

## 4. System Overview

### 4.1. General

The new Tram Train 750V d.c. is based on the Series 2 (107) version. This system will run as a 750V d.c. fed system that incorporates parallel feeders for part of the route where necessitated by power modelling (Reference Enotrac Traction Power Report E349-RW38 Version 1 2017-06-05).

The Sheffield Tram Train will run a single pantograph at 55mph.

The pantograph to be used for Tram Train 750V d.c. is a new style non-interoperable pantograph that is designed to operate in both a.c. and d.c. systems. The static uplift forces are designed to sit within the same range as an a.c. pantograph. (Reference Schunk Dwg 1-32420.15813).

BS EN 50119 states dynamic tests and simulation is not required for mass transit systems. Tram Train falls into this and is therefore not required to fulfil this requirement. The uplift will be validated via in service testing.

It may be a future aspiration to operate trains running 25kV a.c. as well as tram trains running in this mode. This has not been considered as part of this system. If it were then the following aspects would need to be considered:

- 1) specific electrical clearances at some overbridges
- 2) the use of discrete isolators and section insulators that are bespoke to d.c. electrification systems
- 3) removal of double insulation
- 4) bonding and feeding redesign requirements.

All other parameters have been retained for train operation.

### 4.2. Design Development

#### 4.2.1. Series 2 Design Development

The new Tram Train 750V d.c. has been based on the original Series 2 25kV a.c. Design.

The original Series 2 system was developed to offer improvements over existing UK OLE design ranges in the following areas:

- Improve the reliability of the system's electrical connections;
- Increase design life and reliability of the mechanical system;
- Reduce maintenance requirements and complexity of the activities;
- Improve the constructability of the system and take into account the use of high output plant;
- Improve whole life costs of the system;
- Provide compliance with BS EN 50119, BS EN 50122-1 and applicable clauses of the Energy TSI;

- Reduce the material supply chain complexity.

Development of the original Series 2 addresses the above objectives in the following ways:

- Equipment has been designed with a fault current rating of 12kA as opposed to the current standard of 6kA. This not only improves the reliability of the system for current operational capacity but also provides a level of 'future proofing' allowing scope for future increases to capacity and loading requirements.
- The Client Engineering team identified 96 key issues with current OLEMI designs which limit operational performance and are considered to cause the bulk of OLE attributed failures. Series 2 has taken due cognisance of these issues which through the design development have now either been removed completely or the likelihood and impact of failure has been significantly reduced. Section 12 of this document lists the problem statements and Series 2 mitigation.
- The previous OLEMI range contains an excessive number of component, assembly and arrangement drawings, many of which are now obsolete as they reference parts, materials etc. which are no longer available or compliant with current or future system requirements. The Series 2 range is a combination of selected OLEMI designs which have a proven success rate as well as incorporating new design concepts which are proven on continental railways and deemed suitable for use on Network Rail infrastructure. General arrangement and assemblies have been standardised reducing the number of individual components required and aluminium alloys have been adopted in preference to steel where practicable (for example cantilevers). The benefits of which should include more efficient design, fabrication and installation processes and reduction in maintenance regimes.
- The design philosophies have been based on the use of high output plant for installation. As such productivity rates of installation for the new equipment shall be greatly increase enabling high outputs of electrification even with reduced possession availability. Therefore, there should be reduction in requirements for long blockades, which have traditionally been common place.
- Compilation of evidence files to demonstrate that components are compliant to BS EN 50119.
- Assessment of the design against BS EN 50122-1

#### **4.2.2. Tram Train 750V d.c. Design Development**

The Tram Train 750V d.c. design development required an assessment of the deviations from the original Series 2 design and included the following measures:

- Incorporation of a non-TSI compliant, wider pantograph than that used in Series 2. This required an assessment of the registration arms and contact wire/pantograph interface along with the development of new minimum stagger charts.
- Assessment of the suitability of the system parameters against conductor temperature range affected by power modelling for a d.c. traction system. This was used to specify the Tram Train tensioning unit.

- Development of double insulation between live and earth, including double insulated registration assemblies and anchor arrangements. This results in floating sections as defined later in this manual.
- Introduction of new components required for operation with 750V d.c. including isolators, section insulators, bonding arrangements, surge arresters, VLD's, and electrical connectors.
- Product acceptance of a.c. components for use with a d.c. traction system

With regards to Tram Train 750V d.c. , because of the nature of operation, this document will not apply the design principles to comply with applicable Energy TSI requirements. Where practicable, the requirements of the Series 2 system have remained unchanged to aid future upgrade to a 25kV a.c. system compatible with TSI requirements.

In addition to the assessments carried out by the original Series 2, Tram Train 750V d.c. assesses the design against BS EN 50122-2 and the risk of stray current from d.c. lines. Reference Stray Current Assessment MM-377244-TPN-SC-RPT-01.