TS400049

GENERAL TECHNICAL SPECIFICATION OF DIESEL COCO LOCOMOTIVE

R&D Centre Coordinator	Tuba N.EROĞLU			
Locomotive Factory Manager	Meral TUNA			
Electrical Machinery Factory Manager	Güzin TUTAR			
Bogie Factory Manager	Şeref ÇİMEN			
Quality Control Coordinator	Serkan ÇÖKMEZ			
Prepared by	Taner YALÇIN	Yalçın KOŞAR	Onur KAÇMAZ	Ahmet PATLAK
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REVISION TABLE

Rev	Date	Description	Revised By
00	26/08/2025	First release	

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1. SUBJECT AND SCOPE

This technical specification defines the minimum technical requirements for the Diesel Co-Co Axle Arrangement Locomotive (hereinafter referred to as DSL) to be used in freight transportation and to be manufactured by Türkiye Raylı Sistem Araçları Sanayii AŞ (hereinafter referred to as TÜRASAŞ).

2. DEFINITIONS & REFERENCE DOCUMENTS

2.1. INTRODUCTION

Within this Technical Specification, the following definitions are applied:

- **End User:** Legal entities or individuals operating on the national railway lines of the Republic of Turkey
- **Administration:** Turkish Railway Vehicles Industry Inc. (TÜRASAŞ)
- **Designer:** Third legal or private entity responsible for the design of the electric and diesel-electric COCO LOCO
- **Contractor:** The company that won the tender and will supply the products covered by the relevant technical specifications.
- **Documentation:** 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.
- **Bidder:** means the company who want to join to the tender to supply the good object of this specification
- **Traction and Auxiliary Power (APS) System Contractor:** The company which will supply the integrated drive system, which includes all electrical components and auxiliary power unit systems involved in the process of converting energy from its source or supply point into mechanical power via traction motors and transmitting it to the wheels, as well as the sub-components of these systems, for electric and diesel-electric Coco locomotives.

2.2. ACRONYMS AND DEFINITIONS

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

ADMINISTRATION	TÜRASAŞ
Admin. Personnel	TÜRASAŞ and/or Co-Co Project working groups assigned in the relevant subject
AC	Alternating Current
BCU	Brake Control Unit
BP	Brake Pipe
CAD	Computer Aided Design
CPU	Central Processing Unit
DC	Direct Current
DSL	Diesel Type Loco of Co-Co Axle Arrangement
DI	Digital Input
EB	Emergency Brake
ED	Electro Dynamic
EDB	Electro-Dynamic Brake
EMC	Electromagnetic Compatibility
EN	European Norm
ERTMS	European Rail Traffic Management System
ESRA	Electronic System for Railway Application
FAI	First Article Inspection
FEM	Finite Element Method
FPMK	Failure Per Million Kilometre
GPRS	General Packet Radio Service
GPS	Global Position System
HV	High Voltage
HVAC	Heating, Ventilation, & Air Conditioning
HSCB	High Speed Circuit Breaker
I/O	Input / Output
IEC	International Electro-technical Commission
IP	Protection
IRIS	International Railway Industry Standard
ISO	International Organization of Standardization
LED	Light Emitting Diode
LRU	Line Replaceable Unit
MBP	Main Brake Pipe
MRP	Main Reservoir Pipe
MV	Multiple Vehicle
MVB	Multiple Vehicle Bus
N/A	Not Applicable
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 and Safety
SI	International System
ST	Standard

SKD	Unassembled Product
TBC	To be confirmed
TBD	To be defined
TCDD	Turkish State Railways General Management
TCDDT	Turkish State Railways Transportation Inc.
TCMS	Train Control & Monitoring System
TCU	Traction Control Unit
TOR	Top of Rail
TSI	Technical Specifications for interoperability
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)
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 NOI	Document 1304/2014 / EU of the European Commission (technical specification for interoperability relating to the subsystem rolling stock — noise)
TÜRASAŞ	Turkish Railway Vehicles Industry Inc.
TSE	Turkish Standards Institute
UNI	National Standards Unit
UIC	Union International Chemin de Fer
VCU	Vehicle Control Unit
WSP	Wheel Slide Protection
WTB	Wire Train Bus

Table 1 – Acronyms and Definition

2.3. REFERENCE DOCUMENTS

In the following table the documents used for reference document.

Ref	Document	Title
1	TB50160	Standard List
2	TB50161	Fire Classification
3	TB50172	Thermoacoustic Behaviour
4	TB50192	Traction Performance Diesel
5	TB50170	SIL Level
6	TB50165	RAMS Targets Allocation
7	012GX2000301-000	General Layout Diesel

Table 2 –Reference Documents

3. STANDARDS TO BE COMPLIED

The design, assembly, and testing activities of the DSL project will be carried out in accordance with the following nationally and internationally recognized reference standards.

- **European Standards**: TSI, EN
- **International standards:** UIC, ISO, IEC
- **Other International Standards:** DIN, NF F, UNI, CEI, etc.
- **National Standards:** Technical documents published in accordance with TSE directives and related annexes
- **Unit System to be Used:** SI (International System of Units)

Bidders and Contractors shall comply with the directives, standards, and requirements listed in the order of priority defined above in their conformity assessments and/or in other conditions that are not specified in the Technical Specifications but are relevant to the product covered by the technical specifications and the equipment and subcomponents that constitute this product.
In cases where compliance with these directives, standards, and requirements is not possible, other relevant international standards, European standards, national standards, and TCDD guidelines, as well as the conditions required by national legislation, may be used.

If a standard of a higher priority contains omissions regarding the particular matter, such omissions shall be removed by the next standard.
In case of a revision in the standards/norms referred to herein while the work is in progress, the Contractor shall:

- Inform in writing the Administration within 20 (twenty) business days after the revision has been published and put into force.
- Make the necessary processes for adaptation to the new situation no later than 1 (one) calendar month after the revision has been published and put into force and submit them to the Administration for approval. However, this approval process cannot exceed two months (60 calendar days) from the date on which the change to the standards/norms is published and enters into force.
- The Administration shall review the process within 15 (fifteen) business days and forward their decision to the Contractor.

The change of directives, standards, norms will not prevent the completion of the certification. Bidders and Contractors shall review the relevant technical specifications and annexes and confirm that the system/equipment covered by the specifications complies with the relevant standards. If in this technical specifications and its annexes, there are:

- Conflicts with or violations of international standards
- Problems to arise in case of implementation;
- Points that need to be revised technically;
- Matters that are not mentioned in the technical specifications and its annexes, but are necessary/mandatory for the manufacturing of the vehicle,

the Contractor is obligated to report these (together with the Contractor's proposals) in writing to the Administration.

For equipment that is within the scope of the above standards, products that comply with the latest versions of the standards (or their international equivalents) will be selected.

The full list of standards to be complied with is specified in document TB50160.

4. ENVIRONMENT

4.1. CLIMATIC CONDITION

The DSL will be reliable and suitable for continuous operation without being affected by any environmental and atmospheric conditions that may be encountered during service under the climate conditions specified below (temperature, rain, snow, ice, dust, wind, etc.)

General climatic conditions, following the EN 50125-1, are reported below:

Temperatures	
Max. temperature inside of the car (driver and crew constant presence, not machine room)	+ 55 °C
Max. external temperature (shade)	+ 45 °C
Min. internal/external temperature	- 25 °C
Precipitations	
Max. Amount daily	73 Kg/m²
Annual areal precipitation	556,2 mm/m²
Min. areal precipitation	380 mm
Max. areal precipitation	930 mm
Max snow	100 mm
Other Conditions	
Monthly mean relative humidity (summer)	50 %
Monthly mean relative humidity (winter)	85 %
Ambient	Sand Dust
Weather conditions (summer)	Hot Dry
Weather conditions (winter)	Cold Humid
Sun Radiation	
Sunshine duration per year	2986 hours
Radiation rate per year	2080 kWh/m²
Max sun radiation	1120 W/m²
Max. Sun exposition	8 hours

Table 3 - Climatic conditions summary

4.2. ALTITUDE

The maximum altitude for the DSL service is 1400 m above sea level (according to EN 50125-1 § 4.2 class A1).

4.3. HUMIDITY

The DSL will operate in the following outdoor humidity levels in accordance with EN 50125-1 §4.4:

- Annual average : Relative humidity $\leq 75\%$
- 30 days during the year : Relative humidity 75% - 95%
- Other days, occasionally : Relative humidity 55%–100%

4.4. TEMPERATURE RISE

The temperature rise will be measured according to the procedure stipulated by IEC and complies with the limits specified and the ambient conditions defined in the Specification.
Specified temperature rise of equipment are calculated after taking into account at least 25% choking of air filters and radiator fins etc.

4.5. QUICK TEMPERATURE VARIATIONS

The considered quick outside temperature variations are of 3°C per second, with a maximum variation of 40°C, in accordance with paragraph 4.4 of standard EN 50125-1.

4.6. WINDS

The wind speeds to be considered in the design of E-Coco Loco and its sub-assemblies have been determined in accordance with clause 4.5 of the EN 50125-1 standard.
The maximum wind speed to be considered for ventilation, cooling, and similar equipment is 35 m/s.
Exceptionally, winds up to 50 m/s will be considered for locomotives in a stationary position.
Under these conditions, the performance of the equipment and/or vehicle may be temporarily affected; however, no permanent damage shall occur.

4.7. MAXIMUM PRECIPITATION (RAIN, SNOW, BLACK ICE)

Rain precipitation: 6 mm/min, as per EN 60721-3-5 class 5 K3.

Snow, black ice precipitation: The criteria of **class S1** of standard EN 60721-3-5 shall be applied.

To complete the indications in paragraph 4.6 and 4.7 of standard EN 50125-1, the following shall be considered for more severe condition of snow, ice and hail according to TSI RST 1302/2014 (LOC&PASS) § 4.2.6.1.2 (3):

- Snowdrift: Light snow with low water equivalent content, covering the track up to 80 cm continuously above top rail level.
- Powder snow: Snowfall of large quantities of light snow with low water equivalent content. Ice formation on vehicles due to temperature gradient, temperature and humidity changes within a single working period will be taken into account.
- Combined effects with temperature: Depending on the selected temperature zone, combined environmental conditions with the effect of low temperature will be taken into account as defined in clause 4.2.6.1.1.

In accordance with clause 4.8 of standard EN 50125-1, ice formation likely to occur on the stock or equipment, in temperatures under 0°C, shall not lead to any degradation prejudicial to the stock's or equipment's operation and to its utilisation (the nominal performances are to be maintained).

4.8. SOLAR RADIATION

Solar radiation: **Class R2** according to EN 50125-1 standard will be applied.
The vehicle and all sub-equipment will be designed to protect against ultraviolet (UV) rays.
The Loco shall meet requirements laid down in paragraph 4.9 of standard EN 50125-1.
Maximum exposure period to the sun is 8 (eight) hours.

4.9. POLLUTION

Along with the weather conditions, it is necessary to take into account the solid and gas pollutants in ambient air. Regarding above listed items, the EN 50125-1 § 4.11 and the following standards shall be considered (only for polluting substances):

- **Gas pollutants:** the levels defined by the class 5C2 of standard EN 60721-3-5.
- **Pollutant fluids:**
    - For electric power motor: EN 60721-3-5 Class 5F2
    - For thermal motor: EN 60721-3-5 Class 5F3
- **Active biological substances:** EN 60721-3-5 Class 5B2

- **Dust:** EN 60721-3-5 Class 5S2.
- **Other pollutants:** Related classes of EN 60721-3-5.
- **Marine ambient:** EN 60721-3-5:1997 Class 5C2.

4.10. LOCOMOTIVE STORAGE CONDITIONS

The Locomotive could eventually be stored outside and uncovered for several weeks under the weather conditions described above.

4.11. CLEANING

The Locomotive and its equipment are designed so as to be efficiently protected against corrosion. Special measures have been taken to avoid any electrolytic corrosion (different-nature metal materials in contact with each other).

Outside cleaning will be made either through a washing machine, or manually.

Any specific targets relating to cleanability shall be clearly stated in the technical specifications by the supplier of the relevant equipment, if applicable.

The carbody shell, as well as the exterior elements such as access doors, fairings, boxes, hatches, windows, are designed to not lead to any deterioration of the equipment, nor of the washing machine (bristles being pulled out).

5. BASIC DETAILS

5.1. TRACK INFORMATION

5.1.1. *Gauges*

The locomotive shall comply with the following gauges.

Static Gauge: TCDD Gauge

Kinetic Gauge: EN 15273-2.2013 + A1:2016; G2 + GI2

5.1.2. *Superelevation*

Maximum superelevation is 90 mm for operation.

5.1.3. *Cant Deficiency*

Maximum cant deficiency is 165mm.

Rail Cant is 1:40

5.1.4. *Maximum Gradient*

Maximum gradient in main line is 37‰.

5.1.5. *Minimum Radius*

The following prescriptions for minimum radius are applicable:

- Locomotive in depot: 80 m
- Locomotive in-service Line: 150 m

5.1.6. *Track and Circulation Characteristics*

Concerning other information about track curves and circulation characteristics not explicitly mentioned in this document are below:

- S-Curves
  - 150 m radius, 150 m radius with or without any straight portion in between
- Vertical curves
  - 2500 m on vertical

5.1.7. *Wheels & Track Profile*

The track rail profile: 60E1 (UIC60) with rail cant 1:40 and track gauge 1435 mm.

The nominal wheel profile: S1002.

5.1.8. *Applicable Routes and Traction Performances*

The applicable routes for the DSL performance assessment are specified in document TB50192. Below same extracts from the documents above.

The routes that have been considered for the simulations included in the documents above are:

- Malatya -Razi
- Bilecik-Karaköy
- Ankara-Istanbul compatibility test
- Iskenderun-Sivas Divriği single locomotive and double locomotive coupling compatibility test

Max Speed on 16 ‰ slope (km/h)	Starting Acceleration (m/s^2)	Average Acceleration 0-40 km/h (m/s^2)	Average Acceleration 0-120 km/h (m/s^2)	MALATYA - RAZİ 1500ton Forward Run time (sec)	MALATYA - RAZİ 1500ton Forward Average speed (km/h)	MALATYA – RAZİ 1500ton Forward RMS torque (Nm)
23	0 27	0.19	0.09	38666	55	2694

	1500 Ton Payload		1750 Ton Payload	
Diesel GenSet Electric Output	Average Electric Power (kW)	Load Factor (%)	Average Electric Power (kW)	Load Factor (%)
Forward track	1593	57%	1753	63%
Reverse Track	603	21%	662	24%
Overall	1097	39%	1208	43%

Table 4 – Diesel Traction performance

5.2. LOCOMOTIVE CONFIGURATIONS

The main requirements for the DSL are reported in the table below:

TYPE OF LOCOMOTIVE	DIESEL
Operation	Freight
Diesel engine power [kW]	Min. 2750 kW
Traction motor power, nominal conditions [kW]	6x450 kW
Traction motor power, degraded conditions (1 converter in failure) [kW]	3x900 kW
Axles configuration	Co-Co
Max. Speed [km/h]	120
Max. Axle load [t]	22,5
Multi traction availability	YES
Adhesion coefficient @start (min)	0,38
Adhesion force @start (min)	500kN
Continue tractive effort (min)	350 kN
Pull & Buff equipment	Chain coupler + side buffers
Operation period [years]	30 years, avg. 300 000 km annually
Max. Traction force [kN]	Min 500
Emission CO_2 level	Following stage V

Table 5 – Locomotive data

DSL is powered from a power pack installed inside the Locomotive.

The Power Pack is mainly composed by:

- Diesel Engine
- Generator System
- Cooling System
- Air Filtration System
- Exhaust Aftertreatment System

The output from generator system, supplies the power to the electric motor installed on the bogie.

5.3. LOCOMOTIVE MULTI MODE

Regarding multiple locomotive configurations (same family [CoCo] of loco), more than one (max 3) locomotive can be connected to the front booster, rear booster and coupled by complying with the connection conditions defined in A.1.1, A.1.2 and A.1.3 of the neutral section specified in EN 50367 Annex A.

5.4. POWER ARCHITECTURE AND USED VOLTAGE

In the figure below is reported the power line architecture:

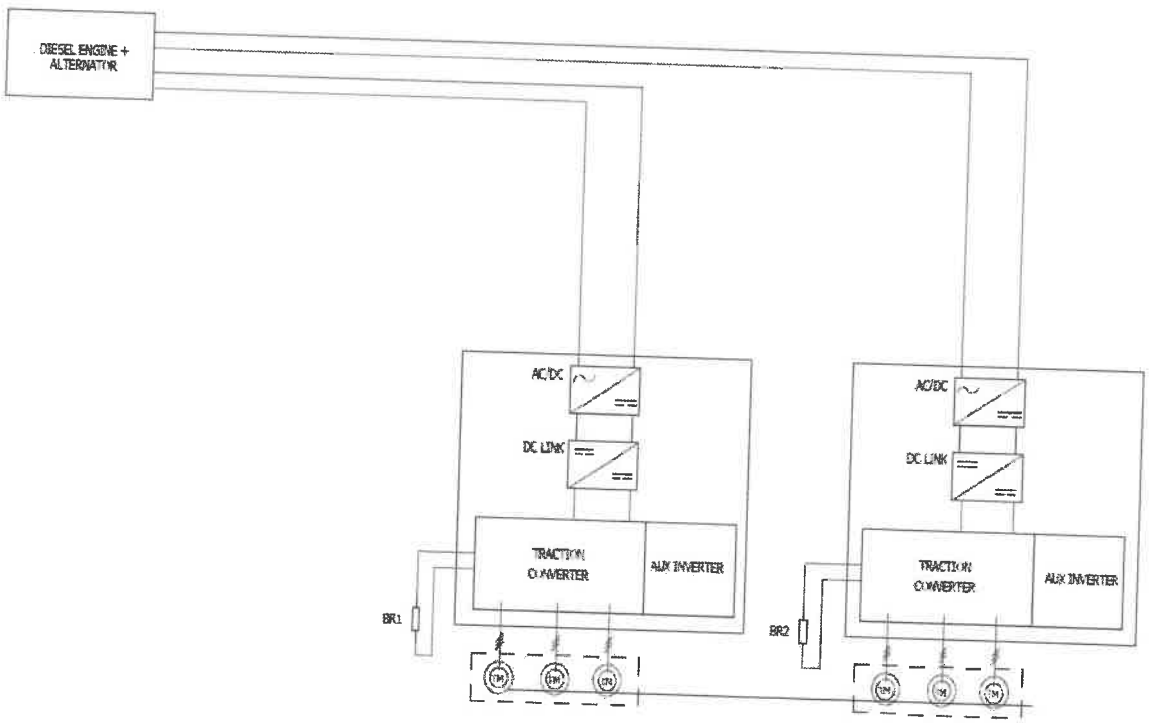

Figure 1 – SIMPLIFIED POWER ARCHITECTURE - DIESEL TYPE

For the DSL, the engine diesel represents the only or alternative power source to the traction system. The engine is connected to a high efficiency generator that delivers on demand the required energy amount to run the locomotive.

5.5. LOCOMOTIVE PERFORMANCE

5.5.1. *Mission Profile*

In the following tables are reported the Locomotive foreseen mission profile:

Yearly mileage	300.000	km/years
Daily average mileage	1000	km/day
Maximum Service Speed	120	Km/h
Average Service Speed	55	Km/h
Carbody and Main Equipment life (years)	30	Years

Table 6 – Locomotive mission profile

5.5.2. *Maximum Speed*

The maximum service speed is 120 km/h. The design speed, performed by DSL during the testing, will be 135 km/h.

5.5.3. *Axle Load*

The maximum axle load will be 22.5 Tons for each axle.

5.5.4. *Brake Performance*

The following braking modes are provided in the Locomotive

- Service brake
  - Electro-Pneumatic (EP) friction
  - Electric regenerative (dynamic) service brakes (ED)
- Parking brake: spring applied and pneumatic-released
- Fail safe
  - Fully Pneumatic (BP controlled) friction emergency brakes (Indirect brake IB)

The braking performance are listed in the following:

- Service brake (pneumatic only); min average braking deceleration: 0,8 m/s^2
- Emergency brake stopping distance: max. 900 m
- Parking brake permanently on slope of 40 ‰

The brake system is compliance with TSI.

The EP can complete the journey without ED.

5.5.5. *Acceleration or Deceleration Variations (Jerk Limit)*

Under all normal operating conditions, the rate of change of the Locomotive acceleration or deceleration (jerk) is less than $1 m/s^3$.

5.5.6. *Shock and Vibration*

Concerning vibration and impact and relevant issues applicable to electric, electronic and pneumatic constituents, the following standards are applied:

- EN 12663-1 Railway Application Structural requirements of vehicle bodies
- EN 61373 Railway applications - Rolling stock equipment - Shock and vibration tests

5.6. NOISE PERFORMANCE

The following are applied:

- **The measurement of interior noise:** will be made according to EN ISO 3381
- **The measurement of exterior noise:** will be made according to EN ISO 3095
- **The Technical Specification of Interoperability of Noise:** TSI 1304/2014 Amended 2023/1694
- The cab noise level must comply with UIC 651 Section 2.10 and TSI LOC&PASS 1302/2014 and TSI Noise 1304/2014/EC.

The requirements are resumed in the TB50172 Thermoacoustic behaviour.

The equipment installed on the Locomotive shall satisfy the requirements detailed in the above documents.

5.7. FIRE PERFORMANCE

The fire protection on the Locomotive is designed and constructed in accordance with TSI 1302 Loc&Pass.

The vehicle is classified as freight locomotive 2N (Operation and design category) as described in TB50161 Fire Classification.

The applicable Hazard level will be HL2.

The Locomotive is designed to prevent fire propagation by use of fire barriers:

- in the floor (cab area)
- in walls at ends of cab (division with equipment area)

The requirement is 15 minutes duration tested; refer to doc TB50161 for details [2].

The fire strategy prevention is described in TB50161 Fire Classification.

5.8. EMC

All components in the locomotive shall be designed and manufactured to meet all requirements specified in EN 50121-3-2.

5.9. RECYCLABILITY AND FORBIDDEN MATERIALS

The DSL shall be designed for optimal recyclability.

The equipment/systems materials shall not affect both safety and health of crews and maintainers or the environment.

Reference Norms are the following:

- The European regulation REACH RG 1907/2006
- UIC leaflet 345: Environmental specifications for new rolling stocks
- EN ISO 14025: Environmental labels and declarations — Type III environmental declarations — Principles and procedures
- EN ISO 14040: Environmental management - Life cycle assessment -- Principles and framework.

5.10. ELECTRIC GENERAL REQUIREMENT

The Low Voltage 0V level in the Locomotive is floating, so shall be avoided any 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.

6. LOCOMOTIVE GENERAL DETAILS

6.1. LAYOUT

The layout for DSL is depicted in the drawing ref. [7]:

6.2. MAIN DIMENSIONS

in the following table are reported the main dimensions of the DSL:

Description	Values
Loco length over coupler [m]	23,000
Width [mm]	2900
Roof height of car body from top of rail [mm]	4520
Wheel Diameter (new) [mm]	1250
Bogie centre distance (pivot distance) [m]	13,160
Floor height from TOR [mm]	1870

Table 7 – Locomotive main dimensions

6.3. MAIN COMPONENTS

6.3.1. *Main Components Distribution*

The distribution of the main components is depicted in the following table.

Component	Value
Cabin HVAC	2
Traction Converter	2
Auxiliary Converter	2
Cooling Traction Chain	2
Brake Package	1
Battery Box (110V)	1
Battery box (24V)	1
Power Pack (engine + alternator + exhaust + cooling)	1
Air Production	1
Fuel Tank	1
Urea Tank	1

Table 8 – Locomotive main components distribution

6.4. LOCOMOTIVE CAR DESIGN (BODYSHELL)

The Carbody-shell, in carbon steel, is composed by the following sub-assemblies:

- Underframe
- Cab structure
- Sidewall
- Roof

The design, the mechanical strength and the crash worthiness of the car body meets the following standard:

- EN 12663: Railway applications - Structural requirements of railway vehicle bodies
  The Locomotive category is L.
- EN 15227 Railway applications - Crashworthiness requirements for rail vehicles
  The Locomotive category is C-I.

6.5. DRIVER CAB DESIGN (GRP STRUCTURE)

The following norms are applied for the Locomotive driver's cab design:

- TSI RST 1302 (LOC&PASS)
- UIC 651 OR – "Layout of driver's cabs in locomotives, railcars, multiple units' trains and driving trailers"
- UIC 612 – "Driver Machines Interfaces for EMU/DMU, Locomotives and driving coaches - Functional and system requirements associated with harmonized Driver Machine Interfaces"

6.6. LOCOMOTIVE BOGIES

The Locomotive is fitted with two bogies each consisting of 3 powered axles.
The following scheme shows the bogies in the Locomotive with fitted components.

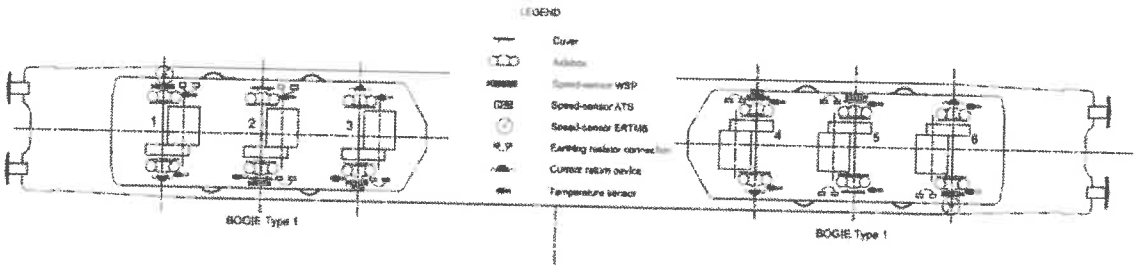

Figure 2 – Bogie Equipment Distribution

The bogie main characteristics:

DESCRIPTION	VALUE
Nominal axle wheelbase 1st-2nd	2150mm
Nominal axle wheelbase 2nd -3rd	2150mm
Nominal wheel diameter	1250 mm
Worn Wheel Diameter	1170 mm
Track gauge	1435 mm
Primary suspension	Flexi coil springs
Secondary suspension	Rubber-metal stick
Motor Bogie brake	6 discs bolted on wheels and 6 brake callipers
Bogie weight	about 30 t

Table 9 – Bogie Characteristic

The welded bogie frame is in S355J2+N EN 10025.

The connection with the carbody is provided by a pivot structure component made in G20Mn5 EN 10293.

6.7. OPERATIONAL MODES

6.7.1. *Stabling*

Loco stabled, battery power off, no compressed air, parking brakes applied.

6.7.2. *Normal Operation*

Battery power on, one driver's cab activated, all functions are available. The Locomotive can either operate alone or in multiple units as a master.

6.7.3. *Normal Operation - Slave*

Battery power on, no driver`s cab activated, all functions are available. The Loco can operate in multiple units as a slave.

6.7.4. *Parking Mode*

The Loco is ready for operation, with minimum energy consumption.
Parking brakes applied, traction is inhibited, driver desk commands are enabled in Loco.

6.7.5. *Change of Driving Cab*

The change of cab mode is identical with the parking mode, but some steps are requested for the correct driving cab change.

6.7.6. *Towing*

It must be possible to tow the Locomotive using another traction vehicle, i.e. the pneumatic brakes of the Locomotive are controlled by the main brake pipe and the spring-loaded parking brakes of the Locomotive must be released.

6.8. SYSTEM FUNCTIONS

6.8.1. *Traction*

6.8.1.1. Traction Converter

Two traction converters, which includes the auxiliary inverters, are present in the DSL; the traction converters are powered by diesel generator.
The traction converters supply power, each, to 3 motors on the same bogie.

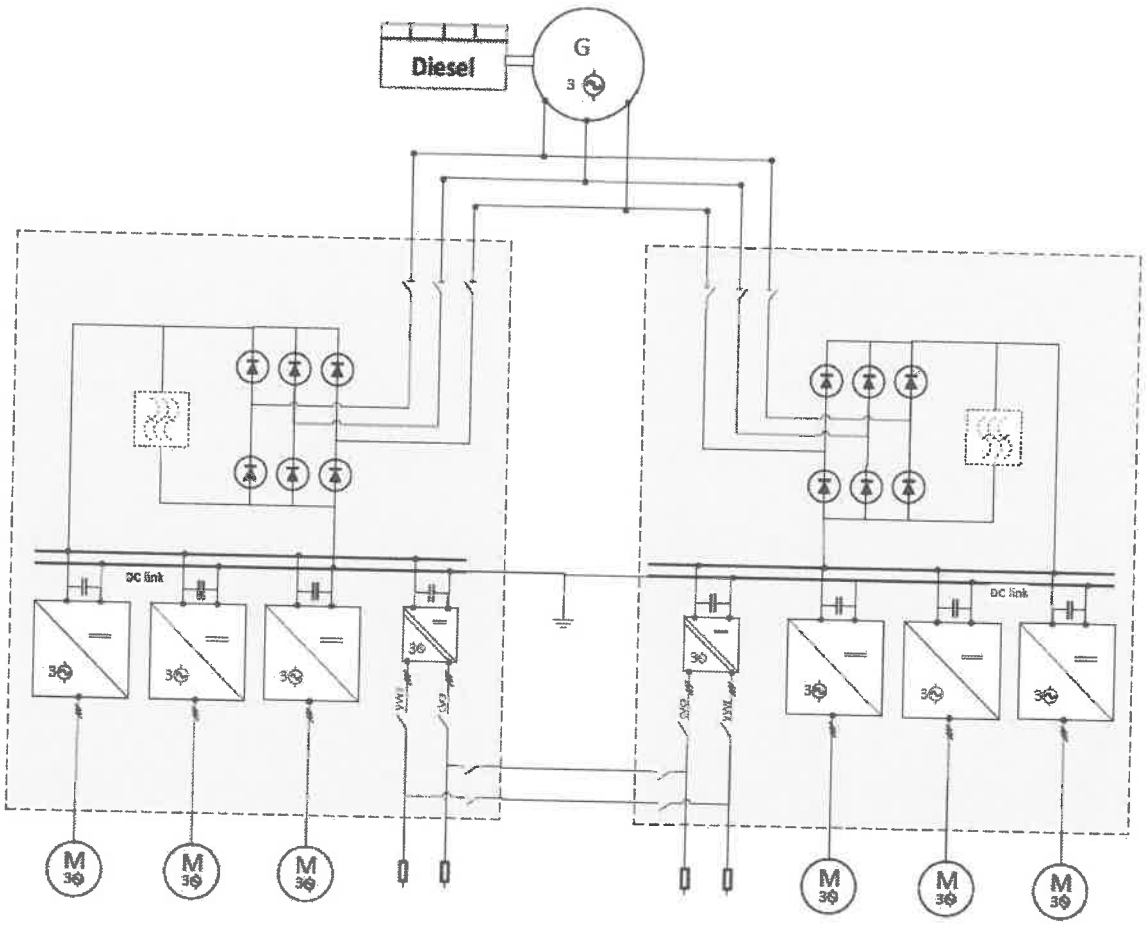

Figure 3 – Converter scheme, for reference

6.8.1.2. Traction Motor

Six traction motors are installed in the Locomotive, traction motors are fed by the 2 traction converters output.

6.8.1.3. Traction Cooling

The cooling of the traction converters and electric traction motor is integrated in the cooling unit equipment, to optimize the space allocation.

In total there will be 2 cooling units in each Locomotive.

6.8.1.4. Traction General Requirements and Redundancy Level

For an optimized weight distribution all traction system components are distributed along the Locomotive.

The traction system has some functional redundancies to completely recover or reduce as minimum as possible the effect on performances due to the failures listed hereafter:

- loss of one traction converter
- loss of a traction system on a bogie

In both cases the Locomotive is allowed to operate in degraded conditions; the Locomotive should reach next convenient station or service depot without assistance.

6.8.1.5. Electro Dynamic Braking

The DSL is fitted with a traction system that allows the electro-dynamic braking.
The electrical energy generated during the ED braking phase is reversed to brake resistors; traditional "rheostat" braking system.
When regenerative braking is not available pneumatic (friction) brake will be used.

6.8.2. *Auxiliary Power Supply*

6.8.2.1. MV and LV Power Generation and Distribution

Two auxiliary inverters will be installed in the Locomotive, to supply the required power to the loads connected to the MV lines in variable voltage and frequency mode (VVVF) and in fixed mode (CVCF, 400V AC 3ph 50Hz).
Auxiliary Power Supply will not include Battery Charger device, which is installed in an electrical cubicle underframe and powered from the medium voltage (fixed mode line output, CVCF).
The Auxiliary inverter is cooled by an opportune cooling system which is integrated with the cooling system of the traction converter and transformer.

6.8.2.2. Battery and Battery Box

Two different battery/battery box are installed in the DSL; one for power pack (24V) and other one for the general electric LV power supply (110V).

6.8.3. *Braking System*

The scope of the braking system is to provide the necessary braking force to meet the performance requirements as described above.

The system is mainly composed by:

- Air production and stock components (AGTU+ Tanks)
- Brake control components (Brake control panel)
- Pneumatic distribution
- Bogie brake components (brake callipers and disks)
- Dead man and Vigilance System (according to UIC 641 and in reference to TSI L&P requirement)
- Wheel-Slide protection system

6.8.4. *Heating Ventilation and Cooling*

The heating, ventilation and cooling capability shall be performed by the cab HVAC system, with the support of independent heaters in driver cabs (in the driver desk) where deemed necessary.
There is 1 independent HVAC unit for each driver cabin.

6.8.5. *Fire Protection*

The DSL is equipped with an automatic firefighting system in order to detect a fire starting in the high-risk areas, and to take the necessary action to reduce the risk of spreading it.

A fire detection system is provided in:

- Driver's cabs
- Traction converters + Auxiliary converters
- Main Electrical Cabinets
- Diesel Engine + Generator

A fire extinguish system is provided in:

- Traction + Auxiliary converters
- Diesel Engine + Generator

Each driver's cab is equipped with an audial and visual fire alarm system integrated with Train Control Monitoring System (TCMS).
The system indicates to the driver the detection of a possible fire and the place where this has been detected.

Fire extinguishers of the dry powder type of approximately 6 kg capacity or better system are installed one on each driver cab.

6.8.6. *Exterior Lights*

Head, tail and marker lights shall be in full accordance with TSI 1302 Loc&Pas 2023 section 4.2.7.1 and EN 15153-1.

6.8.7. *CCTV System*

The CCTV system will include, side cameras, front cameras, cameras for the cabin, and a driver monitoring camera.

6.8.8. *Train Control and Monitoring System (TCMS)*

6.8.8.1. TCMS System Overview

TCMS shall be a smart entity which, acquiring and transmitting information and controls, manages the operation of most of devices installed on the Locomotives and to the relevant components:

- Monitor and control devices directly interfaced with the system TCMS.
- Achieve operational functions necessary to manage the Loco with the level of performance, safety and reliability requirements.
- Provide support for the operation of the locomotive (crew)
- Provide support for centralized maintenance
- Implemented through design and simulation tools to optimize time and cost of design and validation
- Provide a historical data with detailed information about operating the equipment and device.

The TCMS system is directly related to the information of the subsystems connected with it.
The number of information available in the diagnostic system is very high; as a consequence, to enhance effective acquisition and use of information by personnel, a differentiated management is required.
To this purpose, three groups of information are displayed on the monitor in each driving cab (placed on driver`s side of the control desk), depending on the user they are addressed to:

- Driving crew (diagnostic/control monitor and instrument monitor)

- Staff personnel (diagnostic/control monitor)
- Maintenance personnel (diagnostic/control monitor)

TCMS is developed with redundancy characteristics to increase its reliability.

6.8.8.2. TCMS Main Tasks

Main tasks of Command & Control shall be the following:

- supervise functions and manage decision at system level, by adjusting the operation of apparatuses monitored according to the general operating situation
- perform starting procedures and give controls during normal operation
- provide for proper measures and cut-offs in case of malfunctions

Main tasks of diagnostics will be the following:

- find faulty apparatuses and sub-assemblies to reduce the repair time and increase average availability of vehicle
- provide for an operator's guide, to precisely specify operations to be performed during any malfunction on duty
- organise the collection of information to support any statistic management off-board concerning the type of malfunctions per operating hours of single apparatuses

6.8.9. *Event Recorder*

An event recorder is installed in the Locomotive and will be active when the Locomotive is active. Event recorder is a device designed to acquire and store the status coming from other on-board devices, to record driver activities.

6.8.10. *Warning Horns and Whistle*

Horns (audible warning device) will be in full accordance with TSI RST 1302 (Loc&Pas) section 4.2.7.1 and EN 15153-2. Operation of the horn shall not cause noise discomfort to the driver. Warning horns will be fed by an air pressure circuit and will be commanded either by a push button or by a pedal.

The warning whistle will be controlled electronically and powered by the battery line.

6.8.11. *Windscreen Wiper and Washing System*

The Locomotive will be fitted with a wiper and windscreen washing system in accordance with applicable standards and to assure the driver visibility as per UIC 651 and 16186-1.
The windscreen wiper system will be electrical type and include intermittent wipe facility. It will assure good performance and functionality in all the weather condition as specified in this document and at maximum Locomotive speed.

6.8.12. *Flange Lubricating System*

The Locomotive is equipped with efficient and reliable spray type flange lubricating system.

6.8.13. *Sanding System*

The Locomotive is equipped with efficient and reliable sanding system in according to TSI 1302.
The sanding device will be located on axles 1, 3, 4, 6.

6.8.14. *Signalling and Train Communications*

6.8.14.1.Radio

Locomotives will adopt ASELSAN radio equipment for train infrastructure radio communication. Additionally, GSM-R radio will be used on ETCS lines.

6.8.14.2.ATS

TCDD has two different types of ATS systems on its existing signalized lines: "eastern type" and "western type." The Automatic Train Stop System, approved by the Administration and used on existing locomotives in the TCDD Taşımacılık A.Ş. fleet, uses on-board equipment. The relevant components will be installed on the Locomotive in accordance with the system supplier's requirements.

6.8.14.3.ERTMS / ETCS

TCDD's new signaling systems will be equipped with systems that comply with the ERTMS/ETCS Level 2 standard on the lines. Therefore, locomotives will be equipped with onboard equipment compatible with the European Rail Traffic Management System/European Train Control System (ERTMS/ETCS, Level 0/Level 1/Level 2), Baseline 3, or Baseline 4, and will be equipped with equipment that operates in both cabs, without any forward or reverse restrictions.

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