

Metrolinx Reliability, Availability and Maintainability Subsystem Requirements: Product Description

MX-SEA-PD-122

Revision 00

Date: December 2022

Reliability, Availability and Maintainability Subsystem Requirements: Product Description

MX-SEA-PD-122

Publication Date: April 2023

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Amendment Record

Revision	Date (DD/MM/YYYY)	Description of changes

Preface

This is the first edition of the Metrolinx Reliability, Availability and Maintainability (RAM) Subsystem Requirements Product Description (MX-SEA-PD-122). It forms part of a suite of guidance documents that describe the procedures to be followed to comply with Metrolinx's Reliability, Availability, Maintainability and Safety (RAMS) requirements.

The purpose of this document is to describe the document that collects all the RAM requirements and targets that the subsystems under RAM validation shall meet. Project proponents may need to produce this document when they are undertaking a technical change to the railway system or modifying a maintenance regime or undertaking an operational change to the railway system.

Suggestions for revision or improvements can be sent to the Metrolinx Systems Engineering Assurance office at Engineering.Assurance@metrolinx.com. The Director of the Systems Engineering Assurance office authorizes the changes. Include a description of the proposed change, background of the application and any other useful rationale or justification. Be sure to include your name, company affiliation (if applicable), e-mail address, and phone number.

April 2023

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Documents

Table 1 Supporting Documents

Document Number	Document Title	Relation
BS EN 50126-1:2017	Railway Applications - The Specification and Demonstration of Reliability, Availability, Maintainability and Safety (RAMS) (PHASE 1: Adoption of European Standard EN 50126-1:2017)	Parent Standard
MX-SEA-STD-100	RAMS Process Standard	Related Standard
MXSD-SSA-L1-STD-0001	Railway Risk Assessment Standard	Supporting Standard
ISO 9001:2015	Quality management systems – Requirements	Supporting Standard
MX-SEA-GDC-122	Reliability, Availability and Maintainability Subsystem Requirements Guidance	Guidance
MX-SEA-TPL-122	Reliability, Availability and Maintainability Subsystem Requirements Template	Template
MX-SEA-STD-007	Requirements Management	Supporting Standard
MX-SEA-TOR-001	Metrolinx System Review Panel (SRP) Terms of Reference (ToR)	Review Panel ToR
April 5, 2023	Metrolinx Safety Certification Committee (SSC) Terms of Reference (ToR)	Certification Committee ToR

Acronyms and Abbreviations

Table 2 Acronyms and Abbreviations

Abbreviation	Full Name
DRM	Design Requirements Manual
FMECA	Failure Modes Effects and Criticality Analysis
ISA	Independent Safety Assessor
MTBF	Mean Time Between Failures
MTTR	Mean Time To Recovery
RACI	Responsible, Accountable, Consulted and Informed
RAM	Reliability, Availability and Maintainability
RAMS	Reliability Availability Maintainability and Safety
SCC	Safety Certification Committee
SRP	System Review Panel

Definitions

Table 3 Definitions

Term	Definition	Source
Asset owner	Groups and individuals that are responsible for asset ownership, asset maintenance, inventory management, document control, asset handover and reliability engineering	MX-ALM-STD-001
Availability	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.	BS EN 50126:2017
Maintainability	Ability to be retained in, or restored to, a state to perform as required, under given conditions of use and maintenance.	BS EN 50126:2017
Project Company/Project Co.	The private sector entity which enters into the PA with Infrastructure Ontario and Lands Corporation and Metrolinx to design, build and where applicable, finance, operate or maintain a Project.	CKH-QMA-FRM-003
Project Manager	<p>Appointed by Metrolinx as its representative and is responsible for the delivery of the Project within the prescribed Schedule and budget.</p> <p>Metrolinx employees fulfilling the role of the Project Manager may also be considered the Cost Centre Manager, if this person is also delegated signing authority in accordance with the Metrolinx Corporate Administrative Manual, Administrative Management, Approval Authorization Controls and Designations.</p> <p>It is noted that non-Metrolinx employees fulfilling the role of the Project Manager are not considered Cost Centre Managers. In such cases refer to approved Project Chart of Accounts for the Program for the designated Cost Centre Manager.</p>	CKH-QMA-FRM-003
Reliability	Ability to perform as required, without failure, for a given time interval, under given conditions.	BS EN 50126:2017
Subsystem	Part of a system, which is itself a system	BS EN 50126:2017

System	Set of interrelated elements considered in a defined context as a whole and separated from their environment	BS EN 50126:2017
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1 Reliability, Availability and Maintainability Subsystem Requirements

1.1 Purpose

- 1.1.1 The goal of this deliverable is to establish an agreed upon set of detailed RAM requirements for a subsystem, including acceptance criteria and rationale.
- 1.1.2 Requirements are used to ensure that all design inputs (e.g. RAM requirements of the existing system, operating conditions, Project goals, codes & standards, Metrolinx DRM, analysis outcomes including risk analyses) are incorporated into the design. Effectively establishing and managing requirements allows for traceability through the project lifecycle to support design, testing (verification & validation), acceptance and reliable operation of the system.
- 1.1.3 Well defined requirements allows the Project Company (i.e. the Contractor) and Metrolinx to have a shared understanding of the system being developed. This reduces the likelihood of scope revisions, rework due to misunderstandings or missed requirements, and improves the ability for project leadership to plan and schedule work.
- 1.1.4 RAM Subsystem Requirements are the requirements for a subsystem, a portion of a larger system. Defining the subsystem requirements involves developing clear understanding of the system architecture so that interfaces can be defined and system level requirements can be decomposed and allocated to the subsystems that make up the larger system. The goal of this process is to manage the technical scope of work ensuring that when the subsystems are integrated, assembling the larger system, the higher-level system requirements are met.
- 1.1.5 The overall objective of the RAM Subsystem Requirements document is therefore to:
- a) describe the strategy used to define the system RAM targets, as required to achieve acceptance by Metrolinx
 - b) collect in one place all the subsystem RAM requirements and targets
 - c) define the RAM subsystem acceptance criteria
 - d) ensure that system level requirements are decomposed and allocated to the different subsystems

1.2 Applicability

- 1.2.1 This product is mandatory for all projects that undertake a technical change to the railway system (i.e., introduction of a new subsystem, renewal of an existing subsystem, a modification to an existing subsystem, or introduction of a new or modified maintenance regime) or undertakes an operational change to the railway system.
- 1.2.2 This product is not applicable for established routine maintenance activities including like-for-like replacement of components.

1.2.3 This product is considered good practice when developing or modifying any complex system.

1.3 Supporting Material

1.3.1 The RAM Subsystem Requirements template is located in MX-SEA-TPL-122.

1.3.2 Guidance on completing the RAM Subsystem Requirements is located in MX-SEA-GDC-122.

1.4 Products

1.4.1 The RAM Subsystem Requirements document is a product of the System Assurance process. Guidance on this process is available via MX-SEA-STD-100.

1.5 Key Responsibilities

1.5.1 The Project Company is responsible for the production of the RAM Subsystem Requirements document. Preparation of the RAM Subsystem Requirements document may be delegated; however, the Project Company is responsible for its content and quality.

1.5.2 The Project Company is the organization responsible for the contracted scope of work at the time of development

1.5.3 The System Review Panel (SRP) has delegated authority from the Safety Certification Committee (SCC) and is responsible for endorsing the RAM Subsystem Requirements Document. The System Review Panel ensures that the RAM Subsystem Requirements document is compliant with the project requirements, applicable legislation, and national, industry, and Metrolinx standards. The SRP may also identify uncertainties, issues, and assumptions that may arise as the project progresses that should be addressed.

1.5.4 The Project Management may be performed by Metrolinx or may be contracted. For example, in a Design/Build Contract, Metrolinx Project Management may choose not to develop the Safety Subsystem Requirements themselves, but instead ensure contract provisions for the Safety Subsystem Requirements are met by the Project Company.

1.5.5 Some of the Asset Owner obligations and responsibilities may be transferred through contracting, whereby the contract contains RAM and operating requirements. The Metrolinx Asset Owner would participate in endorsing the RAM Subsystem Requirements whereas a contracted party responsible for RAM would develop the RAM Subsystem Requirements as directed by the Project Management.

1.5.6 The full Responsible, Accountable, Consulted, and Informed (RACI) information that sets out the interaction between all stakeholders involved in the production and endorsement of the RAM Subsystem Requirement document is available in MX-SEA-STD-100.

1.6 Competence

1.6.1 All personnel responsible for the delivery of the RAM Subsystem Requirements shall possess the necessary competence to deliver the works. This shall be competency in RAM management, requirements management and a technical understanding of the project.

1.7 Structure

1.7.1 The structure of the RAM Subsystem Requirements is described in the RAM Subsystem Requirements Guidance document located in MX-SEA-GDC-122 .

1.7.2 The document requires the following section titles:

- a) Introduction;
- b) Subsystem Description;
- c) Inputs to Design;
- d) Subsystem RAM Requirements;

1.8 Contents

1.8.1 The structure of the RAM Subsystem Requirements is described in the RAM Subsystem Requirements Guidance document located in MX-SEA-GDC-122.

1.8.2 As a minimum, it shall contain the following:

- a) a description of the subsystem being designed including its functions and interfaces within the whole system, or reference to the System Definition or equivalent document
- b) a detailed description of the sub-system that is the focus of the RAM subsystem requirements document, including interfaces
- c) A list of the Inputs to Design used to develop the requirements including defined environmental, maintenance and operation conditions, standards, project documents, manuals, operating experience etc.
- d) The RAM Subsystem Requirements

1.8.3 The RAM Subsystem Requirements shall:

- a) have a unique identifier for each requirement.
- b) include System Requirements for the current unmodified system and subsystem that must be maintained.
- c) include existing Requirements for the current unmodified system and subsystem that will be revised due to the modification to the railway included in the project scope.
- d) demonstrate traceability to Inputs to Design and higher-level system requirements. (e.g. Operations and Maintenance manuals and procedures, Risk Analyses, System Definition, Project Goals, RAM Analysis, FMECA etc.)
- e) clearly state any assumptions used to develop the requirement, and the corresponding project risk if applicable.
- f) have acceptance criterion, and tolerances where applicable for each requirement.
- g) have a rationale that states its intent, justifies its inclusion, any assumptions and the methods used to determine acceptance criteria for each requirement.

- h) be written to conform to best practices. (clear, accurate, complete, singular, achievable, unambiguous, free of grammatical/spelling errors, able to be verified/validated, free of implementation specifics, free of contradictions... etc.)

1.9 Quality Criteria

- 1.9.1 The specifications in the RAM Subsystem Requirements shall provide clear RAM targets for the project activities. It shall set a clear plan for all actors responsible for RAM activities.
- 1.9.2 The quality management system used shall conform to ISO 9001:2015 rules or equivalent rules accepted by the Metrolinx Project Delivery Team and be appropriate for the system under consideration.

1.10 Document Management

- 1.10.1 The RAM Subsystem Requirements shall be produced at Phase 5 (Apportionment) following the RAM Requirements Specification developed at Phase 4 (System Requirements).
- 1.10.2 The RAM requirements will be managed as per MX-SEA-STD-007.
- 1.10.3 Once requirements are accepted at the Single Design Solution Review Gate, they must be version controlled and are subject to review as per the Contract Agreement.
- 1.10.4 Table 4 provides an overview of the RAM Subsystem Requirements document phases.

Document	Phase
RAM Subsystem Requirements	5 - Apportionment

TABLE 4: DOCUMENT PHASES