Master Specification
Part RW-EE-D1

Electrical Systems for Traction Power

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RW-EE-D1 Electrical Systems for Traction Power

1 General

a) This Master Specification Part sets out the requirements for the design of electrical systems for traction power, including earthing and bonding and SCADA systems, including:

i) the documentation requirements, as set out in section 2;

ii) the Requirements Definition Design Documentation requirements, as set out in section 3;

iii) the Preliminary Design Documentation requirements, as set out in section 4;

iv) the Detailed Design Documentation requirements, as set out in section 5;

v) the Final Design Documentation requirements, as set out in section 6;

vi) the construction and installation requirements, as set out in section 7; and

vii) the inspection, testing and commissioning requirements, as set out in section 8.

b) The design of electrical systems for traction power must comply with the Reference Documents, including:

i) AM4-DOC-000466 – Type approval for railway products;

ii) AR-EL-STD-0102 – Rail Commissioner – Guidelines for the protective provisions related to electrical safety and earthing for the Adelaide metro electrified rail network;

iii) AR-PW-SPE-00129002-PTS-RAIL-EMS-D061 – Design – Stations – Earthing and bonding;

iv) AS 2053 Conduits and Fittings for electrical installations;

v) AS 2067 Substations and high voltage installations exceeding 1 kV a.c.;

vi) AS 3000 Electrical Installations (known as the Australian/New Zealand wiring rules);

vii) BS EN 50121 Railway applications. Electromagnetic compatibility;

viii) BS EN 50122-1 Railway applications. Fixed installation. Electrical safety, earthing and the return circuit. Protective provisions against electric shock;

ix) BS EN 50122-2 Railway applications - Fixed installations. Electrical safety, earthing and the return circuit. Provisions against the effects of stray currents caused by D.C. traction systems;

x) BS EN 50123-1 Railway applications. Fixed installations. D.C. switchgear – General;

xi) CE5-DOC-003511 Public Transport Standard: Electrical Infrastructure Engineering Design;

xii) PR-RC-MC-009 Rail commissioner management of change procedure;

xiii) PTS-MU-1O-EG-PRC-00000016 – Public transport services – Design decision records procedure;

xiv) SAPN Service & Installation Rules Manual No. 32;

xv) TP2-DOC-002020 – Guideline for low voltage electrical earthing and bonding for the Adelaide metro tram network;

xvi) TP2-DOC-002253 – Traction power SCADA functional and performance specification;

xvii) TP2 DOC 003520 Traction DC Substation Design And Construction Tram System; and

xviii) TP2-DOC-003521 Traction Power Network Design and Construction – Tram System.

c) The Contractor must ensure the management of design complies with PC-RW30 “Design” and PC-EDM1 “Design Management”.

2 Documentation

2.1 Design Documentation

In addition to the requirements of PC-EDM1 “Design Management” and PC-RW30 “Design”, the Design Documentation must include:

a) the Requirements Definition Design Documentation inclusions, as required by section 3;

b) the Preliminary Design Documentation inclusions, as required by section 4;

c) the Detailed Design Documentation inclusions, as required by section 5;

d) the Final Design Documentation inclusions, as required by section 6; and

e) the construction specification including:

   i) the construction and installation hold point requirements, as outlined in section 7; and

   ii) the inspection, testing and commissioning hold point requirements, as outlined in section 8.

3 Requirements Definition Design Documentation

In addition to the requirements of PC-RW30 “Design”, the Requirements Definition Design Documentation for electrical systems for traction power must include:

a) concept general arrangement Design Drawings for traction sites including:

   i) feeder station;

   ii) track sectioning cabin;

   iii) track coupling unit; and

   iv) converter station;

b) schematic drawings for electrical systems relating to traction power; and

c) the Design Report which must include:

   i) confirmation of existing electrical system as-built drawings and standards;

   ii) block diagrams for protection systems;

   iii) identification of any new equipment requirements, including switchgear and system components, in accordance with AM4-DOC-00466 Type Approval for railway products;

   iv) confirmation of compatibility with the existing SCADA system architecture;

   v) inputs for load flow study and system modelling concept;

   vi) initial proposals for traction site locations, including incoming distribution supply requirements;

   vii) any Third Party Assets assessment and interface management (electrolysis, Utility Service Authorities, other rail operator assets);

   viii) feeder station power supply arrangement concept schematic; and

   ix) lighting requirements; and

   x) security and other ancillary systems.

4 Preliminary Design Documentation

In addition to the requirements of PC-EDM1 “Design Management”, the Preliminary Design Documentation for electrical systems for traction power must include:

a) all information required by section 3, substituting ‘Requirement Definition Design Documentation’ with ‘Preliminary Design Documentation’;

b) Design Drawings including:

   i) layout drawings;

   ii) traction power system SLD;

   iii) non-traction power system SLD;

   iv) protection and control block diagrams;

   v) switching and operational diagrams;

   vi) earthing and bonding schematic drawing; and

   vii) cable reticulation layout and section drawing;

c) bill of materials;

d) identification of potential network connection locations (following liaison with SAPN on requirements for a network connection);

e) evidence of a high level written agreement with SAPN for network connection at all proposed locations requiring power;

f) earthing and bonding strategy for traction sites;

g) the Design Report including:

   i) a list of:

      A. any engineering waivers being sought pursuant to PC-RW30 “Design”; and

      B. Design Departures being sought;

   ii) all electrical systems relating to traction power;

   iii) protection philosophy report;

   iv) substation load flow and systems modelling;

   v) feeder station electrical systems;

   vi) earthing and bonding for traction sites; and

   vii) electrical SCADA systems; and

h) preliminary independent design certifier assessment report.

5 Detailed Design Documentation

In addition to the requirements of PC-EDM1 “Design Management”, the Detailed Design Documentation for electrical systems for traction power must include:

a) all information required by section 4, substituting ‘Preliminary Design’ with ‘Detailed Design’;

b) detailed system Design Drawings;

c) evidence of approval of any proposed materials and components, switchgear and SCADA systems software compatibility in accordance with AM4-DOC-00466 Type approval for railway products;

d) substation automation Design Drawings;

e) feeder station electrical Design Drawings, including lighting and maximum demand calculations with consideration to future expansion or provision;

f) SLD Design Drawings, including general arrangement of switchgear and protection scheme;

g) the Design Report including:

i) load flow study and system modelling;

ii) protection relay coordination study;

iii) final interlocking arrangement;

iv) earth grid design of all electrical systems;

v) reliability, availability and maintainability analysis (RAM) and hazard and operability analysis (HAZOP) on electrical systems related to traction power;

vi) hardware and software SCADA system details;

vii) substation design, including human machine interface (HMI) design report;

viii) detailed feeder station electrical earthing and bonding calculations and designs;

ix) detailed numbering on switchgear;

x) detailed load flow study and system modelling;

xi) detailed protection philosophy and interlocking requirements;

xii) final isolation procedures and instructions;

xiii) gap analysis of system standards to the specifications, departures and justification of the relevant or equivalent standard; and

xiv) FAT and SAT preliminary requirements in accordance with PC-CN1 “Testing and Commissioning” and PC-RW50 “Inspection, Testing and Commissioning”.

6 Final Design Documentation

In addition to the requirements of PC-EDM1 “Design Management”, the Final Design Documentation for electrical systems for traction power must include:

a) all information required by section 5, in a finalised form, substituting the term ‘Detailed Design’ with ‘Final Design’;

b) SLD Design Drawings with general arrangement and interconnection with OHWS and incoming supply connection points;

c) evidence of a network connection agreement and joint operating protocol between the Department and SAPN;

d) quality management plan for all electrical systems;

e) the Design Report including:

i) earth grid design and interconnections current distribution, electromagnetic fields, grounding and soil structure analysis (CDEGS modelling report); and

ii) final isolation procedures, system switching requirements and instructions;

f) earthing and bonding Design Drawings for feeder station electrical systems;

g) signal exchange list for SCADA system and integration with existing SCADA system;

h) final independent verification report on all electrical systems relating to traction power;

i) drawing index sheets;

j) inter panel drawings and cable schedule;

k) bill of materials; and

l) list of recommended spare parts.

7 Construction and installation

In addition to the construction specification requirements in PC-RW30 “Design”, the Hold Points listed in Table RW-EE-D1 7-1 must be included in the construction specification for the electrical systems for traction power.

Table RW-EE-D1 7-1 Additional Hold Point requirements to be incorporated into the construction specification

Hold Point	Documentation or Construction quality	Occurrence point
Confirm location of conduit run and supply connection points	Construction quality	Prior to civil works commencement
Confirm footings for substations and switch rooms(1)	Construction quality	Before installation of switch room
Confirm switch room(1) construction / final assembly offsite	Construction quality	Before transport of the switch room to site
Confirm incoming supply, cable terminations	Construction quality	Before terminating onto switchgear
Confirm earthing grid connection	Construction quality	Before concrete pouring
Confirm transformer installation	Construction quality	After bund area is completed
Confirm switch room(1) installation on site	Construction quality	After specified footing curing time
Confirm overhead wiring terminations (return conductor), static var compensation (SVC) if any	Construction quality	After switchgear assembly
Confirm SCADA server installation	Construction quality	Upon completion of server room and readiness for service
Confirm feeder station earthing and bonding connections and resistance testing (including spark gaps, voltage limiting devices (VLDs) and any continuity / insulation tests)	Construction quality	Before concrete pouring

Table notes:
(1) “Switch rooms” means any preconstructed building which sites on footings.

8 Inspection, testing and commissioning

a) The Contractor must comply with PC-RW50 “Inspection, Testing and Commissioning”.

b) In addition to the Hold Points listed in PC-RW50 “Inspection, Testing and Commissioning”, the additional Hold Points listed in Table RW-EE-D1 8-1 must be included in the construction specification required by PC-RW30 “Design” for inspection, testing and commissioning of electrical systems for traction power.

Table RW-EE-D1 8-1 Additional Hold Point requirements to be incorporated into the construction specification

Hold Point	Documentation or Construction quality	Occurrence point
Relay coordination testing (interface, inter tripping)	Documentation	Before energisation
Switchgear functional test (interlocking)	Documentation	During commissioning
Incoming and outgoing cable insulation tests	Documentation	During commissioning
Primary and secondary injection tests on switchgear (CT, VT and relays)	Documentation	During commissioning
Transformer soaking	Documentation	During commissioning
SCADA signal simulation test on site with correspondence to switchgear	Documentation	During commissioning
Communication testing WAN and Local Area Network (LAN) substation network	Documentation	During commissioning
SCADA software testing (redundancy primary to backup and traction sites)	Documentation	During commissioning

Hold Point	Documentation or Construction quality	Occurrence point
End to end SCADA signal exchange list testing	Documentation	During commissioning
Energisation plan (Switching program)	Documentation	Post commissioning / readiness
Handover certificate (certificate of currency, Non-Conformance Reports, defects list redlines)	Documentation	Prior to energisation
Section proving	Documentation	Before short circuit test
Short circuit test	Documentation	Post energisation
Feeder station electrical (Isolation transformer, switchboard energisation, lighting control digital addressable lighting interface (DALI) testing and lighting lux level testing testing)	Documentation	Commissioning