

Railway

Master Specification

RW-RAMS-D1 Reliability, Availability, Maintainability and Supportability

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RW-RAMS-D1 Reliability, Availability, Maintainability and Supportability

1 General

- 1.1 This Part defines the Requirements for the Reliability, Availability, Maintainability and Supportability (RAMS) for Railway Infrastructure.

Definitions

- 1.2 The following definitions apply to terms used in this Part:

Term	Definition
Accessibility	Easy access for visual and manipulative tasks. i.e., inspection, adjustment, repair, etc.
Availability	The ability of an item to be in a state to perform a required function under given conditions at a given instant of time or over a given time interval assuming that the required external resources are provided.
Diagnosability	Clear and visible method of fault detection, localisation and isolation. E.g. alarm, built-in and monitoring parameters for failure.
Maintainability	The ability to be retained in, or restored to, a state to perform as required, under given conditions of use and maintenance.
Maintenance, First Line	Activities to be performed by Rail Commissioner personnel on site, including cleaning, simple adjustment, checking, evaluation of maintenance data and repairing of the System limited in complexity to the replacement of line replaceable units.
Maintenance, Second Line	Activities to be executed by Rail Commissioner personnel within the workshops and depot environment on line replaceable units, which may require intrusive procedures in line replaceable units involving changing out sub-assemblies to effect repair, calibration or diagnostic.
Maintenance, Third Line	Activities executed by the equipment manufacturer either on site or at the depot or factory of the supplier, in renewal, refurbishment, reconstruction, recalibration of equipment used in the system, which may involve intrusive activities within line replaceable units for the purpose of component repair or deep diagnostic.
Modularisation	Line Replaceable Unit (LRU) repair or replacement.
RAMS	Reliability, Availability, Maintainability and Supportability.
RAMS Plan	Documented set of time scheduled activities, resources and events serving to implement the organisational structure, responsibilities, procedures, activities, capabilities and resources that together ensure that an item will satisfy given RAMS requirements relevant to a given contract or project.
Reliability	The ability to perform as required, without failure, for a given time interval under given conditions.
Special Tools and Test Equipment	Equipment, tools, systems or processes to be provided by the Contractor that are necessary or desirable for testing the System (or any part of it), and which are not commercially available in the Australia from more than three separate companies.
Standardisation	Interchangeability between components during replacement of faulty component, i.e. no rework to achieve fit and minimum number of adjustments needed to achieve proper functioning. Minimum spares variety.

References

- 1.3 The Contractor must comply with following Rail Commissioner's Standards:
- a) PTS-MS-05-AM-PRS-00000091 Asset Management Technical Data (AMTD) Requirements Specification.
 - b) CH92 Training Railways Operations and Maintenance.
- 1.4 The Contractor must comply with following Standards:

- a) EN 50126-1:2017 Railway Applications—Specification and demonstration of Reliability, Availability, Maintainability and Safety (RAMS) – Part 1: Generic RAMS process.
- 1.5 The Contractor must use the following Standards as guiding principles:
- a) AS ISO 55001:2014 Asset Management systems – Requirements.
 - b) AS IEC 60812:2008 Analysis techniques for system reliability - Procedure for failure mode and effects analysis (FMEA).
 - c) AS IEC 61025-2008 Fault tree analysis (FTA).
 - d) AS IEC 61078-2008 Analysis techniques for system reliability - Reliability block diagram and Boolean methods.
 - e) IEC 60300.3.14 Dependability management Part 3.14: Application guide – Maintenance and Maintenance Support.
 - f) IEC 62402 Obsolescence management.
- 1.6 Advice must be sought from the Principal's representative for any clarification or conflict regarding the standards listed in the above clause.

2 The Contractor's Obligations

- 2.1 The Contractor must:
- a) consider the requirements of RAMS (details in Clause 3) as part of the designed solution, including the following:
 - i) Lifecycle Cost;
 - ii) System Availability;
 - iii) Obsolescence Planning; and
 - iv) Maintainability and Maintenance Support.
 - b) establish a system and framework and continuously provide evidence, which meets the requirements of EN 50126-1 (excluding Safety for this Part) and Contract requirements, for the RAMS requirements of the Project. Details in Clause 4.

3 Design for Reliability, Availability, Maintainability and Supportability (RAMS)

- 3.1 The Contractor must:
- a) consider Lifecycle Cost by:
 - i) minimising the Principal's whole-of-life costs, taking into account equipment acquisition cost, disposal cost and operating and maintenance cost; and
 - ii) where practicable, utilising existing systems to minimise the number of spares and test equipment required over the network.
 - b) consider System Availability by:
 - i) minimising single-points-of-failure (SPoF) in systems and their operation;
 - ii) contributing to the joint development of Failure Mode, Effect and Criticality Analysis (FMECA), including identification of failure modes, addressing identified design alteration and reviewing any additional requirements for maintenance; and
 - iii) designing to meet the Reliability, Availability, Maintainability and Supportability (RAMS) requirements.
 - c) conduct Obsolescence Planning by:
 - i) considering obsolescence during the selection of equipment / components;

- ii) implementing and delivering obsolescence management plan (together with RAMS Plan) addressing processes and methodologies of dealing with equipment or spares becoming obsolete throughout Project lifecycle;
 - iii) ensuring minimum design life, as specified in the design requirements of various railway systems, are met;
 - iv) notifying the Principal in writing prior to any component of the System being upgraded or becoming obsolete from general availability;
 - v) providing functionally identical replacement units of any components that become unavailable for the design life of that component or system;
 - vi) ensuring minimum required support from the Original Equipment Manufacturer (OEM) by providing a written notice from the OEM on the availability of required components;
 - vii) advising the Principal of the pending unavailability of components or system within an agreed time frame (or in the absence of an agreed time frame, six months) for component or system, with an additional six months to allow the Principal to purchase additional stock if so desired; and
 - viii) ensuring that any components that have been upgraded or replaced must be fully backward compatible with the originally installed components.
- d) plan for Maintainability and Supportability by:
- i) preparing maintainability and maintenance support from the beginning of the design phase by considering trade-offs between functional needs, capability required, total life cycle cost, reliability and maintainability targets, safety and maintenance support requirements;
 - ii) where practicable, incorporating and display root cause alarms (as opposed to cascaded alarms) as part of systems design;
 - iii) minimising the requirements for special tools and test equipment for maintenance.
 - iv) clearly labelling all Line Replaceable Units (LRUs) and provide instructions on repair / replacement and tools / equipment required for the maintenance in the maintenance manual;
 - v) including keying pins or similar into the design for connectors and Line Replaceable Units(LRUs) to prevent potential wrong insertion or installation;
 - vi) taking into consideration for ease of maintenance during design especially the following:
 - modularity;
 - accessibility ;
 - ease of diagnosis; and
 - standardised support tools and equipment for repairs and replacement.
 - vii) providing clear and detailed information in the maintenance plan with, at minimum, the following:
 - types and amount of maintenance to be carried out by each line of maintenance. The Contractors must inform and obtain approval from discipline specific Principal for potential third line of maintenance or any requirements for new maintenance facilities before procuring any equipment; and
 - maintainer skills levels required for all maintenance task.
 - viii) providing operational and maintenance manuals for all equipment. The maintenance manual must consist of clear and detailed information in accordance with PTS-MS-05-AM-PRS-00000091 Asset Management Technical Data (AMTD) Requirements Specification [1.3a)] as well as the following:
 - tools / equipment / spare part / consumables required for the maintenance;
 - maintenance procedures;
 - maintenance tasks sequences;

- competencies required for the maintenance;
 - maintenance check lists;
 - safety instructions to be observed during maintenance;
 - disposal instructions;
 - maintenance frequencies;
 - tasks required to return the System to operation after maintenance;
 - impact on Operations during the period the LRU has failed and being repaired; and
 - troubleshooting and system restoration guide and method of determining that an LRU has failed or is faulty.
- ix) delivering clear and detailed information for all support tools / equipment in accordance with PTS-MS-05-AM-PRS-00000091 Asset Management Technical Data (AMTD) Requirements Specification [1.3a)]. In addition to the Special Tools / Test Equipment requirements listed in the AMTD, the following information must be provided to the Principal for every support tool / equipment:
- Operational and Maintenance Manual;
 - calibration frequency;
 - calibration type / method; and
 - certification requirement.
- x) providing both draft and final version of inspection, maintenance, and operations manual and procedures to the Principal in accordance with PTS-MS-05-AM-PRS-00000091 “Asset Management Technical Data (AMTD) Requirements Specification”; and
- xi) delivering training and training materials in accordance with CH92 “Training Railways Operations and Maintenance” and PTS-MS-05-AM-PRS-00000091 “Asset Management Technical Data (AMTD) Requirements Specification”.

4 Reliability, Availability, Maintainability and Supportability (RAMS) Assurance

4.1 The Contractor must:

- a) at minimum, ensure the following, as part of the overarching RAMS delivery:
- i) demonstrate compliance with RAMS requirements stated in this master specification, the Contract and EN50126-1, including the RAM programme outline guidance provided in EN50126-1 Annex A;
 - ii) conduct RAMS analysis for all systems, equipment and components that contribute to Rail Commissioner’s ability to meet the service requirements;
 - iii) apportion RAMS performance targets to railway system level. Railway systems include Overhead Wiring, Traction Power, Signalling and Communication, Communications and Electronics, and Track and Civil railway system. The contractor must also translate Rail Commissioner Operational Requirements into RAMS performance targets in cases where RAMS targets, provided in the contract, are insufficient to form complete RAMS model;
 - iv) implement and document the processes and methodology of achieving Reliability, Availability, Maintainability targets for all railway systems: Overhead Wiring, Traction Power, Signalling and Communication, Communications and Electronics, and Track and Civil railway system;
 - v) take into account all potential factors, as part of RAMS analysis, that might affect Services, including those which may be beyond the control of Rail Commissioner;
 - vi) develop and document RAM assurance process encompassing the entire Project lifecycle that is aligned with the Design, Engineering and Testing Plan(s) and is integrated with the requirements management processes;

- vii) deliver Reliability Block Diagram (RBD), a list of identified Reliability Critical Items (RCI) and single-points-of-failure (SPoF); and
 - viii) deliver and document model, formula, calculations and sources of all data used in RAMS analysis.
- b) conduct and deliver Functional Analysis and Failure Modes, Effects and Criticality Analysis (FMECA) as part of RAMS assurance. The following must be addressed as part of the FMECA delivery:
- i) analyse to the lowest subsystem level and if required to Line Replaceable Units (LRUs) level with the aim to identify critical items and failure modes that could result in loss of function;
 - ii) document all interface failure modes within FMECA worksheet and present in the form of an interface block diagram or matrix;
 - iii) ensure that the identified prevention controls that are used to drive design or process improvements through the FMECA addresses all high-risk failure modes with effective and executable action plans. A summary of all high-risk failure modes and actions plans must be appended in the RAM Assurance Report;
 - iv) provide proposed FMECA approach and FMECA worksheet template, including descriptors for all columns of the worksheet; failure likelihood parameters; consequence parameters; risk matrix and risk acceptability as part of deliverable. The contractor must also include all functions / systems / subsystems / components that will be analysed as part of the deliverable for RAM Plan;
 - v) continually update the FMECA worksheet with failure modes of functions / systems / subsystems / component and the resultant criticality and improvement required in the design or process, up to and including the testing and commissioning phases;
 - vi) ensure that a comprehensive FMECA is initiated from the beginning of the design and completed before finalising the design, in consultation with the relevant designers, in order to incorporate relevant design or process improvements;
 - vii) provide a list of reliability critical item (RCIs), single point of failure (SPoF), a list of prevention controls and updates reliability / design verification plan with identified failure modes as the output of FMECA process;
 - viii) prepare interim FMECA report at each design review to accompany proposed design alterations or additions to Built-in Test equipment as required of CAT I and CAT II failure modes and single point of failure (SPoF); and
 - ix) provide details on Local Effect, next Higher Effect (System Effect) and End Effect (Operational Effect) and not just the maintenance responses for each level of effect.
- c) deliver Maintainability Analysis, using, where practicable, manufacturer's data or actual field data;
- d) deliver Spares Analysis to meet the stipulated requirements in the Contract, including, but not limited to the following information:
- i) the recommended number of spares to hold per equipment type;
 - ii) criticality and rational of criticality of the recommended spares;
 - iii) price of spares;
 - iv) required storage condition;
 - v) prediction lead time;
 - vi) OEM and distributor details; and
 - vii) OEM part number and / or part number of purchase.
- e) implement and manage a Failure Review And Corrective Action System (FRACAS) during testing and commissioning phases and continuing into the delivery and operations phases. The FRACAS must:
- i) be integrated into the Rail Commissioner's Asset Information System (AIS);

- ii) include a best practice Root Cause Analysis (RCA) process;
 - iii) record all failures and problems related to a product or process;
 - iv) technical data of the system;
 - v) failure analysis;
 - vi) corrective actions;
 - vii) man-hours for maintenance action;
 - viii) number and skill level of personnel;
 - ix) spare parts / consumables / tool & equipment required; and
 - x) cost of spare parts and consumables.
- f) propose and append a FRACAS template to the RAM Plan. The FRACAS report must contain failures recorded, using the agreed FRACAS template, from testing phase till the end of warranty;
- g) Provision of FRACAS, FRACAS template and FRACAS report will constitute a **Hold Point**;
- h) propose plan and deliver Reliability Demonstration and Verification plan as part of Requirements Management Process and RAATM. The purpose of Reliability Demonstration and Verification plan is to demonstrate the system meets all requirements in the contract. The Reliability Demonstration and Verification must be scheduled together with Project System Test / Validation Phase. The verification of compliance from Reliability Demonstration and Verification must be attached in the RAMS Assurance Report; and
- i) develop, implement and submit RAMS Plan and RAMS Assurance Report according to the requirements stated this part and as requested by the Rail Commissioner on a progressive basis in order to demonstrate progressive RAM assurance;
- 4.2 The RAMS Plan must include, but is not limited to:
- a) the RAM assurance process used to demonstrate compliance with RAM requirements stated in this Part Clause 4, the contract and EN50126-1, including the RAM programme outline guidance provided in EN50126-1 Annex A;
 - b) the RAM assurance process used across the design lifecycle demonstrating compliance with the requirements stated in the Contract, and Clause 3 Design for RAMS which include delivery of Obsolescence management plan as detailed in Clause 3.1c)ii);
 - c) apportioned RAMS performance targets to railway system levels. Details in Clause 4.1a)iii);
 - d) proposed model, formula, calculations and sources of all data used in RAMS analysis. Details in Clause 4.1a)viii);
 - e) proposed FMECA approach and FMECA worksheet template. Details in Clause 4.1b);
 - f) Reliability Demonstration and Verification plan. Details in Clause 4.1h);
 - g) FRACAS template. Details in 4.1e) and 4.1f)4.1e); and
 - h) qualification, experience and authorities for each RAM management role.
- 4.3 Provision of RAMS Plan will constitute a **Hold Point**;
- 4.4 All RAMS Assurance Reports must include, but not be limited to:
- a) verification of compliance with all RAM requirements addressed in this Part, the contract and EN50126-1 as well as EN50126-1 Annex A; and
 - b) a softcopy of RAMS analysis in Excel spreadsheet with all underlying formulas and references.
- 4.5 Provision of RAMS Assurance Reports and RAMS analysis in Excel will constitute a **Hold Point**.

5 Hold Points

- 5.1 The following is a summary of Hold Points referenced in this Part:

Document Ref.	Hold Point	Response Time
4.3	RAMS Plan	10 Working days prior to Gate 4A
4.5	Interim RAMS Assurance Report and Analysis	10 Working days prior to Gate 4B
4.5	Final RAMS Assurance Report and Analysis	10 Working days prior to 100% design complete stage
4.1(h)	Reliability Demonstration and Verification Report (to be submitted together with the Final RAMS Assurance Report)	10 Working days prior to 100% design complete stage
4.1(f)	FRACAS Report	10 Working days prior to Handover phase