Rail Baltica

RBDG-MAN-032-0101

Design guidelines

RAMS Targets

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1. Standards and specifications

Following standards and specifications shall be applied to RAMS:

- European Standards (EN for European Norms);
- European Committee for Electrotechnical Standardization (CENELEC);
- International ISO standards.

EN 50126:2017	Railway Applications - The Specification and Demonstration of Reliability, Availability, Maintainability and Safety (RAMS)
EN 50126-1:2017	Railway Applications - The Specification and Demonstration of Reliability, Availability, Maintainability and Safety (RAMS) - Part 1: Basic Requirements and Generic Process
EN 50126-2:2017	Railway Applications - The Specification and Demonstration of Reliability, Availability, Maintainability and Safety (RAMS) - Part 1: System approach to safety
EN 50128:2011	Railway applications – Communications, Signalling and Processing Systems - Software for railway control and protection systems.
EN 50128:2011	Railway Applications - Communication, Signalling and Processing Systems - Software for Railway Control And Protection Systems
EN 50129:2003	Railway Applications - Communication, Signalling and Processing Systems - Safety Related Electronic Systems for Signalling
CLC/TS 50562:2018	Railway applications – Fixed installations – Process, measures and demonstration of safety for electric traction systems.
EN 50159:2010	Railway applications - Communication, signalling and processing systems - Safety-related communication in transmission systems.
EN 61508-1:2010	Functional Safety of Electrical/Electronic/Programmable Electronic Safety-Related Systems - Part 1: General Requirements
EN 61508-2:2010	Functional Safety of Electrical/Electronic/Programmable Electronic Safety-Related Systems - Part 2: Requirements for Electrical/Electronic/Programmable Electronic Safety-Related Systems
EN 61508-3:2010	Functional Safety of Electrical/Electronic/Programmable Electronic Safety-Related Systems - Part 3: Software Requirements
EN 61508-4:2010	Functional Safety of Electrical/Electronic/Programmable Electronic Safety-Related Systems - Part 4: Definitions and Abbreviations
EN 61508-5:2010	Functional Safety of Electrical/Electronic/Programmable Electronic Safety-Related Systems - Part 5: Examples of Methods For The Determination Of Safety Integrity Levels
EN 61508-6:2010	Functional Safety of Electrical/Electronic/Programmable Electronic Safety-Related Systems - Part 6: Guidelines on The Application Of IEC 61508-2 And IEC 61508-3
EN 61508-7:2010	Functional Safety of Electrical/Electronic/Programmable Electronic Safety-Related Systems - Part 7: Overview of Techniques And Measures

EN 61703:2016	Mathematical expressions for reliability, availability, maintainability and maintenance support terms.
NFPA 130: 2014	Standard for Fixed Guideway Transit and Passenger Rail Systems.
NFPA 101:2015	Life Safety Code.
ISO 9000:2005	Quality management systems – Fundamentals and vocabulary.
ISO 9001:2008	Quality management systems – Requirements.
ISO/IEC 90003:2004	Software engineering - Guidelines for the application of ISO 9001:2000 to computer software.
ISO/IEC 60300	Dependability management

2. Introduction

This document defines the RAMS Design Criteria for the Rail Baltica railway.

One of its objectives is to meet the following RAMS high level requirements:

- The Design Guidelines shall determine Reliability Availability Maintainability and Safety targets (RAMS) which must be achieved by the operating Rail Baltica railway;
- The Rail Baltica railway transport system shall be safe, secure, efficient, cost effective, robust, reliable, durable and comfortable in all aspects, capable of delivering high standards of service quality within the forecasted levels of capacity and employ modern technology with proven performance characteristics;
- Performance and reliability shall be delivered at levels comparable to other leading international railway infrastructure.

In order to ensure that the design and delivery of the Rail Baltica railway transport system complies with the RAMS high level requirements; Design Guidelines shall give guidance to the designer teams on how to consider the system dependability. The future Contractors will then be responsible for the RAMS characteristics of their own systems and are also responsible for the RAMS characteristics of their systems interfaces.

3. Safety design criteria

3.1. Safety methodology

The scope of safety as considered in this document is System Safety meaning that items such as security (vandalism, aggression, terrorism, etc.), occupational safety (staff safety during works), and operational safety (staff safety during O&M) are not addressed here.

The Safety process for the Rail Baltica railway project shall be performed in compliance with the international RAMS Standards EN 50126:2017, EN 50129:2003 and EN 50128:2011. All other Standards listed in chapter 1 shall apply as relevant.

This safety process is based on the Development V-cycle shown in Appendix 1. It unfolds as follows:

- The Rail Baltica project, in compliance with the international RAMS Standards shall develop a Design Preliminary Hazard Analysis based on its Preliminary Design identifying both Hazards and the corresponding Safety Requirements.
- These Safety Requirements shall be passed to the Detailed Technical Design Contractors during the Master Design development phase.
- These Safety Requirements shall be taken into account by the Contractors during the development of their Detailed Technical Design.
- The Hazards and the corresponding Safety Requirements shall be followed-up throughout the systems' lifecycles until their closures using a Design Hazard Log.

Software safety functions within systems and subsystems must be implemented using the architecture, methods, tools and technique defined in Standard IEC 62279/EN 50128.

EMC/EMI, Fire & Life Safety and Ergonomics are specific fields of expertise and the outputs of these studies shall be taken as inputs to the RAMS studies addressed herein.

3.2. Safety targets

The safety targets shall be defined in this document at a further stage for the whole system when the relevant studies are completed.

Then each system safety targets are to be set by the Contractors in compliance with these safety targets. These targets can be either qualitative or quantitative.

Safety targets apply for all railway systems safety related. In particular, signalling systems shall be designed with Safety Integrity Level 4 (SIL4).

No target shall be set for Civil Works. The risk contribution from Civil Works is considered to be negligible on the assumption that the design and construction of Civil Works is in accordance with industry practice and international standards.

4. RAM Design criteria

4.1. RAM Methodology

The RAM process for the Project shall be performed in compliance with the international RAMS Standards EN 50126:2017, EN 50129:2003 and EN 50128:2011. All other Standards listed in Chapter 1 shall apply as relevant.

This RAM process is based on the Development V-cycle. It unfolds as follows:

- The Rail Baltica project, in compliance with the international RAMS Standards shall develop a RAM Verification Report based on its Preliminary Design ensuring that the apportionment of RAM targets on various systems meet the overall RAM targets.
- These systems RAM targets shall be passed to the Detailed Technical Design Contractors during the Master Design development phase.
- These systems RAM targets shall be taken into account by the Contractors during the development of their Detailed Technical Design.
- The systems RAM targets and the corresponding overall RAM targets shall be followed-up during the O&M phase using a RAM Demonstration Report.

4.2. RAM targets

The RAM targets shall be defined for the whole Rail Baltica transport system, which include operation and maintenance of infrastructure and rolling stock.

4.2.1. Rail Baltica transport system

The RAM targets shall be defined for the whole Rail Baltica transport system, which include operation and maintenance of infrastructure and rolling stock.

The Rail Baltica railway transport system design shall permit stable operations for each service that meet the capacity and performance requirements at levels comparable to other leading international railway infrastructure, but with a transport system availability level not less than 99.8%.

The targets must be understood as applicable criteria at the end of the guarantee periods of the different sub-system, when target are reached and stabilised for every system. Demosmtration of RAM targets shall be effective on a one year rolling period.

4.2.2. Rail Baltica infrastructure

4.2.2.1. *Operation Control Centre equipment*

Component (including hardware and software)	**Availability Target**	**Target MTBF**
Visual Control Panel	≥ 99.99 %	≥ 100,000 hours
Server (without redundancy)	≥ 99.50 %	≥ 50,000 hours
Remote Terminal Unit (without redundancy)	≥ 99.50 %	≥ 50,000 hours
Workstation	≥ 99.00 %	≥ 40,000 hours
Printer	≥ 99.00 %	≥ 30,000 hours

1. OCC AVAILABILITY & RELIABILITY TARGETS

4.2.2.2. *Signalling*

Availability of the on-board ERTMS systems shall be at least 99.95% per system, per train.

Availability of the line side signalling, interlocking, train detection system etc. at any point on the line shall be at least 99.98%.

Any electronic equipment part of the signalling system shall have a MTBF higher than 100,000 hours.

The MTTR for the signalling equipment shall be less than 1 hour

4.2.2.3. *Non-traction Power Supply*

The architecture shall comply with no disturbance with an "n-1" order which means any single failure shall not impact train operation. The required availability shall be at least 99.999%.

The MTTR of non traction power supply systems shall be less than 2 hours.

4.2.2.4. *Traction Power Supply*

The architecture shall comply with no disturbance with an "n-1" order which means any single failure shall not impact train operation. The required availability shall be at least 99.995%.

The Availability targets for the power supply system are defined at several levels:

- Availability of each High Voltage connection shall be at least 99.9999%.
- Availability of each Traction Power Sub-Station, Switching Post, Paralelling Post shall be at least 99.9999%.
- Availability of Overhead contact line system shall be at least 99.999%.
- Availability of the low voltage power supply for control systems of traction power supply system shall be at least 99.999%.

The MTTR of traction power supply systems shall be less than 2 hours.

4.2.2.5. *Multi-Service Network*

The system architecture shall be designed in such a way a single failure of any component causes no consequence on the transmission service.

The overall availability of the Multi-Service Network (for end to end users) shall be at least 99.999%.

MSN shall have at least a 99.99% availability for services provided to Safety-critical functions which roughly means a 1h maximum unavailability per year.

4.2.2.6. *Passenger Information System*

The availability of the Passenger Information System shall be at least 99.98%.

4.2.2.7. *Public Address System*

The availability of the Public Address System shall be at least 99.98%.

4.2.2.8. *Access Control System*

The availability of the Access Control System shall be at least 99.95%.

4.2.2.9. *Clock System*

The availability of the Clock System shall be at least 99.99%.

4.2.2.10. *Telephony System*

The availability of the Telephony System shall be at least 99.99%.

4.2.2.11. *Radio Communication System*

The availability of the Radio Communication System shall be at least 99.99%.

4.2.2.12. *Closed Circuit Television System*

The availability of the Closed Circuit Television System shall be at least 99.99%.

4.2.2.13. *Automatic Fare Collection*

The overall availability of the Automatic Fare Collection system shall be at least 99.5%.

4.2.2.14. *Maintenance vehicles*

Diesel locomotive	
Reliability	No more than one failure per year
Availability	97.5% after breakdowns and maintenance
Maintainability	90 % of all failures of an equipment shall be repaired in a maximum time of one day (MTTR ≤ 24 hours)
Road-rail Vehicles	
Reliability	No more than two failures per year
Availability	95% after breakdowns and maintenance
Maintainability	90 % of all failures of an equipment shall be repaired in a maximum time of one day (MTTR ≤ 24 hours)

2. BACK-UP VEHICLES RAM TARGETS

4.2.2.15. *Track*

The overall availability of the track system the shall be at least 99.9%.

Any track equipment shall have a MTBF of at least 300,000h and a MTTR less than 1h without including its transport time on site.

4.2.2.16. *Escalators and elevators*

Availability of the escalators (one equipment) shall be at least 98%.

Availability of the elevators (one equipment) shall be at least 98%.

4.2.2.17. *HVAC*

Availability of the Air Conditioning System shall be at least 99% in stations platform public area.

4.2.2.18. *Electrical distribution*

A single failure of the lighting shall not lead to the total loss of light in any public area.

The availability of the lighting system in each station shall be greater than 99.9%.

The MTTR of the lighting system shall be less than one hour.

4.2.2.19. *Fire Protection*

Availability of the Fire Detection System shall be at least 99.95% per unit. A unit includes the local fire alarm panel with all its services.

The MTBF of the Fire Fighting Pumps shall be at least 10,000 hours.

Smoke Management System:

Equipment	Maintainability MTTR (hours)	Reliability MTBF (hours)	Availability
Axial fan	2	82,000	99.99%
Jet fan	2	82,000	99.99%
Fan motor bearings	Minor failure: 8 Major failure: 48	100,000	99.99% 99.95%
Damper (fire damper, balance damper, shutoff damper)	6	18,000	99.96%

3. SMOKE MANAGEMENT SYSTEM RAM TARGETS

4.2.2.20. *Tunnel Ventilation System and Dewatering*

The following targets are set:

Item	Reliability	Maintainability	Availability
Ventilation equipment	MTBF > 5,000 hours	MTTR < 2 hours	99.96 %
Dewatering pumps	MTBF > 15,000 hours	MTTR < 2 hours	99.98 %

4. TUNNEL VENTILATION AND DEWATERING RAM TARGETS

4.2.3. Rail Baltica rolling stock

4.2.3.1. *Rolling stock*

Availability of Rolling Stock shall be defined in order to reach global Rail Baltica railway transport system. Therefore, requirements shall be passed to the Railway Undertakings as a necessary condition to access the infrastructure.

Availability is related to the trains in service at peak hours, and not to the whole fleet. Availability target for trains in service at peak hours train shall be at least 99.95%.

The reliability targets for one train are set in terms of Mean Kilometres Between Failures (MKBF) as follows:

Delay on operation	Target MKBF
0 to 5 min delay	≥ 20,000km
5 to 30 min delay	≥ 100,000km
More than 30 min delay	≥ 500,000km

Train rescue	≥ 300,0000km

5. ROLLING STOCK RELIABILITY TARGETS

4.2.3.2. *Rolling stock maintenance depot equipment*

Availability of depot equipment shall be defined in order to reach global Rail Baltica railway transport system. Therefore, requirements shall be passed to the entity responsible for train maintenance as a necessary condition to allow the train mainatoned in the depots to access the infrastructure.

The availability of the rolling stock maintenance depot equipments shall be greater than 98%.

The MTTR of the rolling stock maintenance depot equipments shall be less than one hour.