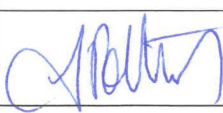



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## TS400023

### TECHNICAL SPECIFICATION OF AIR SUPPLY AND BRAKE SYSTEM

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Revision Table			
Rev	Date	Description of Revision	Revised By
-	21/11/2024	First Issue	
A	05/12/2024	Removed Diesel and Dual Configurations references Replaced standard UIC541-3 with EN15328 Horns marked as “NOT SCOPE OF SUPPLY” Reservoirs marked as “NOT SCOPE OF SUPPLY” Updated Section 2.3 “Reference Documents” Updated Section 5.2.1 “Performance” Updated Section 5.2.2.5 “Regenerative Brake – ED Brake” Added Section 5.2.2.6 “Back-up Brake” Updated Section 5.2.3 “Air Generation and Treatment Unit” Update Section 5.2.8 “Wheel Slide Protection”	
B	11/07/2025	Updated Table 3 – Applicable Standards Updated section 5.2.1 - Performance Updated section 5.2.2.2 – Emergency Brake Updated section 5.2.2.5 – Regenerative Brake (ED Brake) Updated section 5.2.2.6 – Back-up Brake Updated section 5.2.3 – Air Generation and Treatment Unit Updated section 5.2.4 – Auxiliary Air Supply Unit Updated section 5.2.5 - Reservoirs	
C	02/09/2025	Updated section 5.2.2.1 – Indirect Brake – Service Brake Updated section 5.2.3 – Air Generation and Treatment Unit Updated section 5.2.9 – Bogie Mounted Components Updated section 14.1 – Warranty Condition	
D	17/11/2025	Added sentence in sections 2.4.1, 5.2.4 and 5.5 which declares that AASU has to be considered only for the electric loco	
E	29/01/2026	Updated section 7.1 – Training	
F	18/05/2026	Updated section 5.2.2.1 – “Indirect Brake – Service Brake” Updated section 5.2.6 – “Brake Control Panel (BCP)” Updated section 6.1 – “Reliability, Availability, Maintainability & Safety (RAMS)”	



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## 1. SUBJECT AND SCOPE

This document describes the technical requirements for the procurement of the Air Supply and Brake System device to be installed on the Co-Co Type Locomotive (hereafter called LOCO) produced by Turkish Railway Vehicles Industry Inc. (hereafter called TÜRASAS).

The Bidder shall offer a solution totally compliant with the requirements of this specification.

After signing the contract, possible deviations from this specification or from other specifications and norms mentioned in this document, shall be validated by written agreements between TÜRASAS and the Contractor.

The Bidder shall make clause by clause comment into present technical specification together with their offer.

### **IMPORTANT NOTE:**

The present document shall be examined by the Bidder, together with the following document:

**TŞ400048 – Electric General Technical Specification**

**TŞ400049 – Diesel General Technical Specification**

in order to know general applicable requirements established at LOCO level.

## 2. DEFINITIONS & REFERENCE DOCUMENT

### 2.1. INTRODUCTION

Within this Technical System Specification, the following definitions are applied to the words reported below:

- “the Administration” means the Turkish Railway Vehicles Industry Inc. (hereafter called TÜRASAS)
- “the Contractor” means the company who wins the tender to supply the good object of this specification
- “documentation” means all or any specifications, drawings, reports, networks, operating and maintenance manuals and all other information whether on paper or on magnetic or other format which is prepared by the Contractor in the course of the contract
- “the Bidder” means the company who want to join to the tender to supply the good object of this specification
- “End Client” means the railway company that will be the user of the locomotive

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## 2.2. ACRONYMS

The acronyms used in this document are reported in the following Table.

Acronym	Description
TÜRASAS	Turkish Railway Vehicles Industry Inc.
Admin. Personnel	TÜRASAS and / or Co-Co project working groups assigned in the relevant subject
ADMINISTRATION	TÜRASAS
Bidder	The company who want to join to the tender to supply the good object of this specification
ATP	Automatic Train Protection
ATS	Automatic Train Stop
BP	Brake Pipe
CAD	Computer Aided Drawing
CbC	Clause-by-Clause Document
Co-Co	Electrical Mainline Locomotive
Contractor	The winner of the tender and the Contractor of the products covered by this spec.
CSM	Document 402/2013/EU of the European Commission (Common Safety Method for Risk Evaluation and Assessment)
EB	Emergency Brake
EC	European Community
ED	Electro-Dynamic
EN	European Standard
EP	Electro Pneumatic
ERTMS	European Train Control System
ISO	International Standard Organization
MRP	Main Reservoir Pipe
NoBo	Established by the relevant commission of the European Union under the directive 2016/ 797 / EC on the "Interoperability of the rail system within the European Union" directive. "Notified Body"
RAMS	Reliability - Availability- Maintainability- Safety
TCMS	Train Control Management System
TSE	Turkish Standards Institute
TSI CCS	Document 2023/1695/EU of the European (the technical specification for interoperability relating to the control-command and signaling subsystems of the rail system in the European Union)
TSI LOC&PAS	Document 1302/2014/EU and relative amendments of the European Commission (Technical specification for interoperability relating to the rolling stock — locomotives and passenger rolling stock subsystem of the rail system in the European Union)
TSI NOI	Document 1304/2014 / EU of the European Commission ((technical specification for interoperability relating to the subsystem rolling stock — noise)

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Acronym	Description
TSI SRT	Document 1303/2014 / EU of the European Commission (the technical specification for interoperability relating to ‘safety in railway tunnels’ of the rail system of the European Union)
UIC	International Railway Association
UNI	National Standards Unit
VCU	Vehicle Control Unit
WSP	Wheel Slide Protection
N/A	Not Applicable
TBC	To be confirmed
TBD	To be defined
LRU	Line Replaceable Unit
LCC	Life Cycle Cost
CBM	Condition Base Maintenance
FAI	First Article Inspection
MDBF	Mean Distance Between Failure
MTBF	Mean Time Between Failure

**Table 1 – Acronym Description**

### 2.3. REFERENCE DOCUMENTS

In the following Table the documents referenced in this Technical Specification are listed.

Ref	Document	Title
[1]	TS400048	Electric General Technical Specification
[2]	012GX0000201-000	General Layout Electric
[3]	TB50162	RAMS guidelines and templates
[4]	TB50170	SIL Definitions
[5]	TB50165	RAMS targets allocation
[6]	TB50210	Mass Distribution
[7]	TB50172	Thermoacoustic Behaviour
[8]	TS400049	Diesel General Technical Specification

**Table 2 – Reference Documents**

### 2.4. SCOPE OF SUPPLY

#### 2.4.1. HARDWARE

Contractor is responsible for providing all the relevant components related to manufacturing and assembly of Air Supply and Brake System to satisfy the requirements reported in the present Technical Specification. The scope of supply is composed of the following, not exhaustive, items:

ÜRA F.005	This Technical Specification can not be REPRODUCED OR USED for any purposes without the written consent of TÜRASAS	07.04.2016 Rev:02
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1. Air Generation and Treatment Unit (AGTU) – this equipment shall be able to deliver the required compressed air for the Brake System and the other Pneumatic Auxiliary Equipment and guarantee an air quality according to ISO 8573
2. Auxiliary Air Supply Unit (AASU) – this equipment, powered by the Loco 110 VDC battery, shall be used to deliver the required air for Loco “cold” start (e.g. lifting the pantograph) (AASU has to be considered only for the electric loco).
3. Air Reservoirs
4. Brake Control Unit (BCU) – this equipment contains all the electronics required to manage and control the Air Supply and Brake System and interface it with the Vehicle Control Unit
5. Brake Control Panel (BCP) – this equipment shall contain all the main components to control the Brake System of the Loco, including but not limited to:
  - a. automatic indirect brake electro valves
  - b. direct brake electro valves
  - c. parking brake application/release electro valves
  - d. emergency brake electro valves
  - e. UIC distributor valve
  - f. Deadman’s valve
  - g. Pressure governors
6. Cabin equipment, including but not limited to:
  - a. Driver’s Brake Valve (DBV)
  - b. Direct brake handle
  - c. Emergency Brake Application Valve
  - d. Pressure gauges
7. Wheel Slide Protection – this equipment shall be able to detect and correct the wheel sliding at axle level using anti-skid dump valves, speed sensors and relative electronic
8. Bogie equipment, including but not limited to:
  - a. Wheel mounted discs
  - b. Disc Brake Unit w/o parking brake actuators (DBU)
  - c. Disc Brake Unit w/ parking brake actuators (DBUP)
  - d. Brake Pads in composite/organic material



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9. Couplings and Isolation Cocks

10. Sanding Supply Equipment

11. Visual Indicators Equipment

12. Hoses for connections of the pneumatic BP and MP between the cars

13. Hoses for connections of the pneumatic BP and MP to the automatic coupler

14. Hoses for connections between the car body and the bogie pneumatic systems

15. All fixed and mating connectors, accessories belong to connectors, other accessories relevant to the systems

#### 2.4.2. SOFTWARE

The supplier will provide all the software for the system maintenance and operation of the Air Supply and Brake System so that the minimum will be as follows:

- Operational Software
- Diagnostic & Test Software

The SW development shall be at least as per the Basic Integrity level requirements defined in the EN 50716.

If any, Contractor shall provide diagnostic software tools as 6 pieces (programs, special connection cables, licences, CBM data cloud access and analysis, etc.).

If a special software tool for uploading application software, downloading diagnostic files or other functions is necessary, Contractor shall provide related software tool to TÜRASAS.

#### 2.4.3. SPECIAL TOOLS AND EQUIPMENT

Generally, the usage of special tools shall be avoided to perform preventive and corrective maintenance.

If this is not possible, the Bidder/Contractor shall provide a list of tools and 2 complete sets of special tools free of charge.

Nevertheless if they are essential for maintenance (upon Contractor and TÜRASAS agreement), following information shall be supplied in a dedicated section of the Maintenance Manual:

- descriptions and technical data (including SW if present)
- drawings
- use instructions
- list of tasks where the tools usage is mandatory (and of course Maintenance Cards shall refer to the relevant special tools when is needed)

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- all the information for purchasing it correctly (technical data, builder, price, and so on) if the special tool is available on the market

The supplier shall provide the software tools necessary to manage the life cycle of the system (monitoring and troubleshooting SW, special connection cables and adaptors, diagnostics and CBM data cloud access and analysis, etc.).

### 3. STANDARDS TO BE COMPLIED

The LOCO shall be designed, assembled and tested according to the following international reference standards:

European Standards: TSI, EN;

International standards: UIC; ISO; IEC;

System of units shall be SI.

The complete standards list is indicated in the TB50160.

The Bidder/Contractor should satisfy the specific standards indicated in Table below; all the norms shall be considered with the version indicated in the relevant TSI list; if the norm is not listed in the TSI list, shall be applied the last version of the norm available at the signature of the contract.

Standard	Title
TSI LOC&PAS 1302/2014 Amended 2023/1694	Technical Specification of Interoperability: Rolling Stock - locomotives and passenger rolling stock subsystem of the rail system in the European Union
TSI CCS 2016/796 Amended 2023/1695	Technical Specification of Interoperability: Control Command and Signalling TSI
TSI Noise 1304-2014 Amended 2023/1694	Technical Specification of Interoperability: Noise
TSI SRT 1303/2014 Amended 2019/776	Technical Specification of Interoperability: Safety in Railway Tunnels
EN ISO 14040	Environmental management - Life cycle assessment - Principles and framework
EN 286-3	Simple unfired pressure vessels designed to contain air or nitrogen - Part 3: Steel pressure vessels designed for air braking equipment and auxiliary pneumatic equipment for railway rolling stock
EN 14198	Railway applications - Braking - Requirements for the brake system of trains hauled by locomotives

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Standard	Title
EN 14531-1	Railway applications - Methods for calculation of stopping distances, slowing distances and immobilization braking - Part 1: General algorithms
EN 14531-2	Railway applications - Methods for calculation of stopping and slowing distances and immobilisation braking - Part 2: Step by step calculations for train sets or single vehicles
EN 15328	Railway applications - Braking - Brake pads
EN 15595	Railway applications - Braking - Wheel slide protection
EN 16839	Railway applications - Rolling stock - Head stock layout
EN 17050	Conformity assessment - Contractor's declaration of conformity
EN 45545	Railway applications - Fire protection on railway vehicles
IEC 61373	Railway applications - Rolling stock equipment - Shock and vibration tests
ISO 8573	Compressed air - Part 1: Contaminants and purity classes

**Table 3 – Applicable Standards**

The Bidder shall review and confirm compliancy to the above list of applicable norms, any deviation shall be submitted to TÜRASAS for approval.

The Bidder shall declare if its system/equipment is compliant with other national/international, or railroad administration standards not mentioned in the above list.

#### **4. TSI REQUIREMENTS AND DOCUMENTATION**

##### **4.1. TSI CERTIFICATION**

The LOCO shall be certified according to current version TSI PAS/LOC, TSI NOI, TSI PRM, TSI SRT and TSI CCS by Notified Body (NoBo) / Designated Body (DeBo). The Contractor shall provide whole calculations, drawings, analysis, test reports and other kind of documentation which is requested by TSIs for the present Scope of Supply. Within the scope of Supply, Contractor Provide the documentation required for the compliance matrix to be created by NoBo.

The Contractor/Bidder shall provide the declaration of conformity of its Scope of Supply to the relevant technical specifications and applicable norms.

The declaration of conformity shall be in accordance to the EN17050 Norm and shall include also the following documents:

Conformity declaration (The bidder shall submit it at Stage 1, see §12 Table 6)

Conformity report with all conformity evidence (The Contractor shall submit it at Stage 3, see § 12 Table 8)

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Type test reports (The Contractor shall submit them at Stage 3, see § 12 Table 8)

The documentation presented by the Contractor/Bidder relevant to the Conformity report with all conformity evidences and test reports will be examined for approval by the NoBo/DeBo in charge of certification of the LOCO.

If there is a need for corrections to the documents or new documents are required depending on the examinations made by the NoBo/DeBo, the relevant documents will be provided by the Contractor.

The Contractor is obliged to meet the documents that are not foreseen at the tender stage but are requested by NoBo later on.

#### 4.2. EC CERTIFICATION OF CONFORMITY AS INTEROPERABILITY CONSTITUTE

The Air Supply and Brake System object of present Technical Specification is an Interoperability Constituent. The Bidder can join the tender with or without EC Certification of Conformity.

In any case the Air Supply and Brake System shall be supplied with its own EC certification of conformity according to the applicable and valid TSI regulation by the Contractor.

The documentation related to the EC Certification of Conformity shall be accessible for examination by the Notified Body in charge of TSI certification of the LOCO nominated by the Administration.

The Contractor shall enable an assessment by the NoBo at the suppliers location.

### 5. TECHNICAL SPECIFICATION

#### 5.1. INTRODUCTION

The Brake System shall function in coordination with the Traction System, providing independent brake pressure control for both the bogies of the Loco. A brake application command shall take control of the brake system, even in case of active brake release command: only in case of driver intentional brake suppression command it is allowed to not apply this requirement.

The supplied locomotive Brake System shall cover the following functions:

- Emergency braking
- Service braking
- Keeping the Loco/train stationary

Therefore, Brake System shall be equipped with the following brake modes:

1. Indirect Brake
2. Direct Brake

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3. Parking Brake

4. Emergency Brake

5. Electro-Dynamic Brake or Rheostatic Electric Brake – ED Brake

The Brake Control Unit (BCU) consists of all the electronic components required to manage and control all the Brake System Control functions.

Brake System control shall cover both service and rescue mode, where service mode is the normal, working condition, while rescue mode is an anomaly condition, e.g. in case of a power failure.

The driver shall be able to operate a dedicated handle to apply regenerative Brake (ED Brake): the Contractor, in coordination with the other systems contractors, shall provide a complete description and explanation of the different brake combinations.

The proposed Brake System shall present the following characteristics:

- Automatic brake application – any loss of integrity of the brake command shall result in an immediate brake activation
- Inexhaustibility – sufficient braking energy shall be available to perform repeated brake application and release cycles followed by successful emergency brake application
- Gradability – it shall be possible for the driver to incrementally control the brake force during both brake application and release

## 5.2. PRODUCT DEFINITION

### 5.2.1. Performance

The Contractor shall provide an Air Supply and Brake System designed for a Locomotive with the following characteristics:

- Bogie Type CoCo
- Maximum Axle Load 22.5 ton
- Operation Speed 120 km/h
- Design Speed 132 km/h

As a minimum, the supplied Brake System shall meet the following requirements:

- Average Friction Service Brake Deceleration: 0.8 m/s<sup>2</sup>
- Emergency Brake Stopping Distance (design speed): 900 m

Parking Brake shall be able to retain the Loco permanently stationary on a 40 ‰ gradient without any power supply available. The considered wheel-rail adhesion coefficient shall be lower than 0.12.

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According to TSI 4.2.4.5 the Contractor shall evaluate the brake system performance with brake calculations as defined in standard EN 14531-1-2, for the two control modes: emergency brake and maximum service brake.

All Brake Calculation shall be performed for the combinations of modes and conditions here reported.

- Modes
  - Normal
    - Brake system 100% working
  - Failure
    - Brake components isolated due to failure (1 bogie out)
- Conditions
  - Normal
    - Standard brake pad friction coefficient (value shall be justified)
  - Degraded
    - Reduced brake pad friction coefficient (value shall be justified)

According to TSI 4.2.4.6 the brake system shall be designed in a way that it shall not require an adhesion limit higher than 0,15.

If the results of Brake Calculation under Failure Modes do not meet the requirements, the Contractor can propose a suitable speed reduction in accordance with TÜRASAS and Designer.

The Contractor shall also provide the Thermal Calculation considering a scenario consisting of 2 successive EB applications from the maximum speed (time interval corresponding to the time needed to accelerate the Loco up to the maximum speed) on level track for the load condition ‘maximum braking load’.

## 5.2.2. Functions

### 5.2.2.1. Indirect Brake – Service Brake

Service Brake is mainly carried out by the Indirect Brake mode: it is an automatic, indirect acting friction brake.

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This brake is an adjustable braking and releasing pneumatic brake that operates in the locomotive and in the train through the brake pipe (BP).

Service Brake Command shall allow Loco Driver to regulate the brake force from a minimum (brake release) to a maximum (max brake force) value in a range of at least 7 steps: service brake command shall be possible only from the active cabin.

Over 15 km/h, service brake command activation shall result in the automatic cut-off of traction effort.

The control device for the Indirect Brake is the Driver's Brake Valve (DBV), which operates in coordination with the components installed in the Brake Control Panel (BCP): operating this valve, the Brake Pipe (BP) pressure shall be regulated (venting-> brake apply / charging->brake release). DBV shall present a dedicated position for Emergency Braking (EB), connected to an integrated emergency brake valve for fast and direct venting to atmosphere of the BP, through a large cross-section (e.g. SIFA).

While service braking is controllable through the DBV only in the active cabin, the EB position shall be always in function: this will allow the Driver to give EB command also from the non-active cabin.

The drivers brake valve system shall be developed in accordance with EN14198 and shall have been tested in compliance with the test condition specified in Annex E. If requested by the NoBo. Evidence shall be submitted to the NoBo at system level.

The supplied System shall present a solution to automatically compensate the eventual small pressure fluctuations and leaks in the brake pipe.

#### 5.2.2.2. Emergency Brake

The opening of the safety loop or dedicated valves shall cause the activation of the emergency mode and the application of an Emergency Brake (EB).

This brake mode shall override the active modes: its aim is to stop the train within a defined brake distance (see Performance – Section 5.2.1). The BCU shall carry out only backup - redundant actions, because braking in this mode shall be hardware pneumatic controlled, with no need for electronic control.

During EB, the Brake Pipe is vented both through the large cross section of the DBV (max brake effort) and a second independent device (e.g. Sifa Valve).

Emergency Brake command devices shall be available in both the loco cabins and allow emergency brake activation by a simple and single action from the driver in his normal driving position, using one hand (e.g. mushroom buttons).

Until command reset, the following actions shall be applied automatically and permanently:

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- Emergency brake command (electric or pneumatic) transmitted along the train
- Traction cut-off
- Inhibition of brake-release command

EB valves shall present a fail-safe logic (de-energize to operate)

#### 5.2.2.3. Direct Brake

The direct brake (electro-pneumatic) only operates in the locomotive, and it is applied by operating the direct brake handle on the desk. It is a redundant electro pneumatically brake.

Usually, this brake is implemented to be used during shunting or rescue operations.

Direct Brake is applied at vehicle level; therefore, its command only applies a brake effort within the Loco independently from other vehicles.

#### 5.2.2.4. Parking Brake

Parking Brake (PB) is a passive, spring applied – air released brake: this brake is released by applying air pressure to the parking cylinder until it overcomes the force exerted by the accumulating spring. PB callipers shall include an anti-compound valve to avoid the application of an excessive brake force to brake discs.

It will hold the locomotive when it is parked even if there is no electricity or air pressure (it is a spring-based brake, with pneumatic release) for an unlimited period of time on a 40 ‰ gradient.

The Contractor shall provide a solution to manually release the PB actuators in case of emergency: this provision shall be available on both sides of the bogie.

It shall be possible to isolate the Parking Brake pneumatic circuit through dedicated isolation cocks.

#### 5.2.2.5. Regenerative Brake – ED Brake

The locomotive electric brake is a regenerative brake or rheostatic brake (if regenerative brake is not possible) where the energy from the traction motors is returned to the catenary or transformed into heat in the dynamic brake resistors. Driver shall be able to activate this brake by operating the Power-Dynamic Brake handle on brake position.

The Brake System shall receive the information relative to ED (applied/not applied and deceleration level) from Vehicle Control Unit and Traction System: simultaneous application of friction brake and ED brake shall NOT be possible.



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ED Brake shall be used with priority as it ensure higher energy efficiency and lower components wear.

Calculation of necessary brake force, ED brake force request to traction inverter and application of EP brake (if ED brake force is not enough or available) shall be made by Brake System.

#### 5.2.2.6. Back-up Brake

A Back-up Brake shall be provided to ensure an adequate redundancy to Service brake in case of failures of its control components. When activated, Back-up mode shall allow the control of BP using the Direct Brake Handle.

#### 5.2.3. Air Generation and Treatment Unit (AGTU)

The AGTU shall guarantee to the Brake System and the other Auxiliary Pneumatic components a net air delivery rate of 2000÷2400 NI/min and a MRP working pressure shall be 8÷10 bar. Delivered air quality shall comply with ISO 8573 -1 [2; 2;-].

The Contractor shall submit the Air Consumption Calculation Document to confirm the required net air delivery rate: this document shall also prove that the resulting Duty Cycle of the compressor is adequate.

The AGTU equipment shall consist of the following, minimum, components:

- 2 stage, oil-free Piston Ccompressor, AC supply 400VAC, 3-phase, 50Hz
- Safety valves set at 10.5 and 12 bar – protection of pneumatic devices from accidental overpressure
- Dual chamber air dryer
- Filters and Check valves

All the components shall be supplied as a single, ready to install, assembly: any deviation shall be stated and discussed in the CbC Document. As many as possible, of the single components of air supply assembly shall be identical to E5000 reference due to maintenance reasons and spare parts availability.

The dimensioning of the fixing elements (screws, bolts, washers ...) shall be under contractor responsibility; all the not normalized elements necessary for the fixation of the equipment and components shall be considered under contractor scope of supply.

Installation of the AGTU shall be inside the Loco: an adequate cooling air flow and an easy access to components for maintenance operations shall be foreseen. Contractor shall provide any documentation

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The dual chamber air dryer shall be such that air drying and regenerating shall be possible simultaneously. A drain system (not continuous) shall be implemented, with the possibility of manual drainage, if necessary. Drainage shall be supplied with protection against freezing (cold conditions heaters).

There shall be nr. 2 AGTUs to guarantee redundancy, safety and optimization of the operating conditions.

The AGTU management system shall be integrated within the Vehicle Control Unit (VCU – not scope of Air Supply and Brake System Contractor) and based on the signal from the pressure governors installed on the Main Reservoir Pipe (MRP): it shall ensure an optimization of compressor activity both in terms of components wear and energy efficiency under all working conditions.

The AGTU air dryer shall be with cold-start functionality and its main working conditions are:

- Filling up – in this condition the VCU shall control the AGTU with the target to reach the maximum MRP pressure in the shortest time
- Normal service – in this condition the AGTU is used to maintain the MRP at working pressure

VCU shall also:

- keep a log of AGTU running time
- switch off the AGTU of the slave Loco, in case of multi-traction service

Contractor shall propose an AGTU size to ensure an optimal duty cycle and submit an Air Consumption Calculation to further validate it: fill-up time (from 0 bar pressure to working maximum pressure 10 bar) shall be under 20 mins.

A level of 92 dBA is the target for the sound power level, according to ref. [7].

#### 5.2.4. Auxiliary Air Supply Unit (AASU)

A compact, battery-powered (110VDC) auxiliary compressor shall be supplied in order to provide the required compressed air for the first service of “cold” locomotive.

The Loco is equipped with 2 pantographs: the driver shall be able to command, from the active cab, all the position changes for the active pantograph.

In order to lift when no compressed air is available, it shall be possible to power the AASU with the batteries: contractor shall provide the auxiliary air supply unit as a ready to install assembly, complete of frame, dryer, reservoir and governing components (pressure switch, check valve et cetera).

Pressure set-up for AASU shall be defined in accordance to Pantograph data-sheet.

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The Contractor shall analyse and confirm that the characteristics and the functionalities of the auxiliary compressor are compatible with the above additional components to ensure the full control of the raising and lowering of the pantograph.

The contractor shall underline if there are some incompatibilities and consequently propose changes or optimisations to ensure the functionalities.

A level of 88 dBA is the target for the sound power level, according to ref. [7].

AASU has to be considered only for the electric loco.

#### 5.2.5. Reservoirs (NOT SCOPE OF SUPPLY)

The stored compressed air shall have a total capacity of 1000 L, to be stored in separated Main Reservoirs (MR), equipped with drain valves.

Contractor shall provide a correct sizing of the capacity of any other necessary air reservoir.

Contractor shall provide Air Consumption Calculations and any other necessary documentation to demonstrate the correct sizing of the capacity of the air reservoirs.

A drainage system shall be provided for the major reservoirs. Drainage shall be supplied with protection against freezing (cold conditions heaters).

According to Section 3–Table 3, reservoirs shall be produced and certified according to EN 286-3.

#### 5.2.6. Brake Control Panel (BCP)

To ensure a compact installation solution, the main Brake System Control components shall be mounted on a BCP installed inside the Loco; an easy access to this panel shall be guaranteed.

One of the main components installed on the BCP is the Distributor Valve (DV): this UIC approved valve is used to control the brake cylinder pressure in both bogies according to the Brake Pipe (BP) pressure, covering the different braking modes G/P foreseen in the EN 14198. A selector to choose between the different braking modes (G/P) shall be provided and installed in BCP.

BCP shall be equipped with all the required components to transform the pre-control pressure signal from the DV (A-pressure) into a Control Pressure (C-Pressure) signal to individually manage the Brake Cylinder pressure of the two bogies: a set of two pneumatic relay shall be provided to amplify the pressure signal.

Another fundamental component that shall be installed on the BCP is the “Direct Brake/Backup Brake” Selector: this will define working mode of the Direct Brake / Backup Brake Manipulator installed on the Driver’s Desk.

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The distributor valve shall be developed in accordance with EN 14198, and a declaration of conformity shall be submitted to the approval authority upon request. It shall comply with the requirements of EN 15355 and be listed in UIC 540, Annex A.

The relay valve shall be developed in accordance with EN 15611, and a declaration of conformity shall be submitted to the approval authority upon request.

#### 5.2.7. Cabin Equipment

Each one of the cabin shall be equipped with all the components necessary to control and monitor all the pneumatic functions including the following, not limited to, components:

- Pressure Gauges to monitor BP, MRP and Brake Cylinder pressures
- Driver/s Brake Valve (DBV) – this valve is used to specify the brake effort request by controlling the BP pressure. It is a gear handle with four positions:
  - Neutral – maintains the pressure
  - Charge – increase the BP pressure (brake release)
  - Vent – reduce the BP pressure (brake application)
  - Emergency – rapidly reduce BP pressure by venting to atmosphere: this position will cause the Safety Loop opening, thus the commutation of the Emergency Magnet Valve
- Direct Brake / Back-up Brake Manipulator – this manipulator is used to control Loco brakes independently from BP Pressure (mainly during shunting operations). The working mode of this manipulator is defined by the relative selector installed on the BCP:
  - Direct Brake – used to produce electric signals for locomotive brake control independent from the Loco ones
  - Backup Brake – used to produce pneumatic signals for locomotive brake control
- Emergency Mushroom Valve
- Parking Brake application/release devices

Brake commands shall be available only from the active cabin, with the exception of the Emergency Brake activation.

#### 5.2.8. Wheel Slide Protection (WSP)

A Wheel Slide Protection System shall be supplied to avoid/reduce the risk of wheel flats due to wheel blockage: this system shall conform to the UIC 541-05 and the EN 15595 standards.

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As a basis, this system shall contain a double-channel speed sensor to monitor the axle speed, an anti-skid dump valve (to vent the compressed air from the Brake Cylinder) and a WSP electronic to manage and control the system.

The Contractor shall foresee a VCU interface as well for diagnostic functions.

Slide detection and correction shall be performed at axle level: therefore, each axle shall have its own speed sensor and anti-skid dump valve.

The proposed system shall be of proven design and service.

The Contractor shall propose a WSP dedicated to pneumatic brake only: during ED Braking, the wheel slide detection and correction shall be managed through a dedicated system in charge of Traction System.

#### 5.2.9. Bogie Mounted components

The CoCo type bogies of the Loco shall be equipped with a set of two wheel-mounted discs and disc brake units (DBU) per axle.

The brake caliper units:

- must be maintenance-free between the defined overhaul cycles, with no regreasing required during service
- must maintain a high and constant efficiency greater than 95% throughout its operation
- are connected to the bogie with one single interface (bracket), without any hanger. This simplifies the installation of the unit and the bogie interface with the caliper
- must ensure free kinematics, ensuring that lateral movement is not hindered by the hangers

A Parking Brake (PB) actuator shall be implemented on 3 of the total 6 DBUs installed on each bogie: the PB shall be of spring applied – air released type, with an anti-compound valve to avoid the application of excessive force on the brake disc.

Also, an individual manual release of these actuator shall be possible from both sides of the bogies: the Contractor shall declare the required force for manual release.

The Contractor shall confirm or propose a different number of PB actuators, based on submitted Brake Calculation and the specified operation condition.

DBU and DBUP dimensions shall be agreed and frozen with the Designer.

An adequate signal interface shall be provided so that the VCU monitoring is possible.

The Contractor shall indicate clearly in the drawings the connection interface of the calliper and shall give recommendation for the fastening elements of the callipers.

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Disc Brakes shall be of wheel-mounted type, in accordance with standard EN 14535-2: the fitting of the disc to wheel shall achieved by bolting.

The brake disc and wheel interface dimensions must be:

- Disc outer diameter:  $\Phi 1085\text{mm}$
- Disc inner diameter:  $\Phi 805\text{mm}$
- Wheel contact area outer diameter:  $\Phi 1056\text{mm}$
- Wheel contact area inner diameter:  $\Phi 810\text{mm}$
- Pitch circle diameter of the fixing element on the wheel:  $\Phi 947\text{mm}$  (to be confirmed)

The brake pads shall be of composite/organic material, in line with the EN 15328 Standard. Brake discs and pads wear shall also be automatically compensated (slack adjuster), and particles deriving from it shall not be dangerous for the locomotive working or hazardous to the environment.

Brake pads replacement shall be possible without the disassembly of main vehicle components.

#### 5.2.9.1. Structural analysis

The Contractor shall perform structural verification for all the brake components installed on the bogie (callipers, discs, connecting elements et cetera): this analysis shall be conducted through FEM using standard, agreed procedures.

The verification shall demonstrate for the brake system components, including the elements of link and in any operating condition:

- fatigue safety
- safety in case of overloads
- safety in case of creep

The Contractor is required to give evidence of validation activities and deliver the drawings of the connection elements between disks and wheel to TÜRASAS.

Wheel-mounted brake disc shall carry a mark indicating the maximum allowed consumption, which shall be declared by the Contractor during offering phase.

If the proposed system is of proven design, the Contractor can produce evidence of the already performed analysis.

#### 5.2.10. Couplings and Isolation Cocks

Each locomotive ends shall be equipped with two MRP and BP couplings according to EN15807.

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To open and isolate the coupling 1 ¼" angle must be intended. The angle cocks shall fully comply to EN14601.

In case of defective equipment, it shall be possible to isolate the damaged component and keep the locomotive working: the VCU shall detect the critical conditions according to which speed limitations or stop are required. These conditions are to be defined in accordance with the Contractor, the Designer and the Customer.

#### 5.2.11. Sanding Supply Equipment

Sanding equipment is used to guarantee an adequate wheel-rail adhesion coefficient: therefore, it's used both during Traction and Braking Phases.

A module including function group sanding shall be integrated with supply components for the sanding units. Sanding devices shall be installed on each bogie (axles 1-3, 4-6): the sand ejection shall be operated by Loco compressed air. The Contractor shall provide a solution to implement in the BCU the automatic action of sanding equipment: driver shall be able to manually activate it as well. Sanding equipment shall foresee an interface with Traction Control as well to guarantee the optimal wheel/rail adhesion.

There shall be an isolation cock to isolate the sanding unit, if necessary: diagnostic electrical signal shall be available at the isolation cock.

The following components shall be in scope of supply:

- Sanding control with valve electrically powered to feed pneumatically the sanding device
- Sanding unit with heater (TBC) mounted in the sand box
- Sand box
- Sand box lid
- Sand level indicator (with electric signal for low level to TCMS)
- Sight glass for visual level check
- Sand tube with sand tube heater

Sanding equipment shall allow wheel re-profile operation with minimum operation required.

#### 5.2.12. Wheel Flange Lubricator (WFL)

The Contractor shall foresee an adequate solution in Pneumatic System (and scheme) to feed the WFL devices, such as isolation cocks, pressure regulator et cetera.

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


#### 5.2.13. Visual Indicators Equipment

The status of the pneumatic brake needs to be shown with indicators on both sides of the locomotive: in total two types of indicators are required, one for the status of the service brake, the other for the parking brake.

Service brake status indicator shall be green in no-braking conditions and red with black points in braking conditions.

Visual indicators shall be provided on both sides of both bogies.

On each side of the loco there shall be a panel indicating the status of brake system of each bogie according to the following:

Status	Description	Symbol
Parking Brake Applied	red with black point	
Parking Brake Released	green	
Pneumatic Brake Applied	red with black point	
Pneumatic Brake Released	green	
No air available	white with black diagonal cross	

**Table 4 – Brake Visual Indicators Symbols**

#### 5.2.14. Horns (NOT SCOPE OF SUPPLY)

Two sets of double-tone, compressed air horns shall be provided: these horns shall be compliant with UIC 644.

Each warning horn tone shall be controlled by means of separate pneumatic lines. For each pneumatic line an isolating cock with electrical signal and electro-valve, feeding the line when energized, shall be foreseen.



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The warning horns and their control systems shall be protected as much as possible from impacts and subsequent blockages of airborne objects such as debris, dust, snow, hail or birds.

### 5.3. APPLICATION SOFTWARE

It is under responsibility of the Contractor to develop the software control of the Air Supply and Brake System to guarantee full required performances and required functionality for the system at SIL level.

The software to be installed in the Brake Control Unit (BCU) shall control and manage, at least, the following functions:

- Braking functions
- WSP management functions
- Braking performance management including blending master
- Diagnostic functions

Diagnostic messages shall be transmitted to the VCU and be displayed on driver desk: safety functions monitoring shall be managed by a failsafe output.

According to latest TSI LOC&PAS, diagnostic system shall allow the Loco staff (driver + codriver) to check:

- the status of brake control command line
- status of brake energy supply
- status of main and parking brake
- status of dynamic brake

Contractor shall declare Safety Integrity Level (SIL) of the proposed system and its main components. A SIL certification of system including software and hardware, issued by independent authority according to relevant railway standards shall be delivered by contractor.

Temporary acceptance can be done without delivery of SIL certification, but final acceptance is subject to delivery of SIL certification.

The following functionalities of the braking system shall be certified to reported SIL as a minimum (ref. [4]):

- Parking Brake – SIL 2
- WSP – SIL 2
- Emergency Brake – SIL 4

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SIL level certification of system including software and hardware, issued by independent authority according to relevant railway standards, shall be delivered by Contractor.

Temporary acceptance can be done without delivery of SIL certification, but final acceptance is subject to delivery of SIL certification.

If a special software tool for uploading application software, downloading diagnostic files or other functions is necessary, Contractor shall provide related software tool to TÜRASAS.

Contractor shall submit definitive software documentation which shows definition of necessity of SIL xx for the system and software has been prepared according to SIL requirements according to EN50716 at Stage 3 (see §12 Table 8).

#### 5.4. DIAGNOSTIC

The proposed Air Supply and Brake System shall be equipped with a diagnostic system, continuously running and able to verify the status of the main components and send diagnostic data to TCMS. Diagnostic shall be of two types: one for driver, the other for maintenance staff.

BCU shall present a dedicated memory to store diagnostic information: this shall be downloadable for maintenance and monitoring using a standard PC with a dedicated (included into the scope of supply) diagnostic software and via the TCMS interface (not included into the scope of supply).

LRU list shall be defined by the contractor and shall include all main brake components (including air compressors). Complete LRU list, maintenance troubleshooting and instructions shall be provided by the contractor.

TCMS contractor is the leader of implementing communication protocols. Contractor shall provide requested documents according to defined parameters which are defined by TCMS contractor and the Administration.

Besides the diagnostic reports the BCU shall furthermore provide status data (e.g. BP pressure, C-pressure, MRP-pressure, PB status etc.) Details shall be defined during design phase considering that the safety relevant status/diagnosis (which TCMS will replicate by bus) shall be transmitted in a safe way.

In addition, the vehicle wiring shall provide an additional independent hardware signal for major brake faults. These signals shall be sent by the BCU and displayed to the driver.

The contractor shall deliver a document itemizing the reason of failure, fault code and fault name as well as instructions for maintenance/driver and the respective LRU according to related communication protocol.

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The Administration, TCMS contractor, Brake Contractor and Traction System Contractor shall perform communication tests to verify the correct transmission of data. These tests shall be carried out and reported prior to the commission phase of the vehicle.

## 5.5. WEIGHT

The Contractor shall submit weight data for all the proposed components, clearly indicated in BOM and in 2D/3D models.

Target weights for each main components are listed below:

- AGTU (w/frame)  $\leq 400$  kg
- AASU (w/frame)  $\leq 100$  kg
- Wheel-mounted disc brake  $\leq 150$  kg
- Brake calliper w/o PB  $\leq 80$  kg
- Brake calliper w/ PB  $\leq 100$  kg
- Main Reservoir (w/frame)  $\leq 150$  kg

As weight management is a crucial aspect, any deviation of more than 5% from target weights here reported must be promptly communicated and discussed.

AASU has to be considered only for the electric loco.

## 5.6. MANUFACTURING

N/A

## 5.7. INTERFACE SPECIFICATION

### 5.7.1. Mechanical Interface

The mechanical interfaces for the components of the brake system shall be provided in accordance with EN 12663 and TSI LOC&PAS. All hardware of the organs of the brake shall be done with self-locking nuts.

Interface details shall be specified in related sections of this document and further validated and agreed during later stages of the project.

The Contractor shall provide the correct dimensioning of all fixing components.

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#### 5.7.2. Electrical Interface

All the electronics and electric units shall be connected using dedicated connectors, terminals are not admitted.

For each connector, Contractor shall provide all necessary information and 2D/3D models.

Contractor shall provide the functional scheme for the electrical interface: all the functions relevant to the brake system and managed by the BCUs shall be visible and detailed in the functional schemes. All the other elements, used for the vehicle functions shall be anyway included in the functional scheme with the relevant functional table.

#### 5.7.3. Digital And/Or Analogue Inputs/Outputs

TBD during Detailed Design Phase.

### 5.8. EARTHING

For protective provisions relating to electrical hazards on railway vehicles EN 50153 - standard is valid and shall be obeyed.

All equipment causing an electric shock shall be protected against direct contact.

All conductive surfaces of electrical equipment on the vehicle shall be connected to an earthing point for equalization of the electrical potential.

This includes conductive surfaces of cubicles, doors and covers.

Exceptions are small items of interior trim in an environment otherwise protected by bonding to car body and/or insulation (e.g. grips, coat hooks, etc.).

All equipment operating at AC-voltage >25V or at DC-voltage >60V shall be earthed for safety.

Each earthing point of the equipment shall be designed as follows: the earthing points shall be of good electrical conduction to ensure low touch voltage, the earthing points shall have large contact surface and shall be able to carry a possible short circuit current.

A design according to EN 60529, min IP20 (>12,5mm) is required for cubicles containing Band III voltages.

The min IP20 shall be achieved when there are situations when the cubicle is open and Band III voltage is live.

Each earthing point shall be easily accessible for assembly.

The Contractor shall provide an earthing diagram of its equipment including earthing bonds and shields.

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The Contractor shall indicate which cables of his system will be shielded.

Cable shielding may only be used for shielding purposes and NOT as signal, ground or reference wires.

If Contractor does not request different connection, cable shields shall be grounded on both ends in order to obtain high shielding efficiency against electric and magnetic fields.

This requires potential equalisation between both grounding points, e.g. through chassis or appropriate structural components.

Grounding of cable shields shall be made with low impedance (large contact surface, preferably over 360 deg. circumference).

Grounding by means of sheath wires (pig tails) or connector pins is NOT permitted.

The Low Voltage 0V level in the cars is floating, so shall be avoided an internal connection in the equipment between metallic chassis and the 0V connection; grounding connections in the equipment shall not be connected to car Low Voltage DC power supply.

## 5.9. ENVIRONMENTAL CONDITIONS

### 5.9.1. Climatic Condition

The system object of the present document specification shall work properly in the specified climatic conditions (temperature, rain, snow, ice, dust, wind and so on) in particular, ice, sand and snow shall not be cause of malfunction.

General climatic conditions, following the EN 50125-1, are reported in the mentioned General Technical Specification.

### 5.9.2. Noise, Vibration and Shock

General noise, vibration and impact conditions are reported in the already mentioned in General Technical Specifation and Noise Requirement document.

For shock and vibration the Contractor shall be able to demonstrate that the bogie equipment is tested and validated according to IEC61373

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### 5.9.3. Protection (IP)

The design shall provide the highest possible IP Levels of the equipment and components pending on their function. All the pneumatic control equipment, valves, governors, switches, sensors etc. shall be mounted in the enclosed lockable boxes, made of stainless steel having IP65 protection.

If brake system is of proven design, it's sufficient for the Contractor to produce evidence of such validation.

### 5.9.4. Painting

The Bidder/Contractor can propose its own painting specification to TURASAS. The usage of this painting specification is dependent on TURASAS approval.

Concerning resistance to corrosion, design and processes shall take in account the effect of potential galvanic corrosion.

The colours of products have to be defined by TURASAS during design meetings.

### 5.9.5. Electromagnetic Compatibility (EMC)

The equipment shall comply with the EMC requirements defined in EN 50121-1, EN 50121-3-1 and EN 50121-3-2.

## 5.10. SYSTEM AND COMPONENTS LIFE

The required life shall be equal or greater than 30 years.

## 5.11. MATERIAL REQUIREMENT

### 5.11.1. General Requirements

Materials shall be suitable to allow the normal maintenance activities without need to adopt special protections including welding, cuts and so one. They shall be suitable for the waste disposal without need of particular care.

All information about safety and health shall be provided, even for consumables like glue and cleaning agents.

The choice of materials shall be done to prevent corrosion in every usage condition.

The Bidder/Contractor shall give the list of every material used together with their offer.

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#### 5.11.2. Fire Resistance Behaviour

The supplied system/equipment/components including all their elements therefore shall be compliant to the applicable sections of EN 45545 family norms (-1, -2, -3, -4, -5, -6).

According to EN 45545-1 and EN 45545-2 standards the locomotive hazard level will be HL2 and operation category will be 2N (freight locomotive). The Contractor shall submit to the Administration a certificate of conformity to this standard. This hazard level identifies the relevant tests pass-no-pass condition.

The fire performance requirements established for materials are given by means of R(n) index reported by the EN 45545-2 “table 5”. These performances requirements of materials and components depend not only on their intrinsic nature but also on the location, the shape and the layout, the surface exposure, the relative mass and the thickness of considered material. In “table 2” of the EN 45545-2 are listed different products and their location on the trainset to identify the relevant R(x) requirements.

The Bidder shall follow the instruction of paragraph 4.2 “General” and paragraph 4.3 “Grouping rules” with the flowchart of Figure 1 “Assessment Process – grouping rules” of EN 45545-2 not only to identify all the material eventually not mentioned hereafter or not mentioned at all in the “table 2”, but also to verify if the requirements are applicable or not (i.e. in case of small quantity, small mass, small exposed areas and so on).

Concerning the materials used for the scope of supply of present technical specification following requirements have been identified.

Applicable Product type (No)	Definition	Details	Requirement
EX1C	External surfaces of enclosures containing technical equipment	Enclosures which are located outside the body shell	R7
EX8	Bogie structure and parts	The bogie structure shall include frames, spring leaf guides and bolster.	R7
EX10	Parts of the drive	Wheel sets and brake discs	R9
EL10	Small Electrotechnical products	Examples include low power circuit breakers, overload relays, contactors, contactor relay, switches, control or signalling switches, terminals, fuses	R26

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Applicable Product type (No)	Definition	Details	Requirement
EL9	Printed circuit boards	Printed circuit boards without any attached technical equipment	R24 or R25 or R26
M3	Hoses - Exterior	Pipes and hoses for fuel, oils, hydraulics, pneumatics, water and drainage	R23

**Table 5 – Material Fire Requirements**

The Bidder/Contractor shall adopt materials with required characteristic and identify other materials not mentioned above. The above R(x) list is not definitive and shall be complete according to the information given by the Contractor.

The Contractor shall give the list of the inflammable materials used with material type, quantity and fire resistance behaviour tests.

The Contractor shall prepare a fire safety analysis report and submit it for approval.

The documentation presented by the Bidder or the Contractor relevant fire performance will be examined for approval by the Notified Body in charge of TSI certification of the National Co-Co Type Mainline Locomotive Project nominated by the TÜRASAS. The Contractor/Bidder shall be responsible to perform all necessary activities which are required by Notified Body.

#### 5.11.3. Smoke Opacity and Toxicity

All the materials used do not emit toxic gases in such quantities as to be harmful.

The parameters taken as reference for the selection of materials, and the requirements they must meet, are described in "Table 5" of the EN 45545-2 standard with reference to the classification of the hazard level of the LOCO and the set of requirements R(n) to which the material is associated.

#### 5.12. LABELS/MARKING

The system/equipment/components supplied shall be provided with technical markings, in order to fulfil requirements of electrical safety, and provide information to maintenance personnel.

Wherever required for health and safety purposes, including where necessary to comply with legislation, parts shall be fitted with suitable safety and warning signs.

In particular the parts supplied, including all replaceable parts, shall be identified by a label showing:

- Serial number;



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- Data of manufacturer
- Date of manufacture
- Contractor's part number (if any)
- Revision level;
- Company's part number (if any)

Format and positioning of all labels/markings shall be subject to approval by TÜRASAS. Wherever possible, the position shall be such that any company information (Logo and brand etc) cannot be viewed when the relevant part is installed within the vehicle.

All labels shall be permanent and indelible.

## 6. RELIABILITY, AVAILABILITY, MAINTAINABILITY AND SAFETY (RAMS) REQUIREMENTS

### 6.1. RELIABILITY, AVAILABILITY, MAINTENABILITY & SAFETY (RAMS)

The vehicle concept shall be implemented in such a way that it is technically compatible with the existing vehicle fleet while also incorporating as many common parts (identical items to existing vehicles) as possible in order to enable efficient spare parts management for the operator.

The Contractor shall make RAMS analysis according to TB50165 (ref. [5]).

The Contractor must ensure proven RAMS processes in accordance with EN 50126, EN 50128, and EN50129.

## 7. TRAINING MANUAL

### 7.1. TRAINING

Comprehensive training courses, covering the system/equipment supplied, shall be provided by the Contractor to TÜRASAS or Costumer/Train Operator personnel free of charge.

The level of training shall be congruent with the complexity and criticality of the system/equipment in object, therefore training performed by the Contractor shall be properly prepared in order to be efficient and effective.

This training shall give to the trainees a general overview of the system/equipment, of its performance, as well as sufficient knowledge for carrying out periodic maintenance of the system/equipment and its components, fault finding and repair and carrying out works both of preventive and of corrective maintenance. Additionally the Contractor shall give detailed training about assembly/disassembly of system/equipment.

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Generally the training activities are divided in two steps; the first concerning a general description of the system/equipment and depth training for carrying out scheduled maintenance needed during the first 2 years of operation.

The second step completes the knowledge about all maintenance aspects with particular care to overhaul activities.

The Contractor shall give 15 days training for TÜRASAS personnel for the equipment in TÜRASAS.

The training documentation shall be prepared in English and Turkish languages in number of participants by the Contractor. The language of the training shall be supplied in Turkish by the Contractor.”

The bidder shall propose and detail in the tender phase the training activity to be carried out.

Then TÜRASAS and the Contractors will discuss and agreed details pending on End Client requirements.

## 7.2. MAINTENANCE MANUAL

### 7.2.1. MAIN FEATURES OF THE MANUAL

The Contractor shall prepare integrated manual for the operation and maintenance of its scope of supply equipment.

The manuals shall contain:

- supplied system/equipment description
- preventive maintenance tasks description
- corrective maintenance tasks description (repair instructions included)
- information in order to carry out the overhaul of the system/equipment and the heavy repair (if it is repairable and off Loco).

The manual will be used as the basis for LOCO operation and maintenance by Final User staff.

The manual shall be prepared in electronic editable format and the language UK English and Turkish.

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## 7.2.2. CONTENTS OF THE MANUAL

The manual shall contain as minimum the following information/instructions:

### Description and Operation

- General description and operation of system/equipment
- Functional description and operation of all LRU's and components
- Mechanical and electrical data sheets for all LRU's and components.

### Maintenance Activities

- Preventive Maintenance Plan including the maintenance periodicity (frequency) table for system/equipment.
- Reported information shall be the same of those described by the Preventive Maintenance analysis and be linked with detailed Maintenance Instructions.
- Preventive Maintenance Plan shall report reference to specific/special tools needed for the maintenance works (if used).
- Maintenance Instructions shall report step by step detailed description of each task of the maintenance plan in order to include all information necessary for carrying out the relevant work.
- The Preventive Maintenance Plan shall include all activities foreseen for the system/equipment from daily inspection up to major repair/overhaul.

### Preventive Maintenance card/instruction

Each maintenance instruction shall include:

- task periodicity
- safety warnings
- cleaning materials
- recommended lubricants
- torque values
- special tools (if any): as special tool is intended either a tool (hardware and/or software) that is exclusively produced by the Contractor and is essential for system/equipment maintenance, either a tool available on market but expensive, sophisticated, with long lead time and so on
- step by step activity description with necessary schemes, drawings and illustrations, including:

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- scheduled activities (greasing, topping up, visual check, etc)
- removal and refitting
- off- LOCO overhaul
- final functional check

The Contractor is responsible to update the maintenance instructions until the end of the general warranty period of the last supplied equipment.

#### **Corrective Maintenance card/instruction**

Each maintenance instruction shall include:

- trouble shooting
- safety warnings
- torque values
- special tools (if any)
- step by step activity description with necessary schemes, drawings and illustrations, including:
  - removal and refitting
  - off- LOCO repair
  - failure diagnosis
  - final functional check

The Contractor is responsible to update the maintenance instructions until the end of the general warranty period of the last supplied equipment.

#### **Special tools**

The use of special tools shall be avoided, nevertheless if they are essential for maintenance (upon Contractor and TÜRASAS agreement), following information shall be supplied in a dedicated section of the Maintenance Manual:

- descriptions and technical data (including SW if present)
- drawings
- use instructions

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- list of tasks where the tools usage is mandatory (and of course Maintenance Cards shall refer to the relevant special tools when is needed)
- all the information for purchasing it correctly (technical data, builder, price, and so on) if the special tool is available on the market

### 7.2.3. FORMAT OF THE MANUAL

The format of the Maintenance Manual can vary according to the Company and the Final User requirements, therefore here following are reported some rules generally applicable.

Specific requests shall be communicated when available.

- The Manual shall report/contain the same references, drawings, schemes, component codes, Part Numbers, definitions, descriptions, terminology and so on used in the system/equipment configuration and design documentation to guarantee a perfect correspondence and to avoid mismatching during tasks performance.
- It is highlight the importance for a correct identification of LRUs/components by utilizing the same identification name reported by the technical drawings.
- The Manual shall be transmitted by electronic means (CD copy) and in the final version a paper copy is also requested for each release.
- The documentation in electronic format shall be in a completely editable form (Office Word version TBD)
- The PDF format can be used as formal delivery of the documentation (in order to be used as official delivery towards Final User)
- Pictures and photos shall be inserted and not simply linked.
- Photos should be only JPEG format.
- Pictures should be only TIFF format.

Derogations from above listed issues can be discussed and agreed between TÜRASAS and the Contractors pending the respect of Final User requirements.

## 8. TESTING, INSPECTION AND ACCEPTANCE

The CoCo LOCO shall be certified following the TSI LOC&PAS regulation. If the compoment shall be satisfy the TSI, the Contractor shall be responsible for all relative certification of the equipment presented to NoBo.

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### 8.1. INTRODUCTION TO TEST AND INSPECTION

The Contractor shall perform the tests and the inspection in accordance with the Approved Test Procedure and the Approved Inspection Specification.

TÜRASAS and/or end Client have the right to witness any of these tests and inspections at any stage of test and inspection procedure.

Type test can be waived if system or components are already proven and confirmed to waive by end Final User. In that case, the Contractor shall provide old test report or certificate to submit for approval.

All test and inspection specifications and reports including all repair activities and check-lists shall be submitted and approved by TÜRASAS.

The following prescription shall be observed if the test is defined as a type test in TSI:

- The procedure shall be shared and approved by NoBo,
- The test, and relative documentation, shall be done in either an accredited lab, or with the NoBo attendance
- The test, that will be done on the vehicle, shall be planned in coordination with NoBo (attendance required), Supplier and ADM

### 8.2. TYPE TESTS

Type tests are required to verify that the components of the system object of the scope of supply, operate in accordance with the Approved Design Data.

The Contractor shall perform Type Tests, in accordance with a test procedure approved by TÜRASAS with TÜRASAS and/or End Client participation.

During testing, the criteria shall be observed and recorded. All alterations, adjustments and maintenance works required by TÜRASAS shall be carried out by the Contractor.

The Contractor has the responsibility for the success of mentioned Type Tests.

### 8.3. ROUTINE TESTS

Routine tests are required to verify that the components of the system object of the scope of supply have been built in such a way that it satisfies the requirements of the Approved Design Data as verified by the Type Test.

The Contractor shall perform routine tests in accordance with a test procedure approved by TÜRASAS under his responsibility, and, if necessary, with TÜRASAS participation.

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During tests, the criteria shall be observed and recorded and necessary alterations, adjustments and maintenance works shall be carried out.

Records from Routine tests shall be kept by the Contractor and made available timely for TÜRASAS and/or end Client's inspection.

All copies of the approved routine test results shall be submitted. Additional copies of records of all tests/inspections results shall also be kept at the Contractor's work to be made available to TÜRASAS or their representative on demand.

This test shall include functional test, visual inspection and dimensional inspection, as a minimum. The test details shall be approved.

#### 8.4. FIRST ARTICLE INSPECTION

The Contractor shall perform a First Article Inspection (FAI) of the components of the system object of the scope of supply at the Contractor's factory with TÜRASAS and/or end Client participation in accordance with an inspection specification approved by TÜRASAS and/or end Client, prior to serial production in order to confirm that the hardware & software fully complies with the Contractor's scope of supply design and manufacturing process. Contractor shall submit FAI test procedure to TURASAS at least 4 weeks before FAI. If any changes are requested by TURASAS, Contractor shall comply with these requests.

At the FAI, the Contractor shall make available all pertinent design and manufacturing process documentation, test records, material certifications, etc. Should all the requirements of the FAI not be met, then the inspection shall be considered at a Hardware Review.

Upon acceptance of the FAI by TÜRASAS and/or end client, the Contractor is then free to proceed to manufacture all pertinent hardware. The hardware shall meet or exceed the quality standards set at the FAI, and must incorporate any comments made by TÜRASAS and/or end client at the FAI.

All domestic / international accommodation and travel expenses (international departure and arrival flight tickets, transportation between accommodation and workplace) of all Administration personnel who will go to the Contractor's facilities for the First Article Inspections (FAI) will be borne by the Contractor. ADMINISTRATION personnel will participate in First Article Inspections with a maximum of 20 person/day.

#### 8.5. SUPPLIER TECHNICAL ASSISTANCE

The Contractor shall provide all the technical assistance necessary for the first installation of the system(s) at TÜRASAS.

Installation procedures and check lists shall be provided during this operation in order to be verified and validated. Details will be discussed during evolution of the project.



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The Contractor shall attend to installation of equipment on the first LOCO, to commissioning in TÜRASAS and also to track test on Turkish Railway Network.

## 8.6. COMMISSIONING

### 8.6.1. TYPE COMMISSIONING TEST

For the first prototype LOCO, the Contractor shall perform static (factory test on TÜRASAS workshop) and dynamic commissioning (on track) tests for the system to adequately demonstrate the requirements of TS, in accordance with a test procedure to be prepared by the Contractor and approved by TÜRASAS, under TÜRASAS participation.

### 8.6.2. ROUTINE COMMISSIONING TEST

On the serial LOCOs, routine commissioning test for the system will be performed by TÜRASAS in workshop and service track under the Contractor's responsibility.

## 9. AUTHORIZATION TO START PRODUCTION

The Administration will authorize the Contractor to start production according to the following stages.

### 9.1. DESIGN FREEZING

After the contract is signed, procurement scope Design Freeze meetings will be held with the participation of ADMINISTRATION and the Contractor. The date and place of the meetings will be mutually agreed.

### 9.2. AUTHORIZATION TO START PRODUCTION

According to the final design criteria mutually agreed upon as a result of the design freeze meetings, the ADMINISTRATION will authorize the Contractor to manufacture the first product(s) within the scope of supply.

### 9.3. AUTHORIZATION TO START MASS PRODUCTION

The Contractor will be authorized by the Administration to start mass production after the FAI (First Product Inspection) is performed on the first product(s) produced by the Contractor after receiving the Authorization to Start Production.

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## 10. ACCEPTANCE

### 10.1. TEMPORARY ACCEPTANCE

Temporary acceptance report shall be issued by TÜRASAS after followings have been covered:

- All required components have been delivered.
- All documents have been delivered.
- Routine tests and/or controls (physical inspections, dimension and tolerance control, appearance control, document/report and certificate controls etc.) to be carried out at TURASAS have been successfully completed.

### 10.2. FINAL ACCEPTANCE

Final acceptance report shall be issued by TÜRASAS after Track tests of system for first two LOCOs have been performed successfully.

## 11. PACKAGING AND STORAGE CONDITIONS

### 11.1. PACKAGING

System/equipment/components shall be delivered in suitable packages with adequate strength to be resistant against shocks and transportation damages including effects of dust, rain, snow, solar, wind etc. in the climatic conditions.

Packing boxes shall be convenient for stacking one on another and shall allow easy lifting by fork-lift truck (where reasonably applicable) or travelling bridge-crane.

Following information shall be reported on the package (in a legible, non-erasable and non-removable mean).

- Name, address and registered logo of the manufacturer.
- Assembly Part Number and applicable Tech. Specification reference.
- Date of manufacturing and serial number (if applicable).
- Date and number of the contract.

Furthermore, if the content of a box consists of more than one component, a components list shall be added inside and outside of the box and each individual component shall be labelled. Determination of the content of these boxes shall be performed with the participations of TÜRASAS. Generally, TÜRASAS anticipates packs are divided for one locomotive production. Also, packs should be divided for different production lines, i.e. mechanical and electrical. Lists of the boxes shall be finalized after approval of the lists by TÜRASAS. A copy of each list shall be sent to TÜRASAS at the beginning of the shipment.

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The Contractor shall deliver the equipment that has been supplied for receipt with the manufacturing completed covered in suitable plastic so as not to be affected by environmental factors such as rain, wind and snow and so as not to be damaged during dispatch and stocking; and tied to wood crates from the outside to prevent dispersing. The Contractor shall deliver the products prepared in this form to the TÜRASAŞ Eskişehir Regional Directorate at their own cost.

There will be pallets under the crates so that the load can be discharged with a forklift. The weight of the crates with material will not exceed 400-500 kg. On the crates, the name of the contractor, the name of the material, the order, classification, (technical specification number) and drawing number, the number of parts in the crate, the serial numbers of the parts, the date of manufacture, the contract number, the packaged product quantity, product name, batch number, if any, etc. (not to be affected by climatic conditions) will be specified. The list containing this information will be delivered on the basis of the crate, together with the delivery note and invoice.

The materials shall be placed inside the crates wrapped in a suitable thickness of plastic bubble wrap that will not allow the material to be affected by climate and environment conditions like rain, wind and snow or to be damaged during loading, dispatching and stocking.

If the packaging and/or the delivery documents of the products are not complete and/or not suitable this will be entered on record and the products will be returned to the company without completing the delivery process. If the returned materials are resubmitted after the delivery date specified in the contract the late fine specified in the contract shall accrue. The Contractor shall not claim any rights for delays due to the packaging.

The contract number, the amount of product in the packaging, the product name and party number if any, etc. as well as the “Project Name: National Co-Co Type Locomotive” shall be on the packaging.

## 11.2. STORAGE CONDITIONS

The Contractor shall provide any useful information it is deemed necessary for the correct storage of the goods delivered.

## 11.3. MOUNTING AND HANDLING

All the components shall be supplied ready for installation and possibly already mounted and pre-regulated. Special care is requested to the Contractor to list all the necessary tools for mounting and maintenance.

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## 12. DOCUMENTS TO BE DELIVERED TO THE ADMINISTRATION ALONG WITH THE PRODUCT/EQUIPMENT

The following tables report the list of requested documents (with schedule) to be supplied to TÜRASAS.

Table 6 shows the documentation which shall be given by the Bidders in the offer phase.

Table 7 and Table 8 show the documentation which shall be provided by the Contractor for the Preliminary Technical Review and the Detail Technical Review respectively.

Id.	Stage 1 -OFFER Phase	Time Schedule	Language
1.1	Clause by Clause commentary of present Tech. Specification	With offer	Turkish and English
1.2	Preliminary 3D models or installation drawings showing the main external space envelope		English
1.3	Declaration of Conformity to applicable standards According to EN17050		English
1.4	EC Declaration of Conformity according to the TSI LOC&PAS 1302 if the scope of Supply is considered “Interoperability Constituent”		English
1.5	IRIS Certification of the Bidder (If the Bidder is an agency of the manufacturer, the Bidder shall show the manufacturer’s certificate)		English
1.6	Sub-Contractor List		English

**Table 6 – Stage 1 Offer Phase: list of requested documents and due date**

Id.	Stage 2 - PRELIMINARY Review	Time Schedule	Language
2.1	First level drawings with weight and centre of gravity indications in 3D and 2D formats	Within one month after signing the contract	English
2.2	Technical description of the system, with system characteristics and performance		English
2.3	Functional description (normal and degraded mode) of the system, included diagnostic description		English
2.4	Design justification analysis reports		English
2.5	Definition and specification of applicable I/F’s characteristic (mechanical, pneumatics, electrical, signals, I/O data, etc.)		English
2.6	Certificates of the fire smoke behaviour of non-metal materials and electric cables		English
2.7	Certificates of behaviour versus applicable emissions requirements		English
2.8	Preliminary applicable analysis reports (performance, consumptions, structural strength, etc.)		English
2.9	Scope of supply list		Turkish and English

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Id.	Stage 2 - PRELIMINARY Review	Time Schedule	Language
2.10	General description of the proposed system, including all the characteristics and functionalities and technical documentation and information requested in this specification as preliminary		Turkish and English
2.11	Preliminary applicable schemes		Turkish and English
2.12	Preliminary definition of main I/F characteristics with the other LOCO systems		Turkish and English
2.13	List of tests (FAI, routine, type, commissioning and homologation) that shall be performed on components and systems		English
2.14	List of special tools and test equipment		Turkish and English
2.15	Design schedule, in line with project milestones		Turkish and English
2.16	Detailed part list with price information of each part		Turkish and English

**Table 7 – Stage 2 list of requested documents and due date**

Id.	Stage 3 - DETAIL Review	Time Schedule	Language
3.1	Definitive drawings with weight and centre of gravity indications in 3D and 2D format.	Within one month before FAI and with product/equipment delivery	English
3.2	Definitive schemes		English
3.3	Installation drawings		English
3.4	Installation instruction		Turkish and English
3.5	Detailed description of the supplied components or systems		Turkish and English
3.6	All the technical documentation and information requested during the project (including final version of documents of previous stages)		Turkish and English
3.7	Procedures of tests (FAI, routine, type, commissioning and homologation) performed on components and systems		Turkish and English
3.8	Available reports of tests (routine, type, commissioning and homologation) performed on components and systems		English
3.9	List of special tools and test equipment		Turkish and English
3.10	LRU list		Turkish and English
3.11	Spare Parts and Equipment List (including order codes)		Turkish and English
3.12	Escalation formula for spare parts		English
3.13	Servicing and lubricating table		Turkish and English
3.14	Final documentation for Certification		Turkish and English
3.15	EC Certification according to the TSI LOC&PAS 1302 if the scope of Supply is considered "Interoperability Constituent"		English
3.16	RAMS and LCC documentation: see dedicated paragraphs		Turkish and English
3.17	User Manuals		Turkish and English

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Id.	Stage 3 - DETAIL Review	Time Schedule	Language
3.18	Maintenance Manuals (including periodic maintenance Schedule) (including failure repair documentation)		Turkish and English
3.19	Calculations, tests and analysis report requested by TSI		Turkish and English
3.20	3.1 certificates of the product/equipment according to EN 10204		English
3.21	Documents showing compliance to EN 45545-2 (Certificate of Conformity, Test Report etc.)		Turkish and English
3.22	Guarantee documentation		Turkish and English

**Table 8 – Stage 3 list of requested documents and due date**

The Bidder/Contractor shall review and confirm the above lists of documents for all the phases of the project. Any deviation shall be submitted to TÜRASAS for approval.

The IRIS certificate submitted by the Bidder in Stage 1 will be examined by the Administration for compliance with the scope of the product/work subject to tender.

The documents specified in Stage 3 shall be delivered to the ADMINISTRATION both before the FAI and together with the product/equipment. The documents to be delivered by the Contractor in Phase 3 shall be provided to the ADMINISTRATION in 2 (two) USB devices and in hard copy.

Notes:

- 3D models of all components shall be provided, shall be in “.step” format and shall be complete with all elements, connectors included. In the 3D model connectors can be separated from the model to be used for the harnessing design
- 2D drawings shall be provided in .dwg or dxf format (plus PDF).
- Electrical schemes shall be provided in .dwg or dxf format (plus PDF).
- Other documents shall be provided in an editable format and in .pdf format.
- In the documentation, the Turkish version shall prevail in case of utilisation both Turkish and English languages.
- All documents in stage 1 shall be provided as hardcopy and softcopy in “CD” or “USB”

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### 13. INTELLECTUAL AND INDUSTRIAL PROPERTY ISSUES

- 13.1.** Any projects and documents shared with the Contractor within the scope of the work subject to the tender shall not be used for any other purpose. The Contractor shall share all technical information only with the Administration
- 13.2.** Administration shall be authorized to use the products to be supplied by the Contractor (right of usage) – without prejudice to any mandatory legal provisions applicable and without any detriment to the Contractor’s dignity and reputation.
- 13.3.** In case of proven violation of an intellectual and / or industrial property rights by the Contractor, the Contractor shall be liable for any direct, reasonable and properly documented damages resulting directly from such violation. If the Administration faces legal sanctions, it is allowed to recourse such sanctions to the Contractor within the scope of liability of the Contractor mentioned above. Upon the request of the Administration, the Contractor is obliged to fully inform and certify to the Administration whether the service to be undertaken is a matter of intellectual and industrial property.
- 13.4.** This technical specification is a part of the contract between the Contractor and the Administration. The Contractor does not have the authority to distribute this document or any part of it to third parties without the approval of the Administration.
- 13.5.** If an official document is requested and mutual communication causes any mistake; all possible information requests and their responses shall be made in written format and via e-mail.

### 14. GUARANTEE

#### 14.1. WARRANTY CONDITION

Contractor shall guarantee the quality of products within the scope of this specification against malfunctions, failures and assembly and workmanship defects.

While the warranty period is limited to 30 months starting with the date of delivery of the products to TÜRASAS, it is 24 months starting with the commercial commissioning of the LOCO.

The responsibility of performing preventive maintenance on the normally used parts and the protective maintenance in cases where it is evidently clear that the root cause is not the own malfunctions of the unit, shall belong to TÜRASAS.

Throughout the warranty period, following the notification by TÜRASAS of any malfunction, the Contractor shall respond to that malfunction within three (3) working days and replace the malfunctioning parts and equipment or repair and fix the malfunction. The Contractor shall make available in Turkey throughout the warranty period the required service facilities (service center) in



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order to respond to the possible malfunctions and a sufficient number of spare parts or fully complete equipment within this time period.

Responsibility for making sure that none of the information, document, certificate, component, system, machine, software, technology and design the Contractor supplies to the Administration violates any brand, patent or third-party ownership rights belongs to the Contractor.

The contractor company shall provide a 10 (ten) year service and spare parts guarantee, valid from the end of the warranty period.

#### 14.2. SYSTEMATIC FAULT / EPIDEMIC FAILURE

During the warranty period, if a failure covered by the warranty occurs in more than 15% of the first 24 locomotives and more than 10% of the 25th and the following locomotives in the same parts/components for the same reason, this failure will be considered an “epidemic failure.”

In addition, if mean time between failures (general average failure time) for the failures occurring in main components/parts used in all sets within annual periods during the guarantee term is shorter than guaranteed MDBF or MTBF value, such failure shall be deemed as an epidemic failure.

In case of confirmed systematic faults, proper investigations shall be done in order to define a proper technical solution or modification including Spare Parts modification or replacement.

#### 15. OTHER ISSUES

**15.1** For matters not specified in the technical specification, the administrative specification shall apply.

**15.2** The Contractor is responsible for all transportation costs.

**15.3** The Contractor is responsible for work accidents that may occur during the work of the Contractor personnel at TÜRASAŞ.

**15.4** The food and accommodation costs of the supplier personnel belong to the Contractor.

**15.5** The Contractor must comply with T.B. 2348 in its work within the boundaries of TÜRASAŞ.

**15.6** The Contractor must comply with the safety, protective safety, occupational health and safety instructions and provide the protective materials required by the work and follow their use.

**15.7** The contractor must comply with all kinds of warnings, signs and writings within the boundaries of TÜRASAŞ.

**15.8** All software used by the contractor (Computer Aided Design Programs (CATIA, AutoCAD etc.), MS Office. FEM Analysis Programs etc.) will be licensed. All responsibility in this regard belongs to the Contractor.

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**15.9** The Contractor is responsible for all kinds of damages and losses to TÜRASAS or third parties in relation to the obligations fulfilled within the scope of the work subject to the tender.

## 16. ANNEXES AND NOTES