| Required Action from the Infraco | Timing/Frequency applicable to the Infraco |
|---|---|
| The Infraco shall be responsible for the preparation and maintenance of a Commissioning Risk Control Report which shall detail the plans for mitigating risks associated with the commissioning of the Edinburgh Tram Network. This should cover commissioning, operational and design risks, but not limited to the trams, the tracks, the power supply and the tram depot.<br><br>The Commissioning Risk Control Report shall concentrate primarily on the (commercial risk) associated with the commissioning process, but shall also refer to ongoing issues which also affect the construction and/or operation or part operation of the Edinburgh Tram Network . | Agree format of the Commissioning Risk Control Report to tie's designated risk manager (as notified to the Infraco from time to time) within 6 month of the Commencement Date. Final report to be delivered at least 3 months prior to start of the Testing and Commissioning. The Infraco shall update the Commissioning Risk Control Report as required until the Service Commencement Date.. |
| The Infraco shall be responsible for the preparation and maintenance of a Residual Risk Control Report ("RRCR") that will detail the plans for mitigating the risks arising from the construction and commissioning of the Edinburgh Tram Network, which are still of ongoing importance. The RRCR should clearly detail the areas of importance that could affect the ETN after the Service Commencement Date until the end of the Term. These areas could be associated with design, operational and defects factors.<br><br>Risks to be noted in the RRCR may include, but shall not be limited to commercial risk associated with, snagging, claims, specification defects and other commercial concerns. | Agree format of RRCR with tie's designated risk manager (as notified to the Infraco from time to time) within 12 months of the Commencement Date. Final report to be delivered at least three months prior to the Service Commencement Date. The Infraco shall update the RRCR as required throughout the Term. |

| Required Action from the Infraco | Timing/Frequency applicable to the Infraco |
|---|---|
| The Infraco shall prepare and maintain an Operational and Maintenance Risk Register ("OMRR") that will detail the identified risks associated with provision of the Maintenance Services in relation to the Edinburgh Tram Network and management actions being taken to mitigate.<br><br>The Infraco shall liaise with its Sub-Contractors and the Operator and any other relevant party as required in relation to the creation, development and updating of the OMR | Agree format and assessment criteria of the OMRR with tie's designated risk manager (as notified to the Infraco from time to time) within 12 months of the Commencement Date. First formal report to be delivered at least three months prior to the Service Commencement Date. The Infraco shall update the OMRR in line with the four weekly tram period calendar |

Table 27 - Table showing required actions from the Infraco

## 12.12 Traffic Management / Temporary Traffic Regulation Orders (TTROs)

The Infraco shall be responsible for the preparation of a Traffic Management Plan (TMP) and Work Site Staging Plan (WSSP). The TMP and WSSP shall comply with instructions issued by tie and shall be drafted in consultation with tie and CEC. The Infraco shall be responsible for the preparation of a Traffic Management Plan (TMP) and Work Site Staging Plan (WSSP). The plans shall apply to all work required in connection with the Infraco and including wider area traffic management measures associated with the construction of the main works. The TMP and WSSP shall comply with instructions issued by tie and shall be drafted in consultation with tie and CEC.

The TMP and WSSP shall identify and account for interfaces with parallel works, including the MUDFA Works.

The TMP and WSSP shall also include all necessary survey work, temporary traffic diversion modelling, assessment and design which will take account of the works, network constraints and the traffic control requirements.

The design shall identify the required alterations to road layouts, regulatory changes to be enacted through TTRO, altered/additional traffic signal equipment, new traffic signal installations and advance/local road signage.

The design shall also determine the locations of temporary bus stops and taxi ranks, alterations to parking and access/servicing arrangements for residents and businesses in works areas.

The TMP and WSSP shall be submitted within four weeks of the Commencement Date by the Infraco to tie and CEC for approval in accordance with the Review Procedure and as detailed in the current CEC-tie Interface Protocol relating to TTROs (Protocol Ref: TECH – 01).

The TMP and WSSP submission packages shall be as described in the Protocol and the plans shall include temporary works method statements, and shall identify general traffic, bus and pedestrian diversionary routes, access routes for emergency vehicles, and alternative arrangements for bus stops, parking and loading. The plans shall also include assumptions registers, issues logs and any other means to ensure prompt resolution of issues which could affect the progress and economic execution of the Infraco Works.

Leaflets and other approved publicity material as reasonably required shall be prepared for the information of the public/stakeholders/media showing temporary traffic management arrangements and traffic diversions and how these will operate.

Prior to implementation the TMP and WSSP shall be presented for review and approval to the **tie**/CEC/ Police/TEL Traffic Management Review Panel (TMRP) in-line with the agreed protocols and timescales which include procedures to give stakeholders advanced notification of the proposed arrangements to be implemented during the works.

The TMP and WSSP shall also include all necessary drawings, diagrams and supporting information to show the mobilisation, erection and dismantling of Temporary Works, traffic and pedestrian management during any pre-diversion works and the Infraco Works, access to properties, details of fencing and security measures.

The Infraco shall update the TMP and WSSP every two weeks throughout the duration of the Infraco Works for review at fortnightly design meetings and every four weeks at stakeholder and third part meetings.

The Infraco shall be responsible for the preparation of draft TTROs which shall be submitted to **tie** for onward submission to CEC, in its capacity as Roads Authority, for approval, again as described in the current CEC-**tie** Interface Protocol relating to TTROs (Protocol Ref: TECH – 01). The submission packages shall be as described in the Protocol.

TTRO submissions will adhere to the programme detailed in the Protocol.

The Infraco shall also attend meetings in relation to the TTROs, as required by **tie**, including representations to the **tie** / CEC Roads Working Group Committee, which convenes quarterly.

The Infraco shall develop a set of requirements in relation to TTROs and traffic management, which shall be based on information supplied to the Infraco by **tie** and/or **tie** ("TTRO Obligations and Traffic Management Plan") and shall take account of the interface on traffic management that will be required in relation to the MUDFA Works.

The Infraco shall prepare and develop project-specific procedures for complying with the TTRO Obligations and Traffic Management Plan, and these procedures shall be submitted for approval by **tie** and CEC in sufficient time to avoid disruption to the Programme.

By appropriate induction, the Infraco shall ensure all site-based personnel, management staff, operatives and visitors are fully aware of and understand the procedures contained within these Employer's Requirements.

The designated project or site manager appointed by the Infraco shall be accountable for the implementation and compliance with these requirements and procedures.

The Infraco shall ensure that the overriding considerations expressed in these procedures and requirements shall be the safety of road users, minimising disruption caused by the Infraco Works, pedestrian management and ensuring that traffic and pedestrian disruption is kept to a minimum.

This shall include taking such measures as CEC, in its capacity as roads authority, may reasonably require.

The Infraco shall ensure that reasonable access to all business, residential premises and properties (having regard to Infraco's obligation to comply with the Programme) along the route of the Edinburgh Tram Network is maintained at all times. Infraco shall not be obliged by virtue of this provision to provide access which is more extensive than the access agreed in any Third Party Agreement.

## 12.13 Stakeholder Management

### 12.13.1 General

A Stakeholder and Communications Management Plan has been developed by **tie**. The Infraco shall comply with the requirements of this document.

The Infraco shall be, jointly with **tie**, accountable for minimising any possible adverse impact of the implementation of the Edinburgh Tram Network on stakeholders (both statutory and non statutory), local businesses and the general public.

### 12.13.2 Design

The Infraco shall incorporate the following requirements into the design in addition to any other requirements as defined:

- Securing, implementing and incorporating into the design all necessary Network Rail, BAA and other third party agreements;
- Assisting by providing all technical details relevant to the compulsory purchase order process and land acquisition process (including wayleaves and servitudes); including integration with **tie**'s stakeholder and GIS systems.
- Liaising with CEC, Scottish Executive, Historic Scotland, World Heritage Trust, Scottish Natural Heritage and others as required by **tie** in relation to the performance of the Infraco Works.

### 12.13.3 Liaison and Public Information

The Infraco shall appoint a liaison officer to manage all public relations, information and press related matters relating to the Infraco Works, who shall along with the necessary technical, commercial and other Infraco resource, liaise with **tie**, and if so requested by **tie**, with CEC, other statutory bodies, members of the public, local businesses, the press and the media as may be

necessary on all matters relating to the Infraco Works. Except where expressly stated in the Agreement, the Infraco shall not make any publicity or media statements or make any other formal disclosure of information regarding the Infraco Works without the prior approval of **tie**.

The liaison obligation referred to in the above paragraph shall include, but shall not be limited to the following matters:

- From time to time as directed by **tie**, Infraco shall be required to participate in business, stakeholder and community liaison groups, public meetings and consultation meetings as the progress of the Infraco Works dictate.

- From time to time as directed by **tie**, Infraco shall be required to provide proactive input, information and comment into information initiatives organised by or on behalf of **tie** and attending as requested by **tie** at any relevant consultation meetings

- As directed by tie **Infraco** will assist with the development and maintenance of, and adherence to, a communications protocol for dealing with all stakeholders, businesses and members of the public affected by the Infraco Works. In particular this will require strict adherence to timescales determined by **tie**.

- Assisting with the development and maintenance of procedures developed by tie in relation to stakeholder management by way of the provision of information relating to the Infraco Works

- Provision of weekly updates to tie on the progress of the Infraco Works and all planned Infraco Works in a form reasonably requested by **tie**.

- Depending upon the type of communication, Infraco shall give **tie** a minimum of two weeks notice in advance of all plans for any formal communication with stakeholders, businesses and members of the public (e.g. for major customer works governed by the Customer Interaction Cycle far more weeks would be required). The form and content of such formal communication shall be subject to **tie**'s prior approval

- Provision to **tie** of all information reasonably requested by **tie** in respect of the Infraco Works planned in a form prescribed by **tie** and timescales and frequency agreed with **tie**.

- **tie** and Infraco will be jointly involved in the appointment of appropriately qualified "Tram Helpers". They will be directly managed by **tie**, but integrated into Infraco work areas and teams through joint induction and briefing; appropriate cross training; "Tram Helper" visibility in Infraco work areas; "Tram Helper" involvement in the direct management of stakeholder issues on site;

direct engagement by "Tram Helpers" or appropriate Infraco management and staff to assist in the resolution of on site issues; provision of appropriate Infraco uniform and equipment, etc. "Tram helpers" are to be recruited and in place four weeks prior to commencement of notification.

- Provision and use of approved branding materials, PPE kit and signage at all operational Work Sections. No such materials, kit or signage shall be erected at any Work Section without the prior approval of tie.

- The provision and distribution of traffic routing maps which conform to the terms of the TTROs for all areas affected by the Infraco Works in advance of the Infraco Works starting in any particular location as may be requested by tie. In the event that tie requires that such material is for public issue, public issue shall not occur before the form and content has been approved by tie. Infraco shall ensure that all public statements (including by way of media referred to in the sections below (customer care centre, website, weekly newsletter, monthly newsletter, call centre and communication log) in relation to the Infraco Works are consistent with (tie's) Communications Strategy and integrated with tie's systems and procedures.

### 12.13.4 Information Centre

The Infraco shall provide all information and documentation regarding the Infraco Works as may be reasonably required by tie in respect of the mobile and fixed information centres being operated jointly by tie and Infraco in relation to the Edinburgh Tram Network. The frequency of update and version control of information shall be subject to a process agreed with tie.

### 12.13.5 Website

The Infraco shall provide all information regarding the Infraco Works, reasonably requested by tie, in order to populate the website, which shall be maintained and operated by tie throughout the progress of the Infraco Works, in respect of the Edinburgh Tram Network. The frequency of update and version control of information shall be subject to a process agreed with tie.

### 12.13.6 Weekly Newsletter

The Infraco shall produce and publish weekly newsletters every Wednesday, detailing the Infraco Works to be undertaken in the forthcoming week and outlining, with appropriate maps, drawings and diagrams, the impact on the general public, businesses and in particular any alterations to road traffic circulation patterns required by the coming week's Infraco Works.

Each newsletter, the contents and format of which shall have the prior approval of tie, will also be issued, if requested by tie, by fax and email to: local and national newspapers and other news media, CEC, Lothian and Borders Police, the emergency services, to any party or parties requested by tie and to any other persons or organisations that have requested receipt of the newsletters.

The newsletters shall also be distributed door to door by the Infraco in affected locations and the Infraco shall advise tie when such distribution is occurring.

The Infraco shall monitor and record the distribution of newsletters, recording who is carrying out such distribution, the intended recipients etc, so as to enable tie to carry out its own audit and monitoring of such distribution. Infraco to ensure, by regular surveys that circulation data is accurate and up to date.

Sufficient free distribution take-away hard copies of these newsletters shall be delivered to and placed in the information centre by the Infraco before 08:00 every Thursday morning.

The Infraco is required to submit a draft of each issue of the newsletters to tie no later than midday on the Monday immediately preceding the proposed issue of the newsletters on the Wednesday. tie shall respond before 17.00 hours the same day.

### 12.13.7 tie Monthly Newsletter

The Infraco shall provide all information and assistance reasonably requested by tie in relation to the publication by tie, of a monthly newsletter in relation to the progress of and future plans for the Edinburgh Tram Network.

### 12.13.8 Customer Contact Centre

The telephone number, fax number and e-mail address of the call centre to be operated jointly by tie and Infraco in relation to the Edinburgh Tram Network (the "hotline") shall be publicised through the press and the weekly newsletter and clearly displayed on all appropriate PPE kit, site signage, hoardings and at other suitable locations within and throughout the vicinity of the Infraco Works. All letters, e-mails, customer queries shall be answered by Infraco within timescales, to be agreed in advance with tie.

### 12.13.9 Communication Log

All contacts, communications, complaints, comments and queries howsoever received by the Infraco shall be registered in a suitable electronic log (the "communication log").

The Communications Log shall be developed and maintained by Infraco in a manner that allows it to be fully integrated with tie's Stakeholder Database and GIS systems. The communication log shall set out each contact under the type (e.g. General, Traffic, Safety, Vibration, Noise, Dirt, Disruption, Injury, Parking, Access, RTA, publicity, suggestions etc).

The method of approach shall also be logged (e.g. phone, direct, letter, email, etc.) as well as the time and date.

The log shall be so constructed such that statistical analysis of the different communications can be presented as part of the data to be provided to tie. It shall be a requirement that the Infraco shall deliver an "above average" customer satisfaction level, with criteria, frequency and method of assessment to be agreed by tie. In order to demonstrate this, there shall be a requirement for the Infraco (and as required tie) to undertake internal (and external) audits of the overall engagements with the stakeholders. All this information shall be summarised by the Infraco in its monthly progress report.

Infraco shall take such steps as are required to address any such contact, communication, complaint, comment or query in accordance with the response requirements set out in Table 28 - Notification Hierarchy and in line with the agreed enquiry management process.

To the extent that a stricter response requirement is otherwise required under the Agreement, the stricter response requirement shall apply.

To the extent that Table 26 provides for the recovery of any amount by tie from the Infraco, such amount may be deducted from any monies due to or to become due to the Infraco or, alternatively, may be recovered from the Infraco as a debt.

A record of all remedial actions taken shall be maintained.

In the event of the Infraco receiving a complaint, a follow up letter or electronic communication shall be passed to the complainant by the Infraco within 24 hours of their receipt of the complaint, outlining the complaint and details and timing of the remedial action being undertaken by the Infraco.

An up to date copy of the communications log shall be compiled daily by the Infraco, together with a report on the progress of any actions.

The communications log shall be inspected and signed daily by a nominated senior representative of the Infraco and shall be counter signed by the Infraco's Representative at least once per week.

The Infraco's Representative shall write a report to tie and/or the Nominated City Officer of CEC (as notified by tie from time to time) at a frequency determined by tie (at least once per month) containing a list of any breaches of the requirements as defined within this section and also Schedule 3 (Code of Construction Practice and Code of Maintenance Contract) occurring within the previous month, setting out:

- the nature of the breach;
- the duration of the breach;
- the action taken by the Infraco to mitigate the breach; and
- the steps taken to minimise the likelihood of a subsequent occurrence of the breach.

Subject to the Infraco obtaining tie's prior approval, a copy of each week's communication log shall be placed every Friday in the information centres, where it will remain until completion of the Infraco Works.

Any person, including representatives of tie and CEC's nominated representatives may freely inspect all deposited copies of the communications log during the normal opening hours of the information centres.

The version of communications log on public display should not breach any data protection legislation or other Law.

Copies of the communication log shall be forwarded to **tie**'s Representative and/or and CEC's Nominated City Officer once per week.

The master communication log shall be available for **tie**'s Representative and CEC's Nominated City Officer to inspect at any other time during normal working hours.

| Level of Urgency | Category of Notification | Required Response Time |
|---|---|---|
| 1 | **High urgency**<br><br>Involves an immediate threat to persons or property or the circumstances otherwise require immediate rectification. | Immediate action required.<br><br>If response not completed by the Infraco within 4 hours, **tie** may procure that the relevant work is carried out and the costs of so doing shall be recovered from the Infraco. |
| 2 | **Medium urgency**<br><br>No immediate threat to persons or property, but circumstances require rectification within 24 hours. | Remedial action requires to be completed within 24 hours.<br><br>If the Infraco does not complete the required response within 24 hours, **tie** may procure that the relevant work is carried out and the costs of so doing shall be recovered from the Infraco. |
| 3 | **Issue requires rectification**<br><br>but no immediate threat to persons or property and the circumstances do not otherwise require immediate rectification. | Timescales for rectification to be agreed between the Infraco and **tie**.<br><br>In the event that the Infraco does not comply with the agreed timescales, **tie** may procure that the relevant work is carried out and the costs of so doing shall be recovered from the Infraco. |

Table 28 - Notification Hierarchy

# 13 Permits / Approvals

The Infraco shall obtain all necessary permits and approvals prior to undertaking investigations or works on Site, in accordance with paragraph 3 of the Code of Construction Practice.

## 13.1 Method Statements

The Infraco shall prepare method statements in respect of all investigation and work activities, as detailed in this Section and paragraph 3.2 of the Code of Construction Practice and submit these in accordance with paragraph 3.3 of the Code of Construction Practice.

The Infraco shall produce a method statement entitled "Procedures for dealing with Unidentified Apparatus or Unrecorded Artificial Obstructions", which shall be submitted by Infraco in accordance with paragraph 3.3 of the Code of Construction Practice. This method statement shall contain procedures which shall confirm the processes for dealing with unforeseeable events or circumstances, the discovery of unidentified apparatus (including live services) or unrecorded artificial obstructions. The final version of the method statement and procedures shall be agreed with the relevant key third parties, Approval Bodies, the Utilities and the emergency services The method statement shall be updated and a final version produced which shall be finalised by the Infraco in accordance with paragraph 3.3 of the Code of Construction Practice.

## 13.2 Existing Structures Which May Affect Progress and relationship with Third Parties

The Infraco shall undertake works to address the condition of existing structures where such condition may affect the progress of the Infraco Works. Where such work is completed the Infraco shall take appropriate photographs to fully demonstrate the quality of the reinstatement works.

The Infraco shall undertake survey inspections associated with buildings and structures which may be at risk of physical damage as a result of the Infraco Works.

For such structures and buildings the Infraco shall compile an appropriate schedule of such buildings / structures, and produce surveys / records similar to those described under paragraph 18.2.1 of Schedule 3 (Code of Construction and Code of Maintenance Practice).

Early warning must be given to tie where any third party is, or is likely to start, acting unreasonably. In these situations, tie will seek to resolve any issues with the third party to assist Infraco.

## 13.3 Network Rail

The Infraco shall ensure that the requirements of the Network Rail GRIP process are implemented on the works for which they are responsible whilst working in accordance with all relevant Network Rail Group Standards.

The contract requirements for Network Rail with regard to health and safety are included within the Network Rail document NR/SP/OHS/008. The project specific requirements are identified within the Safety Clause Menu against the requirements of Network Rail document NR/SP/OHS/008 and indicated with 'ticks' in the contractor column sections 51 to 59 inclusive of the safety clause menu and any other requirements that the Infraco is proposing by virtue of his method of undertaking the Infraco Works. The safety clause menu shall be signed off by the Infraco to confirm its proposals.

The Infraco Works shall be undertaken as Third Party Works as identified within the Network Rail document (RT/LS/P/043).

# 14 Human Factors

The Infraco shall provide systems and working practices that are:

- As easy to use as possible;
- Unlikely to cause annoyance or stress to users of the Edinburgh Tram Network, whether members of the public, operators, or maintainers; and
- Likely to promote safety to all.

The Infraco shall systematically and comprehensively:

- identify all the human factors issues associated with the engineering of the Edinburgh Tram Network, using task analysis;
- determine which of these human factors issues pose the most significant risk to the efficiency, productivity, safety and health of the Edinburgh Tram Network; and
- describe the organisational arrangements and processes the Infraco intends to put in place to manage these significant human factors issues as part of the engineering of the Edinburgh Tram Network

The Infraco shall produce and maintain in accordance with the submittals schedule a human factors management plan, covering the requirements summarised above, and where appropriate, shall undertake human factors studies to recommend solutions.

Areas of particular concern are:

- The human computer interfaces in the Control Centre;
- The layout of the driver's cabs;
- The facilities to enable maintenance of equipment:
  - In the workshop and Depot;
  - At trackside;

- In substations;
- At the Tramstops; and
- In the Control Centre.

The Infraco shall adopt all applicable best practice and guidelines for human factors. In designing the environment in the Control Centre, the Infraco shall comply with BS EN 50126 and ISO 11064 "Ergonomic Design of Control Centres.

# 15 Reliability, Availability and Maintainability

## 15.1 Reliability and Availability

The Edinburgh Tram Network is made up of many different subsystems, most of which may affect the reliability of operation of the ETN as a whole. In respect of achieving and maintaining reliability, the Infraco shall design, construct and maintain the Edinburgh Tram Network in accordance with Good Industry Practice, subject to the reasonable constraints of cost. Where necessary, the ETN should be made resilient to single point equipment and cable failure by employing suitable levels of equipment/cable redundancy and duplication.

On equipment or cable failure, subsystems shall be designed in a fail-safe manner, with graceful degradation. Limited back-up facilities shall be provided to maintain services under specified partial failure conditions.

Defined below are the requirements for availability of individual subsystems (each of which is given a definition), and also the availability of individual components of the subsystems.

In addition to the above, the overall availability of the Edinburgh Tram Network and its subsystems must support the tram punctuality requirement that is set out in these Employer's Requirements. Consequently it may be necessary to increase the minimum requirements that are set out below, especially as the consequences of the actions that third parties may take, including delays caused by other road users, need to be included in the punctuality analysis for the Edinburgh Tram Network.

For all components and subsystems, assume a Mean Time to Repair (MTTR) of 4 hours.

Any downtime required for planned maintenance can be discounted from the determination of availability, provided that such maintenance can be reasonably undertaken at a time when the maintenance has no impact on the operation of the ETN. This will often be during overnight shut downs.

## 15.2 Traction Power System

| Component or Subsystem | Minimum Availability |
|---|---|
| AC circuit breaker, where its availability is defined as the probability that it either fails to conduct electricity when commended to be closed. | 99.99% |
| Transformer / rectifier where its availability is defined as the probability that it either fails to provide the nominal 750VDC when energised. | 99.99% |
| DC circuit breakers and busbars, where its availability is defined as the probability that traction power is not available from the DCCB when commanded to be closed, provided that 750 VDC is available at from the rectifier | 99.99% |
| Transformer / rectifier where its availability is defined as the probability that it fails to provide the nominal 750VDC when energised by the HV input. | 99.99% |
| Substation battery and charger, where its availability is defined as the probability that control voltage is not available from the battery at any time during its normal operation, regardless of the state of the incoming LV supply | 99.99% |
| Substation, where its availability is defined as the probability that 750VDC voltage is not available for the OLE when the substation is commanded to provide 750VDC | 99.75% |

Table 29 - Substation Equipment

| Component or Subsystem | Minimum Availability |
|---|---|
| OLE System, where its availability is defined as the probability that in any linear km of the OLE system, trams are not able to operate at the normal operational speed due to defects in the OLE. This is based on an 8 hour incident once every 3 years, 20hr/day operation and (20 route-km plus depot, about 50 track-km) | 99.99925% for each km |

Table 30 – Overhead Line Equipment

## 15.3 Supervisory and Communications Systems.

| Component or Subsystem | Minimum Availability |
|---|---|
| ODN node | 99.99% |
| Fibre Optic Cabling | 99.99% |
| Patch Panels and Connectors | 99.99% |
| ODN network, where its availability is defined as the probability that any message from a given input to a node reaches its intended destination node correctly and could be transmitted onwards by that node. | 99.99% |

Table 31 - Operational Data Network

| Component or Subsystem | Minimum Availability |
|---|---|
| Transponder (if used) | 99.9% |
| Loop Detector | 99.9% |
| TPDS Trackside Controller | 99.9% |
| TPDS subsystem, where its availability is defined as the probability that any given tram has its position detected and passed to the signal controller and to Control Centre operators correctly, assuming that the ODN is fully functional and that the hardware component of the Control Centre servers and workstations is fully functional | 99.75% |

Table 32 - Tram Position and Detection System

| Component or Subsystem | Minimum Availability |
|---|---|
| Passenger Information Display | 99.9% |
| Local Controller (if required) | 99.9% |
| PID subsystem, where its availability is defined as the probability that the appropriate message is displayed correctly at a given PID, assuming that the ODN is fully functional and that the hardware component of the Control Centre servers and workstations is fully functional | 99.75% |

Table 33 – Passenger Information Display

| Component or Subsystem | Minimum Availability |
|---|---|
| Telephone Handset | 99.9% |
| PABX | 99.99% |
| Telephone network, where its availability is defined as the probability that any 30 second conversation between a given telephone and another given telephone is heard clearly and completely by the caller and the intended recipient, assuming that the ODN is fully functional. | 99.75% |

Table 34 – Telephone Network

| Component or Subsystem | Minimum Availability |
|---|---|
| PA speaker | 99.9% |
| PA controller | 99.9% |
| Microphone and speaker | 99.9% |
| PA subsystem, where its availability is defined as the probability that an operator can make an intended announcement clearly at a given platform, assuming that the ODN is fully functional and that the hardware component of the Control Centre servers and workstations is fully functional. | 99.75% |

Table 35 - Public Address System

| Component or Subsystem | Minimum Availability |
|---|---|
| Base Station | 99.95% |
| Mobile Handset (Tram, Vehicle, or Hand Held) | 99.7% |
| Central Switch | 99.99% |
| Operational Radio subsystem, where its availability is defined as the probability that a 10 second call (voice) or short data message can be received clearly by the intended recipient, assuming that the ODN is fully functional and that the hardware component of the Control Centre workstations is fully functional | 99.75% |

Table 36 - Operational Radio System

| Component or Subsystem | Minimum Availability |
|---|---|
| Help / Emergency Help Point | 99.9% |
| Help Point subsystem, where its availability is defined as the probability that a member of the public can contact the Control Centre operator and can carry out a Help Point conversation lasting 20 seconds, clearly and without interruption, assuming that the ODN is fully functional and that the PABX is fully functional | 99.75% |

Table 37 - Passenger Help / Passenger Emergency Help System

| Component of subsystem | Minimum Availability |
|---|---|
| CCTV camera | 99.95% |
| Digital Video Recorder | 99.95% |
| CCTV Matrix | 99.95% |
| CCTV subsystem, where its availability is defined as the probability that an image is displayed correctly and in the specified sequence at the Control Centre, assuming that the ODN is fully functional and that the hardware component of the Control Centre servers and workstations is fully functional | 99.9% |
| Recording and replay subsystem, where its availability is defined as the probability that an image is displayed from any given time in the past (within the recorded period) can be retrieved and displayed correctly, assuming that the ODN is fully functional and that the hardware component of the Control Centre servers and workstations is fully functional | 99.9% |

Table 38 - CCTV System

| Component or Subsystem | Minimum Availability |
|---|---|
| SCADA RTU (including I/O cards and interface cards) | 99.95% |
| SCADA subsystem, where its availability is defined as the probability is the lesser of<br>(a) that an indicator is read correctly at the RTU, transmitted to the SCADA Master Station in the Control Centre, and displayed correctly on any SCADA display that is in use within four seconds: and<br>(b) that a control is effectively transmitted to an outstation within two seconds, assuming that the ODN is fully functional and that the hardware component of the Control Centre servers and workstations is fully functional | 99.75% |

Table 39 - SCADA System

| Component or Subsystem | Minimum Availability |
|---|---|
| Servers (if necessary, by use of hardware and software redundancy) | 99.99% |
| Workstations | 99.9% |
| Printers | 99.5% |
| CCTV Matrix Controller | 99.9% |
| LAN Switches, Routers and Hubs | 99.99% |

Table 40 - Central Control Equipment

## 15.4 Maintainability

The ETN and its components shall be designed with maintainability in mind. To this end, the following shall be observed:

- Important equipment shall be in a redundant configuration, so that a component may be replaced while standby equipment takes over its duty;
- Equipment shall be replaceable, if possible, as field replaceable units, so that defective components can be replaced without the need to power down the overall piece of equipment; and
- Equipment, particularly at trackside and on Tramstops, shall be positioned so that where possible it is accessible for maintenance or replacement without the necessity to halt tramway traffic or to close the Tramstop and without the need to use access equipment such as steps.

## 15.5 Supportability

The equipment selected for use on the Edinburgh Tram Network shall be selected so that:

- It has a long design life, as specified in section 6 of these Employer's Requirements.
- It shall be based on standard Commercial Off-the Shelf (COTS) equipment as far as appropriate, so that replacement parts may be easily obtained and integrated into the ETN without the necessity of resorting to the original subsystem or equipment suppliers.

# 16 Electromagnetic Compatibility

## 16.1 EMC Directive

On 20th July 2007 a new EMC Directive came into force in the European Union. Statutory Instrument 2006 No.3418 implements the new EMC Directive 2004/108/EC in UK law. The rules for the new EMC Directive have changed significantly from the old Directive (89/336/EEC). After 19th July 2009 declarations made will require appropriate "Technical Documentation". This means that the Declaration of Conformity made using the old conformance mechanisms will have to be updated to use "Technical Documentation". The Infraco must be aware of the relevance of the 19th July 2009 date and insist that suppliers provide documentation accordingly.

## 16.2 Essential Protection Requirements

The purpose of the EMC Directive is to ensure that electrical/electronic equipment does not cause or be susceptible to electromagnetic disturbance. The protection requirements required of all electrical/electronic equipment/systems/installations are as follows:

- the electromagnetic disturbance generated shall not exceed the level above which radio and telecommunications equipment or other equipment cannot operate as intended; and

- they shall have a level of immunity to the electromagnetic disturbance to be expected in their intended use which allows them to operate without unacceptable degradation of that intended use.

The Infraco must produce an Edinburgh Tram Network specific EMC strategy document in accordance with the Submittal Programme that clearly defines its strategy for achieving compliance with these essential protection requirements and shall submit it to tie for its approval.

# 17 Health, Safety, Quality and Environment

## 17.1 Quality Management

The Infraco shall undertake the Infraco Works fully in compliance with quality management processes and procedures referenced in ISO 9001 and ISO 9004.

The Infraco shall develop a Quality Plan to meet the requirements of ISO 10005 - 1995, and which fully defines all quality aspects of the Infraco Works. The Quality Plan shall be submitted in accordance with the Review Procedure. The Quality Plan shall demonstrate an integrated quality management system relating to the design, construction, testing, commissioning and maintenance of the Edinburgh Tram Network and shall show how Infraco and its Sub-Contractors shall comply with the requirements of the Quality Plan.

The Infraco shall have all associated documentation readily available for internal review and review by tie. Regular internal audits shall be undertaken by the Infraco to ensure full compliance with ISO 9001 and ISO 9004 in accordance with paragraph 5.1 of the Code of Construction Practice. The Infraco shall prepare and submit in accordance with the Review Procedure a "Schedule of Internal Audits" for agreement with tie. This shall define the planned nature and timing of the internal audits. Furthermore tie reserves the right to undertake external audits in accordance with paragraph 5.2 of the Code of Construction Practice.

The Infraco shall ensure that its management system for the Infraco Works is developed to ensure that it aligns with the requirements of the Tram Project Quality Policy Statement (DEL.HSQE.103).

Quality control including materials and works on Site shall also be undertaken by the Infraco in accordance with the requirements of paragraph 3.2 of the Code of Construction Practice and the Project Safety and Quality Interface Document. The Infraco shall be required to comply with the requirements of this document including the completion of forms and other systems in order to assist tie in complying with tie's own safety and quality management systems.

## 17.2 Health & Safety

### 17.2.1 Safety Management Plan

The Infraco shall submit a safety management plan that is over-arching with regard to safety and defines the management procedures that shall be put in place to ensure health and safety for the design, construction, testing, commissioning and maintenance of the Edinburgh Tram Network. This document shall be stand alone and separate from other safety deliverables such as health and safety plan, system safety management plan, case for safety development etc. The Safety Management Plan shall address all issues relating to the safety of the Infraco Works, staff and third parties, however specific details relating to the items below are required and shall be submitted by the Infraco in accordance with the Submittal Programme:

- The plan shall detail the approach and all management procedures relating to health and safety for the Edinburgh Tram Network;
- The plan shall show how the Infraco will ensure that its Sub-Contractors apply all relevant health and safety policies and procedures to all Sub-Contractors;
- Details of all interfaces associated with safety and the procedures of how these shall be managed. Interfaces shall include Roads Authorities, Health and Safety Executive; any other relevant statutory authorities, HMRI; Competent Person (ROGS); Network Rail; Police; Fire and Rescue Services; Ambulance Service; and all applicable Law;
- Proposed Safety Initiatives;
- How the Infraco proposes that a safety culture shall be cascaded and enforced throughout the team including with Sub-Contractors;
- Infraco proposals for how safety shall be incentivised throughout the team, including with Sub-Contractors;
- The emergency procedures which the Infraco propose to implement;
- Details of how the Infraco shall implement accident and incident reporting and promotion of an open culture;
- The Infraco's safety inspection & safety tour regime;

- An outline of the Infraco's procedures relating to safety for compliance with tie's Drugs & Alcohol Policy and procedures and details of the Infraco's own similar policy and procedures;
- Details of any particular safety issues the Infraco considers would be significant and initial mitigation measures the Infraco considers necessary;
- Commissioning of the Edinburgh Tram Network;
- Driver Training on the Edinburgh Tram Network;
- Maintenance of the Edinburgh Tram Network.

### 17.2.2 Occupational Health & Safety Management System

The Infraco shall adopt an occupational health & safety management system consisting of the implementation and use of those processes and procedures referenced in BS 8800, OHSAS 18001-2007 and/or HSG 65 (Successful H&S Management).

### 17.2.3 Project Health & Safety Plan and Health & Safety File

The Infraco shall develop a construction phase plan and supply all necessary information for the Project Health & Safety File in accordance with the Construction (Design and Management) Regulations 2007 and L144 Managing Health and Safety in Construction and as described in the pre-construction information. The construction phase plan shall require to be submitted in accordance with the Review Procedure.

### 17.2.4 Interface with tie's Safety Systems

The Infraco shall ensure that the management system for the Infraco Works is developed to ensure that it aligns with the requirements of the Tram Project Safety Policy Statement (DEL.HSQE.105). Section 32 of the Agreement contains the Project Safety (and Quality) Interface Document. The Infraco shall be required to comply with the requirements of this document including the completion of forms and other systems in order to assist tie in complying with tie's own safety and quality management systems.

### 17.2.5 System Safety Management Plan (SSMP)

The Infraco shall be responsible for the development of the SSMP.

The SSMP shall define the engineering process that shall ensure, and provide a record of, assurance that the tramway has achieved an acceptable level of performance. This is achieved through a staged "case for safety" submission (refer below) process to signify that safety has been engineered into the design of the Edinburgh Tram Network. The SSMP shall define the process, activities and requirements for the preparation for a "case for safety" at the relevant design stage. The SSMP shall also define the system safety management organisation and the strategy to achieve the individual hazard system safety targets. The SSMP is concerned with only with those hazards that could give rise to an increased level of risk to passengers, staff and the general public from the operating system. (All health and safety hazards related to the risk to workers, staff and the general public from the construction activities should be covered under the safety management plan.)

### 17.2.6 The Railways and Other Guided Transport Systems (Safety) Regulations 2006

The Edinburgh Tram Network shall be delivered in accordance with The Railways and Other Guided Transport Systems (Safety) Regulations 2006 (ROGS).

The Infraco shall design and execute the Infraco Works using safety management and procedures to demonstrate that the Edinburgh Tram Network is safe to introduce into service as defined by the Safety Management System under ROGS. This shall also include the development of the Case for Safety to the satisfaction of the Competent Person and the Project Safety Certification Committee. These aspects form an integral part of the design of the Edinburgh Tram Network and are detailed in this section of these Employer's Requirements.

The Infraco shall undertake all Infraco Works in accordance with the written safety verification scheme requirements prepared by tie. Safety verification will be undertaken by tie. The Competent Person shall assure the process and its outputs. The Infraco shall allow tie and the Competent Person access to undertake safety verification activities, such as system safety audits. The Infraco shall develop a safety management system for when the Edinburgh Tram Network is operational which complies with the requirements of ROGS and other relevant legislation to the satisfaction of the Competent Person and tie/TEL.

Whilst there is no requirement in ROGS for projects such as the ETN to be notified to or given prior consent or approval by HMRI, HMRI have been involved in the development of the Edinburgh Tram

Network scheme to date and it is tie's intention to continue this involvement. The Infraco shall assist tie in any liaison with the HMRI when requested to do so.

### 17.2.7 Health and Safety Management

The health and safety responsibilities and CDM/ROGs application are defined in the matrix below for each phase of the project.

Table 41 – Matrix showing Contractual Responsibilities – Health & Safety Management

| | | Infraco | | | | Revenue |
|---|---|---|---|---|---|---|
| **UDFA** | **Pre Novation Design** | **Post Novation Design** | **Construction / Installation** | **Commissioning / Test running *** | **Shadow running** | **Operation** |
| DM Client. | CDM Client. | CDM Client. | CDM Client. | CDM Client. | - | - |
| | **ROGS duty holder.** | **ROGS duty holder.** | **ROGS duty holder.** | **ROGS duty holder. **** | **ROGS duty holder. **** | |
| | Adviser to **tie**. | Adviser to **tie**. | Adviser to **tie**. | Driver training.<br>Inputting into hazard log. | Operator of tram system.<br>Inputting into hazard log. | Operator of tram system. |
| signer. | Designer. | Designer. | - | - | - | - |
| | Managing hazard log. | Inputting into hazard log. | | | | |
| ncipal contractor | - | - | - | - | - | - |
| | - | Design manager. | Principal contractor. | Principal contractor. | - | - |
| | | Managing hazard log. | Managing hazard log. | Managing hazard log. | | |
| | - | Designer. | Contractor. | Contractor. | - | - |
| | | Inputting into hazard log. | Inputting into hazard log. | Inputting into hazard log. | | |
| | - | - | - | - | - | **ROGS duty holder.** |
| | - | - | - | - | - | - |
| | | | | | | |
| s – Construction ase Plan, Residual sk Register.<br>alth & safety file iated. | Yes – Pre-construction information, Residual Risk Register.<br>Health & safety file progressed. | Yes – Pre-construction information, Residual Risk Register.<br>Health & safety file progressed. | Yes – Construction Phase Plan.<br>Health & safety file progressed. | Yes – Construction Phase Plan.<br>Health & safety file completed & handed over to TEL. | No – no longer construction work. | No. |
| . | Yes – Safety Verification Scheme.<br>Appointment of | Yes – Safety Verification Scheme.<br>NoNOs from ICP. | Yes – Safety Verification Scheme.<br>NoNOs from ICP. | Yes – Safety Verification Scheme + Safety Management System. | Yes – Safety Verification Scheme + Safety Management System. | Yes – Safety Management System. |

| | | | | | | |
|---|---|---|---|---|---|---|
| | Person (ICP). | | | | | |
| **TEMS** | | | | | | |
| MIS SMS – nstruction.<br>OS SMS – design. | **tie** SMS – safety verification.<br>SDS SMS - design. | **tie** SMS – safety verification.<br>Infraco SMS – design management.<br>SDS SMS – design.<br>Tramco SMS – design. | **tie** SMS – safety verification.<br>Infraco SMS – construction/installation<br>Tramco SMS – manufacture/installation. | **tie** SMS – safety verification.<br>Infraco SMS – installation/operation.<br>Tramco SMS – installation.<br>Transdev SMS – operation. | **tie** SMS – safety verification.<br>Infraco SMS - operation.<br>Transdev SMS – operation. | TEL SMS.<br>Transdev SMS - operation. |

tage in phases once key milestones have been achieved e.g. the energisation of the OLE within the depot.
sume the role of **ROGS duty holder** during this phase.

es under the CDM Regulations  Responsibilities under the ROGS Regulations

## 17.3 Environmental Management

### 17.3.1 Environmental Management System

The Infraco shall adopt an environmental management system consisting of the implementation and use of those processes and procedures referenced in ISO 14001.

Documentation developed to meet the requirements of the environmental management system shall be submitted in accordance with the Review Procedure.

The Infraco shall ensure that the management system for the Infraco Works is developed to ensure that it aligns with the requirements of the Tram Project Environmental & Sustainability Policy Statement (DEL.HSQE.101).

### 17.3.2 Environmental and Sustainability Action Plan

The Infraco shall submit and maintain an Environmental & Sustainability Action Plan (EAP). This shall be based on SDS Environmental Mangement Plan and shall cover environmental issues for the duration of the Infraco Works, including design and construction stages. It shall describe the management process, procedures and interface requirements associated with meeting the Infraco's environmental responsibilities.

It shall then develop in detail the potential impacts on environmental resource, mitigation measures and responsibilities associated with all stages of the Infraco Works.

The EAP shall be prepared using the following sources of information.

- the Environmental Statements;
- The Design Manual;
- The Noise and Vibration Policy as contained within the Code of Maintenance Practice;
- The Code of Construction Practice;
- The Landscape and Habitat Management Plan for the Roseburn Corridor;
- The Badger Mitigation Plan for the Rosebum Corridor;
- Agreements made with statutory bodies; and

- Parliamentary agreements.

The EAP shall be amended by the Infraco to reflect any changes to the tramway design or engineering solutions and the results of surveys..

### 17.3.3 Construction Environmental Management Plan (CEMP)

The Infraco shall prepare a construction environmental management plan (CEMP) including method statements, as necessary, to convey the required level of information during the construction stage of the Infraco Works.

Site specific EMPs shall be prepared for each geographical section and intermediate geographical section as appropriate. These plans shall be produced by the Infraco prior to any works commencing on Site and must be reviewed by tie before work starts. The site specific EMPs must separately address the following sites and/or issues:

- Site accommodation, compound and offices and storage areas;
- Site clearance;
- Geographical sections and intermediate geographical sections of the Tram route;
- The Depot;
- Structures, such as sub-stations not already included in the above; and
- Road, cycleway and footway works, including drainage, signage and lighting.
- A series of site specific and topic related EMPs shall also be produced by the Infraco that shall address all the environmental issues, landscape, ecology etc. These shall cover the general control and protection measures for each topic as it relates to each of the site specific sections in the plan area. The Infraco shall have responsibility for the production, content and implementation of the Site Specific EMPs.
- The Infraco shall submit to tie the site specific EMPs 8 weeks prior to the commencement of the relevant section of the Infraco Works.

- tie shall comment on the plan(s) submitted, in accordance with the Review Procedure and agree the final plans prior to the commencement of any work on the relevant section or activity.

### 17.3.4 Requirement of Site Specific EMPs

The Infraco shall develop the site specific EMPs to include the following details:

- **A description of the works to be undertaken**
- List of all separate work activities that fall within the scope of the works.
- **A detailed programme of the construction activities**
- Proposed dates and sequence of the works (showing how environmental impacts are affected by potential changes to the Programme);
- Details of proposed normal working hours and intended start up and close down times; and
- Outline of any works which may require construction activities outside of normal working hours.
- **Location of the works, including a site plan, showing construction site boundaries**
- This shall show the position of plant and position of any sensitive receptors e.g. watercourses, local residents, etc.
- **Personnel access routes/points**
- Location plan of each access route/point;
- List of activities for which each access point is to be used
- **Vehicular access routes/points**
- Location plan of each access route/point;
- List of activities for which each access point is to be used
- **Equipment and plant to be used (including type, make and expected number)**
- **Method of delivery/removal of materials and plant**

- **Details of proposed site accommodation**
- **Details of how public right of way and access to property will be retained and managed**
- A list of Consents/permissions obtained or to be obtained for the works
- **External Consultation**
- A list of those notified of the works and the date notified
- A list of proposed notifications and dates
- **Significant environmental impacts relating to each activity.**
- (This should draw upon the definitions of significant impacts used in the Environmental Statement).
- **Significant environmental risks relating to each activity.**
- **Receptors which are likely to be affected by the works.**
- **On-site mitigating measures for each impact and risk.**

These will be transferred onto site management statements which will briefly state the key risks and mitigating measures which have been agreed. The site management statement will be attached to the construction method statement for the works to ensure that it is brought to the attention of all site staff. The Site Management Statement will be briefed out to all site based staff as a toolbox talk.

- **Monitoring proposals that shall include:**
- The receptors for which monitoring will be undertaken;
- Frequency of monitoring;
- Factors against which the monitoring results will be analysed;
- Threshold levels;

- Timescales within which results will be analysed;
- List of organisations/individuals to whom results will be distributed; and
- Actions to be taken in the event that thresholds are breached.

### 17.3.5 Permits to Work

Prior to being granted access to commence construction works, the Infraco shall complete and submit to tie for its autorisation, the required Permits to Work.

Further details of the Permits to Work process are included within the Code of Construction Practice, the Project Safety & Quality Interface Document and Section 39 of the Employer's Requirements.

# 18 Cabling and Ducting

This Section sets out the requirements with the Infraco must comply with in relation to cabling and ducting.

## 18.1 Cabling

All cables must be mechanically protected such that they cannot be accessed by the public without using tools to remove separate mechanical protection.

Cables and associated supports must be rated such that neither the cables nor the supports degrade due to thermal or mechanical stress during their design life.

Cables must operate satisfactorily under all foreseeable fault, and loading conditions.

Cables must operate satisfactorily under all foreseeable environmental conditions. This must include the effects of sunlight, dampness, temperature, and exposure to water. Cables must be selected to recognise risk that they may be submerged in water.

Cables must be designed to last for the durations that are set out in Table 22 - Equipment Design Life.

Cable terminations must not impose any stress on the cables, and sufficient spare length must be provided in all cables to permit foreseeable maintenance and repair work.

Cables must be identified in accordance with requirements agreed with tie.

Where joints in cables are required, and cannot be reasonably avoided, they must be located in draw pits and identified on the as-built drawings. Joints in draw pits must be both suitably supported and accessible. This may require draw pits that are larger than normal size to be used to contain cable joints.

All cables in all draw pits will be identified with a suitable label.

## 18.2 Ducts

Spare ducts shall be provided on all duct routes as follows:

| Number of ducts in cable route | Minimum number of spare (unused) ducts | Minimum size of spare duct |
|---|---|---|
| 2 | 0 | N/A |
| 3 or more | 20% of the number of ducts | Maximum size of used ducts |

Table 42 – Ducts

All ducts, and all individual ducts in banks of ducts, must contain draw ropes of sufficient mechanical integrity to enable additional new or replacement cables to be pulled through the duct.

All ducts, including ducts that are installed but not used for cables, must be free from debris and free from obstructions.

All installed ducts, including ducts that are installed but not used for cables, must not be crushed. All internal dimensions of the duct as built must never less than 90% of duct's nominal dimensions.

Ducts must be provided with drainage that is integrated with the specification of the cables used such that there is no foreseeable risk of degradation from any water that may be in the ducting system.

Ducts must be of sufficient mechanical integrity to protect both themselves and the cables contained in the ducts from all foreseeable damage, degradation and vandalism.

The bending radii of ducts must be integrated with the requirements of the cables to be installed such that the cables can be installed, replaced and terminated without damage.

Ducts must be provided in sufficient number and size to ensure that there is no degradation in the cables due to thermal effects or chafing of cables. It shall be possible to remove and replace any individual cable in the ducting system without the need to remove or significantly disturb any other cables from the system.

Cable ducts shall be installed with appropriate warning arrangement to anyone who may be undertaking excavation work that may damage the ducts. This may be achieved by the installation of plastic warning tape in the ground above the ducts.

Where cables are installed in segregated parts of the tramway, they shall not be installed in cable troughs unless specifically agreed by **tie**. Any proposals for the use of cable troughs must include:

- Locked lids or equivalent to minimise the risk of vandalism and/or theft;
- Where cable troughs form part of the walkway along the tram route, a proven design of locked lids that will eliminate any rocking of the lids must be used; and
- Troughs must be secured against any lateral movement.

For the avoidance of doubt, where cable troughs form part of a structure, the above requirements still apply.

Where ducts are used on the off street tramway, these are preferred to be placed under the walkway with draw pit covers forming part of the walkway.

Any slipping and/or tripping hazards associated with draw pits that are located in a walkway must be eliminated.

Some cables terminate in equipment on ballasted track. These include:

- traction return bonding connected to the rails;
- connections to loops; and
- possibly some connections to some Point Position Indicators.

These cables are to be installed such that the risk of damage to the cables due the activities of track maintenance equipment, vandalism and people walking on the track is minimised.

## 18.3 Duct Chambers and Draw pits

Duct chambers must be structurally sound and built to the requirements of the cabling network as specified in this section 18.

The design of the location of draw pits must such that they can be safely accessed without stopping the operation of the tramway or requiring a road closure, unless specifically agreed by tie.

The integration of draw pit covers into the surfacing in the surrounding area shall be included in the design. This will include the orientation and the surfacing of the cover.

Draw pit covers will be of a family, such that the number of different keys needed to lift draw pit covers is minimised.

The Infraco shall provide sufficient draw pit keys and access equipment to adequately operate and maintain the system.

## 18.4 Cable separation

Sufficient separation between cables must be provided in order to:

- ensure that any risk of damage to the insulation of the cables that could cause potential risks of energising other circuits is minimised. All cables carrying +750V dc must not be in physical contact with any other cables unless the cables are permanently bonded together,
- ensure that electromagnetic compatibility between cables is provided, and
- permit access to cables and any essential cable joints for maintenance purposes

## 18.5 Other requirements

Where cables are installed inside conducting items that are not earthed, such as OLE poles, the insulation and the mechanical protection of the cables must be sufficient to mitigate any associated hazards.

As built drawings will accurately identify:

- the cables that are contained in each duct, to aid cable location and fault finding; and
- the location of all draw pits and all duct runs.

# 19 Cabinets

This Section 19 sets out the requirements which the Infraco must comply with in relation to cabinets and the environmental conditions as defined in Section 3.6.4.

Cabinets, cubicles and equipment housings will be required in the following instances as a minimum:

- To house communications equipments at the Tramstops;
- To house SCADA equipment within substations;
- To house radio equipment at base stations; and
- To house points control, points indicator control, points heaters and Tram control equipment at rail junctions.

All cabinets that are located externally shall meet the following requirements:

- They shall provide an ingress protection rating of 55 (BS EN 60529 Specification for Degrees of Protection Provided by Enclosures) as a minimum;
- They shall be coated with materials that inhibit graffiti and assist with its removal;
- Equipment housing, enclosures, cable routes etc. shall allow for an increase of temperature caused by the equipment, whereby the housing itself shall not cause any harm to the functionality of the equipment or the temperature reached at the surface of the enclosure
- All cabinets shall provide an entry for cabling, with no cables visible or accessible without opening the cabinet;
- All cabinets are provided with a robust lock, satisfying the tie lock suiting requirements set out in these Employer's Requirements;
- The cabinet doors shall be equipped with a multi point locking mechanism that complies with the Edinburgh Tram Network security locking policy;
- In the event of the equipment cabinets being opened, an alarm shall be transmitted to the Supervisory Control and Data Acquisition system so that staff in the Control Centre can be alerted;

- The equipment contained within the cabinets shall be of a modular construction that shall allow rapid replacement should that become necessary;
- When the cabinet doors are open, they do not obstruct tramway operation, road vehicles, passengers or other members of the public; and
- Work can be carried out safely on the contents without affecting tramway operations or requiring temporary traffic management.

In addition, those cabinets located at Tramstops shall be designed to integrate visually with the Tramstop furniture. The external colour and appearance of the cabinets, shall match and complement the architectural finishes and materials of the structures of the Tramstop where the cabinet is to be mounted.

# 20 NOT USED

# 21 Utilities / MUDFA

Where Infraco is instructed by a **tie** Change to carry out utilities diversions, relocation or protective works to deliver the Edinburgh Tram Network the following shall apply.

The philosophy adopted for the MUDFA Works is to clear the ground of utilities such that the track can be installed in ground that has no live utilities within it. The MUDFA Works considers utilities that lie below the area of land that is described by the tram's DKE. It is assumed that the width of ground needed for the construction of the track slab is no more than the width of the tram's DKE.

Where utilities lie below 1200mm from the surface, they are left in-situ.

Where utilities occupy ground that is within 600mm of the existing road surface, they are removed and replaced.

Where utilities lie between these two limits, they are considered on a case by case basis. Generally, utilities that cross the tramway are protected (sleeved for example) and left in position. Where utilities run along the tramway, they are diverted and placed outside the tram's DKE.

Special arrangements are made for major utilities such as the HV cables and the service tunnel along Leith Walk.

Schedule 46 details specific locations and utility types which shall be either left in situ or be diverted by Infraco as a tie Change. Where utilities' scope decisions and responsibilities fall outside this schedule Infraco and tie shall jointly agree the most appropriate party (either MUDFA or Infraco) to undertake the diversion works.

The generic allocation of responsibility for relocating utilities is set out in Section 21 of these Employers Requirements. Infraco will only be responsible for relocating such utilities after receiving a **tie** Notice of Change instructing such relocation.

Tie will obtain designs for all utility diversion works and issue them to Infraco.

Infraco shall deliver the utilities diversion works instructed in accordance with designs provided.

Infraco shall ensure that the Programme as amended in accordance with Clause 80 contains adequate allowance for these utility diversion works.

Infraco responsibilities in respect of utilities diversions instructed as a **tie Change** shall also include:

1. Where diversion works are to be delivered by Statutory Utilities (SUs) supporting tie in the development and agreement of utilities diversions works package agreements with the SUCs. Such support mean supporting tie and providing all necessary information to enable tie to negotiate contracts for diversion works with SUCs, assembling and checking work package agreements, defining detailed scope, providing constructability advice and agreeing programme of works with SUC's and co coordinating such so that impact on programme for delivery of the Infraco Works is minimised, agreeing construction and delivery methodologies with SUCs, finalising the scope of Utilities diversion works and the boundary of responsibility between work to be delivered by Infraco and that of SUCs.
2. Providing all enabling, traffic management requirements, ancillary building, civil engineering, electrical and mechanical works in connection and all attendances required to enable SUCs to carry out and complete their works.
3. Coordinate the works of SUCs with each other and with that of the Infraco.

| Service | Description | MUDFA SCOPE | INFRACO SCOPE | NOTES |
|---|---|---|---|---|

| Service | Description | MUDFA SCOPE | INFRACO SCOPE | NOTES |
|---|---|---|---|---|
| Water | Connections | Connections to new mains will be required before old main can be decommissioned. This is part of the advance diversion scope of MUDFA. | If any connections are missed by MUDFA and subsequently identified by Infraco, they must be carried out at the time of Infraco. However, this risk is small as missed connections would usually lead to immediate customer complaints when the old service was decommissioned. | Note that this is not intended to be the primary mitigation of this risk. site investigation and planning should ensure that connections are identified and dealt with by MUDFA. |
| | Diversion (other than 800mm at Depot) | Part of the advance diversion scope of MUDFA. | If any apparatus is discovered by Infraco that was not identified at the time of the utility advance diversion works, the diversion must be carried out by (or at the same time as) Infraco. Extensive site investigation has been carried out to reduce this risk, but it cannot practically be eliminated. | |
| | Diversion of 800mm at Gogar Depot. | Part of the advance diversion scope of MUDFA. | If any apparatus is discovered by Infraco that was not identified at the time of the utility advance diversion works, the diversion must be carried out by (or at the same time as) Infraco. | There is little, if any, risk of encountering any other water service in the Gogar Depot area that has not been dealt with by MUDFA. |
| | External Protection | Part of the advance diversion scope of MUDFA. | | Long longitudinal protection would not be acceptable for water mains |

| Service | Description | MUDFA SCOPE | INFRACO SCOPE | NOTES |
|---|---|---|---|---|
| | Insurance Pipes | Part of the advance diversion scope of MUDFA. | | |

| Service | Description | MUDFA SCOPE | INFRACO SCOPE | NOTES |
|---|---|---|---|---|
| Waste water | Diversions and manhole construction | Part of the advance diversion scope of MUDFA. | If any apparatus is discovered by Infraco that was not identified at the time of the utility advance diversion works, or where the designs of works have been unable to be sufficiently progressed prior to MUDFA vacating the Work Sections, the diversions must be carried out by (or at the same time as) Infraco. Extensive site investigation has been / will be carried out to reduce this risk, but it cannot practically be eliminated. | Sewer design and agreement with SUC (Scottish Water) regarding treatment required to existing sewers is not currently complete and the programmed completion of the telecoms cabling works is such that existing services cannot be abandoned to allow the manhole and sewer construction works to be undertaken for significant periods of time after all the ducts and other utility diversions are complete. This may result in sewer diversion works to be undertaken after all other MUDFA programmed works in Work Sections are complete. Works may be undertaken by either MUDFA or Infraco. |

| Service | Description | MUDFA SCOPE | INFRACO SCOPE | NOTES |
|---|---|---|---|---|
| | Internal Refurbishment | Part of the advance diversion scope of MUDFA. | | |
| | External protection | Where crossing or short longitudinal - part of the advance diversion scope of MUDFA. | Where long longitudinal: would be relatively easy to incorporate into Infraco - for a section, excavation would be deeper with (e.g.) concrete placed - this would avoid double excavation by MUDFA and Infraco. | |
| | Connections to new sewers | Connections to new mains will be required before old main can be decommissioned. This is part of the advance diversion scope of MUDFA. | If any connections are missed by MUDFA and subsequently identified by Infraco, they must be carried out at the time of Infraco. However, this risk is small as missed connections would usually lead to immediate customer complaints or evidence of flooding when the old service was decommissioned. | This is not intended to be the primary mitigation of this risk: site investigation and planning should ensure that connections are identified and dealt with by MUDFA. |
| | Existing connections | An existing connection to an existing (and left in place) sewer may have to be repositioned. This would be part of the advance diversion scope of MUDFA. | A connection may not be identified at the time of MUDFA, and uncovered by Infraco. The connection must be repositioned at the time of Infraco. | |

| Service | description | MUDFA SCOPE | INFRACO SCOPE | NOTES |
|---|---|---|---|---|
| | Manhole access level change (eg raise height of access cover) | St Andrews Square and North & South St Davids Street will be undertaken by MUDFA as part of the road realignment and construction works required to accommodate the proposed Traffic Regulation Order (TRO) | Manhole access level changes must be adjusted at the time of Infraco. Manhole lids to be flush with the finished road surface. | It will also mean that new manholes installed by MUDFA may have to be modified by Infraco. |
| | New Gully connections | St Andrews Square and North & South St Davids Street will be undertaken by MUDFA as part of the road realignment and construction works required to accommodate the proposed Traffic Regulation Order (TRO) | Infraco shall install road gulleys. These will have to be installed at the same time as the road construction is carried out. | If a new road gully is required at a place where the road level is not to be changed, MUDFA could install it. However this situation is unlikely, and for consistency and avoidance of confusion Infraco should probably do all of this. |

| Service | [illegible] | MUDFA SCOPE | INFRACO SCOPE | NOTES |
|---|---|---|---|---|
| Telecoms | Protect | Where crossing or short longitudinal - part of the advance diversion scope of MUDFA. Where long longitudinal: would be part of the advance diversion scope of MUDFA allowing Infraco a "clear run". However would necessitate double - excavation of a long length of the tram foundation area. | | Where long longitudinal: would be relatively easy to incorporate into Infraco - for a section, excavation would be deeper with (e.g.) concrete placed - this would avoid double excavation by MUDFA and Infraco*. |
| | Slew/Lower | Part of the advance diversion scope of MUDFA. | If any apparatus is discovered by Infraco that was not identified at the time of the utility advance diversion works, the diversion must be carried out as Infraco Works. Extensive site investigation has been carried out to reduce this risk, but it cannot practically be eliminated. | |

| Service | Description | MUDFA SCOPE | INFRACO SCOPE | NOTES |
|---|---|---|---|---|
| | Divert (inc manhole construction) | Part of the advance diversion scope of MUDFA. | If any apparatus is discovered by Infraco that was not identified at the time of the utility advance diversion works, the diversion must be carried out as Infraco Works. Extensive site investigation has been carried out to reduce this risk, but it cannot practically be eliminated. | |
| | Insurance Ducts | Part of the advance diversion scope of MUDFA. | | |
| | Manhole access level change (eg raise height of access cover) | St Andrews Square and North & South St Davids Street will be undertaken by MUDFA as part of the road realignment and construction works required to accommodate the proposed Traffic Regulation Order (TRO). | Manhole access level changes must be adjusted at the time of Infraco. Manhole lids to be flush with the finished road surface. | This will also mean that new manholes installed by MUDFA may have to be modified by Infraco. |

| Service | Description | MUDFA SCOPE | INFRACO SCOPE | NOTES |
|---|---|---|---|---|
| Gas | Divert | Part of the advance diversion scope of MUDFA. | If any apparatus is discovered by Infraco that was not identified at the time of the utility advance diversion works, the diversion must be carried out as Infraco Works. Extensive site investigation has been carried out to reduce this risk, but it cannot practically be eliminated. | |
| | Protect | Part of the advance diversion scope of MUDFA | | Long longitudinal protection would not be acceptable for gas mains |
| | Insurance Pipes | Part of the advance diversion scope of MUDFA | | |
| | Connections | Connections to new mains will be required before old main can be decommissioned. This is part of the primary scope of MUDFA. | If any connections are missed by MUDFA and subsequently identified by Infraco, they must be carried out as part of Infraco Works. However, this risk is small as missed connections would usually lead to immediate customer complaints when the old service was decommissioned. | This is not intended to be the primary mitigation of this risk: site investigation and planning should ensure that connections are identified and dealt with by MUDFA. |

| Service | [illegible] | MUDFA SCOPE | INFRACO SCOPE | NOTES |
|---|---|---|---|---|
| Electricity | Divert | Part of the advance diversion scope ofMUDFA. | If any apparatus is discovered by Infraco that was not identified at the time of the utility advance diversion works. the diversion must be carried out as part of Infraco Works. Extensive site investigation has been / will be carried out to reduce this risk, but it cannot practically be eliminated. | |
| | Protect | Where crossing or short longitudinal - part of the advance diversion scope ofMUDFA. | Where long longitudinal would be relatively easy to incorporate into Infraco - for a section, excavation would be deeper with (e.g.) concrete placed - this would avoid double excavation by MUDFA and Infraco. | Where long longitudinal would be part of the advance diversion scope of MUDFA allowing Infraco a "clear run". However would necessitate double - excavation of a long length of the tram foundation area. |
| | Insurance ducts | Part of the advance diversion scope ofMUDFA. | | |

| Service | Description | MUDFA SCOPE | INFRACO SCOPE | NOTES |
|---|---|---|---|---|
| | Domestic + Business connections | Connections to new cables will be required before old cable can be decommissioned. This is part of the primary scope of MUDFA. | If any connections are missed by MUDFA and subsequently identified by Infraco, they must be carried out as part of Infraco Works. However, this risk is small as missed connections would usually lead to immediate customer complaints when the old service was decommissioned. | This is not intended to be the primary mitigation of this risk. site investigation and planning should ensure that connections are identified and dealt with by MUDFA. |
| Street Furniture (eg street lighting, traffic lights, lighted bollards, bus stops, etc) | Existing power & telecoms Divert | St Andrews Square and North & South St Davids Street will be undertaken by MUDFA as part of the road realignment and construction works required to accommodate the proposed Traffic Regulation Order (TRO) | All existing power and telecoms diversions required must be carried out by (or at the same time as) Infraco. Depth of cover and the final road infrastructure alignment and construction to be finalised by and carried out by Infraco. | Extensive site investigation has been / will be carried out to reduce this risk, but it cannot practically be eliminated. |
| | Protect | St Andrews Square and North & South St Davids Street will be undertaken by MUDFA as part of the road realignment and construction works required to accommodate the proposed Traffic Regulation Order (TRO) | All existing power and telecoms diversions required must be carried out by (or at the same time as) Infraco. Depth of cover and the final road infrastructure alignment and construction to be finalised by and carried out by Infraco. | |

| Service | Description | MUDFA SCOPE | INFRACO SCOPE | NOTES |
|---|---|---|---|---|
| | New connections | For future street furniture, appropriate ducting would be installed by MUDFA where (1) design details are available sufficiently in advance, (2) the road/tram alignment is formally finalised and (3) the future ground levels are such that new ducts can be buried beneath the existing ground level, without either excessively deep excavation or inadequate (or no) cover. | Where design is not available in time for MUDFA, or where future road levels do not facilitate advance installation, duct installation work must be carried out as part of Infraco Works. | |
| Other | SP transmission cables | If the design agreed with Scottish Power requires external protection beyond that provided by the track slab in that area, and if the design is available in good time, then MUDFA could undertake these works if required. | Infrastructure design will have to take account of the specific requirements to avoid diverting these cables. This will include special track slab construction (for Leith Walk) and careful bridge abutment/pier design (for 3 other areas). Should this design be impossible, the diversion work would be carried out by Scottish Power directly. | This would not be possible before 2008 (at the time of writing; lead time requires a notification before October in one year for work in the summer of the following year). Consultation between utilities and infrastructure design teams should facilitate this design. |

| Service | Description | MUDFA SCOPE | INFRACO SCOPE | NOTES |
|---|---|---|---|---|
| | BT cables at A8 by Gogar | | Infrastructure designs shall take account of the specific requirements to avoid diverting these cables. | This may include a deeper excavation for the tunnel under the A8 than had previously been envisaged, plus provision of temporary support for the cables during the construction of the tunnel. Should this design be impossible, the diversion work would be carried out under MUDFA terms and conditions. Consultation between utilities and infrastructure design teams should facilitate this design. Trial holes have been undertaken on behalf of BT to confirm the depth of the existing cables – the initial, informal, impression from BT is the cables are higher than anticipated which indicates the cables may not require diversion but incorporation into the infrastructure design. |

| Service | Description | MUDFA SCOPE | INFRACO SCOPE | NOTES |
|---|---|---|---|---|
| | BT cables at Roseburn street | | Infrastructure design will have to take account of the specific requirements to accommodate these cables. Infraco shall consider the design solution for cabling installation as part of the Infraco Works. | This will include careful bridge abutment/pier design. The cabling element of this work is to be carried out by BT following diversion works, and may impact on the Infraco programme. Consultation between utilities and infrastructure design teams should facilitate this design. Note: a design solution for the cables as part of the Infraco works has been agreed with BT. |
| | Utility work dependent on prior structures work, eg cables in bridge decks | | Will require structures work to be completed before utility work can be started. Infraco shall complete any and all utility diversions, utility protections works etc. including design (by SDS) following (or at the same time as) the Structures are completed. | |

Table 42a – Table showing the responsibility for diversion/protection work on the utilities for the Edinburgh Tram project

# 22 Locks and Key Suiting

## 22.1 General

The Edinburgh Tram Network will have many locks installed to provide a suitable level of secure access to equipment and rooms. The locks and keys used shall be integrated into appropriate key suiting families. The philosophy is to strike an appropriate balance between the following two extremes:

- A single fully integrated key suiting arrangement for the whole of the Edinburgh Tram Network;
- No suiting, with every lock needing a different key;

The Infraco shall propose key suiting arrangements that are subject to approval by tie. In developing the proposals, Infraco shall consider:

- The need for staff to be able to undertake their duties without having to carry large numbers of keys with then to access the places that their duties require;
- Future expansion of the Edinburgh Tram Network;
- Changes to the key suiting that are likely to be needed as the system matures, and any key suiting must bear be sufficiently flexible to enable such changes to be made; and
- The ongoing costs of providing keys to staff during the life of the Edinburgh Tram Network;

## 22.2 Key Suiting System

A key suiting system that is based by the Infraco on the following is likely to be acceptable to tie.

A stand alone suite of keys, hierarchically structured to provide access to equipment such as:

The suiting documentation will list all locks to be installed on the Edinburgh Tram Network, including any locks that are not proposed to be included in the suites. There should be 4 completely separate suiting systems, as set out below:

### 22.2.1 Tram

- The Infraco shall procure all keys that are required for operating each tram. It is anticipated that each tram driver will need to carry no more than two keys for each Tram in order to undertake their duties. One key would permit access onto the tram, into the cab, and enable the Tram to be driven. The second key would open any panels that the driver may need to access and may also provide for such tasks as locking doors out of use;

- A different key would permit staff such as cleaners to access the inside of the Tram and the Tram cabs, but would not enable the Tram to be driven;

- Tram Maintenance staff may also need additional keys to access sensitive or potentially dangerous equipment.

### 22.2.2 Substations and Power

A stand alone suite ofkeys, hierarchically structured to provide access to equipment such as:

- Isolator cabinets, to check the position of isolators and to fit isolation padlocks;

- Substation LV areas;

- Substation HV areas in substations;

- Isolators, to permit hand operation;

- Equipment within the substations may also have a multitude of locks that may be suited, depending on the Infraco maintenance philosophy.

Separate individual locks with a single key will be used for securing isolations. There will be no suiting whatsoever for these.

### 22.2.3 Depot and buildings

A stand alone suite of keys, hierarchically structured to provide access at doors in the Depot building and other buildings in the Depot area such as the Depot plant building. A low level key in this structure could be used for any trackside gates that are required along the alignment.

### 22.2.4 Signalling and Communication Equipment

A stand alone suite of keys, hierarchically structured, to provide access to all trackside cabinets, including:

- Points control;
- Points heating;
- Signalling and;
- Tramstop.

Isolator cabinets are substations are excluded from this suite because they are included in the substations and power suite of keys.

# 23 Testing and Commissioning

## 23.1 Systems Acceptance

### 23.1.1 Scope

This section of the Employer's Requirements is to define the systems acceptance requirements applicable to the Edinburgh Tram Network (ETN) which the Infraco must comply with.

### 23.1.2 General Description and Principles

The process for acceptance of the Edinburgh Tram Network set out in this document is designed to ensure that the ETN is delivered in an acceptably safe, compliant, and efficient manner. The objectives of the process are to ensure that system performance, integrity, reliability, availability, and safety are rigorously tested and that throughout all stages of the delivery process the many sub-systems and the overall System are validated and verified against tie's requirements and applicable standards. The detailed sequence and scope of infrastructure testing and commissioning prior to System Acceptance Testing shall be programmed out and proposed by the Infraco.

The acceptance process is heavily dependent on the delivery of the planned service timetables, the Operational Timetable (see 2.8 of these Employer's Requirements) and the Enhanced Timetable (see 2.8 of these Employer's Requirements). Details regarding the tram service frequency, number of trams and the phased opening of the Edinburgh Tram Network are contained in 2.8 of these Employer's Requirements.

Pre-system acceptance testing includes both Factory Acceptance Tests (FATs), Site Acceptance Tests (SATs), Sub-system Integration Tests (SITs) and System Commissioning Tests (SCTs).

Once a Section of the ETN is physically completed and the System Integration Tests are satisfactorily completed then the formal acceptance process requires the Infraco to carry out and pass a series of System Acceptance Tests (SATS) in order to achieve Sectional Completion. These tests are:

Table 43 - Description of the Acceptance Tests

| Test | Test Name | Test Description | Programme |
|---|---|---|---|
| T1 | Post Commissioning Test | The test shall demonstrate and prove that each Section of the ETN in sequence is able to perform in an acceptably safe manner and deliver the required run times. Please refer to relevant section below. This is the gateway test to driver training. | Post Commissioning Test will immediately follow the successful commissioning of the nominated section and is a requirement for progressing into the Driver Training. |
| T2 | Performance Test 1 | After Section D has passed Test T1 then this test shall demonstrate and prove that Phase 1a of the ETN is able to perform satisfactorily to move into the three-month Shadow Running period. Please refer to relevant section below. This is the gateway test to shadow running. | Performance Test 1 will immediately preceed the Shadow Running period and is a requirement for progressing to this phase of the programme. |
| T3 | Pre-operations Test | The test shall cover a seven day period during the latter part of the Shadow Running phase of the programme. The Test is the operation of the initial entry into service timetable and includes infrastructure, trams, and operations systems – Please refer to relevant section below. | Pre-operations Test shall immediately precede the Service Commencement Date. |
| T4 | Network Performance Test | The Test shall be carried out over a 28 day period in Passenger Service to establish that the ETN can reliably operate the Operational Timetable – please refer to Please refer to relevant section below. | To be completed within twelve months of the Service Commencement Date. |
| T5 | Network Reliability Test | Reliability Testing of certain sub-systems in Passenger Service – please | To be completed within twelve months of the Service |

| | | | |
|---|---|---|---|
| | | refer to Please refer to relevant section below. | Commencement Date. |

The Post Commissioning Test (T1), Performance Test 1 (T2) and Pre-operations Test (T3) have to be passed before the Edinburgh Tram Network (or Sections thereof) can open for passenger carrying service and are therefore to be scheduled during the test running and driver training and shadow running phases.

The Post Commissioning Tests (T1) can be undertaken in isolation for each Section.

Performance Test 1 (T2) and the Pre-operations Test (T3) can only be undertaken for that/those section(s) that are to be opened for passenger carrying service immediately thereafter.

The Network Performance (T4) and Network Reliability Test (T5) shall not be carried out until Passenger carrying Service has commenced on the whole Edinburgh Tram Network.

The figure on the next page shows the structure of the tests.

Figure 10 - Edinburgh Tram Network: Extract from System Life Cycle Model

| Stage | | | Description |
|---|---|---|---|
| 8 | Passenger Service | Network Performance (T4) and Reliability Test (T6) | The date upon which the Edinburgh Tram Network starts in public service |
| | | | PASSENGER SERVICE COMMENCEMENT |
| 7 | Shadow Running | Pre-Operations Test (T3) | The period of Tram operations that simulates full public service operation including running to published timetable and calling / dwelling at Tramstops before the ETN enters public service |
| | | Performance Test 1 (T2) | ENERGISATION OF COMPLETED PHASE OF THE ETN |
| 6 | Test Running & Driver Familiarisation | | The period post ETN commissioning used to complete driver and control room staff training and gain confidence to enter Shadow Running Phase |
| | | Post-Commissioning Test (T1) | |
| 5 | Commissioning | System Integration Test | All subsystems, including the tram, are fully integrated to form the ETN and are tested to demonstrate that they work together successfully and meet the Employer's Requirements |
| | | | ENERGISATION OF SECTION OF THE ETN |
| 4 | Set to Work Tests | Site Tests | The point at which subsystems have been installed and then tested to prove they meet their requirements with both Type tests and Site Acceptance tests |
| | | | LIMITED ENERGISATION OF PART OF THE ETN |
| 3 | Installation / Construction | | Once the subsystem has successfully passed Factory Acceptance Tests installation / construction at site will take place and as appropriate a delivery test undertaken |
| | | | |
| 2 | Factory Acceptance Tests | FAT | Thorough demonstrable testing of the subsystem at Infraco's premises |
| | | | |
| 1 | Build / Manufacture | | Manufacture and assembly of the System by the Infraco |
| | | | |
| D | Design | | The scope of the works designed through Approval in Principle and Approved for Construction & Manufacturing Drawings, with associated verification and validation test and integration plans complete |

## 23.2 Test Planning

The efficient programming of the tests is vital to the success of the system acceptance test process. Infraco shall, therefore, consider and incorporate, in a coordinated manner at each stage of the implementation of this process, the relevant documentation, the required tram availability and commissioning site availability and staff (from all concerned parties), into the overall Infraco test plan.

The Infraco shall prepare and present the Infraco test plan for review no later than six months after the Effective Date. The Infraco test plan shall describe how the Factory Acceptance Testing, Site Testing and Commissioning, Test Running and Driver Training and Shadow Running, as well as the Network Performance and Network Reliability tests are to be undertaken. The definition of these tests is shown in Figure 10. The programming of the tests shall be in accordance with the Programme as described in Section 39 of these Employer's Requirements. Infraco shall ensure that the PSCC and the Independent Competent Person (or the appropriate approval regime in force) are satisfied that the testing process is robust, comprehensive and satisfies all of the safety issues legislated and mandated for the system.

As the project evolves the Infraco Test Plan/Risk Register/Hazard Log shall be maintained by the Infraco. Infraco shall demonstrate that the issues raised in this log have been mitigated or that the tests have demonstrated the risk has been resolved. It is therefore important that the testing procedures and results are correlated with the Project Risk Register and Hazard Log.

## 23.3 Pre-Systems Acceptance Testing (before starting the systems acceptance process)

The following should be noted with regards to any tests to be undertaken:

- The individual test documentation / specifications shall be submitted to tie for acceptance in accordance with Schedule 14 (Review Procedure) and tie's approval obtained before the test can take place;
- A notice period of at least seven working days shall be given to tie prior to any test in order that tie, and/or its representative(s), can arrange, at their option, to witness the test. The Operator's staff shall also be invited to witness all testing activities;
- Factory Acceptance Tests (FAT) and Site Acceptance Tests (SAT) test results shall be submitted to tie for review;

- tie reserves the right to be present during any of the tests to be undertaken; and
- Any such review will be undertaken in accordance with Schedule 14 (Review Procedure).

The following tests shall be carried out in advance of the systems acceptance testing sequence.

## 23.4 Factory Acceptance Tests (FAT)

### 23.4.1 Overview

Factory Acceptance Tests consist of a series of progressive activities all of which are undertaken at the sub-system manufacturer's premises.

Initial testing at the component manufacturer's premises of components to be used as part of a sub-system shall be undertaken to verify that the components behave as predicted in the design and satisfies the Employer's Requirements for that component.

Initial testing undertaken at the manufacturer's premises shall be undertaken to verify that the sub-system or component behaves as predicted in the design and meets the requirements of the design specification and provides correct functionality.

Once sub-systems or components have been successfully tested they shall be incrementally integrated and tested to verify that the sub-systems behave as predicted in the design and meet the requirements of the design specification and provide correct functionality.

Part of the FATs are first article inspections or type tests. These shall be undertaken on the first production item. This inspection shall verify that the Quality and functionality of the product is acceptable and that the manufacturers' quality control processes and procedures have been implemented.

The test specification(s) shall be produced by Infraco and shall be subject to acceptance in accordance with the Review Procedure. tie agreement to all proposed component, sub-system and Factory Acceptance Test specifications is required at least ten business days prior to the date of the component, sub-system and FAT tests identified above and any additional tests required by Infraco.

### 23.4.2 Pass Criteria

FAT testing shall demonstrate that the individual sub-systems or components and equipment fully meet the requirements and are suitable for the subsequent release from the factory environment, delivery to site and installation.

FATs demonstrate the integration of the modules and sub-systems under factory conditions and their reliable operation under cyclical testing.

As far as applicable the FAT will demonstrate that the sub-system or components has been successfully exercised through simulation, including a demonstration on how the alarm handling manages the worst case alarm flood. This test will be subject to tie approval.

## 23.5 Site Tests

### 23.5.1 Overview

The objective of site tests is to demonstrate that:

(a) Construction/installation activities have been completed correctly by demonstrating that the design specification and functionality of these Employer's Requirements have been achieved;

(b) The sub-systems, in isolation and before passengers are carried, function and behave at site as designed and tested in the FAT;

(c) The infrastructure sub-systems and the tram will then be integrated with each other insofar as is possible to prove that they collectively function and behave at Site as designed and tested in the FAT; and

(d) The ETN functions and behaves at Site as designed and tested in the FAT. This is defined as system commissioning tests and involves the integration of the infrastructure sub-systems and the tram.

The Independent Competent Person as defined under the ROGS Regulations, other regulatory bodies and the PSCC shall need to be satisfied that the ETN is safe to operate before commencement of system commissioning activities. In order to verify this it shall be necessary for the Infraco to address the issues raised by the Independent Competent Person, PSCC, HMRI (or the appropriate approval regime in force) and Approval Bodies. This may necessitate defining specific tests or incorporating additional Network Performance Test details into the suite of verification commissioning tests. Often the areas of interest to these bodies do not become clear until the majority of issues on the risk register and hazard log have been closed out. Typically these may include items such as:

- pedestrian collision, and the risk of a person being "run over " by a tram;
- gauging and possible entrapment of people in pedestrian areas;
- failed tram recovery;
- control room operational procedures; and
- Recovery from derailments, including rerailing a tram.

It is assumed that tie shall procure all electrical power and that a supply is available for the complete on site test procedures until commencement of passenger service.

## 23.6 Sub-system Integration Tests (SIT)

### 23.6.1 Overview

Sub-system Integration Tests cover items 23.5.1 of these Employer's Requirements. They shall be undertaken on Sections.

The Infraco shall produce the suite of SIT testing specifications for acceptance by tie no later than three months prior to the commencement of the tests through the Review Procedure.

### 23.6.2 Pass Criteria

The tests are passed when:

- Each sub-system, module or component of the system functions in isolation as designed and does not deviate from FAT results.

- All sub-systems for the given section of tramway are demonstrated to collectively perform in accordance with the operations and performance, and all of these Employer's Requirements.

## 23.7 System Commissioning and Integration Tests (SCT)

### 23.7.1 Overview

System Commissioning and Integration Tests shall be undertaken on Sections.

Such activities include the running of tram(s) over section(s) of the Edinburgh Tram Network for which Sub-system Integration Tests have been successfully completed. This will verify that the ETN behaves as predicted and as demonstrated as far as was practical in previous tests.

Infraco shall liaise with both tie and the Operator to ensure that sufficient competent operational personnel are available to conduct the required activities, including tram drivers and control room staff.

### 23.7.2 Pass Criteria

The tests are passed when:

- Each sub-system, module or component of the system functions collectively as designed and do not deviate from FAT results.

All sub-systems for the given section of tramway are demonstrated to collectively perform in accordance with the operations and performance, and all of the Employer's Requirements for a representative number of consecutive passes of a tram in each direction over the given section of the network.

- The integration testing shall include demonstrating that the control room systems and control centre equipment connected to a representative sample of the substation SCADA and other

equipment required for Tramstops can be effectively exercised under a robust simulation of trams progressing around the ETN.

## 23.8 System Acceptance Activities and System Acceptance Tests

The Infraco shall produce the suite of System Commissioning Test specifications for review by tie no later than three months before commencement of the tests. These will be reviewed in accordance with the Review Procedure

## 23.9 Operations and Maintenance Staff Training

The object of this series of activities is to complete driver, control room and maintenance staff training and provide said staff with greater system familiarisation, demonstrating competence to enter Shadow Running phase upon the passing both of the Post Commissioning and Performance Test 1 (T1 and T2). It therefore forms an integral part of the driver-route familiarisation and training programme.

Staff Training shall achieve the following objectives:

- Enables control room staff to gain experience running a tramway without passenger pressures;
- Allow operational staff to fulfil their duties; and
- Enables the drivers to gain route knowledge and familiarity with the trams and procedures without passenger pressures.

The activities undertaken during this phase are designed to demonstrate confidence in the system performance and system safety by means of passing the post commissioning test and performance test T1, and to gain approval of the Independent Competent Person, PSCC and HMRI. (or the appropriate approval regime in force) to progress to Shadow Running.

Infraco shall liaise with the Operator to undertake careful integration of the operational training programme and testing needs in order to avoid conflicts between operational requirements and the technical validation/verification. These comprise items 4, 5 and 6 of the system commissioning model in Figure 10 – Edinburgh Tram Network –Extract From System Lifecycle Model.

## 23.10 Shadow Running

The Shadow Running phase will last three months and shall:

- Build and validate the operating pattern up to the Service Commencement Date;
- Carry out any further emergency exercises;
- Demonstrate that the ETN can be safely operated in a routine manner and can recover from emergency situations and emerging perturbations;
- Resolve any issues in respect of operating practices;
- Demonstrate that reliability growth is being monitored and corrective action taken as necessary;
- Allow mileage accumulation to be carried out on the trams;
- Permit infrastructure and tram maintenance staff to familiarise themselves with the procedures, practices and operations regimes and to demonstrate competence development;
- Ensure experience is gained in the gathering and evaluation of the performance monitoring regime data in accordance with Schedule 7 of this Agreement; and
- Allow minor adjustments and tuning of systems.

This comprises item 7 of the system commissioning Model in Figure 10 – Edinburgh Tram Network -- Extract From System Lifecycle Model.

The evaluation of Shadow Running is the pre-operations test (T3), the passing of which is the gateway to moving into operation, provided all necessary HMRI (or the appropriate approval regime in force) consents are obtained.

## 23.11 Final System Acceptance Tests in the Operations and Maintenance Phase

Within twelve months of opening the ETN to passenger service Infraco shall undertake and pass the Network Performance (T4) and Network Reliability Test (T5) (as described in Sections 23.16 and 23.17).

## 23.12 Emergency Exercises

The Infraco and the Operator shall prepare a plan for review by tie and the Competent Person and following approval of the plan, the Operator shall perform with support from the Infraco a series of exercises with the emergency services and other stakeholders such as Network Rail and BAA. The planning for these exercises will require close liaison by the Infraco and the Operator with the various emergency services. They will be planned to take place in the commissioning period, test running or in the shadow running phase. The nature of the exercises will require detailed planning with Fire, Police, and Ambulance services but are likely to include, as a minimum:

- A simulated road traffic accident at a major road junction;
- A major tram collision/derailment including emergency isolations; and
- A rescue of persons trapped underneath a tram.

## 23.13 Post Commissioning Test Specification – T1

This sub-section sets out the Performance Test assumptions applicable to all Performance Tests. Should the Infraco be able to prove to the reasonable satisfaction of tie's Representative that any of the Performance Test pass criteria have been exceeded by reason of a Performance exclusion then the test results will be amended to discount the effects of such Performance Test exclusions.

The following exclusions shall apply:

- Operator staff in the Control Room causing or significantly contributing to delays in the operation of the System;
- Failure to provide the correct number of trained Tram Drivers as defined in the DPOFA save where the failure is as a result of the Infraco's own failure in respect of its own obligations in the Agreement;
- Failure of the Tram Drivers to consistently drive the Trams to good industry practice;
- Failure to procure all electrical power that is required for the operation of the System. Periods when the electrical supply is not available will be discounted from the Test and the test period shall be extended by an equivalent period;

- A failure by the Operator to comply with the relevant parts of the Operations and Maintenance Manuals; and

- Damage caused by the Operator.

However, in no event shall any allowances or relief or Network Performance Test exclusion be granted to the Infraco where any delays or failure to pass the Network Performance Test has been caused or contributed by:

(a) Any default, breach or omission by the Infraco or its subcontractors;

(b) Infraco Defects or Snagging;

(c) Equipment undergoing modification or rectification by the Infraco and;

(d) TRAMCO's failure pursuant to the Tram Maintenance Contract.

The burden of proof shall be on the Infraco to show that such failures of the Operator were caused by reasons for which the Infraco was not responsible and for which the Operator should be properly accountable for by reason of the Operator's default, omission, negligence or breach of statutory duty. The Infraco shall develop and agree audit procedures with tie, and the Operator in respect of the Network Performance Test exclusions set out in this paragraph.

Dwell times at Tramstops shall be regulated; as set out in the Employer's Requirements.

### 23.13.1 Overview of Post Commissioning Test

This section describes the requirements for the Post Commissioning Tests, their execution, monitoring and completion. Post Commissioning Tests form part of the requirements for the final system acceptance.

### 23.13.2 Test Objectives

This Post Commissioning Test seeks to achieve the following objectives:

Prove that the system is capable of controlling an 'off-street' section of Edinburgh Tram Network in an acceptably safe manner; and

Prove that the system is capable of controlling an 'on-street' section of Edinburgh Tram Network in an acceptably safe manner.

### 23.13.3 Network Performance Test Description

The Post Commissioning Test is a multi part test, with each part of the test required to be passed in sequence before the entirety of the Post Commissioning Test can be passed. It cannot be conducted until Phase 1a of the Edinburgh Tram Network has been successfully commissioned.

### 23.13.4 Features

The Infraco shall demonstrate that Gogar Depot and Phase 1a of the Edinburgh Tram Network can be monitored and controlled in accordance with the Case for Safety.

Tests shall provide for:

- Demonstration of the run times as defined below.
- Forty end-to-end tram movements on the nominated section of which twenty are in each direction; and
- Trams will dwell at each Tramstop, and will exercise opening and closing of the doors at each Tramstop, the minimum period of doors being fully opened at each Tramstop will be 13 seconds.

The undertaking of the test shall essentially be an operational function led by Infraco but in conjunction with the Operator. Infraco shall manage the preparation for the tests with technical and maintenance support and monitoring by Infraco (along with representatives from tie).

For the demonstration of run time, the following conditions shall apply:

- Targets of the run time demonstrations shall be developed in accordance with Section 2.12 of the Employers Requirements and agreed between the parties from the agreed maximum journey times and associated assumptions detailed in Section 2.11 of the Employers Requirements during the design phase, as further details of tram performance and traffic lights are available;
- For avoiding of influences due to public traffic, run time demonstrations shall take place during night times only;
- tie will be responsible for the communication with local authorities like CEC, UTC or police;
- run time demonstration to be performed in both directions and shall include the following two demonstrations:
  - run allowing tram priority at each traffic junction along the route
  - run following the regulations and phasing of traffic lights under regular conditions
- Sufficient runs shall be carried out in both directions to provide a level of confidence that the target runtimes have been achieved as agreed in accordance with Section 2.12 of the Employers Requirements.
- Infraco shall undertake and pass the Post Commissioning Test (T1) before proceeding to the Performance Test 1 (T2).

**tie** shall be given thirty working days advance notice of the finalisation of the Post Commissioning Test plan and seven working days written notice of the Test commencement date.

### 23.13.5 Pass Criteria

Subject to the exclusions defined in23.13 above, the following shall define the pass criteria for the T1 test.

- All test results from previous tram and system and sub-system tests are to be available and signed off as accepted by **tie**, including all the closed out Snagging Rectification Certificates.
- The test shall have been successfully completed when:
  - At least 95% of the end-to-end tram movements are within the agreed target runtime; and
  - Acceptance of the Case for Safety and test results by the Independent Competent Person and where appropriate Her Majesty's Railway Inspectorate (or the appropriate approval regime in force) and approval or "No Objection to Proceed" respectively for full driver training has been obtained.

### 23.13.6 Monitoring and Reporting of Test Performance

Appropriate levels of observation by Infraco shall be conducted to satisfy **tie** that the auto-generation of reports from the systems is accurate.

## 23.14 Performance Test 1 Specification – T2

### 23.14.1 Overview

This section describes the requirements of Performance Test 1 and the proposals for its execution monitoring and completion. Performance Test 1 forms part of the requirements for the final System Acceptance.

### 23.14.2 Test Objectives

Performance Test 1 seeks to achieve the following objectives:

- Demonstrate that the Edinburgh Tram Network (or sections thereof) can be operated in an acceptably safe manner;

- Demonstrate that the completed Operator training programme has achieved an adequate competency to proceed in Shadow Running; and

- Demonstrate the mobilisation and competency of the maintenance teams provided by the Infraco.

### 23.14.3 Network Performance Test Description

Performance Test 1 builds upon Post Commissioning Test and cannot be undertaken until Post Commissioning Test has been passed.

### 23.14.4 Features

The Infraco shall demonstrate that the Edinburgh Tram Network can start Shadow Running and can be monitored and controlled in accordance with the Case for Safety.

Performance Test 1 shall provide for:

- Operation from 07:00 to 20:00 hrs on three consecutive days (none of which are Saturday, Sunday or Bank Holidays);
- The System will run to the Operational Timetable with headways extended by no more than 50%. For the avoidance of doubt, the trips scheduled for this test are the same as in the Operational Timetable as set out in Sections 2.11 and 2.12 of these Employer's Requirements; and
- Trams shall dwell at each Tramstop and shall exercise opening and closing of the doors at each Tramstop. The minimum period of doors being fully opened shall be 13 seconds at each Tramstop.
- The undertaking of the test shall be an operational function led by Infraco but in conjunction with the Operator. Infraco shall manage the preparation for the Tests with technical and maintenance support and monitoring by Infraco (along with representatives from tie).
- Infraco shall undertake and pass Test T2 before proceeding to the Shadow Running phase.
- tie shall be given twenty working days advance notice of the Performance Test 1 plan and seven working days written notice of the Test commencement date.

### 23.14.5 Pass Criteria

The following define the pass criteria for the T2 test.

All test results from previous tram and system and sub-system tests are to be available and signed off as accepted by **tie**. Any Defect Correction lists shall be available and agreed as being programmed to be remedied.

The test shall have been successfully completed when:

- At least 95% of the end-to-end tram movements meet the requirements of the Performance Regime in terms of Punctuality Service Element as defined in 2.16.

- Acceptance of the Case for Safety and test results by the PSCC , the Independent Competent Person and where appropriate Her Majesty's Railway Inspectorate (or relevant approval body) and their approval or 'Letter of No Objection to proceed" into Shadow Running.

### 23.14.6 Monitoring and Reporting of Test Performance

The primary data used to evaluate the test shall be automatically generated from the Supervisory Control & Communications performance monitoring sub system and validated independently.

## 23.15 Pre-Operations Test Specification – T3

### 23.15.1 Overview

This section describes the requirements of the Pre-Operations Test and the proposals for its execution monitoring and completion. The Pre-operations Test shall be conducted during the Shadow Running phase of the project and forms part of the requirements for the final System Acceptance.

### 23.15.2 Test Objectives

The Pre-operations Test seeks to prove that the Edinburgh Tram Network, or section thereof, in the event of sectional opening operates to a sustained level of performance determined by the Opening Timetable and the performance regime such that:

- The Operator can safely commence passenger carrying revenue earning service;
- The Infrastructure and Tram Maintainers can commence the Planned Maintenance proposed for passenger carrying revenue earning service; and
- The Edinburgh Tram Network passes the ride quality criteria in Tables 62 & 63 of the Employers Requirements.

### 23.15.3 Network Performance Test Description

Pre-operations Test is a four-part test upon successful completion of all parts of which the Edinburgh Tram Network or section(s) thereof can be opened to public service. The Pre-Operations test cannot be undertaken ahead of the successful completion and passing of the respective Performance Test 1.

### 23.15.4 Features

The Infraco shall demonstrate that the entire Edinburgh Tram Network or section(s) thereof can be operated to the defined levels of performance, reliability and availability and in accordance with the operational Case for Safety.

The Part 1 test shall comprise:

- Five consecutive days (none of which are Saturday, Sunday or Bank Holidays) of testing in accordance with the Operational Timetable. This test is to be undertaken no sooner than two weeks after commencement of the Shadow Running phase;

The Part 2 test shall comprise:

- Five consecutive days (none of which are Saturday, Sunday or Bank Holidays) of testing in accordance with the Enhanced Timetable, which cannot commence until two weeks from successful completion of the Part 1 test, and must be completed at least two weeks prior to the end of the Shadow Running phase, unless agreed otherwise by tie.

For both the Part 1 and Part 2 tests, trams shall dwell at each non-terminus Tramstop for a nominal 25 seconds and the doors shall normally remain closed.

The Part 3 test (which can be undertaken at any time during shadow running) shall comprise:

- One of the fleet of trams shall be selected by tie to be instrumented and monitored. The selected tram shall provide results for 100 journeys of the selected tram consecutively over all sections of the ETN;

- Measurement of lateral, longitudinal and vertical accelerations to be taken on the floor of the trailing cab of the tram.

- All tram journeys during the test period that provide data for this test shall be completed within a tolerance of plus or minus 10% of the journey times that are setout in the Operational Timetable;

- Analysis to be performed as follows:

    - For each journey between Tramstops a root mean square average of the combined lateral, longitudinal and vertical accelerations (RSS addition) is to be determined in accordance with ISO 2631.

The Part 4 test shall comprise:

- One tram from the fleet will be loaded to AW0
- Measurement of lateral, longitudinal and vertical accelerations to be taken on the floor of the trailing cab of the tram
- Entire Edinburgh Tram Network to be covered within 10% of the journey times that are setout in the Operational Timetable
- Load the tram to AW2 and repeat steps above; and
- Analysis to be performed as follows:
    - Select the greater of the results (AW0 or AW2) for each of the journeys to be used as a benchmark for each individual tram for any particular journey.

The undertaking of the test shall essentially be an operational function led by Infraco but in conjunction with the Operator. Infraco shall manage the preparation for the Tests with technical and maintenance support and monitoring by Infraco (along with representatives from tie).

Infraco shall undertake and pass Pre-operations Test before proceeding to the Service Commencement Date.

tie must be given thirty working days advance notice of the Performance Test 1 plan and seven working days written notice of the Test commencement date.

### 23.15.5 Pass Criteria

The following define the pass criteria for the T3 test.

All test results from previous tram and system and sub-system tests shall be available and signed off as accepted by tie including the clearance of all Defect Correction lists unless dispensation has been proposed by Infraco and agreed by tie acting reasonably.

### 23.15.6 Part 1 and 2 Pass Criteria

Each Pre-operations Test can only be successfully completed:

- As soon as 99% Punctuality Service Element as defined in chapter 2.16 has been achieved in accordance with the Infraco and Tram Maintainer performance regimes.

For the avoidance of doubt any delays caused by road traffic shall not be included in the delay measurement.

### 23.15.7 Part 3 and 4 Pass Criteria

Part 3 test can be deemed to be passed when none of the 100 journeys have an rms of the combined lateral, longitudinal and vertical accelerations exceeding 30mg.

Part 4 test can be deemed to have been passed when the instrumented tram from the fleet has attained a Ride Index equal to or less than as shown in the tables below in accordance with ISO 2631:

| Speed | Wz Vertical | Wz Lateral |
|---|---|---|
| 40 km/h | 2,32 | 1,58 |
| 70 km/h | 2,96 | 2,36 |

Table 44 - Ride Index in the Drivers Cab

| Speed | Wz Vertical | Wz Lateral |
|---|---|---|
| 40 km/h | 2,24 | 1,64 |
| 70 km/h | 2,82 | 2,28 |

Table 45 - Ride Index in the Passenger Compartment

### 23.15.8 Consents

This is in addition to passing the above tests.

All consents to achieve full passenger service must have been obtained and evidenced as part of Test T3.

### 23.15.9 Monitoring and Reporting of Test Performance

The primary data used to evaluate Parts 1 and 2 of this test shall be automatically generated from the Supervisory Control & Communications performance monitoring sub system and validated independently.

During the Pre-operations Test monitoring period Infraco will undertake audits, to the satisfaction of **tie**, of the collection and communication of fault and tram punctuality data against each of the performance indicators.

## 23.16 Network Performance Test Specification – T4

### 23.16.1 Overview

This section describes the requirements of Network Performance Test (T4) and the proposals for its execution monitoring and completion. Network Performance Test forms part of the requirements for the final System Acceptance.

The Test shall cover a 28 day consecutive period, which shall be undertaken after the Edinburgh Tram Network has entered Public Service until the Test is satisfactorily passed or, unless otherwise agreed by **tie**.

The Test is the operation of the complete ETN to the Operational Timetable each day for the duration of the test. The timetable used for the test shall be agreed with **tie**.

The undertaking of the test will be an operational function carried out by the Operator. Infraco shall manage the preparation for the Tests with technical and maintenance support and monitoring by Infraco (along with representatives from tie).

Infraco shall undertake and pass the Network Performance Test within twelve months after the Service Commencement Date of the whole Edinburgh Tram Network.

tie shall be given thirty working days advance notice of the Network Performance Test plan and seven working days written notice of the Pre-operations Test commencement date.

### 23.16.2 Pass Criteria

The test will measure the Punctuality Service Element over twenty-eight days.

The test shall be passed once the criteria stated in the Employer's Requirements Operational and Performance Section (Section 2) have been demonstrated to be met.

The Infraco may discount any one day from the calculation but shall not be a day on which a Special Demonstration shall be planned.

For the avoidance of doubt the exclusions in Section 23.13 shall apply.

### 23.16.3 Special Demonstrations

During the Network Performance Test a number of demonstrations will be performed, these are described in the following two sub-sections.

### 23.16.4 Substation and UPS Demonstrations

Infraco shall demonstrate that the system can operate with two of the traction supplies from a substation taken out of use, one at a time, for a period of two hours during the peak service. The substations concerned and the times for their disconnection will be selected by tie.

The disconnection of the substations and placing them into bypass will be undertaken in accordance with the Operator's normal procedures for such switching.

Operation of the Uninterruptible Power Supplies (UPS) at two tram stops for four hours shall also be demonstrated. During this period the electrical supply to the chosen tram stop UPS's shall be disconnected. The tram stop UPS's concerned and the time for their disconnection shall be chosen by tie.

The Infraco shall prepare a plan detailing the programme for the above events and include this in the test arrangements that will be submitted to tie in accordance with the review procedure.

### 23.16.5 Tram Change Over

The Infraco shall demonstrate, during peak hours, a Tram changeover by which a Tram in service shall be substituted with the "hot spare".

**tie** will give Infraco thirty minutes notice of this test.

### 23.16.6 Monitoring and Reporting of Test Performance

The Punctuality Service Element shall be obtained. The results for the previous day shall be ratified in accordance with the Performance Regime in Schedule 7 of this Agreement and the Operator Performance Regime under the DPOFA Agreement.

A meeting will take place daily where the performance up to that date is reviewed and any investigations concluded and data accepted. The meeting will be recorded and minutes distributed to each party by the meeting secretary within three working days.

During the Network Performance Test monitoring period tie may undertake audits of the collection and communication of fault data against each of the performance indicators.

### 23.16.7 Network Performance Test Timetable

The Enhanced Timetable delivering the ultimate capacity of the ETN as contracted shall be prepared by the Operator as that which shall be the ultimate timetable to be used in Passenger Service, proposed by the Infraco, and agreed by tie.

## 23.17 Network Reliability Test Specification – T5

### 23.17.1 Overview

This sub-section describes the requirements of Network Reliability Test and the proposals for execution, monitoring and achievement of System Acceptance.

Network Reliability Test is a set of sub-system reliability tests each measured over a twenty-eight day period. Each specified sub-system has its own specified target detailed within 23.17.2. The tests may start on the same date as T4 (on or after Service Commencement Date) and as each subsystem is individually demonstrated to meet its contractual target that subsystem reliability test is then considered completed. Network Reliability Test is only passed when all the sub-systems meet their targets.

The undertaking of the test will essentially be a maintenance function carried out by the Infraco. However, it requires Infraco management of the preparation for the Tests with technical support and monitoring by Infraco, (along with representatives from tie during the Test).

Infraco shall undertake and pass Network Reliability Test within twelve months after the Service Commencement Date of the whole Edinburgh Tram Network to pass Network Reliability Test.

If any part of the works or part of the ETN fails to pass Network Reliability Test then rectification, repair, modification or reinstatement of that part shall be undertaken. The defect correction period on that part of the system or any sub-system which fails the test shall be extended a further twelve months beyond the time of rectification, repair or modification. Infraco will propose and undertake the necessary remedial action and retest to achieve acceptance.

tie must be given 20 working days advance notice of the Network Reliability Test plan and fourteen working days written notice of the test commencement date.

### 23.17.2 Sub-Systems Subject to Network Reliability Test and Reliability targets

Table 46 - Network Reliability Test

| TES | TARGET VALUE |
|---|---|
| Tram Reliability | Please refer to Tram Supoly Agreement. |
| | |
| | |
| Passenger Information Display System | As set out in the Employer's Requirements<br>99.75% availability over six consecutive Periods. |
| Passenger Help/Emergency Help Point System | As set out in the Employer's Requirements<br>99.75% availability over six consecutive Periods. |
| On Street Track & Formation | Achieves 99.995% availability over six consecutive Periods. |
| Off Street Track & Formation | Achieves 99.995% availability over six consecutive Periods. |
| Point Machines | Achieves 99.995% availability over two consecutive Periods. |
| Traction Switchgear | Achieves 99.99% availability over two consecutive Periods. |
| OLE Equipment | Achieves 99.999% availability over two consecutive Periods. |
| Earthing & Bonding | No reported stray current instances, or rail to earth voltages that exceed 60 volts as defined in the EN50122/1, for four consecutive Periods |
| Operational Radio | Achieves 99.75% availability over two consecutive Periods. |
| Operational Data Network | Achieves 99.99% availability over two consecutive Periods. |
| UTC Interface | Achieves 99.75% availability over four consecutive Periods. |
| Wheel/Rail Interface | No proven instances of Noise and Vibration exceedence have occurred in a six month periods |
| CCTV System | Achieves 99.9% availability over two consecutive Periods. |
| Tram Position Detection System | Achieves 99.9% availability over two consecutive Periods. |
| Traction SCADA System | Achieves 99.75% availability over two consecutive Periods. |
| Tramstop Lighting | Achieves 98.5% availability over two consecutive Periods. |

### 23.17.3 NOT USED

### 23.17.4 Assumptions and Exclusions

**General Exclusions and Assumptions**

Should the Infraco be able to prove to the satisfaction of **tie** that any of the reliability tests would have been exceeded by means of one or more of the following exclusions then, in consultation with **tie**, the test results shall be amended to discount the effects of such proven Network Reliability Test exclusions.

The Network Reliability Test exclusions and Network Reliability Test assumptions set out in this section relate only to the Network Reliability Test and shall not be used or relied upon in any circumstances in any connection with any other test.

When the tests have commenced, neither **tie**, the Operator or Third Parties shall be entitled to interfere, interrupt or influence the tram operation or service or the tests in such a way that it disadvantages Infraco, or has an impact on the testing process, the results, or causes the non acceptance of the tests.

**Operator Influences**

Defects caused by the Operator's failure to:

Provide properly trained staff as defined in the DPOFA, exercising a reasonable duty of care to good industry practice.

**Exclusions**

The Infraco must demonstrate by reasoned argument that failures or loss of availability resulting from Operator actions were caused by reasons for which the Infraco was not responsible (eg Operating Manuals and supplier training). The Infraco shall develop and agree audit procedures with **tie** and the Operator in respect of the Network Reliability Test exclusions set out in this paragraph.

However, in no event shall any allowances or relief or Reliability Network Reliability Test exclusion be granted to the Infraco where any delays or failure to pass Network Reliability Test has been caused or contributed to by:

- Any default, breach or omission of the Infraco;
- Infraco defects; and
- Equipment undergoing repair, modification or rectification by the Infraco.

Realistic long term response times to repair defects shall be provided by Infraco during the period of the test.

It is assumed that tie shall procure all electrical power and that a supply is available for the tests.

Any failures resulting from inappropriate actions or omissions by the Operator or his contracted staff shall be discounted. as set out in the DPOFA .

For the avoidance of doubt, the impact of third party vandalism shall be excluded.

### 23.17.5 Monitoring & Reporting of Test Performance

The scoring of faults should be achieved by first reviewing the fault logs and performance reports using them as a filter to establish which faults need to go forward into the review. The review meeting will then be used to discuss and allocate the responsibility of faults under the performance regime.

The review meeting will take place daily where the performance of each system will be reviewed for the previous day. Representatives of Infraco, Tramco, tie and the Operator will attend this meeting. Each sub-system will be reviewed and agreement reached on all failures. The meeting will be recorded and the resulting daily report distributed to each party within 3 Business Days.

### 23.17.6 Audit Procedures

During the Network Reliability Test monitoring period, tie may undertake audits of the collection and communication of fault data against each of the sub-system tests and also audit the response times to rectification of notified faults.

### 23.17.7 Services in Connection with the Operator

The Operator shall be appointed separately by tie to provide various services in conjunction with the construction, commissioning and operation of the Edinburgh Tram Network. The Operator's Scope of Supply shall include the following:

Provision of representatives during the Construction, Commissioning and Operation stages to provide the Operator's Services, including liaison with the Infraco.

Observing and reporting on the acceptability of the proposed design and the quality of infrastructure, trams and equipment;

Supporting obtaining the necessary consents for commissioning and Public Operation;

Assisting Infraco in development of a Testing & Commissioning Plan (in conjunction with Infraco)

Appointment and training of staff in support of any commissioning process.

Notwithstanding the Operator's responsibilities described above, the Infraco responsibilities (associated with the interface with the Operator) shall include, but not be limited to, the following:

- providing support to obtain operational approvals and consents in respect of the Edinburgh Tram Network;
- providing technical support on systems integration
- providing technical support on the development of operational plans and management systems; and
- provide technical support with regard to operational interfaces with CEC traffic management systems. This shall include phasing sequence drawings of key junctions
- Preparing and submitting plans for driver training and the training of other operational staff. Undertaking training of the Operator's trainers (8-10 trainers) and control room staff (18-21 staff)
- Prepare and submit plans for maintenance and operations manuals
- Provide support required for System Acceptance, including the development of a Testing and Commissioning Plan;
- Work to mitigate any delays to the system construction and commissioning howsoever caused.

| Comm. Model Ref | Infraco | Operator |
|---|---|---|
| | The following table represents a guide of the key responsibilities associated with the Infraco and the Operator during the various phases of the Life Cycle Model. Further details are provided within these Employer's Requirements and the DPOFA.<br><br>The Infraco Contract (refer to the Code of Construction Practice) allows for the potential for Sectional Completion. Accordingly, where Sectional Completion was to apply, then it would follow that the (System Commissioning Model) stages for each Sectional Completion would apply at different times in the programme (e.g. possible to have "Shadow Running" ongoing for Section A, whilst "Commissioning" for Section B on-going). The listed responsibilities would equally apply to each Sectional stage.<br><br>Items are listed under the most appropriate stage, but this does not exclude the associated activity from being required during other stages | |
| | GENERAL OBLIGATIONS | |
| | The general provision of all the technical and management services as defined within these Employer's Requirements. This shall include design, programming, installation, testing, system acceptance, training and maintenance. The Infraco shall be required to work closely with the Operator to successfully deliver the project. | Liaising and working closely (and timely) in partnership with the Infraco to meet the requirements of the Project associated with design, installation, system acceptance, delivery into service and maintenance, taking account of the Infraco's Scope of Supply. The Operator shall also be responsible for Operator Maintenance. |

| | | |
|---|---|---|
| | Management and implementation of a liaison process, with the assistance of the Operator, to ensure that all parties are fully informed and resources arranged adequately. | Provision of staff resources during the Commissioning, Construction and Operation stages to provide the Operator's Services, including liaison with the Infraco. Provide and keep updated the training and recruitment plan describing the roles of each member of the Operations staff with specific instructions for the proper performance of their duties and training requirements. |
| | | Ensuring that all relevant operational and maintenance subcontracts are in place and that appropriate subcontractor staff training programmes are implemented. |
| | Responsibility for adherence to the programme | Monitoring Progress |
| | Responsibility for complying with the functional and non-functional requirements as defined within these Employers Requirements. | Observing and commenting on the acceptability of the design and installation. |
| | Production of risk deliverables and register in accordance with these Employer's Requirements. | Provision of risk advice (from the Operator's viewpoint) to Infraco and commenting / liaising on risk documentation produced by Infraco. |
| | Under the CDM Regulations, the Infraco shall be responsible as Principal Contractor and shall comply with all associated CDM Responsibilities relating to the design and construction activities until Services Commencement Date (and beyond, where appropriate).<br><br>Beyond the Services Commencement Date, the Infraco may be required to undertake certain elements of work (including maintenance) which fall within the remit of CDM Regulations. In such a scenario the Infraco would be responsible as Principal Contractor for the duration of such works. | As with any party working on a "CDM site", the Operator shall be responsible for complying with CDM Regulations and the Principal Contractors Safe Systems of working (e.g. permit to work system).<br><br>Notwithstanding the Infraco's over-arching responsibility as Principal Contractor up to Services Commencement Date, once the network is energised (and trams begin to operate) the Operator shall have a key role in managing the "operational end" of systems (e.g. the Operator would be responsible for developing and managing a permit to isolate systems within the context of the over-arching Infraco's systems). |

| | | |
|---|---|---|
| | There shall be a requirement for the Infraco to comply where appropriate with the Operators Systems and procedures associated with the Operator's responsibility to manage operational safety. | The Operator shall be responsible for Operational Safety. This shall include developing Operational Plans, timetables and Management Systems and Operating Procedures for the Operational Phase.<br>Operational safety responsibilities shall, by definition, occur once any part of the system is energised (anticipated to be between Stages 4 and 5, "Set to Work Tests" and "Commissioning", respectively. |
| DD | DETAILED DESIGN STAGE | |
| | Completing the full design and meeting all the deliverables as defined within the SDS Providers Agreement with **tie**, which is being novated and which is included in Volume 7 of the Infraco ITN. | Observing and reporting on the acceptability of proposed designs against the Design Manual and the Employers Requirements and the ability of the proposals to meet operational objectives |
| | Obtaining all approvals and consents in respect of the Edinburgh Tram Network; | Supporting the obtaining of necessary consents for Commissioning and Public Operation (and any consents which are relevant to the Operator) |
| | Managing and undertaking all interfaces with CEC traffic management systems. | Assisting Infraco with the interfaces with CEC, which are relevant to the Operator. |
| | Developing and updating a Testing and Commissioning Plan (TCP) for each element of the System including programmes and procedures with controls and acceptance criteria. | Providing input to a Testing and Commissioning Plan (TCP) for each element of the System including programmes and procedures with controls and acceptance criteria. |

| | | |
|---|---|---|
| | Assisting the Operator with the development of a process for the handover for Operational purposes of the infrastructure and equipment from Infraco. | Developing a process for the handover for Operational purposes of the infrastructure and equipment from Infraco. |
| | Scheduling, and coordinating with the Operator, driver training, and the training of other operational and maintenance staff. The scope of the training shall cover all aspects of maintenance (as defined within these Employer's Requirements) and all operations. The Infraco shall be responsible for developing coordinated Training Plans in accordance with section 40 (Maintenance) of these Employer's Requirements. | Assisting the Infraco in the development of coordinated Training Plans and the specification of training documentation requirements from Infraco and Sub-suppliers. |
| | Complying with, and undertaking internal audits, associated with the Code of Construction Practice | Reviewing Infraco's compliance with the Code of Construction Practice, associated with any operator related issues. |
| | BUILD / MANUFACTUR | |
| | Managing and implementing the manufacture and assembly of the System in accordance with the general provision of all the technical and management services as defined within these Employer's Requirements | Observing and reporting on the quality and functionality of Infrastructure and Equipment provision / manufacture and its compliance with Specifications where it affects the operational objectives. |
| | Liaising with the Operator to address any associated issues, and where necessary rectifying any works. | |
| 2 | FACTORY ACCEPTANCE TESTS | |
| | Managing and implementing the Testing process in accordance with the TCP. FAT tests (initial tests and integrated testing) shall be undertaken to verify that the components / system behave as planned in the design, meet the requirements of the design specification and provides correct functionality. | Assisting and providing advice to Infraco to manage the Testing process in accordance with the TCP. |
| | | Observation if necessary and appropriate of any factory acceptance tests on equipment to be provided. |

| | | |
|---|---|---|
| 3 | INSTALLATION / CONSTRUCTION | |
| | Managing and implementing the installation and construction at the Site in accordance with the general provision of all the technical and management services as defined within these Employer's Requirements. | Observing and reporting on the quality and functionality of Infrastructure and Equipment provision and installation, and its compliance with Specifications where it affects the operational objectives |
| | Liaising with the Operator to address any associated issues, and where necessary rectifying any works. | |
| 4 | TO WORK TEST | |
| | Managing and implementing the Testing process in accordance with the TCP. These site tests (System Integration Tests) in accordance with section 6 of Part 1c – Tram Testing and Commissioning of the Employer's Requirements shall be undertaken to demonstrate that the construction / installation has been undertaken satisfactorily and that the systems behave as intended in the design. | Assisting and providing advice to Infraco to manage the Testing process in accordance with the TCP |
| | | In accordance with the TCP; witnessing and reporting on the implementation tests |
| | | Attending Tests |
| | | Managing the Operational Safety of the Testing and Commissioning process in support of Infraco once the system is energised and trams begin to operate. Develop a system of management of safety during testing and commissioning (including the training of staff and contingency provisions) |
| | Obtaining Consents and Approvals required to allow the system to be energised and trams to operate to the extent not the responsibility of tie under Clause 19. | Supporting the obtaining of Consents and Approvals for the system to be energised and trams to operate. |
| | Reviewing and commenting on the proposed Commissioning Phase Operating Procedures. | Developing Commissioning Phase Operating Procedures. |

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| 5 | COMMISSIONING | |
| | Managing and implementing the Testing and Commissioning process in accordance with the TCP. This includes the site commissioning testing as defined within this Section at 23.20.1. | Assisting and providing advice to Infraco to manage the Testing and Commissioning process in accordance with the TCP |
| | | In accordance with the TCP; witnessing and reporting on the implementation tests |
| | | Attending Tests |
| | | Managing the Operational Safety of the Testing and Commissioning process in support of Infraco once the system is energised. Develop a system of management of safety during testing and commissioning (including the training of staff and contingency provisions) |
| | Providing technical support on the development of operational plans, timetables and management systems and Operating Procedures; and | Developing Operational Plans, timetables and Management Systems and Operating Procedures for Operational Phase |
| | preparing and submitting plans, manuals & procedures for maintenance and operations in accordance with these Employer's Requirements, in time for System Energisation. | Reviewing and commenting on the acceptability of plans, manuals & procedures for maintenance and operations. |
| 6 | TEST RUNNING AND DRIVER FAMILIARISATION | |
| | Scheduling, and coordinating with the Operator, driver training and the training of other operational staff as part of the Commissioning activities prior to the start of Shadow Running. Implementing training plans including the undertaking of training of the Operator's trainers (8-10 trainers) and control room staff (18-21 staff). | Appointing and training of Operator staff and Operational rules and procedures training for Infraco. The Operator shall be responsible for training the drivers (utilising the training plans / information developed by Infraco and the Operator Trainers, who shall have been assessed as competent by Infraco on the operation of their systems and equipment). |
| | Demonstrating that the completed Operator training programme has produced a level of adequate | Assisting Infraco to demonstrate that the completed Operator training programme has |

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| | competency to proceed to shadow running. | produced a level of adequate competency to proceed to shadow running. |
| **T1** | The implementation of the T1 Post Commissioning Test: follows successful commissioning of the nominated section, test to demonstrate and prove the system is able to perform in a safe manner and delivers the required end to end run times (these may be up to 5% greater than target runtimes). | Assisting and providing advice to Infraco to manage the Testing and Commissioning process in accordance with the TCP |
| **T2** | The implementation of the T2 Performance Test: precedes Shadow Running: test to demonstrate and prove the system is able to perform satisfactorily to move into the 3 month Shadow Running Period (The T2 Performance Test is performed over 3 days and 95% of runtimes must be within target runtime; whilst service headways may be increased by up to 50% of those of the operating timetable). | |
| | | In accordance with the TCP; witnessing and reporting on the tests |
| | | Attending Tests |
| | | Managing the Operational Safety of the Testing and Commissioning process. Develop a system of management of safety during testing and commissioning (including the training of staff and contingency provisions) |
| | Infraco to review to prepare Go Live timetable to be tested during shadow running. | Operator to prepare the Operational Timetable to be tested during shadow running. |
| | Obtaining Consents and Approvals required to allow the system to start shadow running to the extent not the responsibility of tie under Clause 19. | Supporting the obtaining of Consents and Approvals for the system to commence shadow running. |

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| **7** | **SHADOW RUNNING** | |
| | Implementing the Shadow Running Phase to cover the requirements. Please refer to relevant section below. | |
| **T3** | Implementing the T3 Pre-Operations Test: precedes Service Commencement, the test is undertaken during the Shadow Running Period, the test is the operation of the initial entry into service timetable and includes infrastructure, trams and operations systems<br><br>(T3 is over 2 x 5 days and 99% performance must be achieved). | In accordance with the TCP; witnessing and reporting on the tests |
| | | Attending Tests |
| | | Managing the Operational Safety of the Testing and Commissioning process |
| | | Developing a system of management of safety during shadow running and public operation (including the training of staff and contingency provisions) |
| | Obtaining the necessary Consents and Approvals for Public Operation to the extent not the responsibility of **tie** under Clause 19. | Supporting the obtaining necessary consents for Public Operation |
| **8** | **SERVICE COMMENCEMENT** | |
| | Infraco shall support the preparation for the T4 Network Performance Test with technical and maintenance support and monitoring.<br><br>(T4 is over a 28 consecutive day period on a rolling basis in passenger service with the ultimate timetable in operation. 1 day in the period may be discounted. The test is to show that reliable operation is achieved.) | The Operator shall manage the preparation for the T4 Network Performance Test with technical and maintenance support and monitoring by the Infraco.<br><br>The implementation of the T4 Network Performance Test. |

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| | Demonstrations during the Network Performance Test e.g. sub-stations / UPS – demonstration of operation where a sub-station can be taken out of service for 2 hours during peak service. | |
| | Review, comment and provide support in preparation of the Test and Ultimate Timetables. | Preparation of an agreed Network Performance Test Operational Timetable and Enhanced Timetable as that which shall be the ultimate timetable to be used in Passenger Service. |
| | Infraco management for the preparation of the T5 Network Reliability Test with technical support and monitoring by Infraco. | The implementation of the T5 Network Reliability Test: the reliability testing of certain sub-systems in Passenger Service (within 12 months of opening). |
| | In accordance with the TCP; witness and report on the tests | Managing the Operational Safety of the Testing and Commissioning process. Develop a system of management of safety during testing and commissioning (including the training of staff and contingency provisions) |

Table 47 - Table showing a guide of the key responsibilities associated with the Infraco and the Operator during the various phases of the Life Cycle Model

## 23.18 Tram Testing and Commissioning

### 23.18.1 Document Scope

The scope of this section of the document is to define the Tram Testing & Commissioning requirements that are applicable to all elements of the Edinburgh Tram Network (ETN).

### 23.18.2 General Requirements

This document defines the process for the testing and commissioning of the ETN that shall be carried out by the Tram Supplier together with the requirements of the Tram Tests that must be carried out to meet the Employer's Requirements and all relevant regulatory bodies as to the quality, performance and compliance of the Trams. It also identifies the tests to be carried out to meet the requirements for System Acceptance testing (involving Trams) of the completed Edinburgh Tram Network.

For certain of the type tests it may be acceptable to reference relevant tests previously undertaken on similar systems. The Tram Supplier will justify to the Tram Inspector all instances where this approach is applicable. This approach will only be possible in areas where there has not been anything other than very minor design changes. Where this approach is proposed, the final test reports and supporting data must be provided to allow the information to be assessed and accepted or rejected. It will be the Tram Supplier's responsibility to obtain any necessary permissions for the use of the test results and data concerned.

### 23.18.3 Test Plan

The Tram Supplier shall create and adhere to a Test Plan, which will comply with the requirements of EN50215 and encompass a logical build up of testing that leads to acceptance of the vehicles. The Test Plan shall include sufficient testing to demonstrate that all the Employer's Requirements have been met and to ensure that all relevant consents for passenger operation can be achieved from all relevant bodies. It must also be created in such a way as to maximise off-site testing.

The Tram Supplier shall carry out the Tram tests in accordance with this document, the Test Plan and the Tram commissioning and delivery programme. The Tram Supplier shall submit the Test Plan for agreement by the Infraco. Detailed Test Specifications for all tests shall also be submitted for agreement as part of the design scrutiny process and not less than eight weeks prior to the commencement of the tests.

The Test Plan shall be provided in Microsoft Project, together with any commentary, specifications and all results following completion of the Tram tests, in Microsoft Word/Excel format. The relevant supplied drawings shall be provided in electronic format and as hard copy. Test reports for each Tram Test shall be submitted, within two weeks following the completion of the Tram Test.

### 23.18.4 Tram Test Categories

The Tram Tests shall be divided into five discrete stages:

- Factory Acceptance Tests ("FAT")
- Delivery Acceptance Tests ("DAT")
- Site Commissioning Tests ("SCT")
- System Integration Tests ("SIT")
- System Acceptance Tests ("SAT")

With the exception of the Factory Acceptance Tests, which shall be carried out at the Tram Supplier's Factory, all other tests are to be carried out after the Trams are delivered to the Depot. All the tests are to be carried out by the Tram Supplier, except for the System Integration and System Acceptance Tests, which will be managed by Infraco.

Each category of Tram test can comprise two sub-categories:

- Type tests shall be performed to demonstrate that the vehicle design complies with the relevant section of these Employer's Requirements and all relevant Legislation and regulations;
- Routine tests shall be carried out on each vehicle prior to delivery/handover. The routine tests shall include the agreed measurements and checks to confirm the compliance of each Tram.

The Tram Supplier shall provide all necessary support to the Infraco during the testing and commissioning activities in Edinburgh, from the delivery of the first Tram and until the completion of the System Acceptance Tests. This will include input to the development of the necessary specifications and procedures. The support for the Tram tests to be undertaken in Edinburgh shall include, but be not be limited to, a testing manager and technicians (who will be based in Edinburgh throughout the delivery and testing of the trams), full logistics support for the despatch of urgent and routine spares during the testing process, documentation authors and administrative support for the production and control of test specifications, reports, and supporting documentation.

### 23.18.5 Test Certificates

Upon the successful completion of each of the Tram tests the Tram Inspector will issue the following test certification:

- Factory Acceptance Type Test Certificate;
- Factory Acceptance Routine Test Certificate;
- Certificate of Tram Delivery; and
- Site Commissioning Type Test Certificate.

Upon successful completion of all the tests for any individual Tram the Tram Inspector will issue the following test certification:

- Certificate of Tram Commissioning.

## 23.19 Factory Acceptance Tests (FAT)

Factory Acceptance Tests– This group of tests shall be undertaken at the Tram Supplier's Factory and upon successful completion the Tram Supplier will be issued with a Factory Acceptance Type Test Certificate and/or Factory Acceptance Routine Test Certificate by the Tram Inspector. The Factory Acceptance Tests shall be conducted in accordance with the Tram Manufacturing, Delivery Programme and the Test Plan. The FAT will be broken down into Factory Acceptance Type Tests and a series of Factory Acceptance Routine Tests and will comprise both static inspections and dynamic tests. The Factory Acceptance Type Tests shall be undertaken on a single Tram. This shall be the first Tram unless agreed otherwise in writing by the Tram Inspector.

Static inspections and tests shall be conducted at the Tram Supplier's Factory or at the sub-suppliers' premises during normal working hours during which the Tram Inspector will be entitled to inspect, examine and witness testing of all major systems, sections, apparatus, equipment, components, internal seating, fixtures and fittings and devices, including all structural, electrical, hydraulic and other major components and assemblies (except where the items concerned have been previously tested to the Tram Inspector's satisfaction and the appropriate test certificate issued).

Dynamic tests shall be conducted on the test track at the Tram Supplier's Factory or an alternative location subject to the Tram Inspectors agreement.

The Tram Inspector shall be given adequate prior notice of all tests. tie may, at its sole discretion, waive its right to attend or witness any test.

Whether or not the Tram Inspector is in attendance the Tram Supplier shall keep, and make available to the Tram Inspector on request, true and accurate records of the tests, the performance of the Tram during such tests, and any faults which developed or became apparent during the course of such tests.

The Tram Inspector may require evidence that the Tram has operated an agreed number of kilometres/hours in order to fulfil the requirements of the Test and Commissioning Plan under the agreed test track conditions without major faults or breakdown and has met the performance standards set out in this section throughout such period before issuing the Factory Acceptance Routine Test Certificate and/or Factory Acceptance Type Test Certificate. The distance travelled during the dynamic test on the test track will be limited and the main objective will be to check functions and performances not endurance, hence the distance travelled will relate to an agreed schedule to prove these functions.

The Factory Acceptance Routine Tests and the Factory Acceptance Type Tests referred to in the following tables shall include such examinations and tests as the Tram Inspector may reasonably require to satisfy himself that the Trams qualify or do not qualify for a Factory Acceptance Routine Test Certificate and/or and a Factory Acceptance Type Test Certificate. This will include but not be limited to; the checking of individual manufacturing and inspection records, module and sub-assembly tests including as-built dimensional checks where appropriate, for major items such as but not limited to bogie frames, wheel sets, traction and brake equipment.

The Tram Supplier shall make available to the Tram Inspector throughout the Factory Acceptance Routine Tests and/or Factory Acceptance Type Tests qualified staff and, where appropriate, its major sub-contractors to conduct, supervise and record the results of all such inspections, tests and examinations as are referred to in this document and to respond to all enquiries about the condition or performance of the Trams or its major sub-systems.

Table 48 - Factory Acceptance Tests: Static Type Tests

| TEST | LOCATION | EN 50215 Reference | COMMENTS |
|---|---|---|---|
| Overall dimensional checks | Static test, at the Tram Supplier's Factory | 8.1 | To include external static envelope, internal dimensions, door widths and openings. |
| General examination and security check. | Static test, at the Tram Supplier's Factory | | To establish accuracy and security of fixing of fixtures and fittings. |
| Coefficient of flexibility | Static test, at the Tram Supplier's Factory | 8.2 | Static test with a maximum cant of 100mm simulated.<br>Horizontal and vertical flexibility. |
| Lifting ability | Static test, at the Tram Supplier's Factory | 8.3 | Body Lifting and major component removal.<br>Bogie handling. |
| Tram weight | Static test, at the Tram Supplier's Factory | 8.4 | Tram and axle weights, including individual wheel and axle loading. Load testing of the complete vehicle and the checking of critical dimensions and clearances under a range of loading conditions. Suspension deflections and door entrance height measurement. |
| Sealing | Static test, at the Tram Supplier's Factory | 8.5 | Resistance of body structure to water ingress, humidity and snow. |
| Electrical insulation | Static test, at the Tram Supplier's Factory | 8.6 | High voltage insulation tests. Withstand and impedance of all cabling. |
| Bonding & return circuits | Static test, at the Tram Supplier's Factory | 8.7 | Continuity and integrity of all safety earth bonds and return current circuits. |
| Hydraulic system | Static test, at the Tram Supplier's Factory | 8.9 | Pumps and pipe-work. Pressure tests and leakage. |
| Braking System | Static test, at the Tram Supplier's Factory | 8.10 | Friction brake system |

| TEST | LOCATION | EN 50215 Reference | COMMENTS |
|---|---|---|---|
| Parking brake | Static test, at the Tram Supplier's Factory | 8.11 | Clamping force measurement |
| Auxiliary Power Supply | Static test, at the Tram Supplier's Factory | 8.12 | Power supplies and associated equipment. |
| Battery charging system | Static test, at the Tram Supplier's Factory | 8.13.1 | Batteries, battery chargers and associated equipment. Battery capacity for emergency working. |
| Auxiliary and control system | Static test, at the Tram Supplier's Factory | 8.14 | Vehicle control and management system. Software validation. Drivers' controls and instruments. |
| Doors | Static test, at the Tram Supplier's Factory | 8.14.3 | Passenger Doors, driver's doors. Emergency access and egress. Operation and timing. |
| Heating, ventilation & air-conditioning | Static test, at the Tram Supplier's Factory | 8.14.4 | System operation and effectiveness at the ambient conditions of the test location Thermostats, air flows. Hot/cold areas. |
| Lighting | Static test, at the Tram Supplier's Factory | 8.14.5 | Interior and exterior lighting. |
| Monitoring equipment | Static test, at the Tram Supplier's Factory | 8.14.7 | CCTV System, cameras and displays. |
| Event recorder | Static test, at the Tram Supplier's Factory | 8.14.7 | OTMR, (as far as practicable at the test location). |
| Communications and passenger information systems | Static test, at the Tram Supplier's Factory | 8.14.7 | Radios, PA, emergency communications (as far as practicable at the test location). Warning tones. Passenger information system. Passenger Emergency Help Points. |
| Configuration control | Static test, at the Tram Supplier's Factory | 8.14.8 | Determination of defined software and firmware status for all sub-systems. Modification status for all major and critical components and others as appropriate. |

| TEST | LOCATION | EN 50215 Reference | COMMENTS |
|---|---|---|---|
| Traction system | Static test, at the Tram Supplier's Factory | 8.16 | Motors, gearboxes, control equipment, power supplies and current collection. |
| Tram control system | Static test, at the Tram Supplier's Factory | 8.16 | Tram central control system and interfaces, fault monitoring and diagnostics. |
| Operability and maintainability | Static test, at the Tram Supplier's Factory | 8.17 | Verification of conformity with the proposed and agreed design. Operator and maintainer access to all appropriate areas. |
| Safety systems | Static test, at the Tram Supplier's Factory | 8.19 | Brake control systems, emergency brake, passenger emergency. Driver's deadman system. door safety loop. Emergency pushbutton, Track brakes. Horns/warning devices. |
| Windscreen washers, wipers and demisters | Static test, at the Tram Supplier's Factory | 9.18 | System operation and effectiveness, demisters. |
| Pantograph | Static test, at the Tram Supplier's Factory | 9.12 | Operation. Contact forces. |
| Sanding system | Static test, at the Tram Supplier's Factory | | System operation. Sand delivery rate. Coherence between VTCU output and the correct sanding unit. |
| Flange lubrication system. | Static test, at the Tram Supplier's Factory | 9.11 | Set-up of equipment. |
| Visual examination of all client defined features | Static test, at the Tram Supplier's Factory | HMRI, RVAR | Interior layout, seating, livery and signage. |
| Emergency coupler | Static test, at the Tram Supplier's Factory | | Check of mountings / space envelope. manual operation. |

Table 49 - Factory Acceptance Tests: Dynamic Type Tests

| TEST | LOCATION | EN50215 Reference | COMMENT |
|---|---|---|---|
| Traction system performance | Dynamic test, at the Tram Supplier's Factory test track | 9.1 | Dynamic performance, acceleration and braking rates. Jerk rates. Current collection. Degraded modes. Speed attainment. Power consumption. Wheelslip correction and sanding. Simulated locked axle detection |
| Braking system | Dynamic test, at the Tram Supplier's Factory test track | 9.3 | Friction brake system, service and emergency deceleration rates and stopping distances. Dynamic brake operation and blending with friction brake, jerk rates. Wheelslide correction and sanding. Track brake operation. |
| Thermal capacity | Dynamic test, at the Tram Supplier's Factory test track | 9.4 | Temperature rise monitoring of traction, braking & auxiliary equipment during repeated duty cycles. Including degraded modes and emergency duty. |
| Motion resistance | Dynamic test, at the Tram Supplier's Factory test track | 9.5 | Demonstration/derivation of Tram resistance to motion. |
| Coupling test | Dynamic test, at the Tram Supplier's Factory test track | 9.8 | Coupled Tram operation with emergency couplers, as far as practical and subject to availability of two Trams. |
| Ride quality | Dynamic test, at the Tram Supplier's Factory test track | 9.9 | Assessment of Tram ride quality, (providing that the test is meaningful at this location). |
| Flange lubrication system. | Dynamic test, at the Tram Supplier's Factory test track | 9.11 | System operation. |
| Pantograph | Dynamic test, at the Tram Supplier's Factory test track | 9.12 | Operation, Functional check. |

| TEST | LOCATION | EN50215 Reference | COMMENTS |
|---|---|---|---|
| Electromagnetic compatibility | Dynamic test, at the Tram Supplier's Factory test track | 9.14 | Electromagnetic radiation and susceptibility of vehicle systems. See also EN 50121, within the constraints of the test track. |
| Voltage interruption and jump | Dynamic test, at the Tram Supplier's Factory test track | 9.15 | Reaction of traction/dynamic brake/auxiliary power systems to supply voltage interruptions jumps. Operation over the full-specified voltage range covered by the type test certificate of the traction and auxiliary equipment (as far as practicable at the test location). |
| Windscreen washers, wipers and demisters | Dynamic test, at the Tram Supplier's Factory test track | 9.18 | System operation and effectiveness, including demisters. |
| Tram control system | Dynamic test, at the Tram Supplier's Factory test track | 9.19 | Interfaces between traction, braking, auxiliary, control and safety systems. Tram management systems, displays and diagnostics. |
| Monitoring equipment | Dynamic test, at the Tram Supplier's Factory test track | 9.19 | CCTV System, cameras and displays. |
| Event recorder | Dynamic test, at the Tram Supplier's Factory test track | 9.19 | OTMR, (as far as practicable at the test location). |
| Communications & passenger information systems | Dynamic test, at the Tram Supplier's Factory test track | 9.19 | Radios, PA, emergency communications. Warning tones. Passenger information system as far as practicable at the test location. |
| Safety systems | Dynamic test, at the Tram Supplier's Factory test track | 8.19 | Brake control systems, emergency brake, passenger emergency. Driver's deadman system, door safety loop and speed inhibit. Emergency pushbutton, Track brakes. Horns/warning devices. Speedometer calibration. |

| TEST | LOCATION | EN50215 Reference | COMMENTS |
|---|---|---|---|
| Operability & maintainability | Dynamic test, at the Tram Supplier's Factory test track | 8.17 | Demonstration of degraded modes |
| Parking brake | Dynamic test, at the Tram Supplier's Factory test track | 8.11 | System operation and pull away test |
| Noise and vibration | Dynamic test, at the Tram Supplier's Factory test track | 9.16 | Noise and vibration measurements, as far as practicable at the test location. |

Table 50 - Factory Acceptance Tests: Static Routine Tests

| TEST | LOCATION | EN 50215 Reference | COMMENTS |
|---|---|---|---|
| Overall dimensional checks | Static test, at the Tram Supplier's Factory | 8.1.2 | Reduced overall dimension check. |
| General examination and security check. | Static test, at the Tram Supplier's Factory | | To establish accuracy and security of fixing of fixtures and fittings. |
| Tram weight | Static test, at the Tram Supplier's Factory | 8.4.3 | Tram, and axle, weights. |
| Sealing | Static test, at the Tram Supplier's Factory | 8.5.2 | Resistance of body structure to water ingress |
| Electrical insulation | Static test, at the Tram Supplier's Factory | 8.6 | High voltage insulation tests. Withstand and impedance of all cabling. |
| Bonding and return circuits | Static test, at the Tram Supplier's Factory | 8.7 | Continuity & integrity of all safety earth bonds and return current circuits. |
| Hydraulic system | Static test, at the | 8.9 | Pumps and pipe-work. Pressure tests. Leakage. |

| TEST | LOCATION | EN 50215 Reference | COMMENTS |
|---|---|---|---|
| | Tram Supplier's Factory | | |
| Braking System | Static test, at the Tram Supplier's Factory | 8.10.2 | Friction brake system functional test including parking brake |
| Auxiliary power supply | Static test, at the Tram Supplier's Factory | 8.12.2 | Power supplies and associated equipment. |
| Battery charging system | Static test, at the Tram Supplier's Factory | 8.13.2 | Batteries, battery chargers and associated equipment. |
| Auxiliary and control system | Static test at the Tram Supplier's Factory | 8.14.1 | Tram control and management system. Drivers' controls and instruments. |
| Doors | Static test, at the Tram Supplier's Factory | 8.14.3 | Passenger doors, driver's doors. Emergency access and egress. Operation & timing |
| Heating, ventilation and air-conditioning | Static test, at the Tram Supplier's Factory | 8.14.4 | System operation and effectiveness. Thermostats, air flows. Hot/cold areas. Duct sealing. Functional check |
| Lighting | Static test, at the Tram Supplier's Factory | 8.14.5 | Interior and exterior lighting. Functional check. |
| Monitoring equipment | Static test,at the Tram Supplier's Factory | 8.14.7 | CCTV System, cameras and displays. |
| Event recorder | Static test, at the Tram Supplier's Factory | 8.14.7 | OTMR, (as far as practicable at the test location). |
| Communications and passenger information systems | Static test, at the Tram Supplier's Factory | 8.14.7 | Radio, PA, emergency communications (as far as practicable). Warning tones. Passenger information system. |
| Configuration control | Static test, at the Tram Supplier's Factory | 8.14.8 | Verification of defined software and firmware status for all sub-systems. Modification status for all major and critical components and others as appropriate. |

| TEST | LOCATION | EN 50215 Reference | COMMENTS |
|---|---|---|---|
| Traction system | Static test, at the Tram Supplier's Factory | 8.16 | Motors, gearboxes, control equipment, power supplies and current collection. |
| Tram control system | Static test, at the Tram Supplier's Factory | 8.16 | Tram central control system and interfaces, fault monitoring and diagnostics. |
| Operability and maintainability | Static test, at the Tram Supplier's Factory | 8.17 | Fault handling, diagnostics and indications. Safety isolations. |
| Safety systems | Static test. at the Tram Supplier's Factory | 8.19 | Brake control systems, emergency brake, passenger emergency. Driver's deadman system, door safety loop. Emergency pushbutton, Track brakes. Horns/warning devices. |
| Windscreen washers, wipers and demisters | Static test, at the Tram Supplier's Factory | 9.18 | Functional check including demisters. |
| Pantograph | Static test, at the Tram Supplier's Factory | 9.12 | Operation. Contact forces |
| Sanding system | Static test, at the Tram Supplier's Factory | | System operation. Sand delivery rate. |
| Flange lubrication system. | Static test, at the Tram Supplier's Factory | 9.11 | Set-up of equipment. |
| Visual examination of all client defined features | Static test. at the Tram Supplier's Factory | | Interior layout, seating, livery and signage. |

Table 51 - Factory Acceptance Tests: Dynamic Routine Tests

| TEST | LOCATION | EN 50215 Reference | Comments |
|---|---|---|---|
| Traction system performance | Dynamic test, at the Tram Supplier's Factory test track | 9.1.2 | Dynamic performance, acceleration and braking rates. Current collection. Speed attainment. Wheelslip correction and sanding. |
| Braking system | Dynamic test, at the Tram Supplier's Factory test track | 9.3.2 | Friction brake system, service and emergency deceleration rates and stopping distances. Dynamic brake operation and blending with friction brake. Wheelslide correction and sanding. Track brake operation. |
| Flange lubrication system. | Dynamic test, at the Tram Supplier's Factory test track | 9.11 | System operation, as far as practicable. |
| Tram control system | Dynamic test, at the Tram Supplier's Factory test track | 9.19 | Interfaces between traction, braking, auxiliary, control and safety systems. Tram management systems, displays and diagnostics. |
| Monitoring equipment | Dynamic test, at the Tram Supplier's Factory test track | 9.19 | CCTV System, cameras and displays. |
| Event recorder | Dynamic test, at the Tram Supplier's Factory test track | 9.19 | OTMR, (as far as practicable at the test location). |
| Communications and passenger information systems | Dynamic test, at the Tram Supplier's Factory test track | 9.19 | PA, emergency communications. Warning tones. Passenger information system (as far as practicable at the test location). |
| Safety systems | Dynamic test, at the Tram Supplier's Factory test track | 8.19 | Brake control systems, emergency brake, passenger emergency. Driver's deadman system, door safety loop and speed inhibit. Emergency pushbutton, Track brakes. Horns/warning devices. Speedometer calibration. |

## 23.20 Delivery Acceptance Tests (DAT)

These tests shall be carried out by the Tram Supplier upon the delivery of each Tram. They shall establish that the Tram has not been damaged or affected in any way by the delivery process and that it remains in the condition in which it was inspected prior to despatch from the Tram Supplier's factory. On satisfactory completion of the DAT the Tram Inspector will issue a Certificate of Tram Delivery.

| TEST | LOCATION | EN 50215 Reference | Comments |
|---|---|---|---|
| Overall dimensional checks | Static test, at the Depot | | Reduced to any parts or components which will been adjusted/removed during the transport. |
| General examination and security check. | Static test, at the Depot | | To establish accuracy and security of fixing of all fixtures and fittings, transit damage. Visual inspection |
| Hydraulic system | Static test, at the Depot | 8.9 | Pumps and pipe-work. Visual inspection and checks for leakage. |
| Tram weight | Static test, at the Depot | | Measurement of as-delivered tare weight, plus sand and fluids. |

Table 52 – Table showing Delivery Acceptance Tests

### 23.20.1 Site Commissioning Tests

The Site Commissioning Type Tests shall be undertaken on the Tram(s) as appropriate, when they are delivered to the Depot and following the completion of the DAT. Upon successful completion the Tram Supplier will be issued with a Site Commissioning Type Test Certificate by the Tram Inspector. The tests shall comprises Static and Dynamic tests and will include, but not be limited to, the tests referred to in the tables on the following page.

For the avoidance of doubt the Tram Inspector shall not issue a Type Test Certificate even if by a lack or fault of the system infrastructure a test is failing or cannot be executed.

Table 53 – Site Commissioning Tests: Static Type Tests

| TEST | LOCATION | EN 50215 Reference | Comments |
|---|---|---|---|
| Monitoring equipment | Static test, at the Depot | 8.14.7 | CCTV System, cameras and displays. |
| Tram location and detection system | Static test, at the Depot | 8.14.7 | Tram location and detection system. |
| Event recorder | Static test, at the Depot | 8.14.7 | OTMR |
| Communications and passenger information systems | Static test, at the Depot | 8.14.7 | Radios, PA, emergency communications. Warning tones. Passenger information system. |
| Noise. | Static test, at the Depot | 8.18 | Noise (outstanding from factory), internal & external. At same time as dynamic and performed on specified track section. |
| Safety systems | Static test, at the Depot | 8.19 | Brake control systems, emergency brake, passenger emergency. Driver's Deadman system, door safety loop. Emergency pushbutton, Track brakes. Horns/warning devices. Speedometer |
| Pantograph | Static test, at the Depot | 9.12 | Operation. Contact forces. |
| Electromagnetic compatibility | Static test, at the Depot | 9.14 | Electromagnetic radiation and susceptibility of Tram systems. Completion of the Tram FAT type test. |

Table 54 – Site Commissioning Tests: Dynamic Type Tests

| TEST | LOCATION | EN 50215 Reference | Comments |
|---|---|---|---|
| Traction system performance | Dynamic test, at designated test site | 9.1.1 | Dynamic performance, acceleration & braking rates. Jerk rates. Acceleration and control on gradients. Roll-back protection. Current collection. Speed attainment. Power consumption. Wheelslip correction and sanding. Emergency duty. |
| Braking system | Dynamic test, at designated test site | 9.3.1 | Friction brake system, service and emergency deceleration rates and stopping distances. Dynamic brake operation and blending with friction brake, jerk rates. Wheelslide correction and sanding. Track brake operation. |
| Thermal capacity | Dynamic test, at designated test site | 9.4 | Temperature rise monitoring of traction, braking and auxiliary equipment during repeated duty cycles. Including degraded modes and emergency duty. |
| Tram/track interaction | Dynamic test, at designated test site | 9.8 | Wheel rail interaction. Load testing of the complete vehicle and the checking of critical dimensions and clearances under a range of loading conditions. Suspension deflections and inter-vehicle clearances. Safety against derailment. Coupled Tram operation |
| Ride quality | Dynamic test, at designated test site | 9.9 | Assessment of Tram ride quality. |
| Kinematic gauging | Dynamic test, at designated test site | 9.10 | Dynamic performance, kinematics and gauging. Load testing of the complete vehicle and the checking of critical dimensions, swept path and clearances under load conditions. Suspension deflections. Pantograph sway, |

| TEST | LOCATION | EN 50215 Reference | Comment |
|---|---|---|---|
| Flange lubrication system. | Dynamic test, at designated test site | 9.11 | System operation. |
| Pantograph | Dynamic test, at designated test site | 9.12 | Included in Kinematic gauging |
| Electromagnetic compatibility | Dynamic test, at designated test site | 9.14 | Electromagnetic radiation and susceptibility of Tram systems. |
| Noise and vibration | Dynamic test, at designated test site | 9.16 | Noise and vibration tests performed on the specified section of track. |
| Safety Systems | Dynamic test, at designated test site | 8.19 | Brake control systems, emergency brake, passenger emergency. Driver's deadman system, door safety loop and speed inhibit. Emergency pushbutton, Track brakes. Horns/warning devices. Speedometer. Event Recorder (OTMR). |
| Tram location and detection system | Dynamic test, at designated test site | 8.14.7 | Tram location and detection system. |
| Operability and maintainability | Dynamic test, at designated test site | 8.17 | Coupling test and recovery. |
| Parking brake | Dynamic test, at steepest gradient | 8.11 | System operation, effectiveness on steepest available gradient. |

The Site Commissioning Routine Tests shall be performed on each Tram and comprise static and dynamic tests. This shall comprise of a full functional test, both statically and dynamically, of the Tram, including inspection, examination or testing of all major systems, sections, apparatus, equipment, components, internal seating, fixtures and fittings and devices (including testing the same whilst in operation); with the further inclusion of electrical, hydraulic and other major components and assemblies, as far as practical, at the test location.

The Site Commissioning Routine Test will be designed to establish that each individual tram functions in accordance with the design. It is not intended that the routine test should be a full re-working of the either the type test or the factory tests merely confirmation through carefully targeted testing that the build was correct., It will confirm that it is in a suitable condition to operate safely on the system. Upon successful completion of the Routine Tests the Tram Supplier will be issued with a Certificate of Tram Commissioning by the Tram Inspector.

Whether or not the Tram Inspector is in attendance at a Site Commissioning Test, the Tram Supplier shall keep and make available to the Tram Inspector on request true and accurate records of the Site Commissioning Test conducted, the performance of the Tram during such tests and any faults which developed or became apparent during the course of such tests.

### 23.20.2 Re-Testing

The Tram Supplier shall, if requested by the Tram Inspector, undertake such further examinations and tests as the Tram Inspector may reasonably require to satisfy himself that a Tram and/or the Trams qualify for a Certificate of Tram Commissioning

### 23.20.3 Testing Support

The Operator shall make the following available where required by the Testing and Commissioning Plan, (and agreed by Infraco):

- Depot and workshop facilities at the Depot;
- Reasonable assistance from its drivers, maintenance and other staff; and
- Track, power supplies and other facilities, as agreed, to meet the needs of the Tram Testing and Commissioning Plan.

All parties involved and their respective representatives and staff shall:

- Observe such reasonable requirements as may be notified in writing by the Operator or to preserve health and safety, protect the Trams against damage and avoid unnecessary disruption to the Operator's operations.
- Use all reasonable endeavours to avoid risks to health and safety, damage to the Trams or unnecessary disruption to the Operator's operations.
- The Tram Supplier shall make available throughout the Tram Commissioning Tests qualified staff from the Tram Supplier's organisation and, where appropriate, its major sub-contractors to:
  - Conduct, supervise and record the results of all such inspections, tests and examinations as are referred to in this document; and
- Respond to all reasonable enquiries about the condition or performance of the Trams or the major systems, sections, apparatus, equipment, components, internal seating, fixtures and fittings and devices, including all structural, electrical, hydraulic and other major components and assemblies and to rectify any failures of the same.

Table 55 – Site Commissioning Tests: Static Routine Tests

| TEST | LOCATION | EN 50215 Reference | Comments |
|---|---|---|---|
| Braking system | Static test, at the Depot | 8.10.2 | Friction brake system, including parking brake |
| Monitoring equipment | Static test, at the Depot | 8.14.7 | CCTV System, cameras and displays. |
| Event recorder | Static test, at the Depot | 8.14.7 | OTMR, |
| Tram location and detection system | Static test, at the Depot | 8.14.7 | Tram Location and Detection equipment. |
| Communications and passenger information | Static test, at the Depot | 8.14.7 | Radios, PA, emergency communications. Warning tones. Passenger information system. |

| TEST | LOCATION | EN 50215 Reference | Comments |
|---|---|---|---|
| systems | | | |
| Configuration control | Static test, at the Depot | 8.14.8 | Verification of defined software and firmware status for all sub-systems. Modification status for all major and critical components and others as appropriate. |
| Traction system | Static test, at the Depot | 8.16 | Motors, gearboxes, control equipment, power supplies and current collection. |
| Safety systems | Static test, at the Depot | 8.19 | Brake control systems, emergency brake, passenger emergency. Driver's deadman system, door safety loop. Emergency pushbutton, Track brakes. Horns/warning devices. Speedometer. |
| Windscreen washers, wipers and demisters | Static test, at the Depot | 9.18 | System function |
| Pantograph | Static test at the Depot | | Contact forces and operation. |
| Sanding system | Static test, at the Depot | | System function. |
| Doors | Static test at the Depot | | Cycle times. |
| Heating, ventilation and air-conditioning | Static test, at the Depot | 8.14.4 | Functional check |

Table 56 – Site Commissioning Tests: Dynamic Routine Tests

| TEST | LOCATION | EN 50215 Reference | Comments |
|---|---|---|---|
| Traction system performance | Dynamic test, at designated test site | 9.1.2 | Dynamic performance, acceleration & braking rates. Speed attainment. Operation through supply interruptions and at varying line voltages. |
| Braking system | Dynamic test, at designated test site | 9.3.2 | Friction brake system, service and emergency deceleration rates and stopping distances. Dynamic brake operation and blending with friction brake, sanding. Track brake operation. |
| Ride quality | Dynamic test, at designated test site | 9.9.2 | Subjective ride test to discern any obvious ride irregularity. |
| Flange lubrication system. | Dynamic test, at designated test site | 9.11 | System function. |
| Noise and vibration | Dynamic test, at designated test site | 9.16.2 | Subjective noise and vibration assessment to discern any obvious irregularity. |
| Tram control system | Dynamic test, at designated test site | 9.19 | Interfaces between traction, braking, auxiliary, control and safety systems. Tram management systems, displays and diagnostics. |
| Monitoring equipment | Dynamic test, at designated test site | 9.19 | CCTV System, cameras and displays. |
| Event recorder | Dynamic test, at designated test site | 9.19 | OTMR |
| Tram location and | Dynamic | 9.19 | Tram location equipment |

| TEST | LOCATION | EN 50215 Reference | Comments |
|---|---|---|---|
| detection system | test, at designated test site | | |
| Communications and passenger information systems | Dynamic test, at designated test site | 9.19 | Radios, PA, emergency communications. Warning tones. Passenger information system (as appropriate). |
| Safety systems | Dynamic test, at designated test site | 8.19 | Brake control systems, emergency brake, passenger emergency. Driver's deadman's system, door safety loop and speed inhibit. Emergency pushbutton, Track brakes. Horns/warning devices. Speedometer calibration. |
| Parking brake | Dynamic test, at designated test site | 8.11 | System function Part of braking test |

## 23.21 System Integration Tests (SIT)

The System Integration Tests consist of tests carried out to prove that the ETN as a whole can function as intended. All infrastructure, operation and control systems shall be exercised during these tests. The Tram Supplier will provide reasonable input to the development of the SAT specifications as well as participation in, and support to, the tests whenever reasonable technical support is needed in reference to the Trams.

The System Integration Tests will include, but will not be limited to, the following:

- Comprehensive gauging and dimensional checks under a range of loading conditions;
- Run time tests;
- Interface checks to all items of workshop plant and equipment including the wheel lathe. Tram washing machine, sanding plant, cranes and hoists;
- Access and handling checks for all major items of equipment, sub-assemblies and major capital spares items;
- Validation of the radio communication system; and
- Validation of the tram position detector system.

The System Integration Tests will involve carrying out gauging runs over all parts of the ETN in order to establish that the Trams (when operating individually or in conjunction with other Trams) accord with the Tram Section and the agreed detailed interface arrangements in terms of the alignment geometry, clearances, loads, pantograph dynamics, wheel rail interface, traction power system, communications and route setting equipment, compliance with operational procedures and Tram performance values. In particular it shall be demonstrated that there is sufficient clearance between passing Trams on the Network and between Trams and other Network equipment and installations to ensure that the Trams can be operated safely and without damage to themselves and to the other parts of the System.

There shall be static and dynamic tests to verify that the pantograph conforms to the requirements of the Employer's Requirements.

There shall be a series of tests to demonstrate the ability of one Tram to recover another failed Tram, including on the most severe gradient on the ETN and potentially in a degraded mode.

The testing of the systems, including but not limited to; power supplies, overhead line, Depot equipment, and EMC tests will require the use of a number of Trams running at the same time.

Table 57 – System Integration Tests: Static Type Tests

| TEST | LOCATION | EN 50215 Reference | Comments |
|---|---|---|---|
| Lifting ability | Static test, at the Depot | 8.3 | Body Lifting and major component removal. Bogie handling. |
| Battery charging system | Static test, at the Depot | 8.13 | Battery access for maintenance and topping up. Operation and suitability of external battery chargers. |
| Monitoring equipment | Static test, at the Depot | 8.14.7 | CCTV System, Interface with the Depot systems. |
| Event recorder | Static test, at the Depot | 8.14.7 | OTMR, Interface with the Depot systems. |
| Tram location and detection system | Static test, at the Depot | 8.14.7 | Tram location equipment. |
| Communications and passenger information systems | Static test, at the Depot | 8.14.7 | Radios, PA, emergency communications. Warning tones. Passenger information system. Interface with the Depot systems. |
| Traction system | Static test, at the Depot | 8.16 | Power supply interaction. |
| Operability and maintainability | Static test, at the Depot | 8.17 | Review and demonstration of accessibility and removal of components. Fault handling, diagnostics and indications. Safety issues. |
| Noise and vibration. | Static test, at the Depot | 8.18 | Noise and vibration levels, internal and external. |
| Pantograph | Static test, at | 9.12 | Operation. Contact forces. |

| TEST | LOCATION | EN 50215 Reference | Comments |
|---|---|---|---|
| | the Depot | | |
| Sanding system | Static test, at the Depot | | Refilling system. Verification that the fill level can be observed from inside the tram. |
| Flange lubrication system. | Static test, at the Depot | 9.11 | Refilling. |
| Visual examination of all client defined features | Static test, at the Depot | HMRI, RVAR | Interior layout, seating, livery and signage |
| Electromagnetic compatibility | Static test, at the Depot | 9.14 | Electromagnetic radiation and susceptibility of vehicle systems. |

Table 58 – System Integration Tests: Dynamic Tests

| TEST | LOCATION | EN 50215 eference | ommen |
|---|---|---|---|
| Tram/track interaction | Dynamic test, at designated test site | 9.8 | Wheel rail interaction. Load testing of the complete vehicle and the checking of critical dimensions and clearances under a range of loading conditions. Suspension deflections and inter-vehicle clearances. |
| Kinematic gauging | Dynamic test, at designated test site | 9.10 | Dynamic performance, kinematics and gauging. Load testing of the complete vehicle and the checking of critical dimensions, swept path and clearances under a range of loading conditions. Suspension deflections. RVAR and HMRI requirements. |
| Platform gauging | Dynamic test, at designated test site | 9.10 | Platform stepping distance and heights, tare and loaded conditions. RVAR requirements. |
| Flange lubrication system. | Dynamic test, at designated test site | 9.11 | Effectiveness. |
| Pantograph | Dynamic test, at designated test site | 9.12 | Operation, contact forces, sway. OLE deflection. |
| Electromagnetic compatibility | Dynamic test, at designated test site | 9.14 | Electromagnetic radiation and susceptibility of vehicle systems. |
| Voltage interruption and jump | Dynamic test, at designated test site | 9.15 | Reaction of traction/dynamic brake/auxiliary power systems to supply voltage interruptions, jumps and short circuits. Operation over full-specified voltage range. |
| Noise and vibration. | Dynamic test, at designated test site | 9.16 | Noise and vibration levels. |
| Monitoring equipment | Dynamic test, at designated | 9.19 | CCTV System, cameras and displays. |

| TEST | LOCATION | EN 50215 Reference | Comments |
|---|---|---|---|
| | test site | | |
| Tram location and detection system | Dynamic test, at designated test site | 9.19 | Tram location equipment, throughout the available route. Road junction and point motor control. |
| Communications and passenger information systems | Dynamic test, at designated test site | 9.19 | Radios, PA, emergency communications. Reception and effective communication with the Depot throughout the available route. Warning tones. Passenger information system |
| Operability and maintainability | Dynamic test, at designated test site | 8.17 | Review of all systems as required. Demonstration of degraded modes and recovery practices. Coupling test |
| Traction supply | Dynamic test, at designated test site | | Sub-station load tests, sub-station outages. Regeneration. Overload protection, touch voltage and stray current tests. |
| Section run times | Dynamic test, throughout the System | | Proving of the System infrastructure in stages as it becomes available to operate. |

### 23.21.1 System Acceptance Testing

Tram testing will be undertaken in support of the system acceptance testing set out in these Employer's Requirements.

# 24 Trams

## 24.1 Scope

This section defines the requirements for Trams that are applicable to the Edinburgh Tram Network and with which the Infraco must comply.

## 24.2 General Technical Specification

The Trams shall be of a high quality in design and construction and comply with the following general design criteria:

- High safety standards including, but not limited to:
  - Compliance with Railway Safety Publication 2 - Guidance on Tramways, issued by the Office of the Rail Regulator;
  - Compliance with Rail Vehicle Accessibility Regulations, 1998;
- High reliability, minimum maintenance requirement and ease of repair;
- Proven design and technology;
- Low floor access;
- Easy to clean;
- Modern and attractive appearance;
- Low weight;
- Low environmental impact;
- Meets access requirements for the disabled;
- Minimum use of energy;
- The Trams will be required to have a minimum operating capability of at least 100,000 km per year; and

The Trams shall be designed to have a minimum service life in accordance with Section 6 of these Employer's Requirements.

The Trams shall be articulated in order to negotiate the track alignment. They will be fully bi-directional and capable of being driven from either end and shall have passenger doors on both sides. They will be capable of being operated by one person.

Normal service Trams shall comprise one vehicle, but shall be capable of running coupled together for the purpose of one Tram recovering another failed Tram from any point on the system.

The Tram should be designed and constructed in accordance with a Quality Plan (as prescribed under ISO9001), which should also include a delivery plan and a Test Plan.

A full-scale Tram mock-up shall be provided to demonstrate areas critical to operation and access as part of the formal design process and for use in public consultation. The mock-up shall include the entire cab and a representative portion of one saloon, including a vestibule with at least one operational pair of bi-parting doors and space reserved for wheelchair use. The mock-up shall show the exterior form and livery. The mock-up shall be weatherproof and shall be delivered to a location in Edinburgh designated by tie.

## 24.3 Wheel / Rail Interface

The Trams shall have a wheel profile and suspension characteristic that is compatible with the rail profiles used throughout the System in terms of risk of derailment, noise, wear and vibration. The wheel profile shall allow for flange running at crossings. The Tram will be designed to operate in conjunction with a track gauge of 1,435mm and a flange back-to-back dimension consistent with the rail types to be used on the Edinburgh Tram Network.

## 24.4 Tramway Path

Trams shall be compatible with the System track alignment and the geometric constraints as outlined in Section 26 of these Employer's Requirements, which gives the alignment criteria and the assumed Tram characteristics. From this the developed kinematic envelope ("DKE") calculations and any other information, to show compatibility with the alignment, shall be provided by the Infraco. The Trams shall negotiate the minimum radius horizontal and vertical curves, and maintain acceptable wheel flange wear.

Minimum clearances to existing structures, Tramstops, overhead line equipment structures and all other road furniture shall be maintained in accordance with the agreed DKE and it shall always be possible for one Tram to pass another, at any point on the system. The Infraco shall ensure that the Tram Supplier shall provide supporting information to enable a reduced DKE to be developed for use in locations where restricted speeds are or may require to be applied.

## 24.5 Supervisory, Control & Communications Systems

The Trams shall be fitted with equipment to automatically indicate their position to, and communicate with, a central control centre.

Additionally, a bus tracker box will be fitted.

A voice radio system will be permanently available between the driver and the central control centre. This equipment will be supplied by Infraco and will be free-issue to the Tram Supplier, to be installed and tested as part of the Tram manufacturing process.

The supply and integration of the free-issue equipment will be controlled through a system interface register, to be developed from Schedule 22 of the TSA and managed by Infraco.

All on-board systems with real-time clocks shall be updated and synchronised from a common source, throughout the working life of the Tram.

## 24.6 Depot Facilities

The Trams shall be maintained at the Depot and a system interface register shall be used to ensure that the Trams and the equipment provided for their routine maintenance and operation are compatible.

The Trams shall be compatible with a mechanised sand filling system at the Depot (see Section 29 of these Employer's Requirements), enabling the sand system on the Trams to be replenished within five minutes and by one driver alone. The Infraco shall ensure that the Tram Supplier shall provide a specification for the sand, and contact details for a UK-based commercial supplier of this sand.

The Trams shall have a key suiting system that provides a logical hierarchy of access to cleaners, inspectors, drivers and maintenance staff. It shall not be part of the same suite as detailed in Section 22 of these Employer's Requirements.

The Trams shall be supplied with a nominal 24VDC shore supply, socket compatible with battery charging equipment in the depot.

## 24.7 Electro-Magnetic Compatibility

The Trams and their sub-systems shall not generate excessive, nor be susceptible to, electro-magnetic interference and shall comply with EN 55013, EN 50121 and EN 50122 as appropriate.the requirements of the specification as detailed in section 16 of these Employer's Requirements.

## 24.8 Climate and Environment

The Trams shall operate normally in all climatic and environmental conditions found in the Edinburgh area on the proposed route, including operation in a marine environment having a saline atmosphere and being subject to fine wind-blown sand. This shall also include conditions where ice forms on the overhead line and wind speeds of up to 120km/h.

The Trams shall function, without deterioration in performance and for their whole design working life, within the weather conditions anticipated within the Edinburgh area as described elsewhere in Section 3.6.4 of these Employer's Requirements - taking into account the previously quoted wind speed. All equipment housings/enclosures that contain electronic equipment shall be so equipped to avoid the occurrence of condensation. The Trams shall be capable of being started up normally under the range of weather conditions as outlined above after no less than 72 hours of being left in the open in a shutdown condition.

## 24.9 Interface Management

The Infraco shall procure that the Tram Supplier participates in the interface engineering process. The Tram interfaces are identified in the TSA. The management of the interfaces will be carried out by Infraco using the system interface register.

## 24.10 Systems Assurance

The Infraco shall ensure that the Tram Supplier shall implement a System Assurance engineering process in accordance with the requirements of the Edinburgh Tram Network. This process shall cover all aspects of design, manufacture, integration, testing and commissioning of the Tram, and all interfaces with the system, to demonstrate compliance with the reliability, availability, maintainability and safety requirements of tie.

The Infraco shall ensure that the Tram Supplier shall follow the approach of BS EN 50126:1999 "Railway Applications – The specification and demonstration of RAMS".

The Infraco shall ensure that the Tram Supplier shall implement a reliability, availability and maintainability management process and will detail it in a Reliability, Availability and Maintainability Plan (RAMP).

The Infraco shall ensure that the Tram Supplier shall implement a System Safety Management Plan (SSMP), which shall define the process, activities and requirements for the preparation of a 'Case for Safety' during the design and handover stages of the project. The plan shall also define the system safety management organisation and the strategy to achieve the individual hazard system safety targets.

All foreseeable system safety hazards are to be identified, evaluated and recorded in a Hazard Log that will be managed and maintained throughout the project lifecycle. The Infraco shall ensure that the Tram Supplier shall implement a hazard management process to identify hazards through hazard analysis and the means to mitigate these hazards.

## 24.11 Noise and Vibration

Trams shall at all times meet the requirements of the tie Noise and Vibration Policy (NVP/001/V1.01). Trams shall operate as quietly as is reasonably possible. The proposed design shall incorporate wheel damping, side skirts with sound-deadening linings and resilient mounting of electrical equipment likely to generate noise. The Infraco shall ensure that the Tram Supplier shall provide the anticipated noise levels of the proposed Tram. Noise tests shall be carried out in Edinburgh to determine the frequency peaks generated, in particular by the wheels. The results of these tests shall be used to determine the type and extent of any tuned vibration dampers that should be fitted to the wheels.

## 24.12 Specific Technical Requirements

The Tram body shall be a nominal width of 2.65m externally. Note that external door sills may be required in order to comply with Rail Vehicle Accessibility Regulations.

The total Tram length shall be a nominal value of up to 44m.

The following loading conditions shall apply in this document:

- AW0 = Tram tare weight (empty car)
- AW1 = AW0 + full load of seated passengers
- AW2 = AW1 + weight of standing passengers at 4 persons/$m^2$

- AW3 = AW1 + weight of standing passengers at 5 persons/$m_2$
- AW4 = AW1 + weight of standing passengers at 6 persons/$m_2$
- AW5 = AW1 + weight of standing passengers at 8 persons/$m^2$

Where the mean passenger weight is taken to be 70.5kg.

The passenger capacity of the tram shall be at least 230 persons, of which a minimum of 80 shall be seated, on fixed seats. There shall in addition be provision for wheelchairs in accordance with Rail Vehicle Accessibility Regulations. There shall also be provision for luggage racks.

At least 66% of the floor area available for standing must be low-floor, with a height above rail level of between 300mm and 400mm. High floor areas shall be minimised. All doorways shall allow level boarding access at a height between 300-350mm above the top of the rail. The slope of the floor at the entrance shall be in accordance with disabled access regulations. Suitable means of adjustment shall be provided to compensate for wheel wear in order to remain within these limits.

The Tram shall have a maximum operating speed of up to 70km/h. However, a speed of 80km/h must be achievable, though not sustainable for a prolonged period.

The Tram structure will incorporate a strong and stiff underframe capable of supporting a buffing load in compliance with EN 12663 category V without permanent deformation. The structure shall not deform, crack, fracture, corrode or suffer loosening of rivets or bonding during the normal service life of the vehicle. It shall be, and remain, watertight against rain, passing through standing water and passing through the washing plant throughout its working life.

The tram structure shall be designed and tested to accommodate a passenger loading of AW5 as defined earlier in this clause.

All cavities in the floor structure, body sides and ceiling will be well drained and constructed in such a way that water does not collect and corrosion does not occur. Insulation material will fill all void spaces to minimise noise, vibration and heat loss.

The articulated joints will provide a wide gangway and resistance to vehicle climbing in the event of a collision. The articulation will require minimum maintenance and be capable of being dismantled to separate the Tram bodies with a minimum of equipment.

Where different metals are in contact, due regard shall be given to preventing the effects of dissimilar metal corrosion. All metal surfaces shall be treated to resist corrosion. All body panels will be interchangeable between vehicles and all exterior panels will be lined with water resistant, sound absorbing and heat insulating materials to minimise the possibility of resonance.

Easily replaceable energy absorption devices shall be provided at both ends of the Tram such that frontal and rearward collisions, at speeds up to 5 km/hr shall be fully absorbed without causing permanent deformation of the body structure. The front skirts and lower body side panels shall be mechanically fastened so as to allow easy replacement and shall be interchangeable between Trams. Each panel must be able to be replaced by one person in ten minutes.

The Trams shall be designed to be resistant to fire in accordance with the standard BS6853 Category 2, or the equivalent European Standard.

The maximum axle load at AW4 loading, and including all consumables, shall be 11.5 tonnes.

The windscreen shall be compliant to the equivalent International Regulation ECE 43 (Uniform Provisions Concerning the Approval of Safety Glazing and Glazing Materials (Rev1 08.1990). The windscreen and cab side windows shall consist of laminated glass panes made of safety glass. There should be no diffraction effects or colour distortions in the cab windows. Any glass screens dividing the driver's cab from the saloon shall be treated to minimise reflections. All internal glazing shall be made from safety glass.

The side windows (including the door windows) will be made from heat reflecting safety glass. The glazed area shall be maximised within the limits set by structural integrity, solar gain and passenger modesty. Passengers must have a clear view to the exterior whether seated or standing. Tinted windows shall be used to minimise dazzling.

The windows shall allow permeability for radio waves with frequencies for Global System for Mobile telecommunications, and other public-domain transmissions.

All windows, (including the driver's windscreen) shall be easily replaceable using standard methods and tooling available in the Depot. All glass surfaces must be replaceable within two hours and should be secured so as to be watertight and draught-proof. Bonded glass is not preferred, unless it can be demonstrated that the bonded glazed units can be easily interchanged in less than two hours. Bonding to a mechanically-fixed window frame, or securing using a rubber section, is preferred.

If the windows used are bonded, they should have a black, printed ceramic silk screen print to cover the bonding zone and protect the bonding material from ultra violet transmission, on which the ultra violet -Transmission should be less than 0,1% at 400-600 nm.

Opening hopper windows will be fitted throughout the passenger compartment. All interior glass surfaces in the Tram passenger compartments shall be fitted with Ultra Violet light reducing and shatter resisting film on the inside surface, which shall be easily replaceable as a maintenance task when required yet give good visibility when in place. This film shall also provide effective protection against damage to the glass by 'etching'-type graffiti.

## 24.13 Driver's Cab

The driver's cab shall be arranged so that at least 95% of adult persons can comfortably access the cab desk and all the controls located within the cab, whilst retaining the appropriate field of view out of the cab. The design of the cab shall be undertaken to good human factors practice.

The driver's cabs shall be air-conditioned and the temperature shall be thermostatically controllable by the driver. Air conditioning in both cabs shall be switched on or off from either cab. Temperature selection shall be only available from the cab in use.

An effective windscreen demisting system shall be fitted, suitable for the climatic conditions encountered in Edinburgh. The demisting system shall be able to clear the windows of condensation within ninety seconds of a cab being made operational.

The cab may extend to the full width of the Tram, and be separated from the passenger area by a glazed partition providing good passenger visibility through the cab windscreen. A mirror providing the driver with a view into the saloon (when sat at the controls) shall be provided.

An internal cab to saloon door is required, which must be lockable from the saloon side and cab side but capable of being opened at any time from inside the cab. The door must latch automatically when closed.

An inward opening, hinged and lockable external cab door may be provided. It shall be capable of being locked and unlocked from both inside and outside the cab.

The cab lighting level shall be 250-300 LUX at 1.0m above floor level. The driver shall have the control of switching this lighting on or off.

A generally translucent mesh fabric sunblind shall be provided, with an opaque strip extending 150mm up from the bottom edge. The blind must be able to be deployed by the driver whilst in the driving position. It need only be retractable at stops.

Cab windscreens and cab windows shall maximise the degree of all round vision available to the driver. A clear unobstructed view of the road/track ahead shall be provided with clear and unrestricted sight lines, particularly low down in front of the cab.

The partition between the Cab and Saloon and other glazing surfaces shall minimise the incidence of reflections at all times and in all expected environmental conditions. Blinds or curtains shall be provided to screen the saloon lighting from the cab at night.

The following features that relate to instruction of Tram drivers shall be provided:

- A Tram driver can be under instruction when a Tram is in passenger service, consequently it must be possible for an instructor and a driver to be inside the cab with the cab/saloon door closed, and the instructor must be comfortably and safely located in the cab.
- The instructor must be able to apply the Tram security brakes quickly.
- The instructor must be seated and secure in the cab to the extent that he can apply the brakes even when the Tram is performing unpredictably.
- The instructor's seat may be a portable item,supplied with the Tram.

The driver's seat, unless purposedesigned for a Tram, shall be a seat specifically designed for bus applications rather than for other vehicles such as heavy rail or heavy goods vehicles, as it must be capable of being adjusted frequently without any damage. The seat must be of ergonomic design, easy to clean and easily removable from the cab. The seat cushions shall be easily removable for cleaning.

The driver's seat must be easily adjustable so that 95% of adult persons may be seated comfortably with effective reach to the drivers' controls, and maintain unrestricted lines of sight through the windscreen.

Both cabs on each Tram shall provide stowage for:

- A points handle, typically a steel bar about 1m long (supplied by others). This must be placed so the driver can easily take it with him when leaving the cab, and so it must be stowed and un-

stowed without risk of damage to the cab finishes or equipment. When not in use it must be secured so as to prevent becoming a hazard in the event of an emergency stop or a collision.

- A first-aid box (supplied by others)
- A fire extinguisher to be supplied with the Tram.
- A place to hang a driver's coat, where it will not interrupt the view in any direction.
- A place to hold two A5 ring binders of timetables, information and procedures.
- A place to clip an A5 sheet of paper, which can be conveniently referred to by the driver (whilst at a Tram stop), and which does not obscure any controls or gauges.
- A hand lamp (supplied by others)

Provision shall be made within each cab to allow two operational personnel to separately and securely store personal effects

There shall be provision in each cab for a secure cash box (supplied by others). The dimensions of this are to be provided by **tie**.

There shall be charging points in each cab for a portable radio and a hand-held ticket machine.

The tram shall be fitted with holders in each cab for a destination board, for the purpose of indicating additional destinations of public interest. This board is to be placed in position by the driver so as to be seen from in front of the tram. The dimensions of the board are to be provided by **tie**.

## 24.14 Tram Controls

The layout of controls, switches and instrumentation shall be agreed with **tie** on the mock-up, by use of design submittals and the use of the mock-up. The desk panels shall be made of material that is wear resistant and free from reflections.

It shall be possible to drive the Tram from each cab. Insertion of the driver's key and the operation of one switch in either cab shall switch on all of the equipment needed to enable the Tram to be driven from that cab. Essential sub-systems shall not be separately switched.

The Tram acceleration and braking shall be controlled from a combined controller handle, incorporating a dead man safety device. This shall normally be locked out of use until released by the driver's key, which shall remain captive in the controller until the controller is placed in the off

position. It shall not be possible to operate the Tram with more than one controller in use at any one time.

The controller shall include a slow speed mode, for driving through the Tram washing plant.

The following controls shall be conveniently placed for the driver's free hand when the Tram is in motion:

**First priority**

- Audible warnings (bell, horn);
- Track brake (in addition to the emergency brake on the driver's controller);
- Indicators;
- Pantograph emergency drop.

**Second priority**

- Manual sand (in addition to the automatic sanding system);
- Windscreen washer and wiper controls;
- Headlamp dip/main beam;
- Panic Alarm;
- Tram punctuality display against timetable or headway.

The following controls shall be conveniently placed for use when the Tram is at a Tram stop:

- Door controls;
- Rear-view normal mode push-button;
- Tram Ready To Start (junction calling when at a Tramstop close to the junction);
- Hazard and marker lights;

- Air-conditioning and temperature controls;
- Saloon heating control;
- Fault reset push-button;
- Public Address controls;
- Radio controls;
- Cab light switch;
- Saloon lighting;
- Pantograph control;
- Windscreen demister.

At least one cab shall display an odometer calibrated in km. Both cabs shall display a speedometer calibrated in km/h and mph.

Windscreen wiper control shall be by means of a multi-position switch having intermittent, continuous slow and continuous fast positions. Wipers shall be self-parking to a position close to and parallel with the edge of the windscreen.

There shall also be a separate push button, which operates wipers and windscreen washers for as long as it is held down, and provides one additional sweep of the wipers after it is released.

Each cab shall be equipped with an indicator to inform the driver whether the Tram is running early or late, and by how much.

## 24.15 Rear View Equipment

Rear-views shall be provided by close circuit television equipment which shall function as follows:

The 'normal' view, displayed whenever the Tram is in motion, shall have two screens in the cab integrated into the desk: one on the left side of the desk and one its right. The images in them shall be the same as would be seen in mirrors.

The 'Tram stop' view shall be displayed in the time between the doors being enabled at a stop and all doors being proved closed. In this view, the monitor on the platform side (the side on which the doors are enabled) shall show the same as in normal view. The other monitor shall display the image from the rear camera on the platform side, to enable the driver to view passengers disembarking and embarking and to ensure that doors are clear before they are closed.

Note that the images of views back from the cab will be laterally inverted and those forward from the rear of the Tram will not.

A separate push button conveniently located on the cab desk shall provide the driver with a changeover facility from 'Tram stop' to 'normal mode' for as long as it is held down, to allow a driver to check that nothing is overtaking the Tram at an on-street stop whilst the doors are closing.

Closed circuit television images must remain clear enough to see a cyclist overtaking the Tram before the Tram sets off from an in-street Tram stop, even whilst it is raining, dark, under street lighting and there are car headlamps shining towards the cameras. The tram supplier will be required to demonstrate that the CCTV coverage allows drivers to effectively see all passengers boarding and alighting, as well as being sufficient for the needs of driving the tram on street.

The images from the cameras shall be displayed in the cab to the driver on colour flat-screens with manually adjustable brightness. Images on these screens shall be viewable by the driver under all ambient lighting and weather conditions and at as wide an angle as possible. Care shall be taken to ensure that 'flaring' of the image from brightly lit, wet, road surfaces is avoided. Special consideration shall be given to the use of this equipment in wet weather and poor lighting conditions, when it may be necessary to remove rain droplets or prevent them from forming on the camera lens.

Rain affects closed circuit television both by creating additional reflections from wet road surfaces and by settling on the camera housings themselves. The system must cope adequately with both.

## 24.16 Interior

Care and attention shall be given to provide a safe passenger environment. Passenger movement within the Tram shall be made as safe as practicable, and able-bodied passengers shall be able to move along the entire length of the passenger saloon of the Tram.

The free and safe movement and loading of passengers shall be facilitated by the incorporation of handrails, grab-poles and an interior free of tripping hazards and sharp corners throughout the Tram. The gangway width between seats shall be not less than 650mm. Hand-holds will be provided to maximise the use of standing space, particularly in vestibules and articulations.

Steps may be included to permit the movement of passenger's to or from areas where there is a difference in the height of the floor of the Tram. Steps shall not exceed 200mm in height and the quantity should be as few as possible. There shall be a minimum of 16 seats accessible to passengers without using steps.

All seats shall be at least 450mm wide, ergonomically designed, resistant to damage and soiling and have easily replaceable covers. The seats shall as far as possible not be placed on pedestals, i.e. shall not require a step up for passengers when taking a seat. Wherever practicable seats should be cantilevered from the vehicle side so as to leave a clear floor area to facilitate cleaning. Seat rows shall be pitched no closer than 752mm.

The non-slip, easy clean floor covering shall also continue up the vehicle sides and seat pedestals so that there are no corners that can act as dirt traps. The floor covering shall be hardwearing with minimal openings and continuous welded or seamless glued joints. The edges of the floor covering shall be sealed to prevent water penetration to the structure of the Tram.

The floor covering shall be highly resistant to staining from any source.

The actual floor area available for standing passengers shall be clearly identified. From this the total standing capacity shall be calculated, respecting Rail Vehicle Accessibility Regulations and the limitations of standing room in areas such as articulations. Seating shall generally be arranged transversely with minimum longitudinal seating.

The tram shall be fitted with luggage racks, distributed evenly about the vehicle and situated as close as practicable to the vestibules. The luggage racks shall occupy a floor space of up to $10m^2$ and extend the full height of the interior and have two intermediate shelves. At floor level a horizontal bar shall extend across the opening into the saloon to prevent objects rolling out of the luggage space. Luggage shall be effectively prevented from excessive movement out of the racks, either under high rates of braking or lateral acceleration. The luggage racks should be easily replaced by seating (or standing areas if appropriate) should tie require to do so.

The tram is to be provided with information screens so as to be visible from within most parts of the saloon. The screen should be able to display video information for events and places of public interest, and should also be able to display selected views from the closed-circuit television system. All passenger areas of Trams shall be provided with windows in all sidewalls to maximise visibility for passengers. This requirement shall also apply to draught screens and separation walls to the driver's cabs.

The Tram shall provide data on the number of passengers boarding and disembarking at each Tramstop. This data shall be easily downloaded each day when the tram returns to the Depot. Software to allow analysis of the data shall be provided.

The passenger counting facility shall be incorporated on 6 of the trams in the fleet only. It shall be possible, with minimum disruption to wiring looms, body panels and major equipment, to retro-fit passenger counting equipment should this be required after the vehicles have been delivered.

Passenger stop request buttons shall be provided in the saloon area in accordance with Rail Vehicle Accessibility Regulations.

Interior saloon lighting shall provide glare free, uniformly distributed illumination in passenger areas, to a level of between 280-350 lux. The lighting diffusers shall be easily cleanable.

Emergency internal lights must function after disconnection from the overhead power supply (at all operating temperatures) in accordance with the battery back-up and load-shedding requirements below. Emergency internal lighting shall provide a minimum illumination of 30 lux at floor level and shall be evenly distributed in each passenger area of the Tram. The operation shall be independent from the overhead line power supply. Uniformity of illumination shall not be less than a factor of 0.4 Headroom throughout the seating areas shall be at least 2.1m to ceiling.

There shall be litter bins provided at each vestibule on both sides of the tram, each being able to be filled with typical soft drink cans. The litter bins shall be easily emptied.

All passenger areas of Trams shall be provided with a heating and ventilation system that maintains a constant acceptable ambient temperature during transit between Tram stops and during boarding and alighting at Tram stops when operating in all prevailing climatic and environmental conditions on the proposed route.

The arrangement of heating devices shall prevent excessive draughts caused by high airflow rates, due to the even warm air distribution inside the Tram. With the appropriate arrangement of the

vents, the air inside the Tram shall be heated and distributed over a large area through natural convection. Pockets of hot and cold air shall be avoided.

The interior of each Tram shall be fitted with reserved spaces for on-board advertising and passenger information notices. These spaces shall allow cardboard panels, 210mm deep, to fit snugly into retaining grooves. A clear smooth surface at least 160mm deep shall be available between the grooves to allow for the fixing of vinyls. There shall be a route map above the inside of every passenger doorway. The Infraco shall ensure that the Tram Supplier shall produce and fix all notices required by law or the Safety Management System, and fix free-issue logos, route maps and other notices, using appropriate materials and attachment methods, against a schedule which shall be agreed by tie on the mock-up.

Trams shall be fitted with racks close to the vestibule areas for holding information leaflets and newspapers. The arrangement and design of these racks is to be agreed by tie on the mock-up.

Two night partitions shall be provided which are fully retractable and can be securely stowed when not in use. These partitions shall be located adjacent to the articulations on either side of the wheelchair area towards the centre of the tram.

This night partition should be included in the mock-up.

The function of these partitions shall be to enable the rearmost portion of the tram to be securely locked out of use by the on-board inspector in order to enable him to more closely supervise the passengers in the forward portion of the tram whilst retaining the wheelchair facilities, as required by RVAR.

The partitions themselves shall be simple to operate by one person in the range of 5th percentile female to 95th percentile male. It shall be possible to lock the partitions in either the stowed or fully deployed position using a key which is carried by the on-board inspector as part of his normal duties. It shall be possible to deploy and stow the partition within 2 minutes. When deployed or stowed the partition shall be robust enough to withstand a person falling against it without sustaining damage.

A key operated control, located such that it may be conveniently operated by the on-board inspector with the partition deployed, from either side of the partition, shall cause the lights in the rearmost (isolated) portion of the tram to be reduced to emergency lighting levels, and disable the external door pushbuttons in order to prevent passengers accessing this portion of the tram. Under all circumstances the crew entry functionality at the single end doors shall remain operable and it shall be possible to operate the emergency door release throughout the tram. Additionally the Passenger

Emergency Communication Units shall remain active in all parts of the tram. The activation of the key operated control shall be indicated in the active driving cab but shall not cause a fault alarm.

In order to assist with the design the following information gives the anticipated normal method of operation.

At a terminus where the partition is to be put in place:

- The passenger doors will be opened in the normal way to allow passengers to exit and enter the tram (at this point they may board at any point in the tram);
- The driver will close and remove the enable command from all doors before closing down the cab and walk to the other cab;
- The on-board inspector will move any passengers in the area to be closed off to the portion of the tram forward of the partition;
- The inspector will then secure the partition in place and operate the key switch to deactivate the rearmost door controls and dim the lights;
- The driver will activate the forward cab and enable the doors for passenger boarding in the normal manner prior to departing.

Consideration should be given to providing an indication on the side passenger information displays to indicate to intending passengers that boarding is at the forward end of the tram only.

Tram loading will be uneven when the partition is deployed. The implications on load compensation in traction and braking control of the tram shall be considered and should continue to function appropriately when this condition is in force.

Interior ceiling and coving panels should be securely retained, so that they do not fall onto the maintainer when the catch is released. All interior panels should be small enough to be handled and lifted by one person unaided.

The interior livery shall be developed as part of the system identity and branding package and is to incorporate the features set out in the Design Guidelines. Typically this shall include the following factors:

- Paint finishes should use the same colours as for the exterior;
- GRP interior panels / door interiors / lower finisher trim for bonded glazing shall be Blue RAL 5005;
- Roof / coves / sides laminates shall be the same colour as Perstorp PP5650U Cezanne;
- Seats and wheelchair backrests shall be covered in Holdsworth Edinburgh Tartan – W218ET (including priority moquette);
- Driver's seat covering shall be Black hide material;
- Floor colours shall be as per Taraflex Luna NT Lewis (Taraflex Red BEF 53/01) and Taraflex Polaris NT Arran (Taraflex Blue BEF 33/01);
- Floor covering weld cord – Yellow;
- Seat backs shall be in Lothian Blue; and
- Hand rails and stanchions shall be in Red RAL 3020.

Passenger seats shall be of a similar style to the Grammar Pratico 2845 Low backrest, as currently deployed on Lothian Buses.

## 24.17 Bogies

The vehicle will have a minimum of 66% adhesive weight on motored axles.

The bogies shall be of proven design and have been used successfully in another Tram project.
The bogies will incorporate suspension systems to give a high-quality ride characteristic. The suspension system will be self-adjusting or adjustable for wheel wear so that ride heights can be closely maintained.

The ground clearance (from top of rail) fully laden with worn wheels shall not be less than 50mm to any part of the bogie structure except a track guard.

Each axle on the motor bogies will have a spring-applied friction brake. It shall be possible to release the spring-applied brake manually in the event of failure of the actuation system. Under normal operation the parking brake will release and apply automatically when the driver's controller is activated.

Each bogie shall have two electro-magnetic track-brakes, one suspended over each rail between the wheels.

The wheels shall incorporate resilience and damping in order to minimise noise and vibration. Tuned vibration absorbers will be fitted after carrying out tests to determine their most effective parameters.
Effective under-run protection arrangements shall be provided. The end bogies will carry adjustable track guards on their outer ends, to conform to Railway Safety Publication 2 – Guidance on Tramways, issued by the Office of the Rail Regulator requirements for under-run protection. The motor bogies will be interchangeable with each other.

Removal of components such as brake actuators, suspension units, etc. will be facilitated to allow on-site repair and replacement of major items such as motors or wheels to take place with the minimum of Tram down-time.

The ride comfort levels measured according to the ISO 2631 Standard on a ballasted straight and level track in good condition shall be no worse than:

| Speed | Wz vertical | Wz lateral |
|---|---|---|
| 40 km/h | 2,32 | 1,58 |
| 70 km/h | 2,96 | 2,36 |

Table 59 - Ride Comfort in the Driver's Cab

| Speed | Wz vertical | Wz lateral |
|---|---|---|
| 40 km/h | 2,24 | 1,64 |
| 70 km/h | 2,82 | 2,28 |

Table 60 - Ride Comfort in Passenger Compartment

At least two wheelsets of the Tram shall be equipped with flange lubrication equipment on all wheels. Both sides of the flange shall be lubricated. It shall be capable of being programmed to operate on the basis of either location, or of a time interval, or a combination of these.

## 24.18 Re-Railing

The Trams shall be capable of being returned to the running track in case of derailment with the minimum amount of equipment and in the shortest possible time. The Infraco ensure that the Tram Supplier shall indicate the best methods for re-railing and the equipment required, for all track forms used on the system.

If the Tram design includes suspended body sections, then articulation locks shall be procured by the Infraco from the Tram Supplier.

## 24.19 Propulsion Equipment

The Tram shall not export additional risk onto Network Rail infrastructure. In particular, the harmonic generation from the propulsion and control equipment shall not interfere with train-borne or trackside systems or other third party systems and infrastructure.

The traction equipment shall detect and automatically manage wheel slip and wheel slide, so as to maintain performance and stopping distances in all track conditions and without damage to the wheel treads. When slip or slide is detected sand will automatically be applied to the rails in front of the leading axle. Sanding must not take place due to spurious wheelslip/slide detected at flange running crossings, pointwork or sharply curved or transitional track. The traction equipment shall tolerate variations in wheel diameter.

The Trams will have the following performance when motoring, on straight and level track and with a nominal line voltage of 750V dc:

| Speed (km/h) | Load | Performance | Notes |
|---|---|---|---|
| 0 -> 30 | Up to AW4 | 1.2 $m/s^2$ | Instantaneous |
| 0 -> 70 | Up to AW4 | 0.8 $m/s^2$ | Average |

Table 61 - Tram Performance Levels

The effect of variation of the line voltage (within the prescribed system limits) on the Tram performance, shall be provided by the Tram Supplier on behalf of the Infraco. The maximum line current, and the conditions when it shall be demanded by the Tram, shall also be provided by the Tram Supplier on behalf of the Infraco.

The Trams shall provide safe operation on all gradients under degraded performance modes as imposed by the traction equipment. In particular, the Trams shall be able to complete any journey on the System with one complete traction drive unit isolated.

The traction and braking control system shall be optimised to provide smooth and low jerk values in starting from rest, acceleration, braking and stopping, on level track and on all gradients that are encountered, under all loading and environmental conditions, while protecting against unintended downhill movement.

The Tram may be fitted with a short-time rated emergency mode, with a higher tractive effort, to assist in recovering other Trams.

## 24.20 Braking Equipment

The Tram Braking Equipment shall be designed to comply with BS EN 13452 Part 1 except where stated below.

The service brake application shall be capable of retardation at an acceptable rate (as defined in Tables 3 and 4 of BS EN 13452 Part 1) at all specified laden conditions and the jerk rate shall be limited so as to not cause discomfort to standing passengers. The service brake shall normally consist of a regenerative electro-dynamic brake, (that as far as is practicable shall return the braking energy to the overhead line) and a friction brake. The electro-dynamic brake shall normally take precedence over the friction brake.

The regenerated voltage shall not exceed 900V. Should the overhead line become unreceptive, the braking energy shall be dissipated in naturally cooled resistors. Transition between regenerative and rheostatic modes shall be automatic, instantaneous and free from jerk. Braking distances and deceleration rates shall be unaffected by transitions during braking.

The brake resistors shall be protected from overheating. Malfunction of the dynamic brake system must be detected and recorded by the fault monitoring system.

Electro-dynamic and friction brakes shall be blended. In normal operation the friction brake will take over from the electric brake at a low speed. In addition, sand will be applied automatically during braking when triggered by the wheel slip/slide control system. Should the electro-dynamic brake be unavailable on any particular traction drive then the friction brake will be automatically applied to compensate, without jerk or loss of performance.

For emergency braking applications the jerk rate shall be limited without compromising emergency braking performance. The friction braking system should be capable of repeated full service or emergency brake applications.

The Tram parking brake shall be of sufficient performance for a Tram (whether laden or unladen) to hold without movement and for an indefinite period another unladen Tram without brakes on the steepest gradient on the Edinburgh Tram Network under all adhesion conditions.

The braking function and performance of the Tram shall be in accordance with Tables 3 and 4 of BS EN 13452 Part 1. The definitions of the braking modes given in these tables are as defined at Section 3.2 of the Standard.

When the Emergency brake is applied, the track brakes should be released immediately before the Tram comes to rest in order to minimise jerk to passengers.

All braking and jerk rates shall comply with the requirements defined in Standard EN 13452.

## 24.21 Run Time

The Trams will be capable of being operated continuously for twenty hours in each day.

A runtime simulation will be carried out by the Infraco to demonstrate the required end-to-end journey times. The Trams shall have sufficient performance and ratings to meet the requirements for these run times and end to end journey times. The inputs to the simulation shall be based on theoretical Tram performance validated by type test measurements with similar Trams in service elsewhere. The infrastructure and operational assumptions for the runtime shall include, but not be limited to:

- Alignment information, including speed restrictions due to geometry and sighting restrictions;
- Location of Tram stops and assumed dwell times;

- Speed restrictions due to the presence of pointwork;
- Service brake rates including agreed allowances for driver variation and technique, and varying adhesion conditions;
- Jerk rate and acceleration compliant with the requirements;
- Assumed delays due to operation in mixed traffic, which may be in the form of assumed speeds or time delays;
- Assumed delays due to the operation of the traffic-signal-controlled junctions, which may be in the form of assumed speeds or time delays;
- Tram loading;
- Wheel wear; and
- Traction system supply voltage.

## 24.22 High-Voltage Equipment

All Tram-borne high voltage equipment shall be adequately rated for operation at the line voltage. All high voltage equipment other than the pantograph will be securely enclosed in rigid, metal and earthed equipment cases.

The high-voltage sub-systems will be protected by high-speed circuit-breakers or fuses, which shall be enclosed so that their operation does not cause alarm or danger to persons standing near to the Tram. The length of electrically unprotected cabling between the pantograph and the protection devices shall be minimised.

Wherever feasible, there will be duplication of primary assemblies in order to minimise the potential for single-point failures. There will be a minimum of two self-contained traction groups, so that failure of a traction drive on one bogie does not immobilise the Tram.

## 24.23 Auxiliary Power Supply Systems

The auxiliary supply converter(s) shall start when fed from the overhead line, irrespective of the state of charge of the batteries.

The converter outputs for auxiliary supplies and battery charging derived from the overhead supply shall be isolated from the overhead supply to prevent any possibility of excessive voltages appearing on the low-voltage circuits.

The saloon heating units (if mounted in the saloon area) shall be provided with appropriate protection and insulation for the heating elements and their terminal connections.

The charging system for the batteries will be appropriate to the type and size of battery provided.

A suitable socket for connecting a 24V battery charging supply shall be provided.

The batteries shall be of a low maintenance type suitable for traction applications and enclosed in electrolyte-proof containers to contain environmental pollution in case of damage. There shall be absolutely no possibility of spillage from the batteries entering the passenger saloon or the cab. The battery enclosure shall be vented to prevent the build-up of gases.

In the event of loss of the 750V overhead supply, the batteries will allow all essential systems to operate for a minimum of thirty minutes. Certain critical functions will continue to operate for up to one hour from battery supply:

After ten minutes:

- The saloon lighting system shall revert to emergency lighting only.

For up to thirty minutes, the following systems shall remain in operation:

- Brake system;
- Public Address system ;
- Emergency lighting; and
- Door system.

For up to one hour the following systems shall remain operational:

- Pantograph;
- Minimum exterior lighting; and
- Radio communication system.

## 24.24 Faults and Diagnostic System

The Trams will have a condition and fault monitoring system integral with the vehicle control system, to give indication to the driver of the status of equipment and to allow control of degraded modes. Failures or events requiring maintenance intervention shall be recorded by an on-board system that shall retain all pertinent details after the Tram has been shut down, for downloading and analysis by maintenance staff. This system will have sufficient capacity to store such information at least for the interval between scheduled maintenance examinations, on a first-in, first-out basis. There shall be a visible indication that at least one day's worth of recording remains available.

The downloading of data shall be accomplished using a commonly available lap-top computer or related portable device. Any software or special equipment or licences required to download or analyse the data from the Trams shall be provided by the Tram Supplier.

The display for the driver shall also provide unambiguous information of the status of the Tram, and the severity of any faults present. In particular, the system shall continuously indicate one of the following fault states according to the condition of the Tram:

- Tram OK;
- Minor fault, report to control and continue;
- Major fault, report to control and continue in degraded mode;
- Major fault, Tram must be immediately taken out of service; and
- Major fault, Tram inoperative.

The Tram shall perform a self-check automatically whenever it is started up from a shut-down condition.

## 24.25 Sanding System

The Tram shall be equipped with a system, which deposits sand immediately ahead of the driven wheels in the direction of travel to rectify any poor adhesion conditions at the wheel/raii interface. The system shall be activated both automatically whenever wheelslip or wheelslide is detected, and manually when under control of the driver. Sand will also be automatically applied whenever the emergency or security brakes are used.

Sand shall be deposited on at least two locations on each rail per direction of travel. The rate of sand deposition shall be no more than that required to correct the poor adhesion. The automatic sanding system shall be inhibited when the Tram is stationary, unless activated manually. The sanding unit response time shall be effectively instantaneous.

The Tram-mounted sand boxes shall have sufficient capacity for a full day's service under all conditions of weather and loading.

The sand filler covers shall have seals to keep the sand content dry under all weather conditions, and when the vehicle is being washed.

A means of ascertaining the sand level in the sandboxes shall be provided, visible from within the Tram.

The Tram sandboxes shall be filled from outside of the Tram using a sand dispensing plant at the Depot. The sandbox arrangement will be compatible with the sand dispensing plant such that it is possible for the driver of the Tram to completely fill all the sandboxes in five minutes. In the event of failure of the plant, it shall also be possible to fill the sandboxes manually, and if any special equipment is required for this, the Infraco shall ensure that the Tram Supplier shall provide it.

## 24.26 Passenger Doors

The Tram will be equipped with at least four pairs of bi-parting sliding-plug doors, plus two single doors, on each side of the vehicle for the passenger saloon and one internal cab door per cab with a clear opening of not less than 610mm. The doors shall be equipped so that rainwater does not drip onto passengers when the doors are opened.

The passenger saloon doors shall be fitted on both sides of the vehicle in the low-floor area. The doors will be of the following characteristics:

- The double door clearance width shall not be less than: 1300 mm
- The double door clearance height shall not be less than: 2025 mm
- The closing force shall be: <200N
- The opening force shall be: <250N

The doors will be opened and closed by the driver or simply released by the driver so that the passengers will be able to open the doors themselves using door push buttons. The push buttons will be illuminated when they are activated. The doors shall stay open for a fixed time before closing automatically. A warning tone shall be sounded when the doors are released and a different tone shall sound to give warning of door closure.

Devices will be incorporated into the individual door control mechanisms, or in the leading edge of the door, to detect and protect against door obstruction. Slow or defective door mechanisms will be indicated to the driver by the vehicle fault management system. The driver shall be able to isolate any door by using the driver's key to operate an isolation switch local to each door. Such a door shall be secured from all forms of operation other than emergency release.

It shall be possible to open each door manually in case of emergency (including any door that has been isolated). An internal emergency handle will be provided at each door entrance. Operation of the handle shall cause an immediate application of the emergency brake and unlock the door such that it can then be moved open by hand after the vehicle is stationary. The emergency handle will only be able to be reset using the driver's key.

The door edges shall be fitted with weather-proof seals that are soft enough to allow a person's fingers to be withdrawn after the doors have closed. The seals shall be effective against all likely weather conditions and in the Tram washing plant and shall not offer a hand-hold to allow persons to ride on the outside of the Tram.

The Tram shall accept a door enable command from the driver when the Tram speed is below 10km/h, but the doors shall not become enabled until the Tram is at a standstill. If, having been enabled, the Tram speed then rises above 10km/h, the enable command shall automatically be cancelled.

The time from the Tram coming to rest to doors being fully open in response to a prompt passenger demand, plus the time from the driver pressing the door close button to the Tram moving off, shall be less than 12 seconds. This time shall include all necessary delays for RVAR-required tones. The doors themselves shall move from closed to fully open or vice versa in 3.5 seconds or less.

The door guidance mechanism shall not be a swing plug mechanism nor a folding door.

The following controls shall be fitted in each cab for driver control of the doors:

- Separate door-enable controls for the left and right sides. It must be possible to enable both sides simultaneously. The 'enable' buttons of the Tram should each be located on the appropriate side of the cab desk.

- One door 'open' button, which will open any doors previously enabled, but not opened by passengers, provided the Tram is at a stand still.

- One door 'close' button, which will close all doors that are open. This will be the normal mode of door closing at Tram stops other than termini.

- To prevent the doors being enabled on the wrong side, the door enable shall be interlocked and programmed with the correct side for the platform at each Tram stop along the route. This feature shall be capable of being over-ridden by the driver (for example, if the Tram uses an unusual platform at a terminus), but such over-ride shall require the driver to press at least one additional button, which shall not be located adjacent to the other door controls in the cab. It shall be possible to open all the doors when the Tram is in the Depot.

The door enabled indicator lights at the doors shall illuminate and the door enabled tone start, simultaneously with the door actually becoming available.

A door shall re-close automatically, with warning tone, if no obstacle is detected for twenty seconds (configurable). This will be the normal mode of door closing at termini.

When all doors are closed and traction is available, an audible signal, distinct from all other tones and quieter and less offensive than any alarm tone, shall sound in the cab in use. This is preferred to a lamp or other visual signal as the driver already has to view the platform and check ahead before moving off.

Unless a separate external cab door is provided, the door nearest each cab on each side (four doors in total) of the Tram shall be provided with local internal and external 'door open' and 'door close' switches operated by the driver's key. These shall be spring-loaded centre-off, turned one way to open and the other to close. Any door opened using a local switch shall be capable of being closed either using the appropriate local switch or the 'door close' button in any active cab. The purpose of these switches is to allow local control of the door by a driver who needs to leave and re-enter a passenger-carrying Tram, for example to operate points, at a place which is not a Tramstop. In addition, unless a separate cab door is provided, a separate control shall be provided in the cab to allow the Tram driver to open and close the nearside front passenger door separately from the cab. This is to allow the driver to open and close this door separately at the crew change halt at the Depot. An exterior emergency door release shall be incorporated to comply with the requirments of Railway Safety Publication 2,

The door-enabled tone required by Rail Vehicle Accessibility Regulations 1998 (as amended) shall be audible from both inside the Tram and on the platform. This may require an additional external sounder if, in order to be heard outside, the internal one is uncomfortably loud for passengers on the Tram.

## 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 with Section 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 62 - 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 63 - 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 | 8 | 6 |
| 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 64 - 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 | 15 | 30 |
| Cant | Curves | | mm | Subject to Tram | 75 | 75 | 100 |
| Cant | Plain line track – depot | | mm | | 0 | 0 | 15 |

Table 65 – 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 - when turnout is facing downhill on a grade | mm | | 0 | 0 | 15 |
| Negative cant | Turnouts | Turnouts and acute diamond crossings | mm | | 0 | 0 | 15 |
| Negative cant | Turnouts | Obtuse crossings in diamonds | mm | | 0 | 0 | 0 |

Table 66 - 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 67 - 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 | | 40 | 40 | 50 |
| Cant deficiency - jerk | At switch toes Consider shortest wheelbase | Maximum permited jerk rate at switch toes using theoretical radius formed by shortest wheel-base | m/s3 | jerk = 0.2 m/s3 | 0.3 | 0.4 | 0.5 |
| 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 | | 0.25 | 0.35 | 0.45 |

Table 68 - 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 | 1.8 | 1.8 |
| Transition curves | Clothoid | Minimum length | m | Subject to Tram | 15 | 10 | 6 |

Table 69 - 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 overwriten 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 70 - 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 71 - 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 | | 15 | 10 | 6 |
| 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 | Wth combined average radius ***less than*** 3125m | m | | 15 | 10 | 6 |
| Vertical alignment | Grade distance between vertical curves of opposite flexure | Wth combined average radius ***greater than*** 3125m. | m | | 15 | 10 | 0 |

Table 72 - 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 73 - Vertical Geometry: Tramstop requirements

| Element | Qualifier | Comment | Unit | Comment | Desirable Value | Limiting Value | Exceptional Limiting Value |
|---|---|---|---|---|---|---|---|
| Gradients | | | % | | 5.0 | 6.7 | 8.0 |
| Gradients | Tramstops | | % | | 1.0 | 2.0 | 2.5 |

| Element | Qualifier | Comment | Unit | Comment | Desirable Value | Limiting Value | Exceptional Limiting Value |
|---|---|---|---|---|---|---|---|
| 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 | 6.5 |

Table 74 – 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) | | ‰ | Subject to Tram | 1.5 | 2.0 | 3.3 |
| Twist (as part of the design) | Long wave over length of vehicle | Project Tram geometric capability 10m @ 3mm ‰ + 10mm – i.e. 30+10 = 40 (or 4 ‰) | ‰ | Subject to Tram | 1.5 | 2.0 | 3.3 |

Table 75 - 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).

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 |
| 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 76 - 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 | - 3100 | | | |
| Track spacing | Plus allowance for DKE | Double track main line - track centres - centre poles | mm | - 3600 | | | |
| 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 | | | |

Table 77 - Track Spacing. 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 78 – 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 | | TBA | | | |
| Rail inclination | | Inclination - Non grooved rail | | TBA Subject to Tram | | | |

Table 79 - 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;
- 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 detailed in the relevant section 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 be instructed as a tie Change and follow the principles of Section 21.

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 be instructed as a tie Change and follow the principles of Section 21.

## 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 80 - 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 Consents Programme and Schedule 14 (Design 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 Consents Programme and Schedule 14 (Design 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 81 - Finishes

## 28.13 Protection

Structural steelwork shall be protected by a paint system in accordance with the appropriate standard. 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. This requirement takes precedent over other standards.

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.

## 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 92 – 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 and shall be instructed as a tie Change and follow the principles of Section 21.

## 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 83 - 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 | |
|---|---|---|---|---|
| Anticipate | 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 82 – 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 82 – 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 82 – 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 83 - 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.