks etc. shall not exceed 2.0m in height unless specifically agreed by with **tie**.

The lowest mounting point, plug-in group or terminal block shall not be less than 0.4m above floor level unless specifically agreed by with **tie**.

Cables shall be clearly identified at each end of the cable connections by clearly visible and indelible labels. Related drawings shall describe the labelling conventions.

The maximum use shall be made of readily available and fully proven 'industry standard' materials and components. These shall remain readily available for the projected life of the Edinburgh Tram Network and which shall be supported in the market place on an ongoing basis.

Provision for handling the possible obsolescence of any of the components during the projected life of the ETN without degrading the ongoing performance of the Edinburgh Tram Network shall be individually addressed prior to supply/construction.

The detailed arrangements for the delivery, storage, management, and control of spare parts shall be agreed between the Infraco, the Tram Maintainer and the Operator as part of the arrangements for the ongoing operation and maintenance of the ETN.

In addition, Infraco shall procure that an adequate supply of consumables and spares shall be available to support the testing, commissioning and shadow running.

The Infraco / Tram Maintainer shall establish and maintain a log of all such consumables and spares used during this process and an updated copy shall be presented with each monthly progress report.
Where cables are to be provided, they shall contain sufficient slack to permit reasonable disturbance during maintenance.

40.4.2 Structures and Civil Engineering

As the bulk of these features will be static, the quantity of spares shall include those items that may suffer attrition as a result of accidents and vandalism such as signage, bollards, etc., and any special features bespoke to the ETN.

If not readily available, small quantities of special surfaces, e.g. tactile paving, etc., shall be stocked but it is anticipated that common wearing surfaces will be repaired using materials commonly available to the trade.

40.4.3 Track

In respect of track and ancillaries, the levels and numbers of spare holdings of major replacement elements, such as rails, sleepers, switch half-sets and full-sets, and crossings – 'standard' supply and more importantly of bespoke design – are considered to be of critical importance. At least one point machine, point indicator and hand operated mechanism shall be provided. Additionally, quantities of small parts and day-to-day maintenance items, together with special equipment such as buffer stops, are to be provided, based on instructions contained in the maintenance manual and on forecast component lives. In proposing the numbers of all spares holdings, the objective will be to ensure, as far as will be reasonably practicable, uninterrupted operation of the tram services.

40.4.4 Training

An indicative training plan for all parties involved in the maintenance and operation of the Edinburgh Tram Network System shall be produced and submitted to **tie** within six months of the Commencement Date. This shall be updated as required thereafter and as a minimum, be submitted to **tie** every eight months.

40.4.5 Infrastructure and Trams

Training and Competency

Staff training and competency assessments shall be carried out in accordance with best practice. The requirements of the ROGs regulations for safety critical work shall be observed.

Training Plan

An indicative training plan for all staff of the Edinburgh Tram Network System shall be produced within six months of the Commencement Date.

Both operating and maintenance training courses shall be provided for all of the items of supply associated with the Edinburgh Tram Network, including the operation and maintenance of all specialist plant and tools provided or required. All training materials and classes shall be in the English language.

The training may take place either at an individual contractor's premises or, locally on the tramway system or at other facilities to be agreed with the Operator/Maintainer and made available by the training supplier. All these arrangements shall be with the prior agreement of the Operator/Maintainer. "Maintainer" in this Section regarding Training in maintenance and operation means both Infraco and Tram Maintainer.

A training plan shall be provided for each group of trainees (i.e. Operator and Maintainer) covering all the items of supply. The plan will set out in a logical manner the order, duration, location and the content of the training to be given, the type (i.e. classroom, practical hands on) and the scope (i.e. operation, routine maintenance, first line repair, second line repair etc).

The Training Plan shall take due account of the Operator's proposed operational plan and the maintainer's proposed maintenance plan and any manufacturer's or otherwise recommended maintenance intervals for the scope of equipment supplied as well as all manufacturer's maintenance intervals for the equipment provided.

The Training Plans will clearly set out the course objectives. These will ensure that:

- All appropriate grades of operational and maintenance staff are able to perform, in a proper, effective and safe manner all necessary scheduled and reasonably foreseeable unscheduled tasks in order to functionally operate, maintain, fault find and safely restore in the shortest time in the event of any failure, the full functionality of the systems and equipment forming the Edinburgh Tram Network.

- All appropriate operational and maintenance staff are able to comprehend environmental and operational conditions, safety concepts and the health and safety requirements when carrying out their duties.

- All appropriate operational and maintenance staff are able to correctly interpret and make proper correct safe and effective use of all operational electronic data, displays and printed/written documentation presented to them in the course of their duties.

- The competence of all of the trainees shall be certified in a format that is compliant with all of the obligations placed on the employers of the trainees.

- The Training Plans shall clearly set out the level of testing of trainees, and how the certification of trainees will be achieved and documented. It shall also set out the method of participant feedback to be used following the completion of the training. Where appropriate, the testing and certification process will be split where appropriate to ensure competency on particular items of equipment, systems and methods.

- The training plans shall be agreed with **tie** and the operator prior to the commencement of the training.

Training Material

Infraco will provide, inter alia, the following training materials appropriate to the individual training session.

- Twelve sets of all training material and two sets of the Training plans and trainer's course material and notes, together with copy discs, drawings and artwork shall be provided to enable the Operator/ Maintainer to provide future training courses for himself when necessary.

- All training material, including master discs, drawings and artwork, will be updated within four months of the completion of the training on the basis of the formal feedback from attendees and the Operator/ Maintainer of 'lessons learnt' and from its practical application on the tramway on a routine basis and shall reflect all changes made to the system such that the system and training are fully aligned.

- In the event of any of the systems or equipment supplied and installed having to be modified or amended or the maintenance requirements for the same being revised within the Warranty period, the training material shall be revised and updated to reflect the changes to equipment, components or procedures that have become necessary.

Training Costs

All relevant costs, including travel and accommodation, associated with the effective training of the Operator/Maintainer's staff, on site or remote, shall be at the expense of the training provider, including materials, classrooms and instructors, but excluding the time cost for the trainees.

40.4.6 Maintenance Training

All relevant costs associated with the effective training of the Operator/Maintainer's staff, on site or remote, shall be at the expense of the training provider, including materials, classrooms and instructors, but excluding the time cost for the trainees.

Training courses and materials shall be provided in line with the Training Plans. These shall cover all operations necessary for the maintenance, repair and renewal of all the infrastructure and equipment forming the ETN systems throughout its life including items such as fault diagnosis, replacement and repair of equipment, software maintenance, system structure, integration and interfaces and hardware and software set-up.

The training shall include training on all the specialist tools and test equipment and software required to maintain and operate the system.

The training shall be structured as set out in the training plan to cover the basic theory, system operation overview, routine maintenance, first line fault rectification, second line fault rectification, renewals and software maintenance.

The training documentation shall include reference to manufacturer's documentation and also include all documentation, drawings, and technical data required to provide a single reference for the items covered by the training. The documentation will include fault identification and rectification process flow charts to assist maintenance personnel in identifying and rectifying faults. The initially recommended periodicity of inspections, tests and routine maintenance or rectification processes shall include 'pass' or 'fail' criteria. In the case of a 'failed' test, the appropriate course of action, with remedies for such inspections, tests and maintenance shall be detailed. Course documents, course content and notes shall be submitted for approval by **tie**.

Risk assessments shall be carried out on all of the proposed maintenance methods and where found to be appropriate safe systems of work shall be included within the training material and training. COSHH assessments will be carried out on all substances to be used in the training and proposed for the maintenance of the equipments. All such documentation shall be submitted to **tie** for approval.

Personal Protective Equipment for course attendees shall be provided, as appropriate, by Infraco.

Testing and certification of the attendees shall be carried out. Upon completion of the training on each section of the equipments and systems, all attendees shall be required to pass a written and practical test for evaluation and certification purposes by the trainer to confirm that personnel are competent to carry out all necessary tasks. The certification process and documentation shall be submitted to **tie**. The individual results and certification shall be fully documented and presented to **tie** and the Operator / Maintainer for their records.

40.4.7 Operational Training

Sufficient Operational Training Courses shall be provided in line with the Training Plan for all the various grades of the Operator/Maintainer's staff, to ensure that safe and proper operation of the system can be achieved throughout its life, commencing with the formal take-over of the ETN.

The training shall be structured as set out in the training plan to cover the operation of the ETN under all operating conditions, including normal running and working in the many degraded modes, and in the recovery from degraded modes.

The training shall include operator familiarisation and functional training in conjunction with the Factory and Site Acceptance Tests of the integrated system and Control Centre systems.

The training shall provide comprehensive hands-on training on the equipment and systems for all operational equipment including trams.

This shall include the simulation of a service and all associated equipments and failures.

The training shall include full details of the functionality of the tramway and control systems.

The training documentation shall include reference to manufacturers' documentation and also include all documentation, drawings, and technical data required to provide a single reference for the items covered by the training. The documentation shall include fault identification process flow charts to assist the Operator / Maintainer in identifying faults and to assist in the deployment of the correct maintenance personnel.

40.5 Information Procedures, Records and Manuals

40.5.1 General

All designers, suppliers, installers and maintainers of the Edinburgh Tram Network shall provide comprehensive documentation in support of their works. Such documentation shall be prepared in

accordance with the contractual requirements, Employer's Requirements and any other relevant documentation.

This information will be included in the form of the Project Health and Safety File. The file will be divided into Sections and Volumes in a manner to be agreed with **tie**. Each Section will be numbered in sequence and may comprise more than one volume. The volumes shall be identified by an integrated sequential numbering system.

40.5.2 Information

Information to be provided shall include, but shall not necessarily be limited to:

- Product literature;
- Design parameters, specifications, data and drawings;
- Product specifications;
- Illustrated parts lists;
- Product usage and examples of use service;
- Whole life cycle evidence and documentation;
- Maintenance and fault finding;
- Spares management, product storage and handling; and
- Health and Safety considerations and documentation.

40.5.3 Operation and Maintenance Manuals Information

Infraco shall produce for the Edinburgh Tram Network operating instructions for the system as a whole and for all individual sub-systems consolidated into an overall suite of bespoke Operations and Maintenance Manuals. This data shall be produced in hard copy form and shall also be available as an on-line database to operations and maintenance personnel.

The Edinburgh Tram Network shall have maintenance instructions for the system as a whole and for all individual sub-systems consolidated into an overall suite of Operations and Maintenance Manuals.

This data shall be produced in hard copy form and available as an on-line database available to maintenance personnel. The technical documents and manuals shall be compiled electronically in a universal format such as XTML.

Maintenance instructions shall be available in hard copy form and for download to remote/portable diagnostics terminals.

The Operations Manuals and Maintenance Manuals shall be comprehensively indexed and cross-referenced. They shall meet all requirements of an ISO 9000 Quality Plan, ISO 14000 Environmental Plan and ISO 18000 Health and Safety Plan. They shall take into account the relevant legal requirements and customary practices existing in Scotland. They shall be of a quality at least as good as that outlined in the SDS Maintenance Documentation Specification (reference number ULE90130-SW-SPN-00064).

They shall be prepared in accordance with a uniform approach, combining together the contributions from different contributors. They shall be consistent in terms of the page layout, indexing, language, tense, person and methodology of maintenance of each item of equipment on the system in a clear and concise manner.

The Maintenance Manuals shall include initial planned maintenance schedules and all inspection and maintenance frequencies. These frequencies shall include, but not necessarily be limited to, post commissioning, daily, weekly, specific and periodic inspection and procedural activities. All such activities shall be fully co-ordinated and integrated to minimise the frequency of visits and thus the possible disruption of the tram service.

The contributors shall update the manuals' information at periods considered appropriate to their equipment and/or installation supply throughout during the contracted period of maintenance and/or warranty agreement. Notwithstanding such interim updates, a full review and update will be undertaken at the end of such maintenance and/or warranty agreement. Such updating material shall be carried out and provided by the appropriate maintainer.

The master copy of the Manuals shall be held electronically and be accessible via the Internet using an appropriate access permission regime. The access arrangements shall record who accesses individual sections and when.

The information to be included in the manuals from the relevant subcontractors through the Infraco and Tram Maintainer shall include, but not be limited to the following:

- System Overview (including explanation of manuals content)

Landscaping Manuals, comprising:

- Area Descriptions;
- Inspection and Maintenance Manual; and
- Planting Stock Lists.

Structures Manuals, comprising:

- Structures descriptions, etc.;
- Inspection and maintenance manual; and
- Illustrated parts list.

Power supply Mmanuals, comprising:

- Equipment Description and Operation Manual (how the equipment works);
- Maintenance Manual (including inspection and day-to-day maintenance procedures);
- Overhaul Manual; and
- Illustrated Parts List.

Overhead Line, Manuals, comprising:

- Equipment Description and Operation Manual (how the equipment works);
- Inspection and Maintenance Manual (including erection procedures, etc.);
- Overhaul Manual; and
- Illustrated Parts List.

Permanent Way Manuals, comprising:

- Equipment Description and Operation Manual (how the equipment works);

- Inspection and Maintenance Manual;
- Overhaul Manual; and
- Illustrated Parts List.

Tramstops Manuals, comprising:

- Tramstop descriptions, Lighting, Seating, Signs, etc.;
- Inspection and Maintenance Manual; and
- Illustrated Parts List;
- Supervisory Control and Communications Systems Manuals, comprising:
- Equipment Description and Operation Manual;
- Inspection and Maintenance Manual; and
- Illustrated Parts List.

Tram Manuals, comprising:

- Information to be included in a Drivers Handbook;
- Equipment Description and Operation Manual;
- Maintenance Manual (including inspection and day-to-day maintenance procedures);
- Overhaul Manual (larger overhauls are unlikely to be carried out by **tie** and this will be required by their eventual overhaul contractor); and
- Illustrated Parts List.
- A full suite of vehicle design drawings.

Gogar Maintenance Depot Manuals, comprising:

- Description of Depot and its Equipment (including road and on-track maintenance vehicles);
- Maintenance Manual (covering all equipment including integrated equipment maintenance schedule) under the following headings:
  - Fixed equipment;
  - Mobile equipment;
  - Portable equipment; and
  - Hand tools.
- Illustrated Parts Lists for each of the above.

Central Control Centre Manuals, comprising:

- Operational Procedures (these may be included in System Operation manuals);
- Equipment Description and Operation Manual; and
- Illustrated Parts List.

Signalling, including:

- Equipment Description and Operation;
- Inspection and Maintenance Manual; and
- Illustrated Parts List.

40.5.4 Asset Register

The Operations and Maintenance Manual shall be linked to an Asset Register within the computerised Asset Management System that shall be provided by the Infraco . This shall be populated with actual equipment data, serial numbers etc. This asset register shall be capable of being linked to a graphical information system (GIS) and include as-built, maintenance and other drawings and records.

Performance, reliability, fault/failure data shall be included, presented and made available to enable analysis for product improvement.

40.5.5 Provisional List of Operating Procedures and Standards

A – Operating Procedures (To be developed in conjunction with the Operator)

1. Permit to work;
2. Power switching and isolation;
3. Switching and Safety Interlocking with Inspection Platforms in Depot;
4. Track Safety;
5. Issue and use of Personal Protection Equipment;
6. First Aid;
7. Communication with OCC (Trackside);
8. Communication with OCC (Tram);
9. Depot & Yard Tram Movements & Parking;
10. Use of Wheel Lathe;
11. Lifting & Safe Handling;
12. Recording of Maintenance & Repair in Infraco Records System;
13. Risk Assessments (Safety, and Environment);
14. COSHH Risk Assessments;
15. Preparation and Approval of Method statements;
16. Materials Procurement & Control;
17. Waste Disposal;
18. Evacuation of Depot;

19. Detailed maintenance procedures (as supplied by the Tram Maintainer & Infraco);

20. Monitoring the medical condition of employees;

B – Infraco Standards (to be developed by Infraco prior to Section A completion)

1. Tram (pantograph parameters, door parameters, wheel profile, suspension/coupler heights & clearances, brake parameters and wear limits);

2. Tram Driver routine preparation;

3. Tram Cleaning;

4. Tram related Noise and Vibration (To be developed in conjunction with the Tram Maintainer);

5. Tram clearances with Tramstops (To be developed in conjunction with the Tram Maintainer).