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## Gaziray Commuter Train Project General Technical Specification

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## 1 SUBJECT

This General Technical Specification defines the common technical requirements applicable to all systems/equipment/components installed on the Gaziray Commuter Train (EMU) produced by TÜRASAŞ in urban passenger management.

### 1.1 DEFINITIONS

Within this document, the following definitions are applied to the words reported below:

- “the Company” means the Turkish Railway Vehicles Industry Inc. (hereafter called TURASAS)
- “the Designer” means BLUE Engineering that is the company responsible for the design EMU set
- “the Supplier” 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 Supplier 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

### 1.2 LIST OF ACRONYMS & ABBREVIATIONS

AC	Alternating Current
ATC	Automatic Train Control
ATS	Automatic Train Stop
BCU	Brake Control Unit
BP	Brake Pipe
CPU	Central Processing Unit
DC	Direct Current
DCU	Door Control Unit
DIN	Digital Input
DIS	Driver Information System
EB	Emergency Brake
ED	Electro Dynamic
EDB	Electro-Dynamic Brake
EMU	Electric Multiple Unit
EN	European Norm
ENV	European Norm Voluntary
ERTMS	European Rail Traffic Management System
ESRA	Electronic System for Railway Application
ETCS	European Train Control System
FAI	First Article Inspection



FEM	Finite Element Method
FPMK	Failure Per Million Kilometre
GBB	Gaziantep Büyükşehir Belediyesi (Gaziantep Metropolitan Municipality)
GPRS	General Packet Radio Service
GPS	Global Position System
HV	High Voltage
HVAC	Heating, Ventilation, & Air Conditioning
HSVB	High Speed Vacuum Breaker
I/O	Input / Output
IEC	International Electro-technical Commission
IGBT	Insulated Gate Bipolar Transistor
ISO	International Organization of Standardization
JRU	Juridical Recording Unit
LED	Light Emitting Diode
LV	Low Voltage
MBP	Main Brake Pipe
MRP	Main Reservoir Pipe
MV	Multiple Vehicle
MVB	Multiple Vehicle Bus
NoBo	Notified Body
PRM	Person with Reduced Mobility
RAMS	Reliability, Availability, Maintainability and Safety
SI	International System
SIL	Safety Integrity Levels
ST	Standard
TBC	To be confirmed
TBD	To be defined
TCMS	Train Control & Monitoring System
TCU	Traction Control Unit
TI	Intermediate Trailer
TOR	Top of Rail
TSI	Technical Specification for Interoperability
TÜRASAS	Turkish Railway Vehicle Industry Inc.
UIC	Union International Chemin de Fer
VCU	Vehicle Control Unit
WSP	Wheel Slide Protection
WTB	Wire Train Bus

## 2 STANDARDS

The EMU shall be designed, assembled and tested according to reference standards.  
System of units will be SI.

To correctly address the design, punctual reference to applicable standards and regulations is done in this document and in all the Technical Specifications of systems/equipment.

The present valid TSI and harmonised norms are the following:

- Commission Implementing Regulation (EU) 2020/387 of 9 March 2020 amending Regulations (EU) No 321/2013, (EU) No 1302/2014 and (EU) 2016/919
- Commission Implementing Regulation (EU) 2019/776 of 16 May 2019 amending Commission Regulations (EU) No 321/2013, (EU) No 1299/2014, (EU) No 1301/2014, (EU) No 1302/2014, (EU) No 1303/2014 and (EU) 2016/919 and Commission Implementing Decision 2011/665/EU
- Commission Implementing Regulation (EU) 2019/774 of 16 May 2019 amending Regulation (EU) No 1304/2014
- Commission Implementing Regulation (EU) 2019/772 of 16 May 2019 amending Regulation (EU) No 1300/2014
- TSI RST 1302/2014 (LOC&PASS) not amended parts
- TSI SRT 1303/2014 (Safety in Railway Tunnels) not amended parts
- TSI NOI 1304/2014 (Noise) not amended parts
- TSI PRM 1300/2014 (Person with Reduced Mobility) not amended parts
- TSI CCS (EU) 2016/919 (Control-command and signaling) not amended parts
- CSM 2015/1136 (EU)

Refer to the Annex 1 of present document for the list of main applicable norms with the applicable relevant version. If it is not differently specified, the applicable version of the norms mentioned in the text of the document is the one specified in Annex 1.

The order of priority for standards application is:

EN > UIC > IEC > ISO > Other international standard (TSI; DIN; NF F; UNI CEI etc.)



### 3 ENVIRONMENT

Each EMU shall be capable of continuous operation within the full range of ambient and environmental conditions which will be encountered in service as specified hereafter.

#### 3.1 CLIMATIC CONDITION (EQUIPMENT)

The European Standard EN 50125-1 and the Gaziantep local environmental conditions shall be applied for conception of all equipment installed on the vehicle. The following Table 1 collects the main data relevant to Gaziantep local conditions.

<b>Temperatures</b>	
Max. temperature inside of the coach	+ 45 °C
Max. external temperature (shade)	+ 45 °C
Min. internal/external temperature	- 15 °C
<b>Precipitations</b>	
Max. Amount daily	73 Kg/m <sup>2</sup>
Annual areal precipitation	556,2 mm/m <sup>2</sup>
Min. areal precipitation	380 mm
Max. areal precipitation	930 mm
Max snow	100 mm
<b>Other Conditions</b>	
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
Exceptionally max wind speed	115,5 Km/h
Altitude above the sea level	869 m
<b>Sun Radiation</b>	
Sunshine duration per year	2986 hours
Radiation rate per year	2080 kWh/m <sup>2</sup>
Max sun radiation	800 W/m <sup>2</sup>
Max. Sun exposition	8 hours

Table 1 – Gaziantep local climatic conditions summary

The data in the above table shall be applied only if prevailing to requirements of EN 50125-1. In the following paragraphs the main climatic requirements are specified.

#### 3.2 CLIMATIC ZONE

According to the EN 50125-1 the climatic zone “T3” shall be applied.

#### 3.3 ALTITUDE

According to the EN 50125-1 the altitude class “A2” shall be applied.

### 3.4 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.

### 3.5 WINDS

Wind speeds to be considered shall be those defined in paragraph 4.5 of standard EN 50125 1.

Max wind speed to be considered for equipments, e.g. ventilation, cooling is 35.

Exceptionally, with standing EMU, winds up to 50 m/s shall be considered. In this condition equipment and/or vehicle performances may be temporarily affected, but not permanent damage shall occur.

Cross wind assessment in railway is described in EN 14067-6.

### 3.6 MAXIMUM PRECIPITATION (RAIN, SNOW, BLACK ICE)

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

Snow, black ice precipitation: Class "S1" 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) LOC&PAS § 4.2.6.1.2 (3):

- Powder snow, snowfall of large quantities of light snow with low water equivalent content. — Temperature gradient, temperature and humidity variation during one single run causing ice build-ups on the rolling stock.
- Combined effect with low temperature according to the temperature zone chosen as defined in clause 4.2.6.1.1.

To supplement the paragraph 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).

### 3.7 SOLAR RADIATION

According to the EN 50125-1 the solar radiation class "R2" shall be applied.

In addition, all trainset equipment shall be protected from ultraviolet rays (UV).

### 3.8 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: EN 60721-3-5 Class 5F2 (electric power motor) and EN 60721-3-5 Class 5F3 (thermal motor).
- Active biological substances: EN 60721-3-5 Class 5B2.
- Dust: EN 60721-3-5:1997 Class 5S2.
- Other: EN 60721-3-5:1997.
- Marine ambient: EN 60721-3-5:1997 Class 5C2.



### 3.9 TRAIN STORAGE CONDITIONS

The train could eventually be stored outside and uncovered for several weeks under the weather conditions described above. The Supplier shall clearly indicate the precautions to be taken, as well as the procedures to be followed.

### 3.10 CLEANING

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

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

All the measures shall be taken to avoid water retention after washing.

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

It shall clearly indicate whether precautions are to be taken in order not to damage EMU's equipment and its components.

Specific objectives regarding the cleanability, if any, are clearly indicated in the technical specification of the concerned equipment.

For elements in contrasting colours as per STI PRM requirements (access, gripping elements,...), these shall have a service of life of at least 5 years.

### 3.11 AERODYNAMIC LOADS

All parts of the vehicle, included the carbody and its components, such as windows, doors and gangway, shall withstand with the aerodynamic loads specified in EN 16286-1 and UIC 566 (The specified loads for passenger access doors of vehicles up to speed of 160 km/h, shall be applied as positive and negative pressure loads acting on the vehicle during service).

### 3.12 PRESSURE COMFORT CRITERIA

The pressure comfort criteria specified by EN 14067-5 Annex B2 shall be applied.

### 3.13 OTHER

Impacts of the lightning on the vehicle shall be taken into account. Required measures shall be taken for the protection against stroke of lightning on the vehicle according to EN 50124-2.

It shall be taken into account that abrupt changes in the weather may be faced under the operational conditions on the lines where the vehicle sets will be operated; therefore measures shall be taken against possible water condensation on the vehicle and its equipment, in particular in the electronic systems.

Impact of the contamination (salination, contaminating fluids, insects etc., biological active substances, stones, flying insects etc.) shall be taken into account in the design of the equipment and components of the vehicles.

In the design of the equipment and components of the vehicles, provisions in EN 61373 regarding the vibration and shocks as well as the provisions in EN 50121 regarding electromagnetic environment shall be fulfilled.

Impacts of side winds on the train sets shall be evaluated according to the related standards.

Characteristic of the vehicle shall ensure safe/comfortable passenger transportation.

All the components shall be able to ensure the service of the train-set whatever the external conditions may be. Moreover, they shall be designed so as not to abnormally degrade due to bad weather.

Each EMU shall be resistant to the effects of exposure to salt water spray. Exposure to salt water spray shall not cause excessive corrosion or degradation of exposed surfaces, components and equipment.

Each EMU exterior, when all doors and windows are closed, shall prevent the ingress of snow, rain, wash plant spray, draughts, dust and leaves under all environmental conditions.

In the vicinity of externally opening windows and doors, all controls, equipment and enclosures shall be designed to ensure continued operation with no adverse effects of local ingress of water, dust, snow and leaves.

Each EMU shall be capable of operating normally through snow or flood water, up to the maximum depths for normal operation and thereafter (subject to speed restriction) up to the absolute maximum depths for operation, as established by the Train Operator



## 4 EMU BASIC REQUIREMENTS

### 4.1 MISSION PROFILE

In the following tables are reported the EMU foreseen mission for the Gaziantep Commuter service.

EMU Mission Profile		
Yearly mileage	240.000	km/years
Operating days per year (90%)	330	day/year
Daily average time under power	19,0	hrs/day
Daily average running time	18,0	hrs/day
Daily average mileage	730	km/day
Average speed (powered -up time)	38,30	kph
Average speed (running time)	40,40	kph
Yearly time under power	6.270	h/year
Yearly running time	5.940	h/year
Operating days per month	29	day/month
Carbody and Main Equipments life	30	years
Interior trims and equipment life	15	years
Maximum Service Speed	120	Kph

Table 2 – EMU mission profile

### 4.2 TRACK INFORMATION

#### 4.2.1 Track Gauge

The applicable track gauge is 1435 mm.

#### 4.2.2 Minimum Radius

The following prescriptions for minimum horizontal curves radius are applicable:

- Depot: 100 m
- Nominal Line: 150 m
- Main Line (GBB): 400 m
- Turnout zones (GBB) 300 m

#### 4.2.3 Maximum Gradient

Maximum gradient in GBB line is 20‰ (twenty per thousand).

Maximum gradient in main line is 40‰ (fourty per thousand).

#### 4.2.4 Track and circulation characteristics

Concerning other information about track curves and circulation characteristics not explicitly mentioned in this document, refer to:

- S-Curves, the following (ref. TSI INF Table 43) is applicable:
  - 150m radius, 10.78m straight, 150m radius (with passenger)
  - 200m radius, 4.5m straight, 200m radius (with passenger)

- Vertical curves (no humps and marshalling yards) the TSI INF Par. 4.2.3.5 is applicable:
  - 500 m on a crest
  - 900 m in a hollow

#### 4.2.5 Track and wheels profile

The track and the wheel profiles of the EMU will be according to the following:

- Wheel profile drawing: TCDD 02.029\_A3
- Track type: 60E1 according to EN13674-1

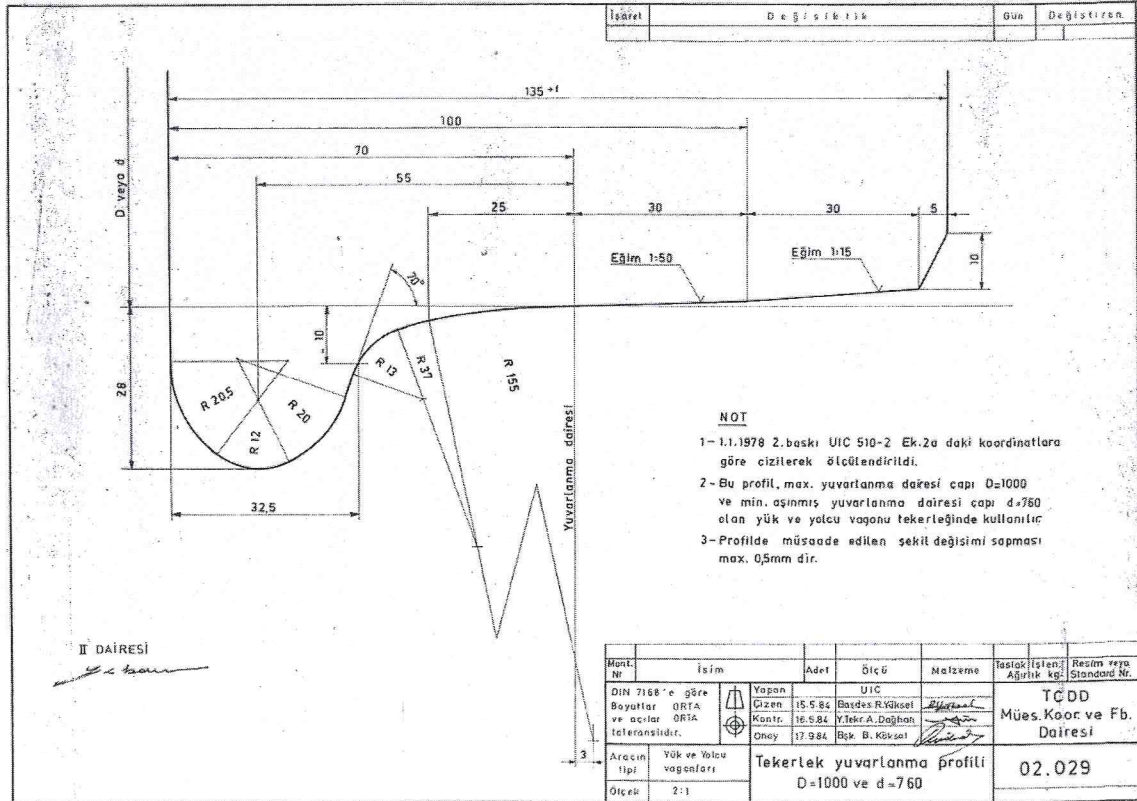


Figure 1 – TCDD applicable wheel profile

#### 4.2.6 Applicable Routes

The applicable route for train-set performance evaluation is the 25 km line BAŞPINAR to TAŞLICA.

The main route parameters are the following:

Distance	25 km
Min altitude	809 m
Max altitude	900 m
Max slope	16 ‰

Table 3 –Track Data



The route station positions with the corresponding stop times are reported in the following table.

Distance [Km]	Station Name	Stop Time[s]
1.2	BAŞPINAR İST.	0
2.0	OSB3 İST.	25
3.0	OSB4 İST.	25
5.4	DOLİCE İST.	25
8.6	STADYUM İST.	25
9.5	BEYLERBEYİ İST.	25
10.4	FISTIKLIK İST.	25
12.1	SELİMİYE İST.	25
14.0	ADLIYE İST.	25
15.7	TOPRAKLIK İST.	25
16.5	MÜCAHİTLER İST.	25
17.6	GAZİANTEP GAR	25
19.6	GÖLLÜCE TIP MERKEZİ İST.	25
21.7	SEYRANTEPE İST.	25
22.6	M.YAVUZ İST.	25
24.8	TAŞLICA İST.	0

**Table 4 –Stations Data**

The details of the routes are reported in Annex 3.

### 4.3 GAUGES

The following gauges are applicable for the body:

- Static Gauge: TCDD Gauge (see following TCDD picture dated on 8.3.1999)

The following gauge is applicable as low gauge for the bogie:

- Static Gauge: TCDD Gauge (see following TCDD picture dated on 8.3.1999)
- Kinematic gauge: UIC 505-1 – Par. 5.2.

The above gauges are applied with the following exeptions:

- The TCDD Gauge is only reference for nominal EMU dimensions.
- The position of MAGNET DTM-101 of ATS is located on bogie



The main dimensions of Standard Gauges are the following:

Tunnel gauge	Height:5400mm/width:5000mm
Structure gauge	Height:4800mm/ width:4000mm
Loading gauge	Height:4650mm/ width:3150mm
Vehicle gauge	Height:4280mm/ width:3150mm

Table 5 – Main dimensions of Standard Gauges

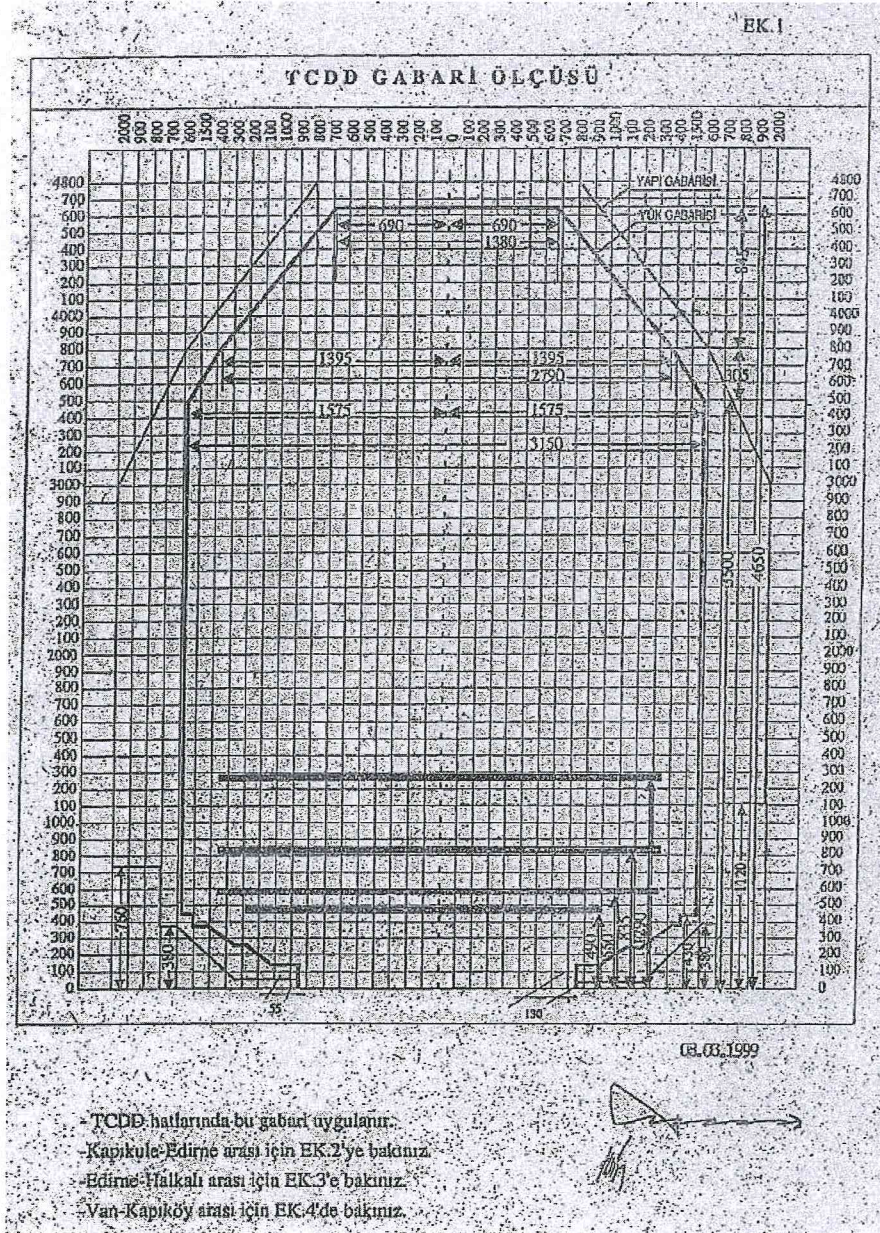


Figure 2 – TCDD applicable static gauge



#### 4.4 PLATFORM

Applicable platform are of stations of GAZİRAY Commuter Operations network. The applicable characteristics are:

- Platform height from elevation of top of rail (TOR) 1.050 mm
- Platform length 200 m
- Distance from the edge of the platform to the line axis 1650 mm

Typical station cross-sections are given in the following picture.

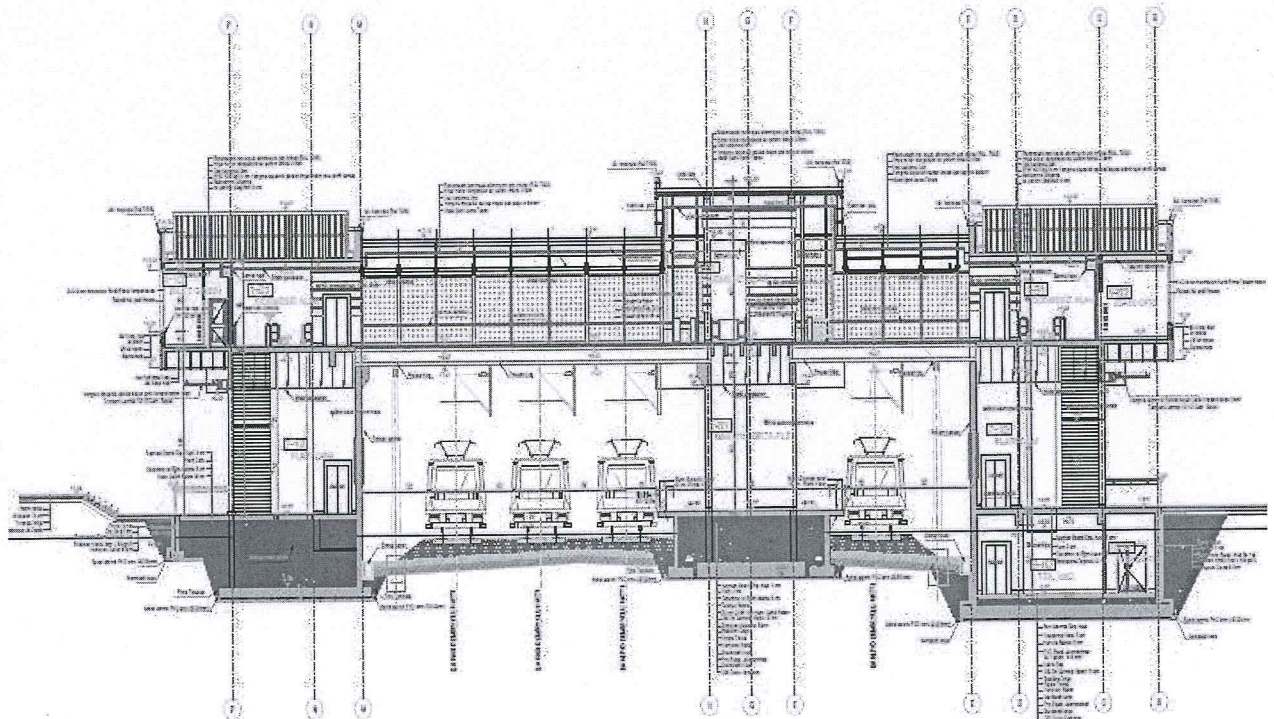


Figure 3 – Typical station cross-sections

#### 4.5 EMU POWER SUPPLY AND USED VOLTAGE

##### 4.5.1 Overhead Line characteristics

The specifications of the catenary system applicable to the EMU will be in accordance with EN 50163.

Following Table 10 reports the line Power Supply System characteristics.

Type of Power Supply System	25.000 V ac 50Hz
Nominal voltage	25.000 V (EN 50163)
Minimum working voltage	19.000 V
Maximum working voltage	27.500 V
Minimum abnormal voltage	17.500 V

Maximum Instantaneous Abnormal Voltage (10 s)	30.000 V
Maximum Distance between TOR from contact wire	6200 mm
Minimum Distance between TOR from contact wire	5000 mm

**Table 6 – Line Power Supply System Characteristics****4.5.2 Operational characteristics**

Used voltages on train are:

- HV (High Voltage) 25.000 V ac
- MV (Medium Voltage) 400 Vac, 3p 50 Hz
- LV (Low Voltage) 110 V dc

**4.5.3 Pantograph widths and other provisions**

The EMU is equipped with 2 pantographs, one for each OA vehicle. The pantographs are single arm with current collector arc width of 1600 mm.

The pantograph shall be designed and manufactured in accordance with EN 50206-1: 2010, EN 50367, and UIC 608 OR.

The pantograph and catenary line shall be monitored by a dedicated camera system.

**4.6 EMU CONFIGURATION**

The EMU will be built in 4 cars configuration: SKA, OA, OA, SKA

There are 2 types of car:

SKA = Head Car with driver cab, PRM area, multifunction area

OA = Intermediate Car

The EMU will be fixed configuration train: the orientation of the different type of cars within a unit is fixed.

The train traction layout will be the following: Bo'Bo'+2'2'+2'2'+Bo'Bo'

**4.7 EMU MULTIPLE CONFIGURATION (Service Mode)**

The EMU can operate in service mode according to the following multiple configurations:

- 4 cars + 4 cars

The above multiple configurations are only between EMU designed and supplied in the present scope of supply.

It shall be possible to monitor the interior of all the vehicles from the control cab if two or three multiple units are connected to each other.

**4.8 EMU MULTIPLE CONFIGURATION (Pushing & Towing Mode)**

The EMU can operate in towing mode according to following multiple configuration:

- 4 cars (EMU 1) + 4 cars (EMU 2)
- 4 cars (EMU 1) + 4 cars (EMU 1) + 4 cars (EMU 2)

Where:

- EMU 1 (AW0 load) is fully operational



- EMU 2 (max AW3 load) in malfunction or need of evacuation

The aim of towing or pushing is to take the EMU 2 in safe at the closer safety point in order to allow passenger evacuation

#### 4.9 LOCO RESCUE Mode

The EMU of 4 cars shall allow rescue operation by a LOCO (equipped with UIC draw hook) up to a maximum slope of 30%. For this purpose, the EMU shall be equipped with:

- Rescue adapter for UIC hook
- Pneumatic Connections

Where:

- EMU (max AW4 load) in malfunction or need of evacuation

The aim of towing or pushing is to take the EMU in safe at the closer safety point in order to allow passenger evacuation.

#### 4.10 LOADING CONDITIONS

The loading conditions are summarized in the following table.

LOAD CONDITION	ID	Cycle Rate in Operation
Empty	AW0	2%
sitting passengers (including the driver)	AW1	8%
sitting passengers + 4 standing per square meter	AW2	40%
sitting passengers + 6 standing per square meter	AW3	48%
sitting passengers + 8 standing per square meter	AW4	2%

Table 7 – EMU Loading Conditions

The following passenger occupation are taken as reference for reference masses and loads definition:

PASSENGER OCCUPANCY	ID	LOAD CONDITION
Normal	AW2	sitting passengers + 4 standing per square meter
Exceptional	AW3	sitting passengers + 6 standing per square meter

Table 8 – EMU Passenger Occupancy

The reference Masses for EMU are defined according to the norm EN 15663 according to the following table.

REFERENCE MASS	EN 15663	Pax Occupancy	ID	Cycle Rate in Operation
Dead mass	MU	-	AW0	2%
Design mass in working order	MVD	-	-	-
Sitting Passengers	-	-	AW1	10%

Design mass in normal payload	MND	Normal	AW2	50%
Design mass under exceptional payload	MXD	Exceptional	AW3	98%

Table 9 – EMU Reference Masses according to EN 15663

**4.11 AXLE LOAD**

The maximum axle load in AW3 is 17,5 t.

The maximum axle load in AW4 is 18,5 t.

**4.12 PASSENGER AND CREW CLIMATIC COMFORT**

The environmental data specified in chapter 3 and the following standard are reference for passenger climatic comfort:

- EN 14750-1: “Railway applications. Air conditioning for urban and suburban rolling stock. Comfort parameters”.

The environmental data specified in chapter 3 and the following standard are reference for crew climatic comfort:

- EN 14813-1 “Railway Applications – Air conditioning for driving cab – Part 1 Comfort parameters”
- EN 14813-2 “Railway applications - Air conditioning for driving cabs - Part 2: Type tests

The specific requirements for HVAC system and units are reported in the relevant technical specification.



## 5 EMU PERFORMANCE

### 5.1 TRACTION PERFORMANCE REQUIREMENTS

The requirements concerning the traction performance are listed in the following.

1. Nominal Continuous Traction Power shall be defined according to UIC 614
2. The minimum traction «nominal» power per electric motor shall be 365 kW at wheel
3. The Traction performance shall be calculated in following conditions:
  - Payload: AW3
  - Conditions: straight line, slope 0 ‰, under nominal catenary voltage
  - GBB requirement for Wheels condition applicable for performance compliancy: half-worn wheels
  - Additional requirement for Wheels condition for performance calculation: new wheels, worn wheels
  - Maximum adhesion limit: 0,20 (AW3)
4. The speed and acceleration performance shall be the following:
  - Maximum Service Speed: 120 km/h
  - Minimum Design Speed: 140 km/h
  - Minimum residual acceleration (140 km/h): 0.05 m/s<sup>2</sup> @ 100% traction power
  - Minimum average acceleration 0-40 km/h: 0.85 m/s<sup>2</sup> @ 100% traction power
  - Maximum time to accelerate 0-90 km/h: 45 s @ 100% traction power
  - Maximum time to accelerate 0-120 km/h: 90 s @ 100% traction power
5. Start capability performance on a gradient shall be the following:
  - Capability to start on a gradient of 20‰ (without sanding)

The supplier shall validate the proposed traction performance during the detail design phase by considering the final train characteristics.

The traction analysis shall be executed by the supplier in AW0 and AW3 loading conditions. A complete round trip of Gaziray line shall be applied.

The following shall be applied for EMU traction analysis.

1. Gradient, curve, station and speed restriction information shall be used for the line which is shown on the line plan profile, cross-section projects attached to the technical specifications.
2. One EMU (4-car vehicle) shall be used.
3. Separate analysis shall be carried out for both AW0 and AW3 loading conditions (see paragraph 6.4) loads of the train set.
4. There is not any power demand from auxiliary power systems. Doors shall not be opened.
5. Train shall be driven in accordance with the maximum speed limits on the line.
6. Acceleration, service braking deceleration and comfort coefficient (jerk) values shall be taken as they are defined in the specifications.

7. The driving mode will comprise: full acceleration, running with the maximum speed that is allowed within the speed limits and full braking. The economical driving methods are not be used (idle running).
8. The train will stop 25 seconds (interval of zero speed at stations) in all stations except for the end stations
9. Energy recovery during the regenerative braking shall not be considered.
10. The line voltage will not affect the performance due to the current limiting of the train as a result of the voltage

The efficiency rates of the following units shall meet the minimum given requirements in the determined operation points (nominal points). Efficiency of:

- Gear Box:  $\geq 93\%$
- Traction Motor :  $\geq 92\%$
- Traction Driver :  $\geq 95\%$
- Transformer :  $\geq 93\%$
- Auxiliary Converter :  $\geq 88\%$

## 5.2 BRAKING PERFORMANCE REQUIREMENTS

The EMU will be provided with the following braking modes:

- ED: Electro Dynamic (Regenerative)
- EP: Electro Pneumatic (Direct Braking)
- IB: Indirect or Automatic Pneumatic (Emergency and back up brake)
- PB: Parking Brake (spring applied and pneumatic released)

The requirements of GBB concerning the braking performance are listed in the following.

1. The Braking performance shall be calculated in following conditions
  - Payload: AW0, AW1, AW2, AW3, AW4
  - Stopping distance shall not be applied to AW4
  - Conditions: straight line, slope 0 %
2. The Service and Emergency braking performance shall be defined as follows:
  - Service brake (EP+ED) maximum stopping distance from 120 km/h: 600 m
  - Service brake (EP+ED) minimum equivalent braking acceleration:  $-1 \text{ m/s}^2$
  - Emergency brake (EP or IB) maximum stopping distance from 120 km/h: 600 m
  - Emergency brake (EP or IB) minimum equivalent braking acceleration:  $-1,2 \text{ m/s}^2$
3. The Service braking performance in case of 25%ED failure shall be defined as follows:
  - Service brake (EP+degradedED) minimum equivalent braking acceleration:  $-1 \text{ m/s}^2$
  - Service capability: all speed up to 120 km/h until the end of the day
4. The Service braking performance in case of >25%ED failure shall be defined as follows:
  - Service brake (EP+degradedED) minimum equivalent braking acceleration:  $-1 \text{ m/s}^2$
  - Service capability: all speed up to degraded speed (limit TBD) until the end of the day
5. In case of catastrophic failures such as disconnections of EMU vehicles or door opening during running the mechanical brake shall be able to comply the following requirements:



- Emergency brake (IB or EP) minimum equivalent braking acceleration:  $-1,2 \text{ m/s}^2$
- 6. In case of bad adhesion conditions (adhesion limit: 15% (AW3)) and failure of a single brake unit the Emergency braking brake shall be able to comply the following requirements:
  - Guaranteed Emergency brake (IB or EP) minimum braking acceleration:  $-0,9 \text{ m/s}^2$

The standstill capability performance on a slope shall be calculated in following conditions

- GGB requirement: at AW3 the PB shall be able to keep the EMU in standstill at slope: 30‰
- Additional requirement: at AW0 the PB shall be able to keep the EMU in standstill at slope: 40‰

The supplier shall validate the proposed braking performance during the detail design phase by considering the final train characteristics, the above requirements and the applicable norms. Specific requirements are stated in the applicable Technical Specification.

### 5.3 NOISE PERFORMANCE

#### 5.3.1 EMU Noise Levels

The noise due to the EMU shall be measured on good quality track in order to comply with the requirements of TSI NOI for internal and external noise. The following shall also be applied:

- The measurement of interior noise shall be made according to EN ISO 3381
- The measurement of exterior noise shall be made according to EN ISO 3095

#### 5.3.2 Specific Noise Levels

Door Operating noise shall comply with EN 14752 standard

Sound level of all horns (air and electric) shall comply with EN 15153-2 standard.

### 5.4 COMFORT VIBRATIONS AND IMPACTS

#### 5.4.1 Running Comfort

The EMU shall ensure running comfort according to the reduced limit of 2,5 hours in ISO 2631 and UIC 518.

#### 5.4.2 Acceleration or deceleration variations

Under normal operational conditions the changes of acceleration or deceleration shall not exceed the value of  $1 \text{ m/s}^3$ .

#### 5.4.3 Shock and Vibration

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

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

#### 5.4.4 Induced Vibration

In stationary conditions, equipment and auxiliary installations mounted at any place in the EMU, vehicle floor, walls, ceiling panels, handrails, holds or around the seats shall not cause vertical or horizontal vibration. The following maximum limits shall not be exceeded:

- Vibrations of 2 mm peak to peak amplitude, with 0 to 1,4 Hz frequency range
- Vibrations of 0,01 g peak acceleration level with 1,4 to 20 Hz frequency range
- Peak velocity vibration level of 0.75 mm/s in the frequency range between 20 Hz to 80 Hz

### 5.5 Operating Speed

The design and calculation of train set shall be made according to 140 km/h operating speed. But the train set will be delivered to the Client with the equipment adequate to 120 km/h operating speed. The project of the critical equipment and systems such as carbody, bogie, traction system, etc. shall be designed in compliance with 140 km/h operating speed. The purpose of the work is enabling existing project to be used in compliance with 140 km/h operating speed.

## 6 GENERAL EMU DESIGN

### 6.1 EMU LAY OUT and Main Dimensions

#### 6.1.1 Train-set Lay Out

The layout of EMU GBB is depicted in the following.

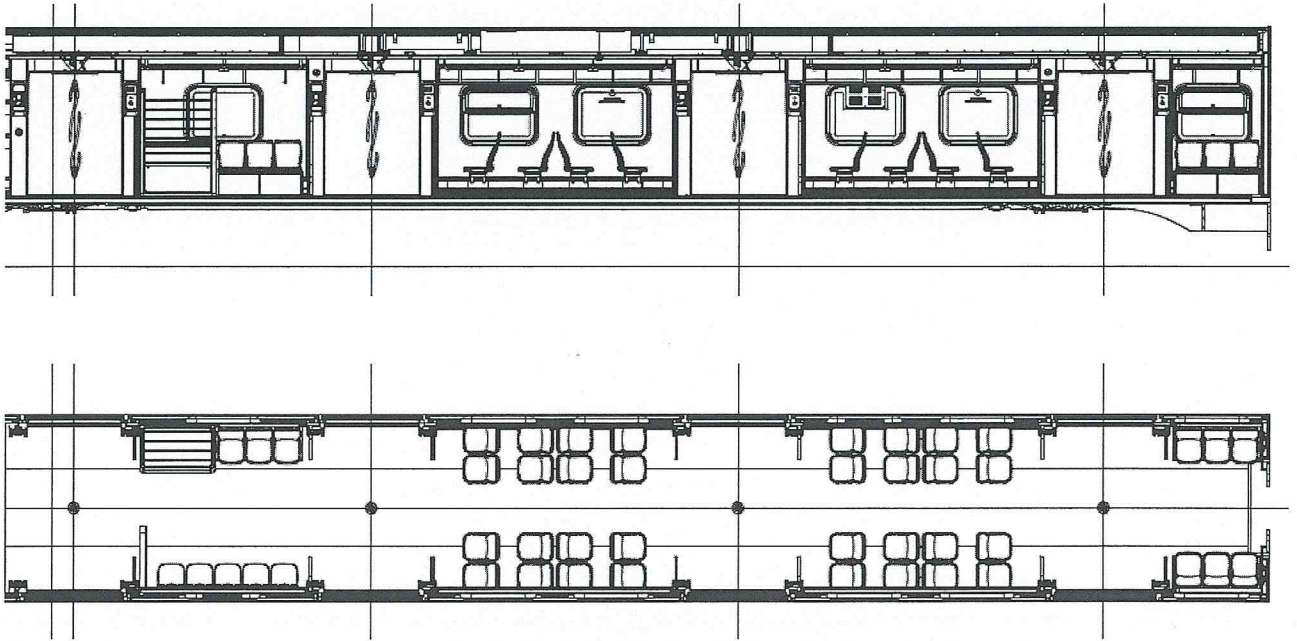


Figure 4 – SKA Passenger Area layout

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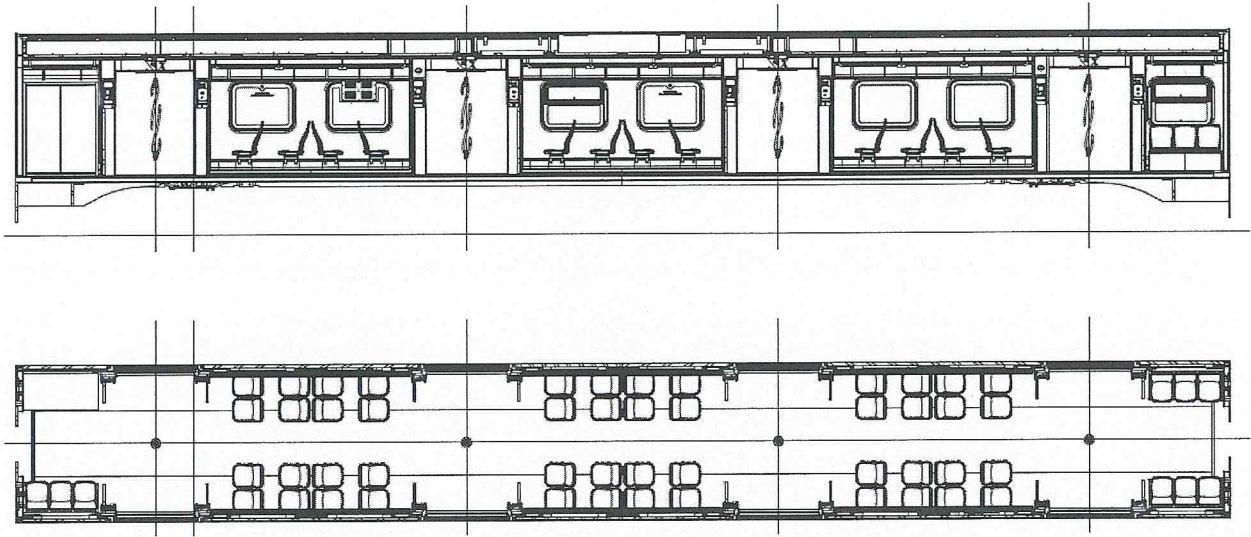


Figure 5 - OA Passenger Area layout

The trainset detailed lay out is depicted in Annex 4: GZ90.00.00.00101 “General layout”.

### 6.1.2 Train-set dimensions

In the following table are reported the principal dimensions of the EMU:

ITEM	DIMENSION [mm]
Train set length over coupler	96000
SKA length over couplers	24720
OA length over couplers	23280
Total width	2950
Roof height of car body from top of rail	3770
Total height over equipment (above rail level)	4400
Coupler height in cab ends (above rail level)	1040
Coupler height in intermediate ends (above rail level)	775
Wheel Diameter (new/worn)	840 / 770
Bogie centre distance	16000
Track gauge	1435

Table 10 – Train set main dimensions EMU

### 6.1.3 Floor heights

The floor height from TOR (nominal with new wheels) is fixed in:

- 1075 mm at entrance (protruding border)
- 1115 mm in passenger compartment and vestibules
- 1300 mm in driver cabin

## 6.2 PASSENGER CAPACITY

The EMU sitting capacity in AW3 is in the following table.

Passengers			
Description	SKA	OA	Trainset
Passengers Seats	41	57	196
Wheelchair Seats	1	-	2
Folding Seats	5	-	10
Standing Area (m <sup>2</sup> )	31.7	34.5	132.4
Standing Passengers	190	207	794
Seated Passengers	46	57	206
Total Passengers	236	264	1000

Table 11 – EMU passenger capacity

Sitting passengers have been considered to have a minimum space available of 0.4 m<sup>2</sup>.

Passenger weight is 70 kg according to definitions of EN 15663 Commuter trains.

## 6.3 EMU's MAIN COMPONENTS DISTRIBUTION

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

Component	SKA	OA	OA	SKA
Roof Mounted Equipment				
Cabin HVAC	1			1
Passenger HVAC	2	2	2	2
Pantograph + HV related devices		1	1	
Air Production		1	1	
Auxiliary Air Production		1	1	
Brake Resistor	2			2
Under Frame Mounted Equipment				
Traction Converter	1			1
Brake Package (EPC+Distributor)	1	1	1	1
Bty Box		1	1	
Auxiliary Converter		1	1	
Main transformer		1	1	

Table 12 – EMU main components distribution

## 6.4 EMU WEIGHTS

EMU cars masses shall respect the allowed axle load. A preliminary mass evaluation for each car (in all loading conditions) is reported for information in the following document. The masses are calculated according to the norm EN 15663.

Every systems/equipment shall respect the established weight target reported in the relevant Technical Specification.



Masses are derived from “TD-GZ.00.0001\_R00\_Reference\_Mass” file.

#### **6.4.1 Weight and Installation Requirement**

The weights, as defined into relevant sections in the dedicated technical specification of the components, shall include also the necessary mechanical interfaces and elements as required below:

- For external equipment, Suppliers shall consider all the components need to be supplied complete with all the mechanical interfaces necessary to be fixed to the available “C-slots” as defined in the drawing GZ90.03.00.00001 “Equipment\_Gauge”.
- The dimensioning of the fixing elements (screws, bolts, washers ...) shall be under Supplier responsibility; all the not normalized elements necessary for the fixation of the equipment and components shall be considered under supplier scope of supply.

#### **6.5 EMU’s CAR DESIGN (BODYSHELL)**

The carbody shell will be extrusion in Aluminum alloy. Bodysell will be designed in accordance with the requirements of EN 12663: 2010+A1:2014 P-II, EN15227:2020 C-1.

## 6.6 PASSENGER WINDOWS

The passenger windows shall be designed to play a multiple role, as described below:

- protect the users from the environment, in terms of passive safety
- protect the users from the environment, in terms of passive comfort
- protect the materials inside the vehicle against harmful solar radiation

The windows shall have innovative contents, for the attainment of objective described above and for the image of the EMU, as well as for purposes of quick, facilitated maintenance.

## 6.7 EMU's DRIVER CAB DESIGN (GRP STRUCTURE)

The following norms will be applied for the EMU driver's cab design:

- TSI RST & LOC&PASS
- UIC 651 – "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"

## 6.8 INTERCAR GANGWAYS

Gangway are be used to allow passenger transit between two adjacent vehicles. The centre line of the gangway shall be coincident with cars centre line. The EMU will be equipped with one-piece gangway systems: the gangway will be installed to SKA cars and to OA1 car. The OA2 car will not be equipped with any gangway.

The gangway shall provide a safe passageway, free from protrusions, finger traps and tripping hazards, for passengers and crew, under all operating conditions. Gangways will be in accordance UIC 561 and EN 16286-1.

## 6.9 COUPLING

### 6.9.1 Front vehicle head coupler (automatic)

The automatic coupler shall be of Type 10. The following train connections shall be ensured through automatic couplers:

- b/w two EMU's: pneumatic + mechanical + electrical LV signals (no LV/MV/HV power)
- b/w and other different EMU's: only pneumatic and mechanical, no electrical

### 6.9.2 Semi-permanent coupler (between cars)

The semi-permanent coupler, as a fixed coupler, links the SKA to OA and two OA vehicles of the EMU. The tractive and compressive loads are transmitted from one car to the next car through two semi-permanent coupler halves. Coupling and uncoupling operation are completely manual.



### 6.10 EMU BOGIES

The EMU is fitted with two type of bogie: the motor bogie and trailer bogie. In the following the main data of bogies.

Nominal axle wheelbase	2400 mm
Nominal wheel diameter	840 mm
width of wheel rim	135mm
Wheel wear (on diameter)	70 mm
Track gauge	1435 mm
Primary suspension	metal/rubber + hydraulic damper
Secondary suspension	pneumatic springs + hydraulic damper
Height of secondary suspension top plate.	875 mm
Motor Bogie brake discs	4 discs bolted on wheels and 4 brake callipers

**Table 13 – EMU bogies basic data**

### 6.11 EXTERIOR REQUIREMENTS

Metallic and non-electrified equipment mounted on the roof shall be connected to the vehicle frame. In addition, appropriate earthing precautions shall be taken against electrical discharges which may be generated by catenary system and pantographs.

## **7 OPERATIONAL CONFIGURATION**

### **7.1 Operational configuration times**

The operational departure time is used to verify the capability of the train during service to restart after a complete system shut off excluding the case of critical failures (Note: this time is not the time needed to put in service the train from depot that includes the preparation tests).

Each EMU shall have an operational departure time of no more than 5 minutes including any time required to set up cab systems such as the passenger information system.

Each EMU shall be capable of reversing at terminating stations and sidings, both involving changing of driving position to the opposite end of the Unit, in no more than 10 minutes excluding door open/close times and any walking time between ends.

To meet the specified targets for minimising service interruptions, the EMU design shall provide the driver with the capability to reset any system which could affect the start-up or reversing of a unit in normal service and to the achievement of rapid recovery from faults.

Resetting of EMU control and other systems shall be achievable from the operating cab.

### **7.2 Operational modes**

#### **7.2.1 Stabling**

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

#### **7.2.2 Normal operation**

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

#### **7.2.3 Parking mode**

The trainset is ready for operation, with minimum energy consumption.

The vehicle is in the following state: parking brakes applied, HVAC in operation in an energy saving mode, traction is inhibited, enabled doors can be operated and train-sets can be coupled.

#### **7.2.4 Change of driving cab**

The change of cab mode is identical with the parking mode with the exception that the HVAC equipment remains in normal operation (instead of energy saving mode).

#### **7.2.5 Towing**

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



## 8 SYSTEM FUNCTIONS

### 8.1 TRACTION

#### 8.1.1 Traction general requirements and redundancy level

The EMU traction system shall not generate interaction with the power supply system that would result in voltage fluctuations or harmonic currents exceeding the limits of EN 50163 and it shall meet the requirements set out herein.

The total power consumption for each train set shall be measured and recorded on board by the TCMS and Energy Meter, this data shall be downloadable.

The traction system shall have functional redundancies to completely recover or reduce the effect on performances due to the failures listed hereafter:

- (1) loss of one pantograph
- (2) loss of one HSVB (High Speed Vacuum Breaker)

In above cases a single failure shall not affect in any way EMU performances

#### 8.1.2 Electro Dynamic Braking (Regenerative)

The EMU shall be fitted with a traction system that allows the regenerative (electro-dynamic) braking.

The electrical energy generated during the ED braking phase shall be returned to supply line.

Traditional “rheostat” energy dissipation system is allowed only if the catenary line is not able to receive the electrical power generated by ED braking.

#### 8.1.3 Main traction and electrical components arrangement on EMU

The traction system of the EMU shall be composed by the following:

- 1 transformer unit mounted on the underframe of each OA car
- 2 traction converters, powering 4 electric motors, with integrated cooling unit, in each SKA
- 2 traction motors for each motor bogie, with 2 motor bogies for each SKA car (bogie suspended with natural cooling)
- 2 surge arrester kit + 1 earthing switch for each OA car
- 1 Vacuum Breaker for each OA car
- 1 Pantograph for each OA car

### 8.2 AUXILIARY POWER SUPPLY

#### 8.2.1 MV (Medium Voltage) and LV (Low Voltage) power generation and distribution

An auxiliary inverter will be installed in each OA car, to supply the required power to loads connected to the MV line (400V AC 3ph 50Hz) on the entire single train; Auxiliary Power Supply includes Battery Charger device.

#### 8.2.2 Battery Box

Each OA car type will have a battery box. It is assumed that the battery box is composed by the following main components:

- Battery box frame
- Battery elements
- Refill system
- Temperature sensor
- Battery Box Heater

Battery cells are in series in each battery box and nominal voltage will be 110Vdc; the 2 battery boxes installed in the OA cars are in parallel, so total available energy stored in the train is the sum of the battery energy of each single battery box.

### 8.3 ENERGY METER

An energy meter device will be installed in the EMU (in each OA car) to measure the consumed and regenerated active or reactive energy; in compliance with EN50463.

### 8.4 CABLES

Cables used on each car shall comply railway regulation.

### 8.5 BRAKING SYSTEM

The EMU brake systems shall be composed by following functional sub-system:

- ED: Electro Dynamic (Regenerative)
- EP: Electro Pneumatic
- UIC type Pneumatic (indirect brake)
- Parking Brake (spring applied and pneumatic released)

The brake systems shall guarantee the following functions

- Service brake (ED + EP blended)
- (EP) Stopping and Holding brake, also managing the rolling back condition
- UIC type indirect brake (brake pipe and distributors)
- Emergency brake i.e. EP by Emergency Loop + UIC type by emergency valves and ERBD (Electro-valve Rapid Discharge Brake)
- Parking brake (EP + manual release)
- Holding brake
- Passenger Emergency Brake (EP).
- Dead man and Vigilance System (according to UIC 641)
- Wheel-Slide protection system

### 8.6 PASSENGER DOORS

The passenger door shall be a sliding and plug door type, electrically powered and shall be compliant with the TSI Loc&Pass, TSI PRM and the EN 14752 and the UIC 560.

Each car has 4 passenger double leaf doors per side. The SKA car (leading vehicle) is equipped with an additional door for direct access of the driver to the driving cab. The driver can even access to the driving cab using the closest passenger door, entering in the vestibule first, then in the cab through the internal door between the passenger compartment and the cab.

### 8.7 HEATING VENTILATION AND COOLING

The heating, ventilation and cooling capability shall be performed by the HVAC system, with the support of independent heaters in both saloon and driver cabs where deemed necessary.

The air conditioning system of EMU shall be based on the following architecture:

- 2 saloon HVAC unit with complete redundant circuits (for full redundancy)
- air distribution ducts
- electronic controllers for each single unit and the compartment heaters
- temperature sensors inside the HVAC units
- heaters in the compartments



- 1 independent HVAC unit for each driver cabin

### 8.8 EXTERIOR LIGHTS

Head, tail and marker lights shall be in full accordance with TSI Loc&Pass and EN 15153-1.

### 8.9 INTERIOR LIGHTING

The EMU train-set shall use high efficiency lighting to provide interior illumination levels in accordance with applicable standard EN 13272 and TSI Loc&Pass.

The interior lighting distribution in the passenger saloon, vestibule and gangways shall be arranged to create a safe, secure and pleasant environment.

### 8.10 PAPIS, CCTV and MD systems

#### 8.10.1 PAPIS and CCTV Equipment

Main components of the PAPIS system and CCTV system shall be:

- PAPIS main control unit
- Audio Amplifier, in each car
- Ethernet switches, with adequate number of connections, in each car
- LCD monitors
- Loudspeakers
- Driver desk HMI used for PIS and CCTV
- Intercom equipment, in each car
- External cameras
- Internal cameras
- Video recorder

#### 8.10.2 Motion Detection System

A motion detection system shall be provided to prevent theft; this system will be active only with trainset disabled (cold parking). A solution, which uses the internal already available cameras, for this purpose, is preferable.

### 8.11 TRAIN MANAGEMENT SYSTEM

#### 8.11.1 TCMS system overview

The control/monitoring and diagnostic system shall be a smart entity which, acquiring and transmitting information of most of devices installed on the train.

- Monitor devices directly interfaced with the system TCMS.
- Provide support for the operation of the train (crew)
- Provide support for centralized maintenance
- Implemented through design and simulation tools to optimize time and cost of design and validation.
- Be designed in a modular way in order to be reused in whole or in different configurations.
- 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.

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.

To this purpose, three groups of information are displayed on the monitor in each driving cab on SKA vehicles (placed on driver's side of the control desk), depending on the user they are addressed to:

- Driving crew (diagnostic monitor and instrument monitor).
- Staff personnel (diagnostic monitor).
- Maintenance personnel (diagnostic monitor).

#### **8.11.2 TCMS main tasks**

Main tasks of diagnostics shall 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.

#### **8.12 WARNING HORNS AND WHISTLE**

Horns (audible warning device) shall be in full accordance with TSI Loc&Pass and EN 15153-2. Operation of the horn shall not cause noise discomfort to the driver.

Warning horns shall be fed by an air pressure circuit and shall be commanded either by a push button or by a pedal.

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

### **9 WINDSCREEN WIPER AND WASHING SYSTEM**

The EMU shall be fitted with a wiper and windscreen washing system in accordance with applicable standards and in particular to assure the driver visibility as per UIC 651

The windscreen wiper system shall be electrical type and include intermittent wipe facility. It shall assure good performance and functionality in all the weather condition as specified in this document and at maximum train speed.

### **10 ELECTRIC GENERAL REQUIREMENT**

The Low Voltage 0V level in the cars 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.

### **11 EMC**

Concerning the electromagnetic compatibility of the complete EMU and of its systems/equipment the following standard shall be applied:

- EN 50121-1 Railway applications - Electromagnetic compatibility Part 1: General.
- EN 50121-3-1 Railway applications - Electromagnetic compatibility Part 3-1: Rolling stock - Train and complete vehicle.
- EN 50121-3-2 where applicable.
- EN 50121-3-3 where applicable.



## 12 SIGNALLING AND SAFETY SYSTEM

### 12.1 JRU (Juridical Recording Unit)

Two event recorders (JRU), one in each OA car, for redundant purposes, shall be installed in the EMU and shall be active when the train is active. Each train event recorders (JRU) shall conform to EN 50155; EN 50121-3-2, EN 61373; 2002/731/EEC or 2012/88/EU standards.

JRU is a device designed to acquire and store the status coming from other on-board devices, to record driver activities. This device shall have a crash-survivable memory which will protect all data within a special housing against fire and shock.

Based on the related standards, the information to be recorded, stored, displayed by JRU (Juridical Recording Unit) due to security shall be described by the Contractor during the design phase.

Train Recording Unit shall be designed to allow recording all data including the information indicated below, at least:

- Driving mode
- Active cabin
- Operation of brake commands/control systems (such as applying the Service Braking, applying the emergency braking, applying the passenger emergency braking)
- List of date / speed (active speed, target speed, permitted speed, release speed) / time / location
- GPS coordinates
- Dead Man's handle system
- Catenary voltage
- Operation of the
- Operation of the door commands ("Door is closed" signals, "0" speed signal, emergency operation for one or more than one door etc.)
- Operation of system bypass switches
- Operation of driver's ERTMS/ETCS and ATS response
- Voice recorder
- Balise status
- Fire alarm, fire detection sensors
- ATMS /Hot box informatio

### 12.2 European Rail Traffic Management and Automatic Train Stop System (ERTMS/ETCS and ATS)

The components of the ERTMS/ETCS and ATS systems to be used in stocks shall be supplied and installed.

This system shall be suitable for the signaling and support systems which have been caused by the Turkish State Railways (TCDD) to be installed on the Başpınar-Gaziantep Oduncular railway line.

Multiple units shall have the necessary equipment, such as ERTMS/ETCS L1+L2 System and GSM-R, fully compatible with all systems on GAZIRAY tracks.

The design of the stocks shall be based on the smooth inclusion of the stocks in the systems installed or GAZIRAY, recognition of the same by the systems, and not affecting the functionality and performance of the systems adversely.



An anthropometric study shall be done at the final design stage for the location/position of these equipment within the stock (control cab).

Maximum attention shall be paid to ergonomics when installing the equipment on the stock.

In ATS and ERTMS systems, transition from one system to another shall be provided automatically.

ERTMS / ETCS Level 1 and Level 2 and ATS-compatible systems are used on TCDD's lines to be equipped with new signal systems.

Also, ERTMS / ETCS Level 1 and Level 2 and ATS-compatible onboard equipment shall be used in the multiple unit.

The ERTMS / ETCS Level 1 and Level 2 and ATS Onboard System and all kinds of subsystems thereof must be vital.

The ERTMS / ETCS Level 1 and Level 2 Onboard System shall be in redundant configuration.

The EDOR (ETCS Data Only Radio) equipment to be installed for data transmission of ERTMS/ETCS Level 2 shall be redundant configuration.

Switching and back-switching between redundant equipment of the system shall be done automatically.

When the redundant system or equipment is activated, there will be no reduction in functions.

The ERTMS / ETCS Level 1 and Level 2 Onboard System shall have Safety Integration Level of (SIL 4) as defined in the IEC 61508 Standard System or an equivalent international standard.

The HSCB of the train will automatically be switched on and off without any intervention from the driver while entering and exiting catenary neutral zones by means of ERTMS/ETCS Level 1 and Level 2 systems.

This automatic switch on and off of the train HSCB shall be controlled by the onboard system.

The air intake vents of the train will automatically be switched on and off without any intervention from the driver while entering and exiting tunnels by means of ERTMS/ETCS Level 1 and Level 2 systems.

The automatic switch on and off of the air intake vents of the train shall be controlled by the onboard system.

With the ERTMS / ETCS Level 1 and Level 2 systems, the control of the service brakes and traction cutoff will be supervised by the onboard system.

The driver-machine interface (DMI) of the ERTMS / ETCS Level 1 and Level 2 systems shall be in Turkish, shall be colored and shall be touchscreen type.

The DMI of the ERTMS / ETCS Level 1 and Level 2 systems shall be in redundant configuration.

ERTMS / ETCS equipment for on board systems will be in SRS (System Requirements Specification) Baseline3.6.0 version. ERTMS / ETCS equipments of onboard systems will be able to work on lines with FRS (Functional Requirements Specification) v4.29 and SRS (System Requirements Specification) version 2.3.0d.

All components of the ERTMS/ETCS onboard system (including EVC and EDOR) shall be selfcontained for each cab of the multiple unit.

The operating temperature of the ERTMS/ETCS onboard system shall be suitable to the conditions of the country and meet EN 50155.

The radar, tachogenerator and antenna which are some components of the ERTMS/ETCS Level 1 and Level 2 systems shall have a minimum protection level of IP66 as defined in the IEC 60529.



### 12.3 Radio System

Each driver cab shall have one fixed radio connected to the TCDD system, one GSM-R radio and one digital hand-held radio, incorporating a charge system, connected to the trunk system of GBB.

## **13 FIRE SAFETY**

### **13.1 Regulatory framework**

The car will comply with the following safety standard:

- TSI Loc&Pass & SRT "Safety in Railway tunnels"
- EN 45545-1-6 Fire protection on the rail vehicles
- UIC 642 Special provides concerning fire precautions and fire fighting measures on motive power units and driving trailers in international traffic

### **13.2 Vehicle classification**

The vehicle classification refers to the categories defined by the TSI and, consequently, by the EN 45545 standard.

According to the TSI, the train has to be classified as category A, as it must work in tunnels not longer than 5 km. For the same reason, according to EN 45545-1, the train has to be classified as:

- Standard vehicle: N
- Operation category: 2(side evacuation available and tunnels not greater than 5 km)

The vehicle results to be classified as 2N, and this implies a hazard level equal to **HL2**.

### **13.3 Running capability**

The requirement of running capability is expressed in the TSI LOC&PAS and in the standard EN 45545-1.

The train should be able to keep the running capability for a time of 4 min.

According to TSI LOC&PAS, braking functions shall be guaranteed for a duration of 4 minutes.

### **13.4 Fire extinguisher**

Fire extinguishers in compliance to the standard EN 45545-6 will be installed as follows:

- 1 HFC 236 Fa gas portable extinguisher in each driver's cab (that according the standard UIC 642 shall be at least of 5 kg).
- 2 HFC 236 Fa gas portable extinguishers in each passenger compartment.

### **13.5 Fire Barriers**

The EMU will implement fire barriers (Requirement: E15) as follows:

- Between the underfloor technical cabinet containing high power electrical supply and the passenger and staff compartment
- Between the technical cabinet located in the body, containing high power electrical supply and the passenger and staff compartment

### **13.6 Fire Detection System**

The EMU will implement fire detection system in following technical cabinets:

- Traction converters
- Auxiliary inverter
- MV cabinet
- HV cabinet



The EMU will implement fire detection system in following areas:

- Driver's cab
- Passenger Compartment

### **13.7 HVAC inhibition**

EMU shall include systems capable of controlling the air flow in and out of the vehicle to minimise the effects of smoke and toxic fumes on the safety of passengers and crew, ensuring that their ability to escape is not impaired.

### **13.8 Other Specific Provisions and Requirements**

Specific provisions and requirements applicable for systems and components, included materials requirement and fire resistance, are reported in the applicable technical specifications.

## **14 RELIABILITY AND SAFETY**

### **14.1 RELIABILITY**

#### **14.1.1 Design for Reliability**

The EMU design incorporates appropriate system functions, levels of redundancy and degraded modes of operation to achieve the reliability outputs expected by the Train Operator.

The system design applies components redundancy as method of reducing the consequences of single point failure, in order to avoid that hidden faults remain undetected.

Each EMU train-set shall have the ability to be moved with an onboard failure to the next station where passengers can be detrained except where the failure is of a major mechanical component.

The EMU shall be fitted with self-monitoring diagnostic equipment that will advise the driver and eventually ground based operations and maintenance staff on failures of any car subsystem.

The EMU design shall minimize the risk of complete train-set pneumatic and mechanical brake system out of service due to loss or lack of air.

In particular, vulnerable air pipes, valves, cocks and other equipment shall be protected from trackside damage and isolation cocks shall be strategically located to allow isolation of leaking sections to prevent complete fault of pneumatic system.

The EMU traction system shall redistribute the available power amongst the remaining operational traction sub systems, within the system limits, in the event of one or more traction subsystem failures, so that the impact on performance is minimized.

The same concept will be applied in case of failure of auxiliary converters and battery chargers.

#### **14.1.2 Failure Classification**

During the design development, a reliability analysis will be improved, with the aim to establish the reliability targets for the complete trainset and its sub-assemblies.

The classification of failure rates reported hereafter helps to identify the type of failure, and to define relevant Reliability targets for systems/equipment/components.

##### **1st Class Malfunctions:**

Major and important malfunction. Train cannot move, they are the malfunctions which require train to be coupled with another train and to be pulled by it.

##### **2nd Class Malfunctions:**

Influent and permanent malfunction. They are the malfunctions which require evacuation of the passengers but allow train to move to the depot with its own power.

##### **3rd Class Malfunctions:**

Permanent malfunction. They are specific malfunctions which do not require evacuation of the passengers but the train cannot continue giving services at the end of the run.

##### **4th Class Malfunctions:**

Temporary malfunction. They are the malfunctions which allow train to reach its scheduled runs and to continue giving services.



MTBF value for the whole fleet shall not be below the operation values of 200 hours and 8000 km.

MTBSF value shall not be below the operation values of 1400 hours and 56000 km.

The proposed reliability targets will be compared with data which shall be collected during a 6-month period in the commercial operations after the provisional acceptance of the last vehicle.

For the calculations, fleet of 8 electrical multiple units with 4 cars shall be taken as 240.000 km / train in total annually and the duration of passenger operations of the train shall be taken as 6000 hours/year.

1st class, 2nd class, 3rd class and 4th class malfunctions described above shall be considered in MTBF (Mean Time Between Failures) calculations (inherent reliability). On the other hand, MTBSF (Mean Time Between Service Failures) calculations shall only consider 1st and 2nd class malfunctions (service reliability).

#### **14.1.3 Not Chargeable Failures**

The calculation of the Reliability failures does not include the unreliability due to failures of the EMU which are not directly caused by systems/equipment failure as:

- Repeated same failure due to same cause will be charged once in the calculation, if the involved part has not been yet substituted promptly;
- Consequential failure due to another failure (secondary failure);
- Failure due do accident or vandalism, by proven infrastructure defects and by other 3rd parties, e.g. suicide damaging a vehicles are excluded
- Failure due to improper action of driver or operator;
- Failure due to not respecting maintenance manual;
- Failure due to completion of service life of a component and train-set operator failed to respect the required action specified in the maintenance manual.
- Failure due to public action or careless omission like forgetting to oil
- Failure due to the equipment out of the supply contract.

#### **14.1.4 Epidemic Faults**

If a failure covered by guarantee will occur in more than 25% of the same parts/components during the guarantee period, such a failure shall be assumed as "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 a failure shall be deemed as a epidemic failure.

#### **14.1.5 Interchangeability**

Exchange capability of the parts and mechanical assemblies shall be assured by mean of following listed ways:

- the use of machining taken from the ISO limits-and-fits systems
- the use of limit gauging for the checking of tolerance dimensions
- the use of ISO threading system

The EMU design allows the standardization of all small equipment, materials, and devices for the work.

All similar parts shall be fully interchangeable with no necessity of modification or adjustment.

All systems, equipment, parts and elements of mass production shall be standardized.

Main equipments are composed by interchangeable parts:

- Motors;
- Pumps;
- Flanges;
- Fasteners;
- Valves and Flow meters;
- Gauge and Detectors;
- Electrical Instruments and Measuring Devices;
- Terminals and Terminal Boxes;
- Contactors, Fuses and Switches;
- Lamps, Bulbs, Sockets, plugs, push Buttons, etc
- Lubricants.

## 14.2 SAFETY

### 14.2.1 Safety General Overview

The provision of a safe, secure and pleasant environment in which passengers travel in safety and comfort is an essential objective.

Safety is defined as freedom from unacceptable risks or harms, i.e. from these conditions that can cause death, injury, occupational illness or damage to or loss of equipment or property.

Safety-critical functions in EMU shall have the feature of Failure Safety, and in case that the vehicle is malfunctioning in any time and anyway, it shall not pose any unsafe and dangerous situation in other systems and equipment due to the mentioned malfunction.

Safety performance shall be assessed by a dedicated approach following the methodology of the mentioned standard EN 50126.

A program based on EN 50126 methodology shall be part of the RAMS Plan describing the Safety policy to follow during the evolution of the project including a management process for identifying and resolving hazards, certification prior to revenue service, and timely investigation, analysis and reporting of accidents and incidents.

Reference to Safety-related standards shall be also kept into account considering following norms:

- IEC 61508 - Functional safety of electrical/electronic/programmable electronic safety-related systems
- EN 50128 - Railway applications – Software for railway control and protection system
- EN 50129 Railway applications. Communication and processing systems. Safety related electronic systems for signalling

The EMU design includes many measures with the aim to ensure the safety of passengers and staff:

- The design of the interior body-side windows and glazed surfaces shall optimise passenger safety in all foreseeable circumstances.
- All interior areas of the EMU which facilitate standing or walking passengers shall be fitted with appropriate means of support to maximise the safety of passengers in all normal and emergency modes of operation.
- Appropriate signage solutions should be utilised to ensure that luggage is stowed in complete safe manner, in accordance with the Train Operator's requirements.



- The door system shall provide an optimised method of obstruction detection that ensures the safety of boarding and alighting passengers.
- The access door must incorporate an opening and closing system which guarantees passenger safety.
- Emergency exits must be provided and indicated.
- An emergency lighting system of sufficient intensity and duration is compulsory on board vehicle.
- The EMU is equipped with a public address system which provides a means of communication to the public from on-board staff.
- In the event of danger, safety devices must enable passengers to inform the driver and to contact train staff.
- Each area intended for passengers (with the exception of toilets) is equipped with a clearly visible and indicated alarm device to inform the driver in the event of danger.

#### 14.2.2 Active Safety Requirements

The active safety shall be achieved by the implementations of specific design provisions that are reported by relevant Technical Specifications of EMU systems/equipment and components, applying relevant standards and regulations.

Specific safety care in design shall be applied to:

- Braking System
- Passenger entrance door
- Passenger Alarm System
- Dead Man Device
- External Lighting System
- Emergency Lighting System
- Emergency Communication System
- Fire Detection System
- Train Safety Loop
- Signalling (on board devices)

#### 14.2.3 Passive Safety Requirements

The passive safety shall be achieved by the implementations of specific design provisions that are reported by relevant Technical Specifications of EMU systems/equipment and components, applying relevant standards and regulations.

Specific safety care in design shall be applied to different systems equipment functions

- Car-body structure about resistance to compression, vertical load and crash (energy absorption of collision)
- EMU dynamic behaviour (against derailment and/or overturning as worst case and passenger comfort as normal characteristic)
- EMU's external body parts and fittings about harms to travellers and pedestrians
- EMU's interiors about potentials harms to passengers
- Guard iron
- JRU
- Driver Cab protection and Driving Desk layout
- Resistance to vandalism acts and aggressions

## 15 MAINTENANCE AND OPERATIONS

### 15.1 DESIGN FOR MAINTENANCE

LRU policy shall be widely apply in order to have quick repair of EMU train-set by substitution of failed components and the repair of them later on in dedicated workshop. This reduces the stay of the car in the workshop increasing the availability.

Each EMU shall be designed:

- to facilitate maintenance, servicing, cleaning and reparability; this shall include the design of interior panelling and other items prone to vandalism. All main equipment and wear parts must be easy accessible and exchangeable
- to incorporate features which enable maintenance and repairs to be carried out quickly and effectively
- to minimize the length of time when the train-sets are out of service for maintenance, overhaul and repair
- to accommodate maintenance activity in times that are outside of the peak service requirement
- to incorporate modular equipment easy to replace
- to incorporate diagnostics, condition monitoring and train data systems which can be easily managed
- to ensure the long-term availability and quality of all spare parts and consumables for the life of the train-set

In particular:

- Components which require lubrication, can be easily worn out and need to be replaced frequently shall be avoided where possible. Time period of maintenance which requires oil change and component replacement shall be at longer intervals as far as possible.
- All components of the coaches, in particular the components which require periodic maintenance, shall be in a modular structure in order to let them being replaced easily using minimum time.
- Units for troubleshooting shall be in a modular structure; in particular, electronic systems shall be in "bus" structure or formed by the cards that can be easily assembled and disassembled; each control unit shall be equipped with a malfunction warning system that helps finding the fault.
- Terminals in all main and auxiliary computer systems on the vehicle shall be located to allow easy access.
- The vehicle shall have a design that allow maintenance personnel to access the component easily when it is required to be maintained or replaced and it shall also provide easy assembly.
- All filters/strainers shall be easily checked and shall be of a type that can be easily cleaned with water. Air outlets shall not disturb the passengers getting off the trainset and waiting at the platform.
- Larger components which require lifting equipment should be configured to allow easy assembly-disassembly and lifting operations. Large components shall be designed as to ensure being disassembled easily.
- All test points, fault indicators, modules, cable terminals, conduits, ducts, cables etc. shall be of a type that can be easily defined, and they shall be indicated with name plate, colour code, number coding or other facilitations that may help maintenance personnel.



- EMU external service connection points shall be located to ensure that only a minimum of trackside servicing points is required regardless of the orientation of the train-set. Connection points shall be safe, durable, simple and quick to use and capable of repeated use in the harsh conditions to be expected at servicing locations. They shall be capable of being changed easily and quickly, in the event of failure.
- Standard, commercially available components and equipment shall be used as far as possible.
- Fixed fastenings shall be used on the covers and access panels where periodic maintenance and inspection are performed. It shall be avoided to use special tools for unscrewing, except for the screwdrivers.
- Flexible and mobile fastenings shall be designed as to require less maintenance but to be lubricated when required.

Dedicated maintenance regime (Maintenance Intervals) shall be identified, keeping into account the EMU mission profile and the foreseen revenue service characteristics.

Maintenance plan will be provided, including the following information/documents:

- ✓ List of all planned protective maintenance procedures, maintenance plan and criteria
- ✓ List and criteria of conditional protective maintenance procedures,
- ✓ The list of the corrective maintenance procedures;
- ✓ Maintenance procedures dependent on special usage conditions;
- ✓ Levels of maintenance procedures;
- ✓ The manual and booklets of maintenance

## 15.2 UNIT REPAIRS

Each EMU train-set shall be designed and constructed so that the time required to repair exterior collision damage is minimised, this is particularly important for front and rear ends damage, as already written in a previous paragraph.

In particular the EMU shall be designed and constructed so that:

- the time to repair vandalism and to replace damaged interior components is minimised
- the time required to replace all major components shall be minimised.

## 16 FORBIDDEN MATERIALS

The EMU shall be designed for optimal recyclability. The equipment/systems materials shall not affect both safety and health of crews and maintainers or the environment.

Following materials are forbidden to be used for manufacturing these vehicles:

- PVC
- Asbestos
- Lead in the brake pads (shoes)
- Urethane foam
- Aluminium threaded fasteners

Vehicle and equipment shall be selected in accordance with the rules specified for the human and environmental health in 2002/95/EC (electric-electronic materials), 2002/96/EC (waste electric and electronic materials), 2000/53/EC, 91/156/EEC, 94/3/EEC, 76/769/EEC, 67/548/EEC, 93/67/EEC, 67/548/EEC, 1488/94/EC, 793/93/EEC, 2000/532/EC (including EWC- European Waste Catalogue/HWL-Hazardous Waste List) and 94/904/EC Directive and materials such as mercury, cadmium, lead, asbestos, chrome 6 compounds which are forbidden to be used shall not be utilized.

PCBs (polychlorinated biphenyls), PCTinside the Transformers and CFC (chlorofluorocarbon) cooling gases inside Ventilation systems which are forbidden by the European Directives shall not be used in the vehicles, due to they are harmful for human and environmental health.

Products which do not contain biocide shall be preferred to be used for vehicle and equipment paints.

Other norms to be referenced for what concern materials are the following:

- The European regulation REACH RG 1907/2006
- UIC leaflet 345: Environmental specifications for new rolling stocks



## 17 ANNEXES

**Annex-1:** Applicable Norms

**Annex-2:** Other Norms

**Annex-3:** Routes Data

**Annex-4:** Reference Drawings & Documents

## **ANNEX 1 – Applicable Norms**

The applicable norms are reported in “TD-GZ.44.0151\_R00\_Standard\_List” file.



## ANNEX 2 – Other Norms

The applicable norms are reported in “TD-GZ.44.0151\_R00\_Standard\_List” file.

## ANNEX 3 – Routes Data

### BAŞPINAR to TAŞLICA B1

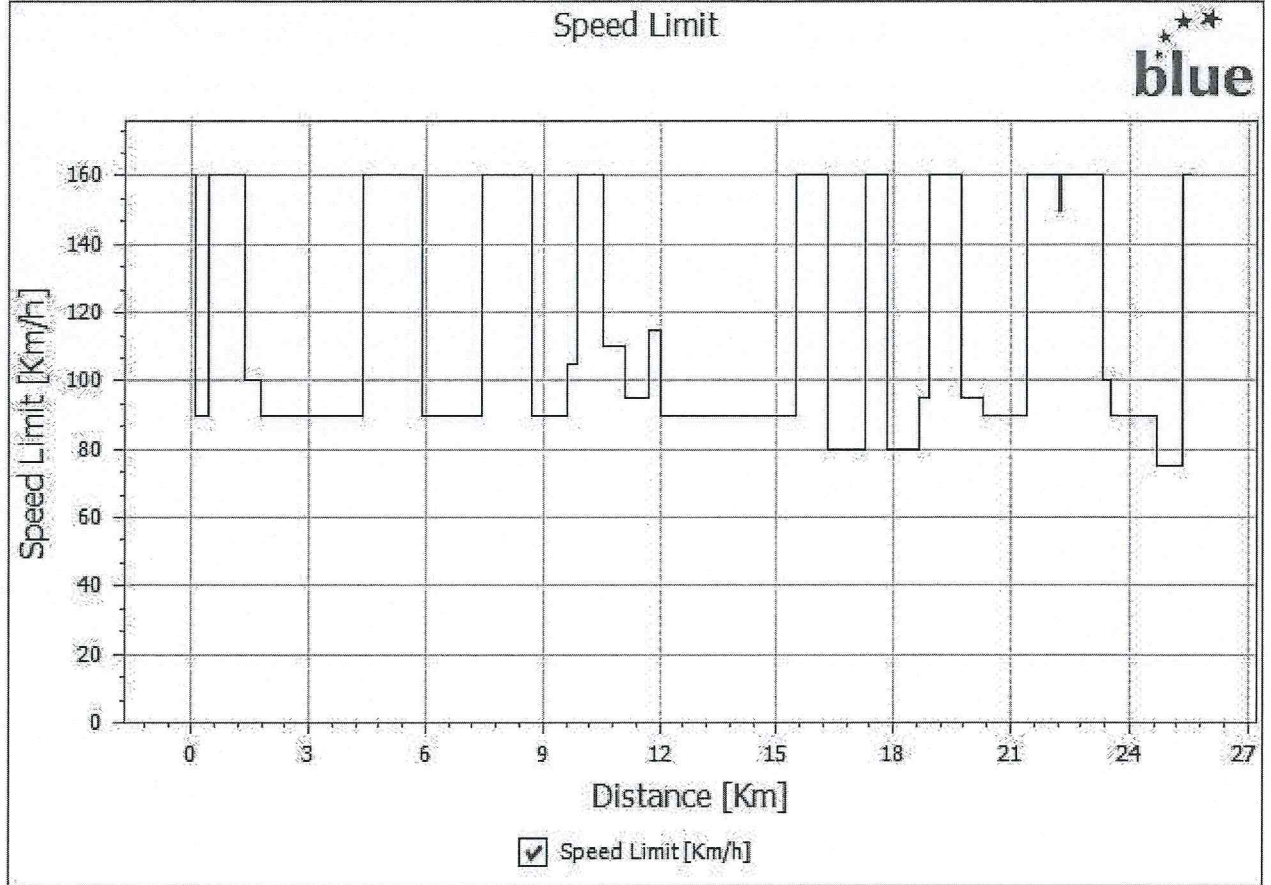


Figure 6 - BAŞPINAR to TAŞLICA B1, Track Speed Limit

The track speed limit shown in the previous figure does not consider the trainset maximum design speed (120 Km/h).



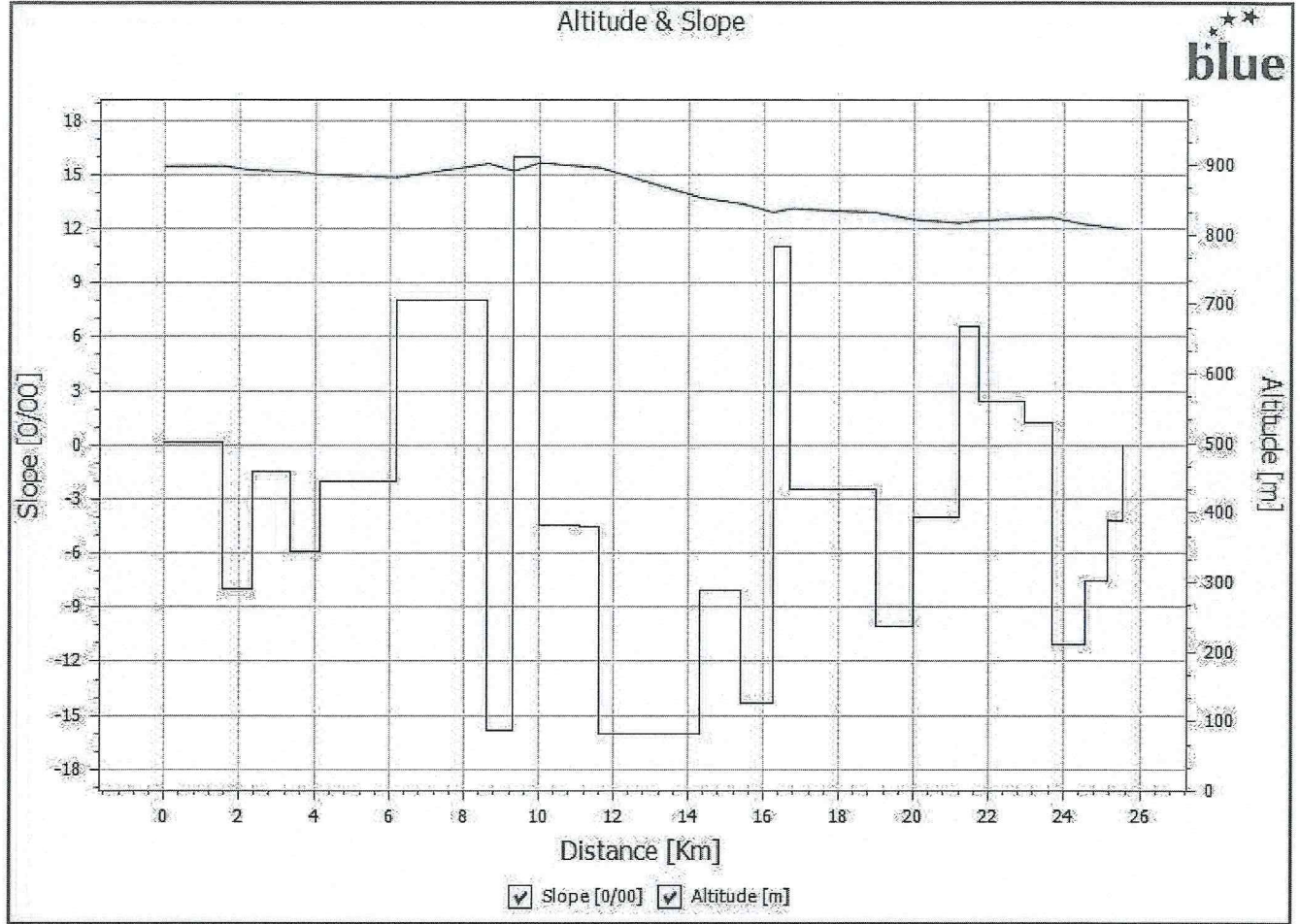


Figure 7 - BAŞPINAR to TAŞLICA B1, Altitude Profile

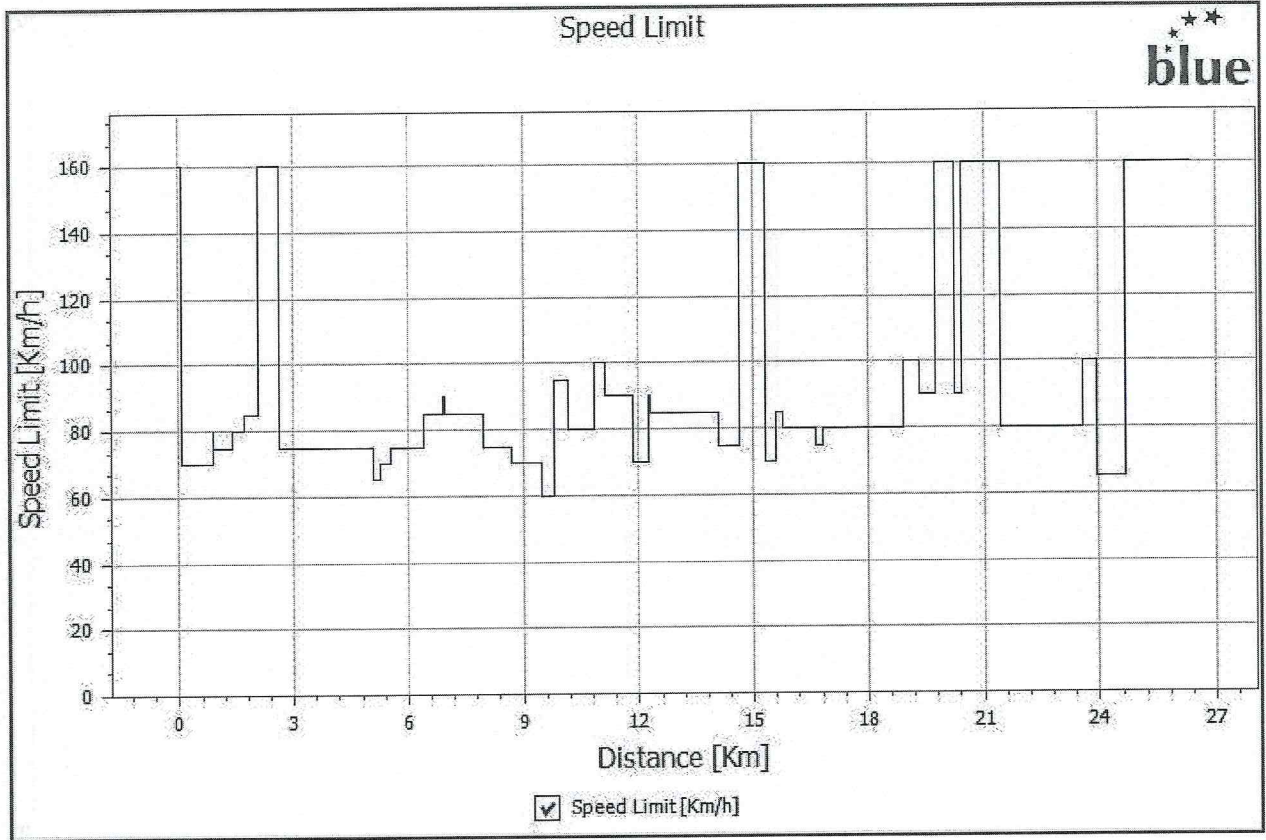
Distance (Km)	Horizontal Curve Radius (m)
0	0
0+065.70	493.25
0+463.69	0
1+339.31	706.75
1+785.71	0
2+018.90	493.25
2+646.37	0
3+108.64	606.75
4+377.84	0
5+920.33	493.25
6+404.82	0
6+485.07	506.75
6+909.86	0
6+980.95	493.25
7+452.14	0
8+729.31	516.75
9+418.02	0
9+634.82	1006.75
9+862.28	0
10+561.73	1106.75
11+095.54	0
11+120.55	593.25
11+590.33	0
11+739.93	1493.25
11+840.79	0
11+904.95	1506.75
11+997.98	0
12+273.16	506.75
12+585.38	0
12+795.35	507
13+151.75	0
13+391.88	493.25
13+747.45	0
14+126.35	493.25
14+400.12	0
14+625.95	493
15+496.87	0
16+324.16	550
16+439.05	0
16+682.24	700



Distance (Km)	Horizontal Curve Radius (m)
16+748.59	0
16+996.88	554.5
17+091.30	0
17+197.96	555
17+292.39	0
17+815.84	555
17+906.78	0
17+942.69	555
18+033.63	0
18+431.43	700
18+499.20	0
18+582.30	700
18+650.08	0
18+676.85	693.25
18+932.29	0
19+725.43	693
20+267.85	0
20+447.79	512
21+417.49	0
22+218.54	7512.116
22+287.89	0
23+346.67	704.5
23+569.66	0
23+930.89	595.5
24+665.37	0
25+089.89	450
25+311.70	0

**Table 14 – - BAŞPINAR to TAŞLICA B1, Curve Radius Profile**

**BAŞPINAR to TAŞLICA B2**



**Figure 8 - BAŞPINAR to TAŞLICA B2, track Speed Limit**

The track speed limit shown in the previous figure does not consider the trainset maximum design speed (120 Km/h).



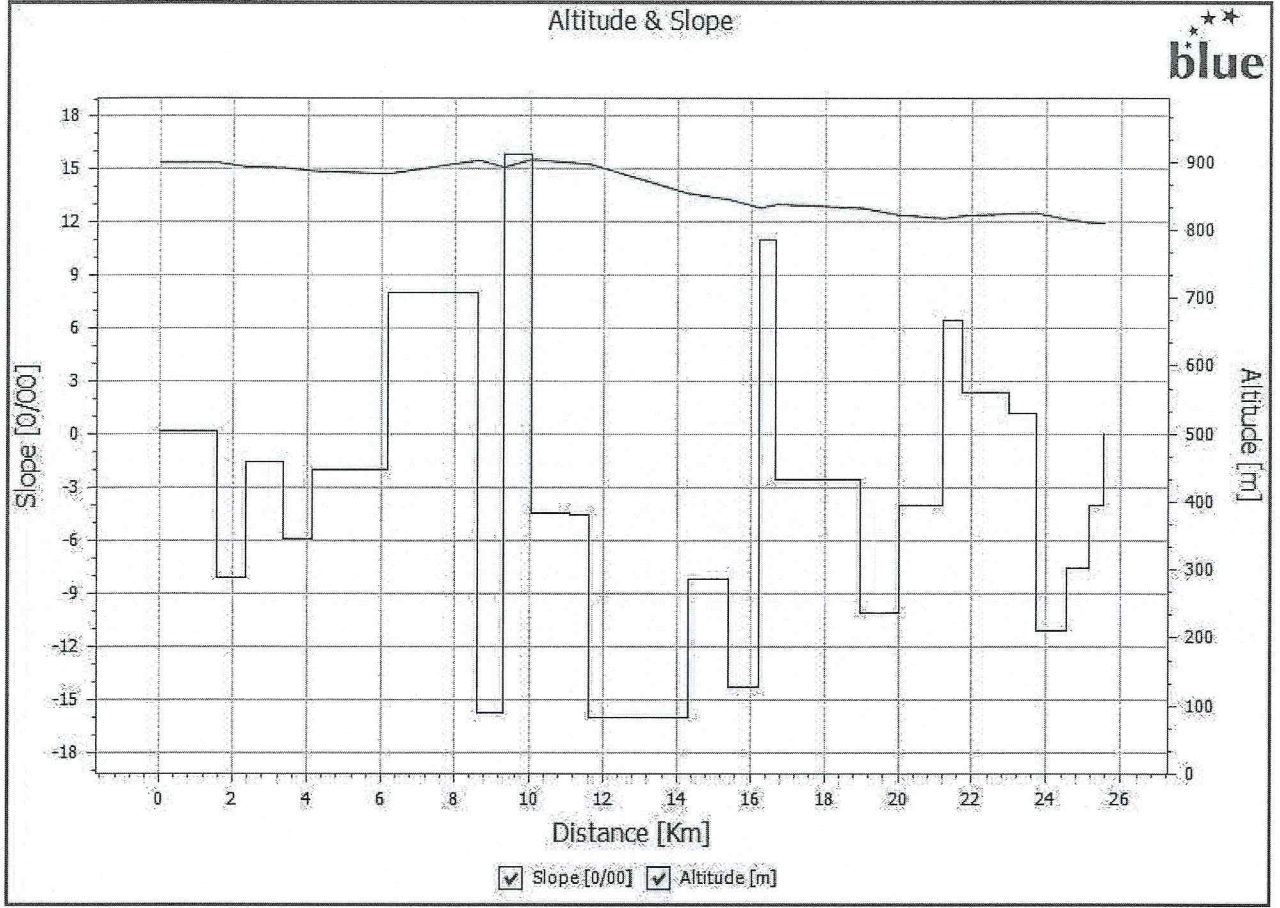


Figure 9 - BAŞPINAR to TAŞLICA B2, Altitude Profile

Distance (Km)	Horizontal Curve Radius (m)
0+065.70	0
0+460.85	489
0+822.60	0
0+904.77	500
0+915.99	0
0+998.15	500
1+281.99	0
1+391.82	600
1+407.88	0
1+693.36	708
1+713.66	0
1+864.74	700
2+061.32	0
2+639.54	474
2+685.77	0
2+763.70	550
2+790.52	0
2+861.09	500
3+062.91	0
3+251.67	810
4+295.04	0
4+390.83	611
5+106.81	0
5+188.13	650
5+198.34	0
5+287.81	800
5+487.79	0
5+568.22	700
5+591.52	0
5+671.95	700
5+923.78	0
6+404.60	489



Distance (Km)	Horizontal Curve Radius (m)
6+484.67	0
6+912.89	511
6+983.80	0
7+451.44	489
7+944.34	0
8+008.73	550
8+067.28	0
8+131.68	550
8+689.27	0
8+953.35	640
9+461.04	557
9+616.24	0
9+803.49	800
10+168.37	0
10+249.00	550
10+270.08	0
10+350.71	550
10+551.87	0
10+825.73	1'000
10+843.36	0
11+103.63	1'111
11+133.53	0
11+606.55	589
11+841.17	0
11+922.83	550
11+941.27	0
12+025.72	550
12+176.75	0
12+246.44	800
12+295.66	0
12+600.02	550
12+808.57	0

Distance (Km)	Horizontal Curve Radius (m)
13+167.79	511
13+398.25	0
13+736.58	500
14+008.01	0
14+093.17	650
14+123.09	0
14+409.55	489
14+635.56	0
15+301.52	400
15+511.49	0
15+581.49	600
15+781.49	0
15+864.70	550
15+877.98	0
15+961.19	550
16+262.98	0
16+365.87	550
16+623.23	0
16+693.15	600
16+698.35	0
16+803.22	550
16+997.97	0
17+091.82	550
17+279.04	0
17+372.88	550
17+734.13	0
17+824.61	550
17+944.88	0
18+036.29	560
18+433.62	0
18+501.66	704
18+584.76	0



Distance (Km)	Horizontal Curve Radius (m)
18+652.27	695
18+679.13	0
18+933.09	689
19+307.84	0
19+388.38	700
19+437.47	0
19+518.01	700
19+750.53	0
20+263.92	650
20+443.55	0
21+421.44	516
21+461.92	0
21+545.13	550
21+558.41	0
21+641.62	550
21+841.59	0
21+924.80	550
21+938.09	0
22+021.29	550
22+222.71	0
22+299.98	550
22+343.99	0
22+417.64	550
22+658.46	0
22+741.11	550
22+756.04	0
22+838.69	550
23+351.55	0
23+575.78	709
23+936.79	0
24+286.87	591
24+665.82	0

Distance (Km)	Horizontal Curve Radius (m)
24+678.36	560
24+750.49	0
25+069.36	700
25+291.18	0
25+543.13	450

**Table 15 – BAŞPINAR to TAŞLICA B2, Curve Radius Profile**



## ANNEX 4 – Reference Drawings & Documents

Code	Made by	Drawing & Document Description
GZ90.03.00.00001	BLUE Engineering	Equipment_Gauge
GZ90.00.00.00101	BLUE Engineering	General Layout
TD-GZ.00.0001	BLUE Engineering	Reference_Mass
TD-GZ.44.0151	BLUE Engineering	Standard List

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