

Specification

ETCS Onboard Equipment

Version 2.0

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1.0	10/09/2015	First issue
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Preface

Specifications are requirements documents that describe the mandatory physical and performance characteristics of a system or an asset.

This specification defines the requirements for European Train Control System (ETCS) onboard equipment, its configuration and installation for TfNSW.

This document supersedes T HR SC 01650 SP version 1.0. The changes from the previous version include the following:

- incorporation of TN 027: 2017 as Section 6.0 Certification, the following sections and subsections renumbered accordingly
- revisions to align with standards produced since the publication of the previous version
- minor clarification to some of the requirements
- significant rewording to comply with current *Network Standards Style Manual*

Table of contents

1. Introduction	7
2. Purpose	7
2.1. Scope	7
2.2. Application	7
3. Reference documents	8
4. Terms and definitions	9
5. ETCS baseline	11
6. Certification	12
7. Tailoring of ETCS baseline	12
7.1. Subset-026	13
7.2. Subset-027	15
7.3. Subset-034	15
7.4. Subset-036	16
7.5. Subset-040	16
7.6. Subset-085	16
7.7. Subset-091	16
7.8. ERA_ERTMS_015560	17
8. TfNSW application	19
8.1. Application tailoring	19
8.2. Fitout	21
8.3. Supplier	23
8.4. AEO status	23
8.5. Asset maintenance	23
9. Equipment requirements	24
9.1. General	24
9.2. IEC 60571:2012 compliance	24
9.3. Odometer radar	26
9.4. Balise antenna	26
9.5. DMI equipment	26
9.6. Juridical recorder	27
10. Installation requirements	27
10.1. General installation	27
10.2. Emergency brake interface	28
10.3. Traction cut off interface	28
10.4. Isolation switch	28
10.5. Cabling	28
11. Reliability, availability and maintainability	29
12. DTRS interface	30
13. Rolling stock vehicle class data	31

Appendix A	AEO engineering services matrix	32
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SUPERSEDED

1. Introduction

The European Train Control System (ETCS) is a form of automatic train protection (ATP). Specifications, standards and documentation for ETCS are available from the European Union (EU) Agency for Railways (formerly known as the European Railway Agency) website.

TfNSW has adopted deployment of ETCS level 2, as far as possible without lineside signals with the addition of automatic train operation (ATO) to support reliable, high frequency operations and when this technology is proven in service. These recommendations have been adopted for implementation on the TfNSW metropolitan heavy rail passenger network which is the area bounded by Newcastle (in the north), Richmond (in the northwest), Bowenfels (in the west), Macarthur (in the southwest) and Bomaderry (in the south), and all connection lines and sidings within these areas, but excluding private sidings, freight lines and non-electrified lines.

Alterations and additions for TfNSW application to the base ETCS standards have been identified as a result of stakeholder consultation, interface limitations and the requirements that are yet to be defined in the currently applied ETCS baseline.

2. Purpose

This document sets out the requirements for ETCS onboard equipment based on the documentation published by the EU Agency for Railways. Tailoring for application on the TfNSW metropolitan passenger heavy rail network are defined with reference to the base ETCS standards and specifications.

This document provides the basis for selection and approval of equipment and generic requirements for the design and application of ETCS onboard equipment to rolling stock.

2.1. Scope

This document covers the selection criteria, configuration and application of ETCS onboard equipment to rolling stock for operation on the TfNSW metropolitan passenger heavy rail network. The fitted rolling stock is to be able to operate in ETCS level 0, level 1 and level 2. Operation in level NTC is not required. Operation in level 3 is not currently planned.

ATO requirements are yet to be considered. Specific requirements for ATO will be defined after the inclusion of ATO into the ETCS documents published by the EU Agency for Railways.

2.2. Application

This document applies to ETCS onboard equipment for fitment to existing rolling stock or as part of new rolling stock and any upgrades of fitted ETCS onboard equipment.

Section 8.1 provides application tailoring options that can be applied by the contract for fitment to a particular type of rolling stock. Application of the option detailed in Section 8.1.4 can be

determined by the Authorised Engineering Organisation (AEO) designing fitment to suit the particular rolling stock type.

Specific requirements for the fitment of ETCS to maintenance vehicles or freight rolling stock have not been considered in developing this document.

RSU 160 of T HR RS 00100 ST *RSU 100 Series – Minimum Operating Standards for Rolling Stock – General Interface Requirements* sets the rolling stock minimum operating standard for ATP.

3. Reference documents

The following documents are cited in the text. For dated references, only the cited edition applies. For undated references, the latest edition of the referenced document applies.

International standards

EN 50159 Railway applications – Communications, signalling and processing systems – Safety-related communication in transmission systems

EN 50343 Railway applications – Rolling stock – Rules for installation of cabling

IEC 60571:2012 Railway applications – Electronic equipment used on rolling stock

IEC 61709 Electric components – Reliability – Reference conditions for failure rates and stress models for conversion

Australian standards

AS 7527:2015 Rolling Stock Event Recorders

Note: AS 7527:2015 is produced and maintained by the Rail Industry Safety and Standards Board (RISSB)

Transport for NSW standards

T HR HF 00001 ST Human Factors Integration – Rolling Stock

T HR RS 00100 ST RSU 100 Series – Minimum Operating Standards for Rolling Stock – General Interface Requirements

T HR RS 00600 ST RSU 600 Series – Minimum Operating Standards for Rolling Stock – Multiple Unit Train Specific Interface Requirements

T HR RS 00117 ST Electric Circuits and Equipment for Passenger Rolling Stock

T HR RS 00840 ST RSU Appendix D – Train (Driver) Safety Systems

T HR RS 01701 ST Mounting and Installation of Electrical Equipment

T HR SC 00006 ST Rolling Stock Signalling Interface Requirements

T MU RS 00164 ST Cables for Passenger Rolling Stock

T MU MD 00005 GU Type Approval of Products

T MU MD 00009 SP AEO Authorisation Model

TS TOC.1 Train Operating Conditions (TOC) Manual – General Instructions

Legislation

Radiocommunications (Low Interference Potential Devices) Class Licence 2015

Other reference documents

European Commission, January 2015, Commission Decision (EU) 2015/14 amending Decision 2012/88/EU on the technical specification for interoperability relating to the control-command and signalling subsystems of the trans-European rail system using set of specifications #2 (ETCS Baseline 3 and GSM-R Baseline 0)

European Commission, May 2016, Commission Regulation (EU) 2016/919 on the technical specification for interoperability relating to the 'control-command and signalling' subsystems of the rail system in the European Union using set of specifications #2 (ETCS Baseline 3 Maintenance Release 1 and GSM-R baseline 1)

European Railway Agency, 2015, Opinion ERA/OPI/2015-6 of the European Railway Agency regarding Mandatory specifications referred to in Table A2 of Annex A to Decision 2012-88-EU (CCS TSI)

European Railway Agency, 2018, Opinion ERA/OPI/2014-8 of the European Railway Agency for European Commission regarding Question of UNIFE - Application Guide related to the ERTMS Maintenance Release 1

European Union Agency for Railways, 2017, Opinion ERA/OPI/2017-5 of the European Union Agency for Railways for European Commission regarding a possible revision of CCS TSI - test specifications

European Union Agency for Railways, 2018, ERA/GUI/07-2011/INT Guide for the application of the TSI for the Subsystems Control-Command and Signalling Track-side and On-board

Note: The current version of this document is now called: GUI/CCS TSI/2019 Guide for the application of the CCS TSI.

4. Terms and definitions

The following terms and definitions apply in this document:

accelerated test a test in which the stress level, or rate of stress application, exceeds that occurring under specified operational conditions, to reduce the duration required to produce a stress response (IEC 60050-192:2015)

AEO Authorised Engineering Organisation

ATO automatic train operation; a method of operation in which the movement of the train is automatically controlled without the intervention of a driver, who, if provided, exercises only a supervisory function (IEC 60050-821:2017)

ATP automatic train protection; system using information of signal aspects, track speed limits, train speed supervision and driver reactions to automatically prevent a train passing a signal at danger and/or exceeding speed restrictions (IEC 60050-821:2017)

Note: ATP is a generic term. ETCS is a common set of specifications for interoperable ATP products

baseline an approved set of specifications for a system

CCS control command and signalling

current legal reference in the context of this document, this is the latest CCS TSI adopted by the by a European Commission decision

DMI driver machine interface

DTRS digital train radio system

EIRENE European Integrated Railway Radio Enhanced Network

ERTMS European Rail Traffic Management System

Note: ERTMS includes ETCS and EIRENE

ETCS European Train Control System

EU European Union

field test a test carried out under user operational conditions (IEC 60050-192:2015)

laboratory test a test made under prescribed and controlled conditions that may or may not simulate field conditions (IEC 60050-192:2015)

LS limited supervision (an ETCS mode)

NTC national train control (an ETCS level)

RAM reliability, availability and maintainability

RAMS reliability, availability, maintainability and safety

Subset an ETCS specification managed by the EU Agency for Railways

TfNSW Transport for NSW

THR tolerable hazard rate

TSI technical specification for interoperability

UN unfitted (an ETCS level 0 mode)

5. ETCS baseline

The ETCS onboard equipment for ATP applied to rolling stock shall be an ETCS 'level 2 class A train protection system' as defined in the technical specification for interoperability (TSI) control-command and signalling subsystems (CCS) available on the EU Agency for Railways website.

The rolling stock ETCS implementation shall comply with European Commission Decision (EU) 2015/14 *amending Decision 2012/88/EU on the technical specification for interoperability relating to the control-command and signalling subsystems of the trans-European rail system* in accordance with the set of specifications # 2 (ETCS Baseline 3 and GSM-R Baseline 0) or European Commission Decision (EU) 2016/919 *on the technical specification for interoperability relating to the 'control-command and signalling' subsystems of the rail system in the European Union* in accordance with the set of specifications # 2 (ETCS Baseline 3 Maintenance Release 1 and GSM-R Baseline 1). This is commonly known as ETCS B3 MR1.

Note: Section 8.1.6 makes reference to later versions of ETCS and the implementation of packet switched radio for the ETCS level 2 deployment being undertaken by the TfNSW Digital Systems Project (DSP)

EU Agency for Railways opinions for the nominated ETCS baseline defined shall be applied as necessary for the purpose defined in this document. Opinion ERA/OPI/2014-8 *of the European Railway Agency for European Commission regarding Question of UNIFE - Application Guide related to the ERTMS Maintenance Release 1* and Opinion ERA/OPI/2015-6 *of the European Railway Agency regarding Mandatory specifications referred to in Table A2 of Annex A to Decision 2012-88-EU (CCS TSI)* are necessary for the onboard subsystem to correct errors in European Union Commission Decision 2015/14. Opinion ERA/OPI/2017-5 *of the European Union Agency for Railways for European Commission regarding a possible revision of CCS TSI - test specifications* is necessary for the onboard subsystem to correct errors in European Union Commission Regulation 2016/919.

The application date for TfNSW shall be the issued date of this document instead of the dates defined in the European Commission Decisions.

Note: Later baselines can be accepted based on assurance of compatibility with the current and proposed trackside installations.

This document will be reviewed when the current legal reference for the European Rail Traffic Management System (ERTMS) is updated on the EU Agency for Railways website. The aim of the review is to consider adoption of the revised current legal reference as the ETCS baseline. Compatibility with the existing trackside infrastructure will be the primary consideration for adoption of the revised current legal reference for ERTMS.

Compliance with the associated 'supporting informative specifications' in the EU Agency for Railways ERA/GUI/07-2011/INT *Guide for the application of the TSI for the Subsystems*

Control-Command and Signalling Track-side and On-board is expected. Suppliers of ETCS onboard equipment shall identify any noncompliance for their equipment for evaluation as part of type approval.

This document includes tailoring for TfNSW application for onboard requirements that shall be incorporated in the ETCS equipment on rolling stock.

T HR SC 00006 ST *Rolling Stock Signalling Interface Requirements* also defines tailoring for TfNSW application related to the interface between rolling stock and trackside. The requirements of T HR SC 00006 ST take precedence over this specification where conflict exists.

6. Certification

The ETCS onboard subsystem and associated equipment shall have evidence of conformity as required for operation in the EU. This typically includes the following evidence:

- EU declaration of conformity for the interoperability constituents of the CCS TSI by the manufacturer
- quality management system approval certificate based on module CH1 of the CCS TSI from a notified body
- EU design examination certificate based on module CH1 of the CCS TSI from a notified body
- evidence of conformity to CENELEC, the European Committee for Electrotechnical Standardization, standards for railway applications that includes tailoring and application of the ETCS baseline specified in this document

The equipment shall be supported by evidence of compliance with the standards required by this specification.

Equipment that is not in service as part of a multi-vendor ETCS rail environment shall be tested to certify compatibility with existing ETCS equipment as configured for the TfNSW environment.

The equipment shall have a TfNSW type approval for use in the application. Type approval is in accordance with T MU MD 00005 GU *Type Approval of Products*.

7. Tailoring of ETCS baseline

Section 7.1 to Section 7.8 specify the tailoring of EU Agency for Railways' documents for TfNSW application.

7.1. Subset-026

Table 1 specifies the tailoring of Subset-026 for TfNSW application.

Table 1 – Tailoring of Subset-026

Relevant Subset clause	Topic	Requirement	Change type
2.6.5.2.3	Onboard equipment	Euroloop transmission equipment is not required. Radio infill transmission equipment is not required.	Selected option
3.6.6.1	Disable the geographical position feature	To avoid confusion with trackside distance markers, the geographical position feature on the driver machine interface (DMI) shall be disabled and hidden by configuration change on the DMI. Geographical position data is not being provided by the trackside ETCS implementation.	Amendment
3.11.7.1.3	Setting of the speed limit when in staff responsible mode	The driver functions for setting the staff responsible speed shall be either permanently disabled by configuration or disabled at the factory in a non-configurable manner prior to delivery.	Amendment
3.14.1.1	Use of emergency or service brake where not specified	ETCS shall use the service brake for brake applications that do not require use of the emergency brake.	Addition
3.14.1.2	Emergency brake in case of service brake failure	The national value Q_NVEMRRLS emergency brake release condition shall be met before emergency brakes applied in this case are released. <i>Note: An implementation that only permits release at standstill has been accepted by means of a concession.</i>	Addition
3.14.1.7.5	Text message with emergency brake command	The national value Q_NVEMRRLS emergency brake release condition shall also be met before releasing any emergency brake command due to not acknowledging a text message. <i>Note: An implementation that only permits release at standstill has been accepted by means of a concession.</i>	Addition
3.16.2.6.1	Linking reaction response for 'no reaction'	In ETCS level 1 when the linking reaction is 'no reaction' either the driver shall be informed of the data consistency problem with the expected balise group or the data consistency problem shall be automatically reported to the infrastructure maintainer while the onboard subsystem is operating in ETCS level 1.	Addition

Relevant Subset clause	Topic	Requirement	Change type														
3.18.3.2.1	Automatic entry of 'train data' by the train	To avoid unnecessary data entry by the driver, the 'train interface' should provide 'train data' as described in section 3.18.3 of SUBSET 026 where it is practical to do so. This can be practical when ETCS is fitted as part of the original train design. Alternatively train data entered by the driver shall be limited to selection from a range of pre-configured values for the particular train type. In this case this shall be expressed as the number of cars and bogies cut out for multiple unit self-propelled passenger trains.	Amendment														
A3.1	Fixed value data	The following fixed value data is changed. All other values remain as specified. <table><thead><tr><th><u>Name</u></th><th><u>Revised value</u></th></tr></thead><tbody><tr><td>dV_ebi_min</td><td>10 km/h</td></tr><tr><td>dV_ebi_max</td><td>10 km/h</td></tr><tr><td>dV_sbi_min</td><td>7.5 km/h</td></tr><tr><td>dV_sbi_max</td><td>7.5 km/h</td></tr><tr><td>dV_warning_min</td><td>5 km/h</td></tr><tr><td>T_preindication</td><td>0 s</td></tr></tbody></table> <i>Note: If integer values are required then the value is rounded up to the next integer.</i>	<u>Name</u>	<u>Revised value</u>	dV_ebi_min	10 km/h	dV_ebi_max	10 km/h	dV_sbi_min	7.5 km/h	dV_sbi_max	7.5 km/h	dV_warning_min	5 km/h	T_preindication	0 s	Amendment
<u>Name</u>	<u>Revised value</u>																
dV_ebi_min	10 km/h																
dV_ebi_max	10 km/h																
dV_sbi_min	7.5 km/h																
dV_sbi_max	7.5 km/h																
dV_warning_min	5 km/h																
T_preindication	0 s																
4.4.3.1.1	Method of isolating ERTMS/ETCS equipment	The device used for isolation mode shall be physically and functionally independent of the other DMI controls and indications.	Addition														
4.4.3.1.2	Indicating to the driver that the ERTMS/ETCS equipment is in isolation mode	The isolation status of ERTMS/ETCS equipment shall be indicated to the driver. The isolation indication shall be in the driver's normal field of view.	Addition														
4.4.3.1.3	Operating procedure required for leaving isolation mode	The special operating procedure required to leave isolation mode shall include an engineering control that ensures the maintainer accepts that the onboard subsystem can return to service. Use of a maintainer's key is an accepted solution to enable leaving isolation mode.	Addition														
4.7.2	DMI function when driver's cabin status is 'cab not active'	DMI shall provide output information 'train speed' when 'cab not active' and ETCS onboard mode is not NP, SF, IS or SB. This addition is to support the train guard's role and the driver under the bypass function.	Addition														

7.2. Subset-027

Table 2 specifies the tailoring of Subset-027 for TfNSW application.

Table 2 – Tailoring of Subset-027

Relevant Subset clause	Topic	Requirement	Change type
4.3.1.1	Trigger events	Provide a trigger event for the general message whenever the train speed sent to the DMI changes by 1 km/h or more.	Amendment

See Section 9.6 for more details.

7.3. Subset-034

Table 3 specifies the tailoring of Subset-034 for TfNSW application.

Table 3 – Tailoring of Subset-034

Relevant Subset clause	Topic	Requirement	Change type
General	Management of interfaces between ETCS equipment and other train systems	The functional interfaces between the ETCS equipment and other train systems shall be implemented to the fullest extent described in Subset-034 given the systems provided on the train. That is, if a system exists on the train that performs a function described in Subset-034, the interface between that system and the ETCS equipment should be provided as described. <i>Note: Track condition related interfaces listed as unused in T HR SC 00006 ST are not required unless they are specifically proposed to meet business requirements.</i>	Addition
General	Location of ETCS system pneumatic isolation cock	If fitted, the ETCS system's pneumatic isolation cock shall be positioned within the crew compartment and in a location accessible to the driver. The location and position of the isolation cock shall be clearly labelled.	Addition
2.2.2.3.3	Configuration of the passive shunting feature	Passive shunting shall be permanently configured as 'passive shunting not permitted'.	Selected option

7.4. Subset-036

The balise transmission module (BTM) immunity shall meet class H as defined in Subset-036.

T HR SC 00006 ST requires specific onboard to trackside compatibility train type tests for trackside guard rail installations and balise reading in addition to Subset-036 requirements.

Laboratory and field test reports shall be provided as evidence confirming compatibility between the onboard subsystem and the trackside subsystem installed on the operational rail network as required by T HR SC 00006 ST.

7.5. Subset-040

The balise antenna mounting position specified in Subset-040 is constrained by the requirements in T HR SC 00006 ST. Refer to T HR SC 00006 ST for details.

7.6. Subset-085

An additional test for guard rail crosstalk is required to that specified in Subset-085. Refer to T HR SC 00006 ST for details.

7.7. Subset-091

Assumptions and values for conventional rail defined in Subset-091 are reasonable for TfNSW implementation and operation given the amendment detailed in Table 4.

Table 4 – Tailoring of Subset-091

Relevant Subset clause	Amendment	Comment
10.3.2.16	Time spent in modes without ETCS supervision of safe speed and distance (for example, unfitted (UN) and limited supervision (LS)) is < 90% instead of < 20%.	LS mode is planned for the majority of trackside.

The amendments for Subset-091 shown in Table 4 affect the tolerable hazard rate (THR) defined as ETCS_OB10 ETCS Auxiliary Hazard THR. Related considerations are as follows:

- LS mode implementation provides supervision of train speed in accordance with trackside speed boards which provides an additional hazard barrier compared to UN mode
- ETCS Auxiliary Hazard THRs derived in Subset-118 *Functional Safety Analysis of ETCS DMI for ETCS Auxiliary Hazard* have a 'factor of 5' reduction applied due to uncertainty

Suppliers of ETCS onboard systems shall provide assurance that compliance with ETCS_OB10 ETCS Auxiliary Hazard THR, as defined in Subset-091, manages the ETCS

auxiliary hazards under the Subset-091 assumptions and the amended assumptions so far as is reasonably practicable (SFAIRP).

7.8. ERA_ERTMS_015560

Table 5 specifies the tailoring of ERA_ERTMS_015560 for TfNSW application.

Table 5 – Tailoring of ERA_ERTMS_015560

Relevant clause	Topic	Requirement	Change type
General	Lights that can distract the driver	After ERTMS/ETCS equipment has been isolated, any ETCS related lights indicating fault, failure, or warning in the driver's primary field of view shall be able to be extinguished either using system design or user action.	Addition
General	Configuration of 'text messages'	The text for 'text messages' generated by the onboard equipment for display on the DMI shall be defined in consultations with the driver, operator and maintainer stakeholders.	Addition
General	Configuration of 'text messages'	The number of 'text messages' generated by the onboard equipment for display on the DMI shall be minimised. The decision to display messages on the DMI and the associated display conditions shall be in consultations with driver, operator and maintainer stakeholders.	Addition
5	Synchronised visual and auditory warnings	Where the DMI provides both visual and auditory warning status information, both shall activate and deactivate within 0.5 s of each other.	Addition
5.3.2.5.5	Hide functions that are not used	Menu options and other functions that are not implemented in the TfNSW configuration shall be option 'b) not shown at all'.	Selected option
5.5.1.1	Pre-configured languages	English shall be the only pre-configured onboard language.	Addition
8.2.1.1.3	Speed dial range	The range of the pre-configured speed dial displayed on the DMI shall be 0 km/h to 180 km/h (option c).	Selected option

Relevant clause	Topic	Requirement	Change type
8.3.5.7	Presentation of gradient numbers	Gradient profile numbers shall either be displayed in the same form as normally presented to drivers on the TfNSW metropolitan heavy rail passenger network or not shown at all. The 'per mille' (‰) format is not consistent with the 'ratio' (1 in X) format provided to drivers on the TfNSW metropolitan heavy rail passenger network.	Amendment
8.4.4.3	Disable the geographical position feature	In accordance with amendment to clause 3.6.6.1 of Subset-026 described in Section 7.1.	Amendment
11.2.1.3	Disable 'maintain shunting' functionality	The 'maintain shunting' functionality shall be disabled.	Amendment
11.2.3	Disable 'SR Speed / Distance' and 'Train Integrity' buttons	The special window 'SR Speed / Distance' and 'Train Integrity' buttons shall be disabled.	Amendment
11.2.4.5	Cleaning of DMI	An additional technical function is required. This shall allow the driver to clean the DMI screen without inadvertently activating any functions or being distracted from driving. The cleaning function shall be accessed quickly, only available at standstill and automatically disable itself when the train moves or time delay.	Addition
11.2.4.5	Access to menus	DMI menus for additional technical functions that are not intended for use by drivers shall be protected against access by unauthorised personnel.	Addition
11.3.2.7 11.3.2.8	Hide ETCS levels that are not able to be supported	The keyboard associated with the ERTMS/ETCS level shall display only currently supported ETCS levels.	Addition
11.3.3 11.3.10	Disable 'Driver ID' and 'SR Speed / Distance' data entry windows	The 'Driver ID' and 'SR Speed / Distance' data entry windows shall be disabled. If necessary, a pre-configured default Driver ID may be used.	Amendment
11.3.12 11.3.13 11.4.2 11.4.3	Disable 'Set VBC' and 'Remove VBC' functions	The 'Set VBC' and 'Remove VBC' functions shall be disabled. The VBC functionality is being managed by the trackside implementation.	Amendment
11.5.1.4	Items displayed in the data view window	The 'Driver ID' item shall not be displayed on the data view window.	Amendment

8. TfNSW application

Application of ETCS to TfNSW rolling stock is detailed in Section 8.1 to Section 8.5.

8.1. Application tailoring

Particular specifications and contracts may set requirements in addition to this specification by applying the following options for application to a train type:

- bypass
- reliability, availability and maintainability (RAM) enhancement
- provision as part of a new train
- driver acknowledgement of intervention
- cold movement detection
- delayed ETCS level 2 commissioning

8.1.1. Bypass

The particular specification for fitment to an existing train type may nominate that a bypass function is required for the train. Bypass functionality permits ETCS fitted trains to be used as intended by ETCS accredited drivers and have ETCS bypassed by the non-accredited drivers.

The bypass function shall not be provided unless required by the particular fitment specification.

Bypass is implemented by a two position switch. One position is normal with the other position being bypass. A bypass switch is provided for each ETCS fitted driver's cabin. The bypass switch shall be positioned in a location not accessible to the driver while they are in the driving position.

The bypass position of the switch shall prevent the ETCS onboard detecting that the driver's cabin is active. This results in sleeping mode (or equivalent) for ETCS onboard system when the bypass switch is in the bypass position and the driver's cabin is active.

The normal position of the switch shall allow the ETCS onboard subsystem to function without any effect from the bypass switch.

The design and implementation of the bypass function shall not require changes to the ETCS onboard subsystem to comply with the tolerable hazard rate allocated under Subset-091 based on Hazardous Event id. TI-3 'Inappropriate sleeping request'.

The status of the bypass switch shall be recorded by the juridical recorder.

The following ETCS related functions shall be available to the driver when bypass function is operating:

- a. view speed display which shall be displayed at the same system integrity level as during normal operation
- b. adjust DMI screen brightness and sound levels
- c. use DMI cleaning function
- d. observe system status messages configured to be provided when the bypass function is in operation

8.1.2. RAM enhancement

The particular specification for the fitment to an existing train type can specify enhanced RAM requirements given a positive life cycle cost impact for the particular train type.

8.1.3. Provision as part of a new train

New train procurements can exclude Section 11 and apply RAM requirements defined for the train as a whole.

8.1.4. Driver acknowledgement of intervention

In fitting ETCS to existing TfNSW trains it may not be reasonably practicable to comply with the requirements of Section 8.2 to not cause a task based reset of the driver safety vigilance systems. In this case a driver acknowledgement shall be provided in addition to the defined conditions to revoke a brake intervention.

In ceiling speed monitoring the revocation of either the service brake command or the emergency brake command shall require a driver acknowledgement of the brake intervention in addition to the condition defined in clause 3.13.10.3.3 of Subset-026.

In target speed monitoring the revocation of either the service brake command or the emergency brake command shall require a driver acknowledgement of the brake intervention in addition to the conditions defined in clause 3.13.10.4.10.1 of Subset-026.

In release speed monitoring the revocation of the emergency brake command shall require a driver acknowledgement of the brake intervention in addition to the condition defined in clause 3.13.10.5.4 of Subset-026.

The driver acknowledgement required to release a brake intervention shall comply with section 8.2.2.3 of ERTMS/ETCS ERA_ERTMS_015560 given the driver acknowledgement requirements defined in Section 8.1.4.

8.1.5. Cold movement detection

Cold movement detection is not normally required. Cold movement can be selected for a train type.

8.1.6. Delayed ETCS level 2 commissioning

The train type is initially commissioned for ETCS level 1 operation only under baseline 3 maintenance release 1. ETCS level 2 configuration and commissioning is delayed to align with ETCS level 2 trackside commissioning applying baseline 3 release 2 (or a later release) using packet switched communications with online key management.

Section 12 details tailoring for ETCS Level 2 application.

The initial ETCS onboard fitment is to make provision for the ETCS equipment supplier's preferred redundant ETCS data only radio arrangement to meet the specified ETCS level 2 requirements.

The provision shall be sufficient so that the ETCS data only radio arrangement can be installed, tested and the ETCS level 2 commissioned for an individual train set in two separate four hour access periods. The train set shall be fit for revenue service between the two access periods.

The initial equipment compliance tests shall include the power load, heat load, space used, mass and electromagnetic compatibility (EMC) for the ETCS level 2 related equipment that will be installed at a later date.

8.2. Fitout

ETCS designs commenced after the issue of this document shall be based on this document and the associated ETCS baseline.

The fitment of the ETCS onboard equipment shall not interfere with or hinder the correct operation of the trip gear, or other driver safety systems fitted to the rolling stock. In particular, the operation of the service brake by the ETCS equipment shall not cause a task based reset of the driver safety vigilance systems. Section 8.1.4 provides an application tailoring option if it is not reasonably practicable to implement this requirement on a particular train type.

The ETCS onboard subsystem shall be implemented in accordance with T HR HF 00001 ST *Human Factors Integration – Rolling Stock*.

A risk control shall be implemented to prevent ETCS onboard subsystem operation if configuration data for a different train type is incorrectly installed in the train's ETCS onboard equipment.

The ETCS onboard equipment fitted to a vehicle shall use one common source for time and date for the vehicle. Any existing time source on the vehicle should be used if reasonably practicable. Adjustments for daylight savings shall be automatic. The time shall not require

adjustment by the driver or maintainer due to drift by the time source or ETCS equipment. Time shall be maintained within 0.5 s of the common time source whilst the synchronisation functionality is operational.

Note: Manual adjustments due to abnormal changes to daylight saving dates are accepted.

Internal time sources in ETCS equipment shall drift by less than 2 s per day from actual time when the common time source is not available for synchronisation.

Any test of the ETCS onboard equipment that requires the train at standstill or driver involvement shall not be required more than once every 24 hours.

A warning shall be provided to the driver if an ETCS onboard equipment test that requires the train to be at standstill within the next hour.

The ETCS onboard equipment shall be configured to perform any tests that require the train to be at standstill when a driver workstation is activated for the first time after the ETCS mode transition from no power to standby. Some driver involvement in conducting these tests is acceptable.

A redundant ETCS data only radio arrangement shall be fitted for ETCS level 2 implementation in accordance with the *EIRENE System Requirement Specification* with the clarifications detailed in Section 12.

Radar units are not accepted as the only source of odometer information.

Two radar units of the one hardware type may be installed as odometer sources on a vehicle provided that diverse software is used for each radar unit.

A speedometer independent of the ETCS onboard subsystem shall be fitted in each driver's cabin. The speedometer is used when the ETCS onboard subsystem is isolated. Isolation of the ETCS shall enable the speedometer. Otherwise the speedometer function is disabled to avoid the potential for different speed information being displayed to the driver. T HR RS 00600 ST *RSU 600 Series – Minimum Operating Standards for Rolling Stock – Multiple Unit Train Specific Interface Requirements* sets the requirements for the independent speedometer. A vehicle's existing speedometer may be used for this purpose.

If other event recorders are fitted to the vehicle in addition to the juridical recorder then functionality shall be provided to facilitate cross referencing events in each recorder when time references are not synchronised. Solutions may include providing the juridical recorder with an external switched digital input for connection to an input common to both the juridical recorder and any other event recorder. The motoring trainline should be used as the common input.

The application design of the ETCS onboard equipment shall detect any isolation of the emergency brake interface. Partial isolation and complete isolation shall generate system status

messages than can be displayed on the DMI. Complete isolation shall switch ETCS onboard equipment to the system failure mode.

The application of ETCS for rolling stock shall comply with T HR SC 00006 ST. The generic ETCS onboard subsystem shall have a conformity assessment in accordance with Section 6. Specific amendments and additions identified in this document shall be supported by an independent safety assessor (ISA) in accordance with Section 6.

8.3. Supplier

TfNSW rail systems strategy is based on ERTMS for the TfNSW metropolitan heavy rail passenger network. Currently TfNSW has no ability to directly influence change in the ERTMS development. Therefore assistance is sought from the ETCS equipment supplier and the supplier shall demonstrate the ability to manage and influence change in the ERTMS development.

8.4. AEO status

Organisations responsible for discipline-specific specialist engineering services shall hold authorisation for the activity in accordance with T MU MD 00009 SP *AEO Authorisation Model* for the required specialist engineering disciplines.

The specialist engineering disciplines required for ETCS onboard subsystems are the rolling stock subsystems service for rolling stock and the interlocking systems service for signalling and control systems. The note for rolling stock subsystems shall explicitly include onboard subsystems for ATP. Interlocking systems shall not have a note that excludes ATP. ATO shall be included in the notes if the service includes ATO functionality.

Note: AEO status is only required for the provision of specialist engineering services. AEO status is not required for the supply of products including both general and type approved products.

An example *AEO Engineering Services Matrix* is provided in Figure 1 in Appendix A for an AEO authorised to provide ETCS onboard subsystem engineering services. Specifically Figure 1 shows the services that an AEO needs authorisation to provide and maintain ETCS onboard subsystem assets.

8.5. Asset maintenance

The asset strategy identified by TfNSW determines when to fit ETCS or upgrade the ETCS baseline for onboard equipment which in turn informs the asset maintenance plan to sustain asset performance.

9. Equipment requirements

The equipment requirements are described in Section 9.1 to Section 9.6.

9.1. General

The ETCS onboard equipment shall be designed to be compatible with the traction system used by the train and the rail lines it is intended to operate on.

Safety related communications between ETCS onboard equipment and to and from ETCS onboard equipment shall comply with EN 50159 *Railway applications – Communication, signalling and processing systems – Safety-related communication in transmission systems* for the combination of equipment, transmission systems, communication protocols and configuration.

The design and configuration of the ETCS onboard equipment shall implement defences against intentional technological attack. The level of defence shall be based on potential safety hazards and potential impact on train operations.

The ETCS odometry subsystem should not constrain the type of axle to which wheel sensors can be fitted.

Subset 104 identifies ETCS versions as X.Y. ETCS onboard equipment provided with a particular X value shall have evidence of design allowances to support upgrades to the forecast Y increments without significant hardware upgrade or replacement. TfNSW strategy has forecast two upgrades. One is the use of packet switched communications for ETCS level 2 applying baseline 3 release 2 (or a later release) with online key management. The other is ATO integrated with ERTMS applying a future baseline that has not yet been released. The evidence of design allowances shall include these forecast upgrades and an assessment of the extent of change required to the supplied product.

9.2. IEC 60571:2012 compliance

All electrical and electronic equipment provided as part of the ETCS onboard equipment shall comply with IEC 60571:2012 *Railway applications – Electronic equipment used on rolling stock*. Evidence of compliance with equivalent standard EN 50155:2007 *Railway applications – Electronic equipment used on rolling stock* is accepted as meeting this requirement.

Note: A later version of EN 50155 has been published. Compliance with the equivalent requirements in the later version is accepted. The later version has significant changes to the requirements and structure of the standard.

Particular compliance requirements are detailed in Table 6.

Table 6 – IEC 60571:2012 compliance

Clause	Requirement	TfNSW requirement
4.1.2	Ambient temperature	Class T3 unless the equipment locker is air conditioned by a system required as part of the minimum operating standard for the train type.
4.2	Special service conditions	Not required.
4.2.2	Atmospheric pollutants	None specified.
5.3	Installation	Any electrical installation requirements for the equipment shall be nominated by the supplier. Equipment should be designed to operate with either a floating vehicle battery supply (isolated from vehicle body) or a battery negative connected to the vehicle body.
6.1.1	Predicated reliability	The supplier shall provide details of the manufacturer's predicated reliability for the equipment including the methodology used, and assumptions made.
6.1.2	Proof of reliability	The supplier shall provide proof of reliability.
6.2	Useful life	The nominated useful life is accepted. Items with a shorter useful life may be accepted provided that their limitations have been detailed prior to purchase.
6.4.1	On-vehicle diagnosis	Manufacturer or supplier to provide proposal.
7.2.1	Interfacing	Galvanic isolation should be provided for communications data links used by ETCS onboard equipment. The galvanic isolation should be rated at 600 V dc or higher. Euroantenna data links are accepted as not requiring galvanic isolation to meet RAMS requirements.
9.1.3	Polarisation or coding	Line replaceable units (LRU) shall incorporate mechanical means of polarisation or coding to prevent incorrect insertion.
9.1.5	Sockets and connectors	The use of integrated circuit sockets and edge connectors shall be minimised. Normally only CPU integrated circuits will use sockets.
9.3.5	Other connections	T HR RS 01701 ST <i>Mounting and Installation of Electrical Equipment</i> defines the accepted alternatives.
12.1.2	Type tests	The user requires type tests repeated under the conditions nominated in this clause.

Clause	Requirement	TfNSW requirement
12.2.9	Radio interference test	Both radio-frequency interference (RFI) susceptibility and emission tests are required as type tests.

9.3. Odometer radar

Odometer radars shall be compliant with *Radiocommunications (Low Interference Potential Devices) Class Licence 2015*.

Radars are exterior-mounted equipment mounted under-car. The requirements of T HR RS 01701 ST apply to mounting and installing this equipment. Resistance and protection against ballast impact is assessed in accordance with T HR RS 01701 ST.

9.4. Balise antenna

Balise antennae are exterior-mounted equipment that are mounted under-car. The requirements of T HR RS 01701 ST apply to mounting and installing this equipment. Resistance and protection against ballast impact is assessed in accordance with T HR RS 01701 ST.

9.5. DMI equipment

The DMI is also called the man machine interface (MMI) in some of the Subset specifications.

A touch screen based solution should be provided. Alternative solutions shall consider the organisational impact of potentially inconsistent DMIs that the train driver would be likely to encounter.

The DMI screen shall use technology designed to manage glare and reflections on the screen when installed in the vehicle cab.

The screen brightness shall be at least 400 cd/m² when set for maximum brightness.

The screen viewing angle shall be at least 45°/45° (left/right) and 45°/30° (up/down).

The contrast ratio for the screen shall be at least 500:1.

The DMI equipment shall be configurable by design so that when S1 – over-speed audible information is played at maximum volume setting the sound level exceeds 80 dBspl at 1 m. The configured maximum sound level is determined as part of the human factors integration for the vehicle type.

The DMI equipment shall be configurable by design so that the minimum sound level that can be set by the driver is the level determined as part of the human factors integration for the vehicle type.

9.5.1. Switches

Separate switches that form part of the DMI shall comply with T HR RS 00117 ST *Electric Circuits and Equipment for Passenger Rolling Stock*. Isolation and bypass switches are separate switches that form part of the DMI.

9.6. Juridical recorder

A juridical recorder shall be provided. The juridical recorder shall comply in part with AS 7527:2015 *Rolling Stock Event Recorders*. Section 1, section 3, section 7, section 8, and section 9 of AS 7527:2015 apply. Section 2, 5 and 6 of AS 7527:2015 do not apply. Section 4 of AS 7527:2015 is replaced by Subset-027 as amended by Section 7.2 of this document.

10. Installation requirements

The installation requirements are described in Section 10.1 to Section 10.5.

10.1. General installation

The requirements of T HR RS 01701 ST apply to mounting and installing ETCS onboard equipment.

T HR RS 00117 ST applies with the following amendments to 'circuits and earthing' requirements:

- ETCS safety significant and safety critical circuits are permitted to switch both positive and negative legs of circuits
- ETCS input and output circuits are not required to be protected by an individual circuit breaker for each circuit function. However power supply circuits should comply with the requirement

Circuit breakers installed external to the ETCS onboard equipment shall be consistent and compatible with the existing type of circuit breakers fitted to the vehicle.

Terminals mounted external to ETCS equipment shall comply with T HR RS 01701 ST.

Relays mounted external to ETCS equipment shall comply with T HR RS 00117 ST and T HR RS 01701 ST.

Installation design and the installation shall ensure that the train remains compliant with its rolling stock outline in accordance with RSU 110 of T HR RS 00100 ST.

ETCS onboard equipment and any associated transmission systems shall be protected from unauthorised access using physical protection. The level of physical protection provided shall be based on the risk of and the risks due to unauthorised access. Physical protection may be

provided by an enclosed wiring system, as part of the construction of the cable or by use of a barrier requiring use of a tool or key with restricted distribution to restrict access.

10.2. Emergency brake interface

The emergency brake interface may control the emergency valves fitted to an existing vehicle.

The emergency brake valves (existing or additional) and relays required for ETCS shall be included in reliability, availability, maintainability and safety (RAMS) analysis.

10.3. Traction cut off interface

The traction cut off (TCO) control shall be arranged so that traction control is only restored after the driving control is set to a non-powering state. This may be achieved by interface circuits between the ETCS onboard equipment and the train.

Note: This sets consistent behaviour for driver response for each ETCS intervention of traction cut off, service brake command and emergency brake command.

10.4. Isolation switch

The ETCS onboard subsystem isolation switch arrangement shall be designed and installed so that it does not interfere with the operation of other driver safety systems or safety system override control.

The status of the isolation switch shall be recorded by the juridical recorder.

The ETCS onboard subsystem is a driver safety system in accordance with T HR RS 00840 ST *RSU Appendix D – Train (Driver) Safety Systems*. If the ETCS onboard subsystem has been isolated then an authorised procedure is applied. The 'authorised procedure' for proceeding when ETCS is isolated shall include the engineering control defined in T HR HF 00001 ST which requires any safety system overrides control to 'not be operable from the driving position'. This engineering control is separate to the ETCS onboard isolation switch.

10.5. Cabling

Onboard cabling for ETCS shall comply with the technical specifications' set by the ETCS equipment supplier.

The cabling design and installation shall be in accordance with EN 50343 *Railway applications – Rolling stock – Rules for installation of cabling*.

The cables shall comply with T MU RS 00164 ST *Cables for Passenger Rolling Stock* with the following exceptions:

- screened cables shall comply with equipment manufacturers' requirements as part of their original design
- communication cables shall comply with the ETCS equipment manufactures' requirements as part of their original design

Note: The requirements for screened cables and communication cables in T MU RS 00164 ST are only a preference for ETCS onboard subsystem installations.

11. Reliability, availability and maintainability

In accordance with section 4.2.1.2 of *European Union Commission Decision 2015/14*, though the requirement for availability and reliability is open, TfNSW has closed the requirement by satisfying the following:

- a. The theoretical mean time of hours of operation between failures of a CCS onboard subsystem requiring the isolation of the train protection functions shall be more than 35,000 operational hours. Failure of DMI functionality will result in the CCS onboard subsystem being isolated.
- b. The theoretical mean time of hours of operation between service affecting failures of a CCS onboard subsystem shall be more than 21,750 operational hours. A service affecting failure has an immediate effect or restriction on the operational use of the train.
- c. The theoretical mean time of hours of operation between failures of any CCS onboard equipment shall be more than 4350 operational hours.
- d. The CCS onboard subsystem shall function without degradation for a minimum of four hours with one redundant equipment item in a failed state. This is required so that the train can continue in operational service until the end of a peak period and then return to a maintenance depot with an operational ETCS onboard system.
- e. The operation from the power on of ETCS to completion of multiple missions totalling eight hours duration shall be able to be completed with any single odometer source failed. This is required so that the train can continue in operational service until the end of the day and then return to a maintenance depot with an operational ETCS onboard system.
- f. The CCS onboard subsystem shall be able to continue to be operated as usual while one of the redundant (for availability) equipment items has failed until corrective maintenance can be performed. 90% of redundant equipment item failures shall permit corrective maintenance to be delayed for up to five days. This will allow the train to continue in operational service until the end of the working week and then return to a maintenance depot with an operational ETCS onboard system for most equipment failures.

Note: The intention is to perform the corrective maintenance at the next scheduled opportunity for access to the onboard subsystem at an appropriate location.

Note: Item f. results in a mean time to restore redundancy (MTTRR) of 40 h of operating time based on 16 h days (item h.).

- g. The mean time to restore (MTTR) shall be less than 1.5 h for active corrective maintenance activities.
- h. The accepted method for theoretical reliability prediction is the application of IEC 61709 *Electric components – Reliability – Reference conditions for failure rates and stress models for conversion*. The defined mission profile is sixteen operating hours per day in a mix of 80% ETCS level 1, 20% ETCS level 2, power on and off cycle once per day in the IEC 61709 basic environment 'E3 portable and non-stationary use, ground vehicle installation'.
- i. The theoretical availability and reliability analysis shall be supported by in-service reliability information that provides at least a 50% confidence level that the theoretical values have been achieved. If the in-service reliability information is not sufficient to meet the required confidence level then the type approval reliability demonstration shall also include field tests, laboratory tests and accelerated tests to achieve an equivalent confidence level by reasonably practicable means.
- j. A reliability demonstration of each first of type ETCS train is required using 20 h error and warning free operation of the fitted rolling stock under ETCS supervision. This demonstration is required to confirm application and compatibility with the particular rolling stock type.
- k. Preventative maintenance, corrective maintenance and inspection or adjustment requirements shall be less often than once every 90 days assuming the defined mission profile.

Note: Cleaning of the DMI screen by the train driver is not considered to be preventative maintenance.

- l. Equipment shall include traceability information to support configuration, maintenance and investigation of hardware issues or software issues or both.

Note: These are the minimum requirements based on retro-fitting ETCS to an existing train. A non-redundant DMI and balise antenna configuration has been assumed.

12. DTRS interface

The digital train radio system (DTRS) implements the European Integrated Railway Radio Enhanced Network (EIRENE) for TfNSW.

The ETCS to DTRS interface and the functionality required by the *EIRENE Functional Requirements Specification* to support train number (also known as 'train running number') to be entered only once by the train driver for the ETCS and radio system shall be provided for ETCS Level 2 or higher implementations.

DTRS clarifications for *EIRENE System Requirements Specification* to support ETCS onboard implementation are as follows:

- R-GSM band is not used due to local spectrum availability and the application is not 'relevant to interoperability of the rail system within the European Community'
- DTRS uses the 1800 MHz band (DSC 1800) for GSM due to local spectrum availability

13. Rolling stock vehicle class data

The initial source of general vehicle class data is TS TOC.1 *Train Operating Conditions (TOC) Manual – General Instructions*.

Car length is the longest 'length coupled' for the particular vehicle class as defined in TS TOC.1. The train length is the sum of car lengths in metres rounded up to the next integer.

Maximum speed shall be as defined in TS TOC.1.

Train category is based on the vehicle's 'track speed signs' allocation as defined in TS TOC.1.

Detailed information shall be obtained from the rolling stock operator or owner.

The national values provided by the trackside subsystem are defined in T HR SC 10031 ST *Signalling Design Principle – ETCS Level 1* as referenced by T HR SC 00006 ST.

When setting the onboard deceleration values and correction factors for deceleration the following shall be considered:

- the reduced adhesion function is not being used
- the national values being used

Appendix A AEO engineering services matrix

NSW

GOVERNMENT

Transport

for NSW

TMU MD 00009 F1

AEO Engineering Services Matrix

Version 4.0

Issued date: 29 August 2017

Matrix use:

X

In the version published on the ASA website an 'X' in a cell indicates the organisation is capable of producing or delivering and self-assuring the selected services.

Where an 'X' appears in a cell in the 'Specialist engineering disciplines' area it relates to the asset lifecycle activity for the specialist engineering sub-discipline whereas 'X' in a cell in the 'Non-asset specific engineering services' area covers the whole asset lifecycle.

Refer to T MU MD 00009 SP for more details.

This asset lifecycle activity is not applicable for the selected specialist sub discipline

		TfNSW asset life cycle		Demand, need, plan							Acquire						Operate and maintain			Dispose			
Correct as at: Publication		AEO activities supporting TfNSW asset life cycle		Transport needs analysis, model or plan	Operations concept development	Maintenance concept development	Optimisation	BRS or user requirements	Single option development	SRS development	Concept or reference design	Design	Material procurement	Manufacturing or fabrication	Construction or installation	Subsystem integration	Testing and commissioning	Acceptance services	Plan asset maintenance	Maintain or upgrade assets	Conduct asset condition surveys	Plan decommissioning or disposal	Conduct decommissioning or disposal
ETCS Onboard subsystem engineering services matrix for acquire, operate and maintain phases																							

Specialist engineering disciplines

Rolling stock

Locomotives

Freight vehicles

Heavy commuter electric multiple units or diesel multiple units

Rail bound infrastructure maintenance vehicles

Rail road vehicles

Trolleys and trailers

Light rail vehicles

Other rail vehicles (shall be specified in notes)

Rolling stock subsystems (shall be specified in notes)

Signalling and control systems

Supervisory and control systems

Interlocking systems

Trackside systems (including cabling)

Communications

Cables and routes, optical fibre and other

Applications and systems – telephony (VOIP and analogue)

Applications and systems – passenger information systems

Applications and systems – alarm and CCTV surveillance

Applications and systems – condition monitoring and wayside telemetry

Networks wired - packet switched (IP, MPLS)

Networks wired - circuit switched (SDH, DWDM and other)

Networks wireless - packet switched (WiFi, WiMax, 4G, LTE and other)

Networks wireless - circuit switched radio systems

Telecommunications power systems and facilities

Network and application management systems (shall be specified in notes)

Track engineering

Wheel and rail interface

Geometry and alignment

Components and structures

Railway surveying

Civil and related engineering

Engineering surveying

Geotechnical

Combined services route

Tunnelling

Bridges and structures

Earthworks

Roads and pavements

Drainage and hydrology

Stations and buildings

Buildings architecture

Buildings structure (note specific areas of specialisation if appropriate in notes)

Buildings services (shall be specified in the notes)

Specialist buildings expertise (shall be specified in the notes)

Electrical engineering

High voltage aerial feeders

High voltage cables

Traction substation and sectioning huts

Distribution substations

High voltage protection systems

Low voltage power systems and low voltage protection

Earthing, bonding, electrolysis and lightning protection

Electrical control systems (SCADA) (shall be specified in the notes)

Overhead wiring

Electrical network planning and modelling

Non-asset specific engineering services

Provided as specialist services directly to TfNSW, or in relation to other service providers in the interest of or on behalf of TfNSW (select from definitions in T MU MD 00009 SP if required)

Service	Service
Asset management systems services (shall be specified in the notes)	Systems engineering and assurance (including systems and safety integration) services (shall be specified in the notes)
Engineering management services (shall be specified in the notes)	Other professional engineering services (shall be specified in the notes)

Notes: specify details of the selected activity for the discipline if required:

1

Onboard subsystem for ATP

2

Including ATP

3

4

5

6

7

8

9

Figure 1 – Example of AEO engineering services matrix