METROLINX

Metrolinx
Reliability, Availability and Maintainability Analysis Process: Product Description

MX-SEA-PD-117

Revision 00

Date: April 2023

Reliability, Availability and Maintainability Analysis Process: Product Description

MX-SEA-PD-117

Publication Date: April 2023

Amendment Record

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

Preface

This is the first edition of the Metrolinx Reliability, Availability and Maintainability (RAM) Analysis Process Product Description (MX-SEA-PD-117). 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 organization and activities in place to demonstrate whether or not the RAM targets and requirements for a system have been met. Project proponents may need to apply the process 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

Contents

Documents ..... **iv**

Acronyms and Abbreviations ..... **v**

Definitions ..... **vi**

1 Reliability, Availability and Maintainability Analysis Process **1**

1.1 Purpose 1
1.2 Applicability 1
1.3 Supporting Material 1
1.4 Products 2
1.5 Key Responsibilities 2
1.6 Competence 2
1.7 Structure 2
1.8 Contents 3
1.9 Quality Criteria 3
1.10 Document Management 3

Tables

Table 1 Supporting Documents iv

Table 2 Acronyms and Abbreviations v

Table 3 Definitions vi

Table 4: Document Phases 4

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
MX-SEA-PD-119	Reliability, Availability and Maintainability Plan Product Description	Related Standard
MX-SEA-GDC-119	Reliability, Availability and Maintainability Plan Guidance	Guidance
MX-SEA-TPL-119	Reliability, Availability and Maintainability Plan Template	Template
MX-SEA-PD-120	RAM Analysis Report PD	Related Standard
MXSD-SSA-L1-STD-0001	Railway Risk Assessment Standard	Standard
ISO 9001:2015	Quality management systems – Requirements	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
AIP	Approval In Principle
CMREA	Canadian Method for Risk Evaluation and Assessment for Railway Systems
FRACAS	Failure Reporting Analysis and Corrective Action System
HF	Human Factors
HMI	Human Machine Interface
ISA	Independent Safety Assessor
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
ToR	Terms of Reference

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	The private sector entity which enters into the Project Agreement with Infrastructure Ontario and Lands Corporation and Metrolinx to design, build and where applicable, finance, operate or maintain a Project. The special-purpose entity which has entered into a Project Agreement with the Contracting Authority.	CKH-QMA-FRM-003
Project Manager	Appointed by Metrolinx as its representative and is responsible for the delivery of the Project within the prescribed Schedule and budget. 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. 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.	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

1 Reliability, Availability and Maintainability Analysis Process

1.1 Purpose

1.1.1 The Reliability, Availability and Maintainability (RAM) Analysis Process describes the organization and activities in place to demonstrate whether the RAM targets and requirements for the system under analysis have been achieved/implemented.

1.1.2 Its overall objective is therefore to:

a) describe the RAM organization and its roles and responsibilities;

b) describe the RAM tasks to be completed for each Phase of the system lifecycle;

c) define and justify the techniques and tools used;

d) define the RAM acceptance criteria;

e) define the RAM deliverables; and

f) define the criteria to set-up an effective Failure Reporting, Analysis, and Corrective Action System (FRACAS).

1.1.3 The RAM Analysis Process is included in the RAM Plan (MX-SEA-PD-119).

1.1.4 The outcome of performing the RAM Analysis is documented in the RAM Analysis Report (MX-SEA-PD-120).

1.2 Applicability

1.2.1 This product is mandatory for any project that undertakes 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.

1.1.1 This product is not applicable for established routine maintenance activities including like-for-like replacement of components.

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

1.3 Supporting Material

1.3.1 The RAM Analysis Process shall be documented in the RAM Plan template MX-SEA-TPL-119.

1.3.2 Guidance on completing the RAM Plan (including the RAM Analysis Process) is located in MX-SEA-GDC-119.

1.4 Products

1.4.1 The RAM Analysis Process is included in the RAM Plan which 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 Analysis Process, documented in the RAM Plan. Preparation of the RAM Analysis Process 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 Analysis Process, documented in the RAM Plan. The System Review Panel ensures that the RAM Analysis Process 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, whereby Metrolinx Project Management would ensure contract provisions for RAM Analysis Process are met and would not develop the Process.

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 Analysis Process whereas a contracted party responsible for RAM would develop the RAM Analysis Process 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 Analysis Process is available in MX-SEA-STD-100.

1.6 Competence

1.6.1 The RAM Analysis Process shall be drafted by a person/persons with competence in RAM analysis techniques and have an overview understanding of the technical, operational and maintenance aspects of the system to be analysed.

1.7 Structure

1.7.1 The RAM Analysis Process forms part of the RAM Plan and is described in the RAM Plan Guidance document located in MX-SEA-GDC-119.

1.7.2 The required document section titles for the RAM Plan are provided in MX-SEA-PD-119.

1.8 Contents

1.8.1 The contents of the RAM Analysis Process are described in the RAM Plan Guidance located in MX-SEA-GDC-119.

1.8.2 As a minimum, it shall contain:

a) details on roles and responsibilities;

b) the RAM acceptance criteria;

c) a description and justification of the techniques and tools to be used, including;

1) reliability analysis and prediction;

2) reliability planning;

3) reliability testing;

4) reliability data acquisition and assessment;

5) availability analysis;

6) sensitivity analysis;

7) availability data acquisition and assessment;

8) maintainability analysis and prediction;

9) maintainability planning;

10) logistic support evaluation; and

d) the criteria to set-up an effective FRACAS.

1.9 Quality Criteria

1.9.1 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.

1.9.2 The RAM Analysis Process shall present a credible approach to RAM analysis that is of appropriate scale and depth for the project. All RAM activities shall be effectively carried out as mandated by EN 50126 in co-operation with other project activities.

1.10 Document Management

1.10.1 The RAM Analysis Process is investigated in Phase 1 (Concept) and continually investigated through Phase 5 (Apportionment) to define the RAM requirements. The outcome of investigating the RAM analysis is documented in the RAM Plan.

1.10.2 The RAM Analysis is performed in Phase 6 (Design) to validate the system to confirm that the RAM requirements have been met. The outcome of performing the RAM Analysis is documented in the RAM Analysis Report.

1.10.3 Later phases may also involve more detailed RAM analysis to address specific issues or confirm that the design continues to meet the requirements.

1.10.4 Table 4 provides an overview of the RAM Analysis Process document phases.

Document	Phase
Within RAM Plan - RAM Analysis Investigation	1 - Concept – 5 - Apportionment
RAM Analysis Report - RAM Analysis Process Performance	6 - Design

TABLE 4: DOCUMENT PHASES