TB50165

[Rev.00]

NATIONAL CoCo LOCOMOTIVE
RAMS TARGETS ALLOCATION

Issued Date:	04/09/2025
Revision Date:	

Turkish Railway Vehicles Industry Inc.

Revision History

Rev. No	Revision Info	Date
00	First issue	04/09/2025

INDEX

I. LIST OF TABLES

ACRONYMS & ABBREVIATIONS

EN	European Norm
FMECA	Failure Mode and Effects Critical Analysis
IEC	International Electrotechnical Commission
LCC	Life Cycle Cost
LRU	Line Replaceable Unit
MTBF	Mean Time Between Failure
MTSBF	Mean Time Between Service Failure
NoBo	Notified Body
PRM	Persons with Reduced Mobility
RAMS	Reliability, Availability, Maintainability, Safety
SIL	Safety Integrity Levels
TSI	Technical Specification for Interoperability

1 INTRODUCTION

1.1 SUBJECT

The aim of this document is to define the targets of the reliability values of the Loco sub-assemblies.

In particular, the following target values will be defined:

- Inherent reliability values of the major sub-assemblies
- Mission reliability values of main sub-assemblies

1.2 DOCUMENTS AND STANDARDS

Reference	Standard number	Description
[1]	EN 50126:2017	Railway applications. The specification and demonstration of Reliability, Availability, Maintainability and Safety (RAMS)
[2]	IEC 61508:2010	Functional safety of electrical/electronic/programmable electronic safety-related systems
[3]	EN 50128:2011	Railway applications – Software for railway control and protection system
[4]	EN 50129:2018	Railway applications. Communication, signalling and processing systems. Safety related electronic systems for signalling

1.3 ASSOCIATED DOCUMENTS

Reference	Document number	Description
[5]	TB50162	NATIONAL LOCO CoCo TYPE: RAMS guidelines
[5]	TB50170	NATIONAL LOCO CoCo TYPE: SIL Definitions

2 LOCO MAIN DATA

The National Co-Co Type Mainline Locomotive project, which will be produced by TÜRASAŞ, is intended for freight service and has an operating speed of 120 km/h.

The loco has 2 different propulsion systems:

1. Electric Locomotive
2. Diesel Electric Locomotive

3 LOCO MISSION PROFILE

The locomotive's mission profile is the following:

- Km per year: 300,000
- Operational life: 30 years
- Max speed: 120 km/h
- Medium operating speed: 55 km/h
- Annual operating days 300
- Hours Day: 18

4 RELIABILITY

Locomotives will be designed and constructed in such a way to be safe for the operating personnel and the people around them, even under normal operating conditions and in the event of a failure.
All systems will be taken into account individually and as integrated in terms of safety.
The RAMS performance of the vehicle and its subsystems/equipment will begin from the design, manufacturing, testing and servicing phases and will be carried out throughout its entire life. RAMS performance of the vehicle and its equipment will be in accordance with EN 50126-1, CLC/TR 50126-2 and CLC/TR 50126-3. Where necessary, the requirements specified in the IEC 61508 and EN 50129 standards will be acted upon.
Each supplier will present safety documents for their products, in compliance with paragraph 4.7, and the principles affecting the safety to the Administration at the first locomotive delivery in accordance with EN 50126.

4.1 RELIABILITY TARGETS FOR MAIN SUB-ASSEMBLIES

Inherent Reliability

Inherent Reliability is linked to the likelihood of any failure occurring and describes the basic reliability values of each sub-system.
It is evidently a parameter linked to the overall quality of the product and to the number of repairs that it will require during its working life, but it is of little significance precisely because it is not very selective.
It can help to give an approximate idea of the repair costs and the unavailability of the vehicle for downtime, although it is not an accurate measure of these factors.

Service Reliability

Service (or Mission) Reliability is linked to the probability that a fault will occur with heavy consequences on an important functionality of the vehicle. Unlike inherent reliability, it is very significant because it describes the ability of the rolling stock to carry out its main mission and is therefore linked to "service disruption", just as perceived by users.
For this reason, the Service Reliability (together with the Availability) is a parameter directly related to the ability of the rolling stock to create profit for the Buyer or the Train Operator.

Failures classification:

The failure class definitions are as follows:

Class A Failures: The locomotive cannot move; the locomotive must be towed with another locomotive.

Class B Failures: These are the failures that require stopping at the first station, but where the vehicle can go to the parking area with its own power.

Class C Failures: Specific failures seen by the customer as an obstacle to service [causing a delay of more than 10 minutes at the destination (last station)] The delay will be calculated only once for each delay at the last station, not for each intermediate stop.

Class D Failures: It will be defined as the failures in which the locomotive can continue service until the end of the day.

The conditions which affect the train service and to be included in reliability calculation are listed in table 4.1:

In this context, for some failures, the classification in the table below will be taken as a basis. The detailed table will be submitted to the Administration for approval at the delivery stage of the first locomotive. Failures that occur during the Warranty Period, but whose system, failure mode and class are not clear despite the table below, will be classified by the Contractor and Administration personnel at the latest one week after the failure is detected.

TABLE - FAILURE CLASSIFICATION

No	Subsystem/Equipment	Failure Mode	A	B	C	D
1	AUXILIARY POWER SYSTEM	Auxiliary power system disabled	X			
		Loss of more than 50% of auxiliary power supply		X		
		Loss of 50% of auxiliary power supply			X	
		Loss of 25% of auxiliary power supply				X
		Other auxiliary power system failures				X
2	BOGIE	Wheelset mechanically blocked	X	X	X	X
		Bogie instability			X	
		Wheelset bearing temperature requiring speed limitation above alarm level			X	
		Unable to provide line guidance		X		
3	TRACTION SYSTEM	A traction motor and/or convertor and/or inverter is disabled				X
		2 traction motors and/or convertors and/or inverters are disabled			X	
		Complete loss of traction capability	X			
		Other Traction System failures				X
		Blocked gear unit	X			
		Minor leak in gear unit				X

TABLE - FAILURE CLASSIFICATION						
No	**Subsystem/Equipment**	**Failure Mode**	**A**	**B**	**C**	**D**
4	BRAKE SYSTEM	Complete loss of braking capability	X			
		Loss of braking capability leading to a C failure, which will be determined during the project phase			X	
		Sudden emergency braking			X	
		Loss of wheel slip protection			X	
		The brakes cannot be released manually or the parking/holding brake does not engage		X		
		A brake unit failure, failures requiring brake isolation or bypass, or electrical braking system failures			X	
		Flat wheel			X	X
		Other brake system failures				X
5	HVAC SYSTEM (DRIVER'S CAB)	Loss of cabin ventilation function			X	
		No heating or cooling			X	
		Other HVAC failures				X
6	CCTV	It is not possible to monitor the interior and exterior of the vehicle from the control center.			X	
		Other system failures				X
		The recording device does not work / does not record.			X	
7	PANTOGRAPH	A pantograph does not rise or lower				X
		Both pantographs do not rise or lower	X			
		Other pantograph failures				X
8	EXTERIOR LIGHTING	All or half of the lighting is not lit		X	X	
		One or two lights not working				X
		Locomotive headlights do not work.		X	X	
9	TCMS (Train Control and Monitoring System)	Miscellaneous failures	X	X	X	X
10	FIRE DETECTION SYSTEM	While there is no fire or smoke, it receives false fire notification in normal operation.		X		
		Other Fire Detection System failures				X
11	ERTMS/ETCS	Interface problems / failures related to the ETCS System		X		

TABLE - FAILURE CLASSIFICATION						
No	**Subsystem/Equipment**	**Failure Mode**	**A**	**B**	**C**	**D**
12	WINSHIELD WIPER	Windshield wiper not working				X
		The windshield wiper works but cannot clear water even though there is water on windscreen.				X
		Other failures				X
13	CAR BODY	Miscellaneous failures	X	X	X	X
14	INTERIOR VEHICLE	Miscellaneous failures	X	X	X	X
		Water is getting into the vehicle.				X
15	HORN	Locomotive horn does not work or is constantly on			X	
		Other horn failures				X
16	HIGH VOLTAGE SYSTEM	Main circuit breaker not closing	X			
		No line voltage due to vehicle	X			
		Other high voltage failures				X

Table 4-1 - Service affecting failures

It will be aimed for each locomotive that MKBF value that covers all A, B, C and D failure classes would be over 25000 km, MKBSF value that covers A, B, and C failure classes would be over 100000 km and MKBSF value that covers A and B failure classes would be over 400000 km. The conversion speed is 55 km/h.
For this reason, reliability targets are set for each sub-assembly, which have to be indicated in the related technical specifications.
According to previous definitions, each supplier must indicate following values of its sub-systems:

- MTBF = Mean Time Between Failures (basic reliability, including A, B, C and D failure classes)
- MTBSF1 = Mean Time Between Service Failures (mission reliability including A, B and C failure classes)
- MTBSF2 = Mean Time Between Service Failures (mission reliability including only A and B failure classes)

All these values have to be complaint to the target indicated in following table:

Analysis	**Target**	**Remarks**
Basic Reliability	**≥ xxx** MTBF [hours]	A + B + C + D failure classes
Mission Reliability 1	**≥ xxx** MTBSF [hours]	A + B + C failure classes
Mission Reliability 2	**≥ xxx** MTBSF [hours]	A + B failure classes

Table 4-2 - Reliability targets

Depending on the sub-assemblies, some targets refer to the single assembly, others are indicated at the vehicle level.

The reliability target values of the vehicle main sub-assemblies, which must be respected by Suppliers, are shown in the following tables and have to be indicated in Loco technical specifications.

Assembly	MTBF (H)	MTBSF (H)	MTBSF (H)
Lateral window (single)	700.000	Not applicable	Not applicable
Driver seat (single)	500.000	1.500.000	4.000.000
Wiper wash (single)	200.000	400.000	1.000.000
Windscreen (single)	330.000	330.000	330.000
Complete motor bogie (single)	8.000	20.000	50.000
Primary suspension (single)	400.000	1.000.000	3.000.000
Secondary suspension (single)	250.000	500.000	1.500.000
Bogie damper (single)	800.000	2.000.000	4.000.000
Gearbox (single)	100.000	200.000	400.000
TCMS (loco)	15.000	50.000	100.000
Auxiliary converter including battery charger (single)	100.000	300.000	900.000
Main transformer (single)	30.000	60.000	120.000
Traction motor (single)	150.000	300.000	600.000
Traction converter (single)	50.000	100.000	150.000
Master Controller (single)	100.000	200.000	400.000
Battery assembly (single)	200.000	600.000	1.200.000
Anti-fire system (loco)	100.000	300.000	600.000
Internal lighting system (loco)	200.000	600.000	1.500.000
External lights (loco)	100.000	200.000	500.000
Cab internal door (single)	185.000	500.000	1.500.000
Cab external door (single)	300.000	600.000	1.500.000
Signalling system	100.000	200.000	300.000
Radio system (loco)	100.000	300.000	600.000

Assembly	MTBF (H)	MTBSF (H)	MTBSF (H)
Vigilance Control Device (loco)	50.000	100.000	200.000
HV box including MCB, surge arrester, transducers (single)	20.000	50.000	100.000
Compressor (single)	50.000	250.000	750.000
Anti-slide system (one bogie)	25.000	100.000	300.000
Brake system (loco)	3.000	7.500	20.000
Automatic coupler (single)	200.000	600.000	1.500.000
Cab shell structure (single)	1.000.000	2.000.000	6.000.000
Assistant seat (single)	800.000	2.000.000	6.000.000
Rollbar components (single)	300.000	1.000.000	2.000.000
Wheel (single)	2.000.000	4.000.000	8.000.000
Axle Box (single)	150.000	450.000	1.200.000
Vacuum circuit breaker (single)	100.000	200.000	400.000
Pantograph (single)	50.000	100.000	300.000
Braking Resistor (single)	125.000	500.000	1.500.000
Driver desk (single)	40.000	80.000	200.000
Tachograph device / JRU recorder (single)	50.000	150.000	300.000
Operator's Cab Heating, Ventilation & Air Conditioning (single)	50.000	200.000	500.000
Diesel engine (single)	27.000	55.000	150.000
Cooling System (loco)	40.000	120.000	300.000
Filtering System (Fuel and Air - loco)	5.000	15.000	50.000
After-Treatment System (loco)	20.000	50.000	100.000

Table 4-3 – Locomotive reliability targets

5 AVAILABILITY

Availability is assumed to be targeted at 90% per month during the warranty period under optimum operating and maintenance conditions. Service reliability will be based on the service life of the locomotives. Availability tracking and calculation for locomotives will be made by the Customer after the first locomotive is put into operation.

Calculations will be made by the Customer for 12 consecutive months.

In the availability calculation, it will always be assumed that there are ten (10) locomotives for maintenance during the day (heavy maintenance will not be considered in this context).

The time spent in the maintenance of the locomotives during planned maintenance will not be considered as available for the operation.

In addition, the time elapsed between the locomotives being out of service as a result of their failure and being ready for operation after repair will not be considered as available for the operation.

In addition, if the locomotives are out of service due to Failures/Events Not Included in RAM Calculation, they will not be included in the availability calculation.

Fleet Availability formulation below will be applied in availability calculation.

Availability / Operational formula (a locomotive is considered ready when it is ready to be put into commercial service):

Availability of electric locomotives within one month = N / F x 100%

N = Number of days of total locomotive available in a month

F = Total number of locomotives x days in a month (locomotives that are not ready for the above reasons will be excluded from the Fleet count.).

6 MAINTAINABILITY

SCHEDULED MAINTENANCE

Scheduled (Preventive) maintenance consists in any scheduled operation to maintain an assembly/subassembly or components in its specific operating conditions:

- periodical inspection and diagnostic test for prevention of malfunctioning.
- scheduled replacement operations.
- checks, at specified time intervals, whose outcome determines whether or not replacements will be performed.
- routine operations, such as filling, topping up, change oil, greasing, adjustments, and so on.
- general overhaul of systems and subsystems of the train.

The preventive maintenance can be divided in short term preventive maintenance (carried out at defined interval during a year) and cyclic heavy maintenance (carried out after a certain number of years with a lot of km covered). The different intervals are defined applying the so called “Preventive Maintenance Regime”.

UNSCHEDULED MAINTENANCE

Unscheduled (Corrective) maintenance consists in any maintenance operation which is not scheduled (part of preventive maintenance) as a result of a failure happened during service, i.e. any intervention performed following a fault to restore a component/subsystem/system to its specified operating conditions.

Sometimes interventions are necessary after acts of vandalism or malfunctions due to the improper use of the system or external causes as traffic incident; all these interventions are not considered in the costs calculated in the analysis.

To minimize the down time, the corrective maintenance can be performed by replacing some subsystems or LRU which can be subsequently repaired off train. LRU means Line Replaceable Unit, i.e. the smallest component that can be replaced in first level maintenance.

The maintenance activities must be such as to guarantee an availability of the the locomotive's availability is assumed to be no less than 90%

For this reason, it is necessary that each Supplier provides a list of scheduled and unscheduled maintenance activities, indicating the times necessary for their implementation. The expected maintenance costs for each piece of equipment must also be indicated.

SCHEDULED MAINTENANCE PLANNING

The Supplier shall give periodic maintenance intervals on the basis of kilometers.

These intervals shall be optimized on vehicle basis and must be compliant to these requirements:

- No scheduled maintenance in the trainset depot shall be required before one month or 40,000 km.
- Intermediate overhauls shall not be required before 3 years.
- General overhauls shall not be required before 6 years.

The Supplier shall agree with Administration upon possible different frequency keeping into account particular needs of CoCo Loco on its scope of supply.

The overhauls interval can be proposed by Supplier, as a multiple of previous intervals.

6.1 GENERAL REQUIREMENTS

Locomotives will be designed in a way that minimizes all costs in terms of maintenance, repair time and lifecycle. The following aspects will be taken into account in the locomotive design:

The vehicle structure will be in accordance with the latest technological developments in a way that will reduce maintenance and repair costs. Where possible, use of parts requiring lubrication or frequent replacement will be avoided. All parts of the vehicle, especially those that require periodic maintenance, will be modular for easy replacement in a minimum of time.

Units will be modular for diagnosing and troubleshooting; In particular, electronic systems will have a "bus" structure or will consist of cards that can be easily removed and installed, and as many cards or modules as possible will be equipped with a fault notification system to help find failures.

Terminals in all main and auxiliary computer systems in the locomotive will be placed in such a way that they can be easily reached with a laptop.
Large components that require the use of lifting equipment will be configured to allow disassembly, installation and removal as easily as possible.
All systems and components used as part of periodic preventive maintenance shall be easily accessible for service and inspection.
Modules or plug-in assemblies and components that are not functionally interchangeable shall not be physically interchangeable. All equipment and modules will be eligible for replacement with the same type used on the same locomotive type.
All test points, fault indicators, modules, cable ends, piping, ducts, cables etc. shall be easily identifiable by technical documentation and, where applicable, shall be indicated by nameplate, color code, number coding or other means to assist maintenance personnel.
Whenever possible, standard, commercially available components and hardware will be used where applicable.
All filters/strainers will be easily checked and cleaned.

6.2 LRU POLICY AND SPARE PARTS

It is highly recommended to perform LRUs (Line Replaceable Unit) revision or the main repair operations (corrective maintenance) off-Train.
Consequently, LRUs involved in the task, will be replaced with its ready spares from the depot. All that to save time and cost as already written.

To follow this approach the Supplier shall supply:

- Spares parts list including the list of spares used for preventive and corrective maintenance analysis,
- Consumables list for all scheduled maintenance activities.

6.3 SPECIAL TOOLS LIST

Generally, the usage of special tools shall be avoided to perform preventive and corrective maintenance.
As special tool is intended either a tool (hardware and/or software) that is exclusively produced by the Supplier and is essential for system/equipment maintenance, either a tool available on market but expensive, sophisticated, with long lead time and so on.
If this is not possible, the Supplier shall provide 2 complete sets of special tools free of charge.
The list to be supplied shall be consistent with the Special Tools mentioned into the preventive and corrective maintenance analysis.

7 RESPECT OF RAMS TARGETS

The fulfillment of the above specified RAMS targets will be verified in service during a dedicated Verification Period, as specified before.

Declared RAMS targets shall be to be demonstrated and evaluated, during the development of the project, supplying a RAMS analyses according to the table 4.3 reported in this document.

In particular the Supplier shall demonstrate that all maintainability requirements and levels of repair have been considered and satisfactorily introduced into design.

In case of missed fulfilment, the Supplier has:

- to perform all necessary modifications at no costs for the Customer, in order to fulfil all RAMS targets.
- to pay for penalties, in the event that the Final User will charge penalties due to not compliant Supplier system, as described in the supply contract.

The RAMS targets verification, by recording field data for every system/sub-system/component, will be done in a “Verification Period” during the system/sub-system/component service.

8 RAMS DOCUMENTATION (DELIVERABLES)

Documentation
Reliability breakdown
Inherent reliability prediction, based on reliability breakdown and including failure rates and MTBF/MBDF of each LRU
Mission (critical) reliability calculation/analysis (Fault Tree Analysis)
Failure Mode Effects and Criticality Analysis (FMECA)
LCC analysis, including preventive and corrective maintenance
Spare parts list
Special tool list
Sub system Hazard Analysis (SSHA), including Interface Hazard Analysis and Operation and Support Hazard Analysis
Safety critical components list
A subsystem safety dossier, including also subsystem validation report, containing evidence of safety process application, compliance with safety requirements, and a residual risk assessment associated to subsystem installed on the vehicles under contract

Table 3 – RAMS documentation deliverables

All the provided documentation shall be updated during design development, taking into account design revisions.

The required documentation shall be produced using the template supplied by CoCo Loco (doc. ref.[5]) or using its own formats pending upon a specific agreement (same contents and requested data shall be reported).

END OF DOCUMENT