SECTION VI – REQUIREMENTS

Section VI: Requirements

1. Scope of work

The works under the present Contract are divided in five sections:

Section 1: DURRES - TIRANA PTT RAILWAY LINE, KP 0-639 - KP 2+000

Section 2: DURRES - TIRANA PTT RAILWAY LINE, KP 2+000 - KP 20+700

Section 3: DURRES - TIRANA PTT RAILWAY LINE, KP 20+700 - KP 33+540

Section 4: TIRANA INTERNATIONAL AIRPORT RAILWAY LINE AND CONNECTION BRANCH TO DURRES

Section 5: SIGNALLING - TELECOMAND AND TELECOMMUNICATIONS FOR SECTIONS (1), (2), (3) and (4)

The railway line from Durres Terminal Station to Tirana PTT has an overall length of 34.5km. The starting point is at KP 0-639, i.e. the head on platform of Durres Terminal Station and the ending point at KP 33+540 at the end of the Tirana PTT forestation.

The new railway link to Rinas airport has an open line length of approximately 5 km in addition to the triangular railway intersection

The contractor must design and construct part of works related to the future 25kV/50Hz electrification system including the foundation of electrification poles, provisions for future earthing of neighboring structures to the railway line, provisions for cable trenches etc.

All project components shall be designed and constructed in order to be compatible to the future 25kV/50Hz electrification system.

1.1 Section 1: Durres - Tirana PTT Railway Line, KP 0-639 - KP 2+000

Works within this section will be executed and completed under parallel railway operation. More specifically, railway operation will be maintained in order to ensure the following functions:

- Operation of the Durres Terminal Railway Station

Throughout all stages of works a minimum length of 100m of platform at Durres Station will remain operational and accessible to passenger trains, along with an auxiliary line with the necessary turnouts for shunting purposes.

A minimum 3.50m platform width will be maintained along the operational section of the platform to serve passenger boarding and alighting. A minimum 2.50m wide corridor will be maintained to connect the operational platform section with the Durres Station building.

The operational platform section will be furnished with a 10.00m x 1.50m canopy of a 2.20m height clearance for the protection of passengers.

Both operational platform section and the connecting corridor will be separated from the work site by means of appropriate safety fencing.

- Connection of Durres Terminal Railway Station

During all stages of works a single line railway operation will be maintained between the operational section of Durres station platform and:

- The railway branch to the south towards Rrogozhine
- The railway branch to the north towards Vore, for any period this section is operational, according the time schedule of the construction works.

- Connection with the Shkozet stabling and maintenance yard

During all stages of works appropriate railway connection will be maintained, by means of turnouts and connecting line, between the single line serving the connection of Durres station and the HSH depot and stabling facilities of Shkozet.

Connection includes all necessary auxiliary lines and turnouts to allow for necessary shunting and connection with Durres Station, the line to Rrogozhine and the line to Vore (for any period the latter is operational during the course of works).

Phasing of the works under parallel railway operation as per the above described conditions will constitute the subject of a separate study to be prepared in cooperation with HSH and submitted for the approval of the Engineer and the Client before commencement of the works.

Works within this Section include:

- Relocation of public utility networks as necessary
- Dismantling of existing railway tracks, turnouts etc. along the section as needed and disposal / storage according to the directions of HSH and the Client.
- Any required demolition of existing elements (fence, walls, platform sections etc) along with the disposal of materials.
- Excavations and removal of existing ballast / sub-ballast layers etc according to the cross sections of the detailed design, to be carried out by the contractor and approved by the Client.
- Temporary works as may be needed to achieve uninterrupted rail operation during construction phases along this segment
- Earthworks and new railway substructure.
- Civil works for the future electrification system (foundations of electric poles, cable trenches, earthing installations etc).
- Construction of drainage works of Durres and Shkozet stations and of the railway lines along the section.
- Construction of new double track railway corridor
- Construction of Durres and Shkozet railway stations' tracks and turnouts
- Construction of Durres and Shkozet stations' platforms.
- Construction of retaining walls along the section
- Construction of railway corridor fencing.
- Maintenance of pedestrian walkways and access to unauthorized settlement at approx KP 0+800 according to approved design and environmental terms.

1.2 Section 2: Durres - Tirana PTT Railway Line, KP 2+000 - KP 20+700

Works within this section include:

- Relocation of public utility networks as necessary
- Dismantling of existing railway tracks, turnouts etc. along the section as needed and disposal / storage according to the directions of HSH and the Client.
- Any required demolition of existing elements (fence, walls, platform sections etc) along with the disposal of materials.
- Excavations and removal of existing ballast / sub-ballast layers etc according to the cross sections of the detailed design to be carried out by the contractor and approved by the Client.
- Excavations for ground bearing capacity improvement, sections:
  - KP 4+110 - KP 4+790,
  - KP 13+000 - KP 13+650,
  - KP 16+080 - KP 17+070

  (according to the existing design)
- Construction of embankments and new railway substructure.
- Civil works for the future electrification system (foundations of electric poles, cable trenches, earthing installations etc).
- Construction of new single-track railway corridor
- Construction of Sukthi and Vore railway stations tracks and turnouts
- Construction of drainage works of Sukthi and Vore stations
- Construction of Sukthi and Vore stations platforms
- Construction of retaining walls along the section
- Construction of railway corridor fencing.
- Reinstatement construction of local and access roads along the railway corridor, as needed
- Reinstatement of access to adjacent land, as needed.
- Construction of channels and gutters along the railway corridor.
- Construction of culverts (the following list according to the existing design):

Kilometric Position	Dimensions		Demolition of Existing Culvert
	Pipe Φ	Box B x H	
2+076.50		3x2	√
2+415.93	1,50		
2+648.7		2x2	√
4+559.94	1,50		√
5+377.4	1,00		√
5+833 (road culvert)		4x2	√
5+908.53		3x2	√
6+418.07	1,50		√
6+961.5	1,00		√
7+441.36	1,00		√
7+906.5		3x3	√
9+041.6	1,00		√
9+295.88		2x2	√
9+660 Pedestrian Underpass		3x3	
9+800 Pedestrian Underpass		3x3	
10+676.4	1,50		√
11+090.37	1,00		
11+100.74		3x2	√
11+575.30	1,50		√
12+071.3	1,50		√
12+291.3		3x2	√
12+693.6	0,50		√
13+009.5		3x2	√
13+501.74		3x3	√
13+831.7	1,50		√
15+181.98		4x2	√
17+590		2x2	
18+865.09		2x2	√
19+790.52		2x2	√

Kilometric Position	Dimensions		Demolition of Existing Culvert
	Pipe Φ	Box B x H	
20+526.3	1,50		

- Demolition of Existing Culverts (the following list according to the existing design)

Kilometric Position	Dimensions	
	Pipe Φ	Box B x H
14+841	0.80	
16+570	0.80	

- Reinstatement / construction of at-grade road crossings (the following list according to the existing design)

KP	2+136.03
KP	4+761.03
KP	6+412.09
KP	9+289.33
KP	10+418.27
KP	12+533.81
KP	15+199.95
KP	19+410.80

- Construction of new railway bridge over Tana River, at KP 16+540
- Rehabilitation/upgrading of existing bridges as per the existing design or new design to be carried out by the contractor and approved by the |Client

- Arched bridge over drainage channel, at KP 3+560: According to the existing design, rehabilitation features the construction of a new deck seated on the existing backfill between the side walls has been proposed. The arches and the major part of the walls will be maintained in their existing condition. Partial demolition of the sidewalls of the arches and re-construction of the upper part of the walls according to the design to be approved will be required. Expansion joints will be arranged at the abutments and piers.
- Existing bridge, at KP 5+130: According to the existing design, rehabilitation features the replacement of the existing deck by a new one, seated on new bearings, by keeping piers and abutment in existing conditions, save for the reconstruction of their heads. Expansion joints will be arranged at the abutments and piers.
- Existing bridge at Ergeni River, at KP 9+370: According to the existing design, rehabilitation features the replacement of the existing deck by a new continuous composite deck (steel and reinforced concrete). Intermediate piers and the abutments will be preserved and strengthened by shotcrete, save for the demolition and reconstruction of the upper parts of the abutments and piers, as well as of the back walls of the abutments.
- Existing bridge at KP 19+525: According to the existing design, rehabilitation features the maintenance of the abutments and replacement of the superstructure by a new slab, seated on elastomeric bearings on the top head of the abutments.

  - Maintenance works at Rashbull tunnel, at KP 3+900: According to the existing design limited works are required, featuring concrete repairs, moisture treatment with cementitious waterproofing materials and sealing existing segment joints with joint sealants.

1.3 Section 3: Durres - Tirana PTT Railway Line, KP 20+700 - KP 33+540

Works within this section include:

- Relocation of public utility networks as necessary
- Dismantling of existing railway tracks, turnouts etc. along the section as needed and disposal / storage according to the directions of HSH and the Client.
- Any required demolition of existing elements (fence, walls, platform sections etc) along with the disposal of materials.
- Excavations and removal of existing ballast / sub-ballast layers etc according to the cross sections of the detailed design to be carried out by the contractor and approved by the Client, including the triangular railway intersection at Domje area.
- Stabilization of cut slope KP 24+760 - KP 24+910 (according to the existing design)
- Excavations for ground bearing capacity improvement, sections:
- – KP 28+200 - KP 29+100 (according to the existing design)
- – Along the section of the triangular railway intersection according to the detailed design to be elaborated for this section
- Construction of embankments and new railway substructure.
- Civil works for the future electrification system (foundations of electric poles, cable trenches, earthing installations etc).
- Construction of new single-track railway corridor
- Construction of Kashar and Tirana PTT railway stations tracks and turnouts.
- Construction of any auxiliary tracks works in Tirana PTT station as may be required by the Client during the execution of the detailed engineering design forthe future extension of the line towards Tirana City Centre.
- Construction of drainage works of Kashar and Tirana PTT stations
- Construction of Kashar and Tirana PTT stations platforms
- Construction of retaining walls along the section
- Construction of railway corridor fencing.
- Reinstatement/constraction of local and access roads along the railway corridor, as needed
- Reinstatement of access to adjacent land as needed
- Construction of channels and gutters along the railway corridor
- Construction of culverts (the following list according to the existing design)

Kilometric Position	Dimensions		Demolition of Existing Culvert
	Pipe Φ	Box B x H	
20+987.15		4x3	√
21+566.5		2x2	√
22+056.6		2x2	
22+320		2x2	
22+645.38		3x3	√
23+870.3	1,50		√
23+973.4		2x2	√
24+056.67		2x2	√
24+313.42		3x2	√
24+623.08 (*)		2x2	√
25+691.07 (*)		2x2	√
26+176 (*)		2x2	
26+802.5 (*)		4x2	
27+093 (*)		3x2	

27+244.47 (*)		2x2	
27+580	1,50		
27+728.9		2x2	
27+880		3x2	
28+300	2x1.5		
28+602.45	1,50		√
28+971.6	1,50		√
29+411.4		2x(3x2)	√
30+156.3	1,50		√
30+540.08	1,50		
30+982.25	0,80		
31+400		2x2	
31+840.08		2x2	√
32+680	0,50		
32+840		1.5x1.5	
33+320		1.5x1.5	

- Demolition of Existing Φ 0.80 Pipe Culvert at KP 26+000 (according to the existing design)
- Reinstatement / construction of at-grade road crossings (the following list according to the existing design):

KP	21+224.12
KP	22+047.18
KP	(*) 29+947.10
KP	(*) 29+989.63
KP	30+982.25
KP	32+608.90

(*) Roundabout at Kashar Station

- Construction of at-grade pedestrian crossings (the following list according to the existing design):

KP	23+806.80
KP	29+189.30
KP	32+289.10
KP	33+323.56

- Rehabilitation/upgrading of existing bridges as per the existing design or new design to be carried out by the contractor and approved by the Client
- Existing bridge at KP 25+130: According to the existing design, rehabilitation features the maintenance of the abutments and replacement of the superstructure by a new slab, seated on elastomeric bearings on the top head of the abutments.
- Arched bridge over Limuthi River, at KP 25+400: According to the existing design, rehabilitation features the replacement of the existing deck by a new one, seated on new bearings, by keeping piers and abutment in existing conditions, save for the reconstruction of their heads. Expansion joints will be arranged at the abutments and piers.
- Existing bridge over Lana River, at KP 30+194.70: According to the existing design, rehabilitation features the replacement of the existing deck by a new one, seated on new bearings, by keeping piers and abutment in existing conditions, save for the

reconstruction of their heads. Expansion joints will be arranged at the abutments and piers.

1.4 Section 4: Tirana International Airport (TIA) railway line and connection branch to Durres

- Works within this section will be executed according to the implementation study in detailed design to be carried out by the contractor and approved by the Client , including the triangular railway intersection at Domje area or alternatively in part according to the existing approved design subject to the approval of the Client and will include:
- Relocation of public utility networks as necessary
- Any required demolition of existing elements (fence, walls, structures, etc) along with the disposal of materials.
- General excavations according to the finally approved detailed design
- Excavations for ground bearing capacity improvement at sections (Kilometric Position according to the existing design):
  - KP 1+780 - KP 1+870
  - KP 4+220 - KP 260
- Construction of rip - rap, embankments and new railway substructure.
- Civil works for the future electrification system (foundations of electric poles, cable trenches, earthing installations etc).
- Construction of new single-track railway corridor to Tirana International Airport and connecting branch towards Durres, along with the connections with the Durres - Tirana PTT railway line (triangular railway intersection at Domje area).
- Construction of Passing Loop, and TIA railway stations’ tracks and turnouts
- Construction of drainage works of TIA station
- Construction of University Stop and TIA stations’ platforms
- Construction of retaining walls along the section as needed
- Construction of railway corridor fencing.
- Reinstatement/construction of local and access roads along the railway corridor, as needed.
- Reinstatement of access to adjacent land as needed.
- Construction of channels and gutters along the railway line
- Construction of culverts (the following list according to the existing design)

Kilometric Position	Dimensions	
	Pipe Φ	Box B x H
0+530.5		3x2
ROAD 0+797.5	1,5	
ROAD 0+825.9		3x2
0+961.4		3x3
1+327.15	1,5	
1+607.67		3x2
1+849.0		2x2
2+130.0		3x2
2+670.0		2x2

Kilometric Position	Dimensions	
	Pipe Φ	Box B x H
3+112.3		2x2
SIPHON 3+367.04	0,8	
3+570.0		2x2
3+804.7		2x2
4+022.7	1,5	
4+240.0		2x2
ROAD 4+820.0	1	
4+990.6	1	
5+155.13		2(1.4x1)

- Construction of at-grade road crossings (the following list according to the existing design):

KP	0+807.15
KP	1+614.08
KP	3+121.12
KP	4+842.20
KP	5+258.45
KP	(*) 5+562.05

(*) Inside Tirana International Airport landside

- Construction of new railway bridge for Lana River, at KP 1+196.74
- Construction of new railway bridge for Tirana River, at KP 3+318.24
- Construction of at grade pedestrian crossings at KP 2+679 (according to the existing design)
- Relocation of utilities as necessary within TIA
- Rearrangement of TIA internal road circulation system according to detailed design, to include all necessary works, indicatively (but not limited to) pavement, road signage, marking, lighting, drainage etc.
- Demolition and reconstruction of TIA long term parking canopy along the terminal station, to include all necessary works, indicatively (but not restrictive) lighting, signage, marking etc.
- Construction of new parking canopy along the eastern side of the long-term parking area, to include all necessary works, indicatively (but not limited to) lighting, signage, marking etc.

1.5 Section 5: Signalling and telecommunication systems

1.5.1 Works for signalling and telecommand system

1. Scope of work

Supply, installation and commissioning of the signalling and telecommand ETCS level 1 system, (expandable to ETCS level 2 in the future) in train stations and between stations of the Durres – Tirana railway line including the new line from the Domje railway intersection to the Tirana International Airport, given the schematic plan (796/06/09/DR/GL/STT/01/0 General Layout) of the railway line .

The Contractor shall prepare the implementation study in detailed design and after its approval by the HSH, to install and put into operation all systems.

2. Safety requirements

For signalling and telecommand system safety level SIL 4 is adopted.

3. Technical devices

The technical devices are taken into consideration in the signalling and telecommand system of the railway stations, open line signalling equipment rooms and interstation sections and applications, as well as in the Traffic Control Centre (TCC), (railway line switches, signals, axle counters, etc. including level crossing protection systems)

4. Controlled facilities

The facilities controlled and managed by the system are, as follows:

- Electric turnout machine controls: The contractor must deliver electric turnout machine controls for the actuation and control of the railroad switches, which must be delivered with switch suites for railroad switches according to the superstructure of the permanent way, in compliance with par. 4.2 and 5.7.2 as described in Book 5.
- Signals: The design contractor must deliver all signals and the other necessary permanent signalling according to the requirements of the specific regulatory framework of HSH. See par. 4.4 and 5.7.3 as described in Book 5.
- Axle-counters: The contractor shall deliver, install and operate equipment for detection of trains in stations and between stations in compliance with par. 5.7.4 as described in Book 5.
- European Train Control System /ETCS: The design contractor must deliver, install, integrate, test and hand-over for operation ETCS Level 1 train control system through Euro-balises along the railway line, fully meeting the requirements of ERTMS SRS UNISIG, Class 1, version 2.3.0d, defined in Decision of the EC 2007/153/EC and all subsequent decisions of the EC for the amendment of Annex A of TSI of the ”Control-command and signalling” sub-system.
- System for detection of Hot Axle Boxes: The contractor shall deliver, install and operate a system for detecting hot axle boxes in compliance with par. 4.3.12 as described in Book 5.
- Cables: The contractor must perform external cable runs in a trench and under the railway tracks. The contractor has to dimension, specify, purchase, install and test all cables in compliance with par. 5.8 as described in Book 5.
- Power supply systems: The contractor must calculate the required power consumption and deliver, install and put into operation the necessary power supply of signalling and telecommand equipment in compliance with par. 5.10 as described in Book 5.

5. Traffic Control Centre (TCC)

The contractor shall deliver, install and operate all necessary equipment for centralized dispatching of train traffic and shunting in the Durres –Tirana railway line, including the new line from the Domje railway intersection to the Tirana International Airport, from TCC office, located in Shkozet Station. See par. 4.7 and 5.6 as described in Book 5.

6. Technical facilities at stations

The contractor should construct or arrange technical rooms with special technical facilities for electronic interlocking equipment at stations of Durres, Shkozet, Sukthi, Vore, Kashar, Tirana PTT, Airport Terminal and where, in accordance with the implementation design, it becomes apparent that equipment has to be installed,.

7. Equipment for signalling and telecommand
   - The contractor shall deliver, install the technical rooms (including workstations in Station’s Master room) and put into operation all equipment necessary for the control and management of the Signalling and Telecommand system.
   - The contractor shall deliver, install and operate all of the equipment necessary to equip the railway line between stations Durres –Tirana, including the new line from Vore Station & Kashar Station towards the airport terminal station
   - The contractor shall deliver, install and operate the Traffic Control Centre (TCC) to be set up in the Shkozet Station building, including all kinds of construction, electrical, ergonomics, etc. works required for the proper rearrangement of the existing Shkozet Station areas. See par. 5.6 as described in Book 5.

8. Automatic Level Crossing Protection Systems (LCPS)

The contractor shall deliver, install and put in operation automatic road and pedestrian level crossing protection systems within Stations’ control areas and in the open line in compliance with par. 16.6 as described in Book 5.

9. Staff Training

Contractor shall provide the necessary staff training and familiarization with new equipment in accordance with chapter 11 as described in Book 5.

10. Design Documentation

The contractor must submit project documentation in accordance with chapter 14 as described in Book 5.

11. Interfaces

The contractor shall be responsible for provision of fully operating signalling equipment. His responsibility covers all interfaces and is not limited to the internal interfaces (technical or organizational connections), specified in the technical specifications. The internal interfaces shall be specified in detail by the Contractor. Each of the systems of the signalling equipment apart from its own and mutually connected interfaces requires also interfaces to the Telecommunication system, the Power supply system etc.

12. Additional Services

The contractor shall provide all additional services described in the Technical specifications (Signalling and Telecommand System) as found in the Tender documentation as well as all the necessary works for the complete installation of a fully operational Telecommunication System (civil works, E/M works, earthing and lightning protection works, testing and commissioning, software and hardware equipment) as well as Implementation Design Studies described in Book 5 which is part of Tender Documents.

Contractor is obligated to prepare and submit for approval Implementation Design Studies 1 and 2 for Signalling and Telecommand system according to referred requirements described in Book 5.

1.5.2 Works for telecommunication

1. Scope of the telecommunication system

The contractor must deliver, install and put in operation the whole necessary equipment for the telecommunication system of the operational points: Durres, Shkozet, Sukthi, Vore, Kashar, Tirana Public Transport Terminal, the new terminal of Rinas airport as well as their connection with telecommunication centre in the Shkozet Station, in compliance with par. 2.1 as described in Book 6.

2. Transmission medium

The contractor must deliver, lay in the ground and put in operation optical cables from the technical building at Shkozet Station to the technical rooms in Durres, Tirana PPT and the new terminal of Rinas airport, in compliance with par. 2.2 as described in Book 6.

3. High-speed digital transmission system – (SDH/STM16)

The contractor must deliver, install and put in operation the High-speed digital transmission system SDH/STM16 for the implementation of a highway transport network of the telecommunication connection in compliance with par. 2.3 as described in Book 6.

4. Access systems / multiplexer equipment

The design provides for the delivery, installation and putting in operation by the Contractor of an Access system (Multiplex equipment for low-frequency connections) and the required installation for realizing a low-speed digital interface (n x 64), LF (low frequency) interface and others, in compliance with par. 2.4 as described in Book 6.

5. Specialized communications

The contractor will deliver, install and put in operation the facilities for the following specialized telecommunication connections:

- Inter-station direct telephone connection
- train traffic control connection
- Telephone connection for general usage (automatic telephones)

Technical requirements for the different specialized connections are detailed in par. 2.5 as described in Book 6.

The existing radio telecommunication equipment will remain as the backup facility. The main equipment, if needed, will be reinstalled in new positions according to the new arrangement of TCC and Station Master’s rooms, and supplied by the uninterruptable power supply network of each Station.

6. Data transmission backbone network

The design provides for the delivery, installation and putting in operation by the Contractor of a high-speed network for the transmission of voice and data with speeds not slower than 1 GB/s and a tie-in of possible local networks to it, in compliance with par. 2.6 as described in Book 6.

7. Systems for local services

Not included in the scope of works. The system will be designed to support future installation of:

- Passenger information systems (announcement systems in stations);
- Station clocks;
- Information boards for passengers in waiting areas and platforms;
- Video-surveillance of stations’ critical areas.

- Loudspeaker passenger announcement system;
- Ticketing machines.

8. Network Management System (NMS)

The contractor must deliver, install and put in operation all of the required equipment for the Centre for control and management of all devices and systems (Network Management System), located in telecommunication centre at the Shkozet Station, in compliance with par. 2.7 as described in Book 6.

9. Technical facilities

The contractor must install the equipment of the telecommunication system in special existing or newly constructed (in case the existing ones do not comply with the technical requirements) technical rooms in stations, in compliance with par. 2.7 as described in Book 6. and par. 5.3.2 as described in Book 5 (Signalling and Telecommand).

10. Radio telecommunication equipment

The existing radio telecommunication equipment will remain as the backup facility. The main equipment, if needed, will be reinstalled in new positions according to the new arrangement of TCC and Station Master's rooms, and supplied by the uninterruptable power supply network of each Station.

11. Training

The contractor must provide the necessary training, familiarizing the corresponding personnel with the new equipment, in compliance with chapter 4 of the Book 6 (Telecommunication System) and chapter 10 of the Book 5 (Signalling and Telecommand System).

12. Project documentation

The contractor must present the design documentation in compliance with chapter 7 as described in Book 6.

13. Additional services

The contractor must provide additional services according to chapters 5, 6, 7 as described in Book 6 as well as the necessary works for complete installation and full operational Telecommunication System (civil works, E/M works, earthing and lightning protection works, testing and commissioning, software and hardware equipment) as well as Implementation Design Studies described in Book 6 which is part of Tender Documents.

Contractor is obligated to prepare and submit for approval an Implementation Design Study for Telecommunication system.

2. Technical Specifications

2.1 General Requirements

This Article refers to the General requirements for the project which are necessary during the time of execution of the civil and EM-works of the project, associated with the constructions and installations as described in relative Books.

The Works specified under this Contract shall include all works necessary for the construction including demolition and removal of existing and construction of new culverts and bridges, the installation of a modern Signalling and Telecommunication system, including all materials of any kind, necessary for the execution, completion and maintenance of the project to the intent and meaning of the drawings and these Specifications. Compliance by the Contractor with all General Conditions of Contract, whether specifically mentioned or not in the Clauses of these Specifications.

2.1.1 Abbreviations

Whenever the following abbreviations are used in the specifications or on the plans, they are to be construed the same as the respective expressions represented.

Abbreviation	Definition
AASHTO	American Association of State Highway and Transportation Officials
AC, AB	Asphalt Concrete
ASTM	American Society for Testing and Materials
AT	Automatic Tensioning (tensioning of CW and MW)
ATP	Automatic Train Protection
BNS	Bituminized Base Course
BNHS	Bituminized Base Wearing Course
BS	British Standard
BTU	British Thermal Unit
CAD	Computer-aided design
CBI	Computer Based Interlocking
CBR	California Bearing Ratio
CC	Control Cable
CCTV	Closed Circuit Television
CD	Compact Disk
CE	Conformité Européenne
CEN	Comitée Européen de Normalization - European Committee for Standardization
CENELEC	Comité Européen de Normalization Eléctrotéchnique - European Committee for Electrotechnical Standardization
CESMS	Construction Environmental & Social Management System
CLC	Central Logic Unit
cm	Centimeter
CO	Central Operator
CPM-PS	Critical Path Method -Project Schedule

Abbreviation	Definition
CR TSI INS	Conventional Rail 'Infrastructure' Technical specification for interoperability relating to the subsystem infrastructure
CTC	Centralized Traffic Control
CW	Contact Wire
CWR	Continuous welded rails
dB	Decibel
DIN	German Institute for Standardization (Deutsches Institut für Normung)
DTN	Data Transmission Network
DVD	Digital Video/Versatile Disc
EBRD	European Bank for Reconstruction and Development
EC	European Community
EC (sign.)	Electronic Centralization
EEC	European Economic Community
EHS	Environmental, Health & Safety
EMAS	Eco-Management and Audit Scheme
EMC	Electromagnetic compatibility
EMI	Electro Magnetic Interference
EMU	Electric Multiple Unit
EN	Europe Norm
ERA	European Railway Agency
ERTMS	European Rail Traffic Management System
ESHSS	Environmental, Social, Health, Safety & Security
ESIA	Environmental and Social Impact Assessment
ESMMP	Environmental and Social Management and Monitoring Plan
ETCS	European Train Control System
ETHD	Electric Turnout Heating Devices
ETSI	European Telecommunications Standards Institute
EU	European Union
FAT	Factory Acceptance Tests
FC	Feeder Cable
FL	Feeder Line
FO	Fibre Optic cable
g	Gram
GB	Gigabyte
CBI	Computed Base Interlocking
GB/s	Gigabyte per second
GHz	Gigahertz
GPS	Global Position System
h	Hour

Abbreviation	Definition
HBD, BBD	Hot Box and Blocked Brake Detectors
HDPE	High Density Polyethylene
HSH	Hekurudha Shqiptare (Albanian Railways)
Hz	Hertz
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronic Engineers, Inc.
IES	Illuminating Engineering Society
ISO	International Organization for Standardization
ISSA	International Slurry Surfacing Association
ITU	International Telecommunication Union
IXL	Interlocking Electronic System
I/O	Input/Output
kg	Kilogram
kJ	Kilojoule
km	Kilometre
km/h	Kilometre per hour
KP	kilometric position
kV	Kilovolt
kW	Kilowatt
LAN	Local Area Network
LC	Level Crossing
LCPS	Automatic Level Crossing Protection System
LED	Light Emission Diode
m	Meter
m/s	Meter per second
mm	Millimetre
MMI	Man Machine Interface
MN	Meganewton
MoEPP	Ministry of Environment and Physical Planning – Environmental Administration
MPa	Megapascal
MTBF	Mean Time Between Failures
MTTR	Mean Time to Repair
MUX (telec.)	Multiplexer
MW (elec.)	Messenger Wire
N	Newton
NMS	Network Management System
NFPA	National Fire Protection Association
OC (telec.)	Optical Cable
OCLS	Overhead Contact Line System

Abbreviation	Definition
ODF (telec.)	Passive Optical Distribution Frame
OH&S	Occupational Health and Safety
PCA	Portland Cement Association
PCI	Prestressed Concrete Institute
pcs	Pieces
PLP	Parallel Coupling Point
PPC	Public Power Company
ppm	Parts per million
PTI	Post-Tensioning Institute
R	Radius
RAL	State Commission for Delivery Terms and Quality Assurance (Deutsches Institut für Gütesicherung und Kennzeichnung)
RAM	Random Access Memory
RAMS	Reliability, Availability, Maintainability, Safety
RAP	Resettlement Action Plan
RCF	Resettlement Compensation Framework
RTU	Remote Terminal Unit
SA	Social Accountability
SAT	Site Acceptance Tests
SCADA	Engineer y for Control and Data Acquisition
SDH	Synchronous Digital Hierarchy
SER	Signalling Equipment Room
SIL	Safety Integrity Level
SMP	Site Management Plan
SN	Swiss Norm
SSPC	Steel Structures Painting Council
STM	Synchronous Transport Module
t	tons
TC (telec.)	Telecommunication Cable
TCC	Traffic Control Centre
ToR	Top of Rail
TPS (elec)	Traction Power Substation
TSI	Technical Specifications for Interoperability
TSI CCS	TSI Control, Command and Signalling
UBM	Under Ballast Mats
UIC	International Union of Railway (Union internationale des chemins de fer)
UPS	Uninterruptable Power Supply
USL	Upper Specification Limit
USP	Under Sleeper Pads

Abbreviation	Definition
VDE	Association for Electrical, Electronic & Information Technologies (Verband der Elektrotechnik, Elektronik und Informationstechnik)
ZLC	Local Logic Unit
ZTV	Additional technical conditions (Zusätzliche Technische Vertragsbestimmungen

2.1.2 Definitions

Whenever in the specifications or in other Contract Documents the following terms or pronouns in place of them are used, the intent and meaning shall be interpreted as follows:

Addendum - A written amendment or revision to the Contract Documents or plans issued to bidders subsequent to the date of advertisement and prior to the final date and time for submission of Tenders indicated in the "Instructions to Tenderer."

Acceptable Quality Level (AQL) - The level of Lot percent defective at/or below which the work is considered to be satisfactory.

Acceptance Program - All factors comprise the agency's determination of the degree of compliance with contract requirements and value of a product. These factors include agency or agency supervised sampling, testing, measuring, and inspection. These factors should also include validated results of contractor sampling and testing.

Advertisement - The public announcement, inviting Tenders for the Work.

As-Built Plans / Drawings - Plans prepared at the site during or immediately after construction representing the exact executed work.

Award - The official acceptance by the Employer of the Tender submitted by the Bidder selected to be the Contractor.

Base Course - The layer or layers, of specified or selected aggregate materials of designed thickness placed on a sub-base or a subgrade to support the remainder of the ballast prism or layer of pavement structure.

Ballast prism or layer – Railway track layer of crush stones in scheme according to typical cross-section, suitable to withstanding track forces

Ballast bed– The layer underneath the ballast layer

Sub-ballast layer– The layer underneath the ballast bed

Bench Mark - A permanent or semi-permanent marker of known coordinates and elevation relative to a datum plane.

Borrow - That material necessary to construct the embankment which is not available from the staked excavation.

Calendar Day - Every day shown on the Hegira calendar.

Calibrate - (1) To determine settings of the plant which will provide correct proportions of the components of plant-mixed materials. (2) To compare with a standard or check the graduations of a gauge or other measuring devices.

Centreline - The defined and surveyed line shown on the plans from which the highway / railway track construction is controlled.

Consecutive Days - Two or more calendar days, one following the other.

Consolidation - The densification of a mass by compaction, vibration, passive loading or other means.

Contract Item (Item of Work) - A specifically described unit of Work for which a unit price is provided in the Contract Documents.

Change Order - A written order to the Contractor, approved by the Employer, issued by the Engineer authorizing additions, deletions or revisions in the Work. The Change Order will set forth force account or negotiated unit prices, and any adjustments in the contract price and/or contract time as appropriate to the variation in the Work.

Contract Time - The time allowed for completion of the contract, including authorized time extensions. When a calendar date of completion is shown in the Tender, in lieu of the number of working or calendar days, the contract time is the period between the Process Verbal for Handing over the Site to the date of completion.

Contractor Process Quality Control - All contractor activities that have to do with making the quality of a system what it should be, including sampling and testing. The Quality Control activities include, but are not limited to, all operational techniques and activities that are used to fulfil the contract requirements.

Cut Section - A section of railway and/or roadway where the bottom of the excavation or subgrade is lower in elevation than the original ground.

Date - Day, month and year reckoned according to the Hegira calendar.

Deck - The surface layer of concrete and reinforcing steel on a bridge.

Density - The mass per unit volume of material, usually expressed in kilograms per cubic meter or grams per unit centimetre or tonnes per unit cubic meter.

Design Engineer - The duly authorized representative of the Employer at the project site, acting directly or through his duly authorized representatives, who is responsible for engineering supervision of the Designs made by the Contractor.

Design Load - The maximum anticipated loads that must be supported by a structure.

Detour - (1) A temporary rerouting of traffic. (2) The route of the temporary rerouting.

Directive - An official written communication, having contractual status, from the Engineer to the Contractor with respect to any or all phases of the Contract and Work including, but not limited to, progress, approvals, rejections, procedures, methods, safety, etc.

Elevation - Height above sea level or other datum.

Embankment - A raised earth structure on which the railway sub-ballast and ballast layers and/or the roadway pavement structure is placed.

Embankment Foundation - The original ground on which any embankment is constructed.

Engineer - The duly authorized representative of the Employer at the project site, acting directly or through his duly authorized representatives, who is responsible for engineering supervision of the Work.

Extra Work - Additional or new work not provided for in the Contract as awarded but subsequently ordered by the Employer for the satisfactory completion of a project within its intended scope.

Feasts and Holidays - All recognized feasts, holidays, days of rest, and other religious customs officially recognized.

Final Handover - The final acceptance of the Work, by the MOC, as authorized by the Technical Conditions of the Contract.

Fines - (1) Aggregates - Portion finer than the 4.75 mm (No. 4) sieve. (2) Soils - Portion of a soil finer than a 0.075 mm (No. 200) sieve.

Free Water - Water in aggregate or soil in excess of that absorbed into the surface of the particles.

Gravel - Aggregate deposited naturally by water.

Ground Water - Free water contained in the zone below the water table.

Grout - Mortar, composed of sand, cement, and water of such consistency that it can easily be placed by pouring or pumping if necessary.

Guardrail - A protective cable or rail device placed along the roadway edge for the purpose of redirecting vehicles which have left the roadway at a point of hazard.

Hardpan - Layer of extremely dense soil.

Inspector - The Engineer's authorized representative assigned to make detailed inspections of the Work.

Levelling Course - The layer of material placed on an existing surface to eliminate irregularities prior to placing an overlaying course.

Limit (USL, LSL) - Upper and lower specification limits outside of which the material or work is defined to be defective.

Lot - A discrete quantity of material or work to which an acceptance procedure is applied.

Median - The portion of a divided highway separating the travelled ways for traffic in opposite directions.

Median Barrier - A longitudinal system used to prevent a vehicle from crossing the median of a divided highway.

Minor Concrete - Nonstructural concrete as designated on the plans or in the specifications.

Moisture Content - The percentage, by weight, of water contained in soil or other material, usually based on the dry weight.

Muck - An organic or saturated soil of very soil or liquid consistency.

Open-graded Aggregate - A graded aggregate, containing little or no fines, with a high percentage of aggregate voids.

Overburden - The mass of soil which overlies a source of rock, gravel or other railway or road base sub ballast and embarkment material. This material is removed before the materials are quarried to avoid contamination.

Pavement Structure - The combination of subbase, base course, and surface courses placed on a subgrade to support the traffic load and distribute it to the roadbed.

Percent Defective - Percentage of the Lot falling outside specification limits, may refer to either the population value or the sample estimate of the population value.

Performance Guarantee - The approved form of security, executed by the Contractor and his Surety or Sureties, guaranteeing complete execution of the Contract and all supplemental agreements pertaining thereto, and the payment of, all legal debts pertaining to the construction of the project.

Period of Maintenance - Period of maintenance shall mean the period of Contractor maintenance named in the Contract, calculated from the date of completion of the Work as certified by the Provisional Handover Committee.

Permanent way – track line with railway components and additional layers

Pit - A natural deposit of gravel or other type of soil which has been, or may be, excavated.

Plans (Drawings) - The approved plans (drawings), profiles, typical cross sections, working drawings, and supplemental drawings, or exact reproductions thereof, which show the location, character, dimensions, and details of the Work.

Preconstruction Conference - A conference arranged by the Engineer between himself and representatives of the Contractor before Work begins to discuss schedule of progress and contract administration requirements.

Prime Coat - The application of a low viscosity liquid asphalt to an absorbent surface, preparatory to any subsequent treatment, for the purpose of hardening or toughening the surface and providing a transition between it and the succeeding bituminous construction.

Process-Verbal - Any written statement of record concerning the Works of the Contract signed by the Engineer and the Contractor.

Producer's Risk - The probability that an acceptance plan will erroneously reject a Lot that is truly acceptable.

Profile Grade - The trace of a vertical plane intersecting the top surface of the proposed wearing surface, along a defined point on the roadway typical section or the longitudinal centerline of the roadway / permanent way.

Program of Work - A work schedule prepared and submitted by the Contractor to the Engineer for his approval prior to the commencement of the Work. The Program shall show the equipment, the order of procedure, and methods which the Contractor proposes to use to carry out the Work.

Provisional Handover - A conditional acceptance, by the Employer, of a partial or total completion of the Work as authorized in the General Conditions of the Contract.

Quality Assurance - All those planned and systematic actions necessary to provide adequate confidence that a product or service will satisfy given requirements for quality.

Quality Assurance Procedures - Specific sampling, testing, measuring, and evaluation procedures for determining the degree of conformance to the quality and quantity requirements of the Specifications.

Quality Index (Q) - A statistic computed when applying the variables acceptance procedures to estimate the level of quality actually achieved.

Random Sample - A sample selected in such a way that every element of the population has an equally likely opportunity to be included in the sample.

Ravelling - The progressive loosening of the aggregate in the surface course of a road.

Rejectable Quality Level (RQL) - The level of Lot percent defective at/or above which the work is considered to be unacceptable.

Riprap - A protective covering of graded boulders, pieces of concrete or stone, with or without mortar, to prevent erosion.

Roadbed - The graded portion of a road, usually considered as the area between the intersection of top and side slopes, upon which the base course, surface course, shoulders, and median are constructed. The top of the subgrade.

Screed - A mechanical device to strike off, smooth and (at least partially) consolidate a newly placed concrete or bituminous surface.

Segregation - Separation of portions of a mixture from the mass or the localization of sizes or portions within a mixture or mass.

Shoulder - The portion of roadway contiguous with the travelled way for accommodation of stopped vehicles for emergency use, and for lateral support of base and surface courses.

Site - The lands and other places provided by the Employer for the execution of the Work.

Site Engineer - The on-site representative of the Contractor duly authorized to receive and execute all instructions of the Engineer and to supervise and direct all of the Contractor's construction operations in all phases of the Work.

Specified Completion Date - The calendar date on which the Work is specified to be completed.

Subbase - The layer or layers of specified or selected aggregate materials of designed thickness placed on a subgrade to support a base course.

Subgrade - A defined layer thickness of select material (normally thirty (30) centimetres) on which the ballast prism or the pavement structure, including shoulders, is constructed.

Substructure - All of that part of the structure below the bearings of simple and continuous spans, skewbacks of arches and tops of footings of rigid frames, together with the backwalls, wingwalls and wing protection railings.

Superelevation - The increasing of the cross slope on a curve to partially offset the centrifugal force generated when a vehicle rounds the curve.

Superstructure - The entire structure except for the substructure.

Supervision Team – It is Engineers staff, representative of the Employer at the project site, acting as authorized representatives, who are responsible for engineering supervision assistance.

Tack Coat - An application of bituminous material to an existing surface to provide bond with the succeeding bituminous course.

Toe of Slope - The intersection of a roadway embankment side slope with the original ground surface.

Topsoil - Naturally occurring surface soil, usually containing organic matter.

Track / **Track line** – A single railway line, including both rails.

Water-Cement Ratio - The ratio of the amount of water, exclusive of that absorbed by the aggregates, to the amount of cement in a concrete or mortar mixture; preferably stated as a decimal by mass.

Well Graded - Aggregate material of varying particle sizes which produce maximum density when mixed.

Working Day - A working day shall be any day upon which the Contractor can physically and legally prosecute the Work.

Working Drawings - Stress sheets, shop drawings, erection plans, falsework plans, framework plans, cofferdam plans, bending diagrams for reinforcing steel, electrical diagrams, cable routing diagrams or any other supplementary plans or similar data which the Contractor is required to submit to the Engineer for approval.

2.1.3 General Conditions

a. The general conditions apply to all the types of works described in these technical conditions as well as to the works that could arise and could be accepted as necessary for the complete performance of the agreed works.

b. All works and costs related to the Contractor's construction sites like installation, maintenance, running, demolition, etc., will not be remunerated separately but must be included in the unit rates for works implementation.

c. The Contractor shall provide as part of his site installation at no extra compensation premises for the Employer`s Supervision Service while the works are under construction. These premises should satisfy the requirements of the Supervision Engineer (the Engineer) in regard to the needs for work and conveniences. The premises will include a total 150m^2 room area for the Supervision Service. The Contractor should hand over the premises to the Engineer within 42 days upon the signing of the Contract Agreement; which should be accepted by the Engineer. The Supervision Service will be responsible for the equipment required for carrying out the supervision.

2.1.4 Quality Control

The Contractor is responsible for quality control and is obliged to establish a quality assurance system to prove the compliance with the Contract. Quality assurance system consists of plans, procedures, as well as organization of works execution, whereof final goal is to generate the final product meeting the requirements stated in contractual documents. The system must cover all works, on site and out of it, and is always connected to the proposed phase of construction.

The Contractor shall, through the quality assurance system, determine and document its policy and objectivity of the quality.

Within the quality assurance system, organizational chart and description of works should be done to clearly define the responsibility, management and internal relations of the entire assignment on turn-key basis.

Compliance with the quality assurance system does not relieve the Contractor of any obligations, responsibilities or duties under the Contract. All costs related to the quality control are deemed to be included in the lump sum prices.

Not later than 30 calendar days from the Contract signing, the Contractor shall prepare the Quality control project (QCP) and hand it over to the Engineer for comments and approval. This plan elaborates the requirements stated in the contract documents. This plan identifies the Contractor's engineer responsible for quality control, programmes, procedures, control tests, protocols and forms of communication between the Contractor and the Engineer. Commencement of particular works shall depend on the approval of the Quality control project i.e. approval of particular enclosures to QCP which refer to corresponding works.

QCP should cover all operations during construction, both on and out of the site, suppliers of necessary materials or components, but also the materials purchased in shops, according to the following minimum contents:

a. Description of organization of quality control, including the scheme of hierarchy of staff to be engaged.

b. Name, qualifications and position for each person engaged in quality control. CV of the quality control engineer shall be included in the list of staff

c. Resolution on appointment of the quality control engineer

d. Copy of license of the Contractor's quality control engineer

e. Procedure for updating and submission of documents related to quality control

f. Control, verification and approval of control tests programme, pointing out the name of the test, relation of the test to the standards stated in the technical specifications, relation of the test to the item of works, frequency / scope of testing, laboratories and names of persons responsible for carrying out of tests

g. Procedure for monitoring of preparation for control tests, for monitoring of the tests as well as for verification of obtained findings including all necessary documents

h. Procedure for monitoring of errors (failures) to arise during construction, including their identification, works for their rectifying according to the approved procedure and final acceptance of such works

i. Procedure for communication between the Contractor and the Engineer

j. List of defined characteristics for every type of works set out in the Technical Specifications Requirements. The contents of this list are not fixed, but it needs to be adjusted i.e. amended during works execution. Adjustments of the contents of this list are defined on regular coordination meetings between the Contractor and the Engineer.

k. Plan of acceptance of works / materials is prepared by the Contractor and hands it over to the Engineer for approval prior to commencement of works under particular works item. Approval of this plan by the Engineer is conditional, i.e. it implies that all works shall be performed according to the required / envisaged quality. The Engineer is entitled, in case that works are not performed in line with the approved documents and procedures, to ask for modification of QCP, including the change of staff in charge of implementation of QCP

l. The Contractor shall, when all works under the Contract are completed, inform the Employer in writing

The Contractor is entitled to propose the modification of QCP during the construction at least 7 days prior to commencement of the works under item to which such modification refers. The proposed modification is subject to approval of the Engineer.

The Contractor shall carry out all control tests envisaged in the Technical Specifications, i.e. relevant standards, to demonstrate that material / product / work performed, meets the requirements defined in the contract documents. Materials or products which have appertaining documents of compliance issued by institutions authorized for quality control and at which the control tests were conducted based on EN standards, shall be accepted without particular conditions.

The Contractor shall perform activities and provide data to:

- Confirm that the procedure of control tests is in line with the contract documents
- Set up a separate register of control tests
- Check the scope and contents of the reports on tests conducted

All tests results have to be recorded in the Report on test conducted.

The Contractor places at the disposal of the Engineer (the Employer's site supervision team), all the attests and data from the tests, in the required scope and form.

The tests shall be performed in compliance with the corresponding standards stated in the technical conditions.

Laboratory

a. The Contractor shall provide the necessary laboratories depending on the organization of the performance of the works.

b. The laboratory equipment must be satisfactory for the performance of all the necessary tests.

c. Prior to the beginning of the works, the Contractor must submit to the Engineer a scheme of the organization of the laboratory, the professional staff who are to perform the tests and the laboratory equipment, in compliance with these Technical specifications.

d. The total laboratory equipment must periodically be checked and attested

2.1.5 Procedure in case of deviation

If the Contractor's quality control, in the course of any inspection on the tested facility, finds deviation from specified requirements, all works on the facility to which the control refers shall not be accepted. The Contractor shall promptly inform the Engineer on deviation of results and propose proper rectifying actions. The action may imply retesting, repetition of works on the part of or entire work on the facility where deviation is established.

The Engineer shall decide whether the repeated test or work is acceptable. Otherwise the Contractor shall repeat the works at his own expense.

2.1.6 Unsatisfactory materials

If results of control tests show that the quality of the materials incorporated and the quality of the works completed do not satisfy the requirements, the Engineer shall order the Contractor to replace the unsatisfactory materials with the quality ones and rectify the works.

The Contractor shall comply with the Engineer's order at his own expense.

2.1.7 Suspension of works

If the Contractor in spite of the Engineer's warning and request fails to remedy defects and continues to perform the works of unsatisfactory quality the Engineer shall suspend the works and notify the Employer immediately.

The works may be resumed only when the Contractor undertakes and enforces all necessary measures which will ensure the quality performance, in the Engineer's opinion.

2.1.8 Deductions due to unsatisfactory performance and materials

The Engineer will only accept works executed by the Contractor of satisfactory quality. The Engineer will have the right to retain any amounts from an interim monthly statement or the final statement equivalent to the value of those unsatisfactory works until all defects will be remedied.

2.1.9 Non-apparent works

The Contractor shall, when so requested by the Engineer, uncover or open any such works performed for additional inspection and testing. After such an inspection and testing the Contractor shall reinstate all such uncovered and inspected works as instructed by the Engineer.

The costs of uncovering, reinstatement and additional tests shall be borne by the Contractor.

2.1.10 Approved materials

The Contractor shall, prior to any delivery and use of particular materials, obtain certificates on preliminary tests of the quality and suitability of materials he intends to use from a professional and/or an accredited institution and the Contractor shall hand them over to the Engineer for inspection and approval.

The Contractor shall obtain the test certificates stipulated in the contractual specification.

The Contractor shall not use any materials without the Engineer’s approval and if otherwise, he shall bear the risk and costs ensuing therefrom.

2.1.11 Liability for defects of materials

The Contractor shall be responsible for the use of any materials and equipment that comply with the contracted or specified quality requirements. The Contractor shall warn the Employer of any noticed or identified defects.

2.1.12 Material storage and procedural guidelines

a. General terms

The Contractor shall carefully unload and store the materials to prevent damages.

The materials shall be stored in the way which enables fast and safe reloading for the purpose of installation.

The Contractor shall unload the materials and properly store them stating their quantity and quality in a protocol in conjunction with the relevant Commission.

If the material arrives with damages, the Contractor shall record that in the relevant minutes in conjunction with the Commission and inform the Employer thereabout.

The site organization chart shall contain a plan for the storage of materials. This plan shall show areas for the receipt of material that shall be both stable and steadfast to avoid damages or deformation of the materials stored.

For inflammable materials, a fire fighting system shall have to be envisaged.

The Contractor shall pay attention to the quantity and quality of the received materials keeping proper cards on receipt, issue and use of materials. The Employer shall have the right to control materials by inspecting the cards and the materials on the site.

The material shall be stored in order to be accessible for inspection, easy and safe reloading or mounting. The Contractor shall protect the materials from damage, theft or rust.

Environmental Restrictions, if any, should be duly considered while selecting quarry locations.

The Contractor must propose the location of the storage area for new/used material and after the Approval of the Supervising Engineer the Contractor is responsible for all required permits/licences at his own cost. All associated costs with the temporary/permanent storage area will be at the Contractor’s cost.

b. Temporary disposal areas and treatment area for old material, material deposits

Appropriate locations of the areas alongside the alignment for the temporary disposal for treatment and reuse of materials (i.e. existing ballast, sleepers etc.) should be proposed by the Contractor compliant to the approved environmental terms in order to be approved by the Engineer and the Client.

It is the responsibility of the Contractor to examine the site, investigate the ownership status of the available locations, assess the volume of material that can be disposed in each location, assess the environmental and communal impact of the disposal and treatment process in each location and finally submit his proposal for approval.

The Contractor, amongst other designs and reports (required by the Laws), must submit for approval an Environmental Impact Study and a Disposal Area Backfilling Report in which he will demonstrate (on the basis of the required calculations) the safety of the produced backfill (i.e. slope inclinations etc.) on the basis of the proposed thickness and degree of compaction that will be implemented during the execution of the Project.

2.1.13 As-built documents and maintenance instructions

As-built documents and maintenance and handling instructions shall, at least, comprise set of as-built drawings, set of Contractor's measurements, full list of used materials, description of installations and functions, system data and components, all drawing charts necessary for operation and maintenance of installations, operation and maintenance instructions, instructions for activation and deactivation, safety procedure and list of spare parts. Further details are stated at paragraph 2.2.5.

As-built drawings and documents shall be made in an approved digital system (AutoCAD 2013 format or newer), along with the printed copy.

Detailed documentation and instructions for maintenance must be in the English/Albanian language.

Maintenance instruction shall set out the expected intervals between maintenance works and provide any procedure necessary as a part of well-planned maintenance scheme.

As-built documents should be in line with the Law on planning and construction.

2.1.14 Coordination of works

Contractor is obliged to coordinate the execution of works with other Contractors, which also work on the upgrading of existing or constructing of new railway and of the associated works with the full cooperation of Engineers. The Contractor shall provide a Coordination Design study for Civil and E/M works (Schedules scale 1:1000 / 1:500 for layouts and 1:100, 1:50, 1:20, 1:10, 1:5 for details).

The coordination study shall unify all design elements into one form and shall be updated until completion of all works. At the end, this study shall include all as-built drawings of all sections.

2.1.15 Documentation during execution of works

a. The Engineer may ask and instruct the Contractor to prepare particular drawings and calculations, or to make modifications in any documents included in the existing Project Documentation. On the basis of the Technical Specifications, Drawings and other information contained in the Tender Documentation, the Contractor shall prepare and submit such drawings to the Engineer, together with all other necessary documents, calculations, official permissions and other data necessary for the construction of the Works and for satisfying the technical parameters stipulated in the Contract. The Contractor may supply these drawings successively in parts, but each part submitted should be complete to such an extent that it can be judged and approved by the Engineer in isolation as part of the whole Project.

b. The Engineer shall make comments and/or objections concerning drawings, documentations and data supplied by the Contractor within 28 days of their submission. It shall be considered that all these comments and/or objections are accepted by the Contractor, if he should not contradict them in writing, either by registered letter. telex or facsimile sent on the Engineer, within 7 days of their receipt.

c. The Contractor shall amend, without delay, the documentation and drawings supplied by him to the Engineer for verification, in respect of all the modifications and differences occurring during the execution of the Works. These drawings of each actually executed and completed (As-built) part of the Works, prepared in easy-to-follow form, the Contractor shall permanently supply to the Engineer in four copies.

d. All these drawings of actually executed works, together with all necessary reports and explanations and other documents, constitute the As-built Drawings (As-built Project) which is going to be used by the Employer or by a specialized Company appointed by the Engineer for the purposes of maintenance during the serviceability period. Original of the As-built Drawings and at least three hard copies shall be submitted by the Contractor to the Employer not later than 14 days prior to the date of the Taking-Over Inspection.

e. Any defaults or omission in the drawings and in the As-built Project submitted by the Contractor and approved and certified by the Engineer, and any defects and irregularities in the Works performed according to such drawings and As-built Project shall not release the Contractor of any of his responsibilities and obligations under the Contract.

f. The Contractor shall permanently keep records, make daily entries into and sign the Workbook which shall be supplemented and certified by the Engineer. The Engineer has the right not to accept and not to certify payment of any item or part of the Works if this accomplishment has not been recorded into the Workbook. All notifications between the Contractor and the Engineer and all instructions, decisions and orders by the Engineer to the Contractor presented in the Workbook shall be considered as a write notice, instructions, decision or order. The Workbook is maintained in three copies out of which, after supplementing and certifying by the Engineer, the original and one rests with the Engineer and one copy with the Contractor.

2.1.16 Construction journal (Workbook)

The construction journal shall be a bound book of double numbered pages (original and copy), copies being detachable from it.

The construction journal is maintained by the site manager or a person delegated by him, from the date of site possession till commissioning of works after their completion. If the site manager does not maintain the construction journal himself, it is however necessary for him to verify the stated data with his signature and stamp.

The original of the construction journal is kept by the responsible Contractor and the copy by the Engineer in the course of works execution. The following data shall be daily entered into the construction journal: development and method of works and any other data that may affect the safety and quality of works such as data on the inspection of any works that will be out of sight in subsequent phases, tests on sites, results and certificates, deviations from the technical documentation, weather conditions and temperature, natural events and incidents, delivery, origin and quality of materials and equipment delivered to site, site inspection, inspectors' findings and other works and events that may affect the safety and quality of works.

Further also the data that may serve as documentary evidence for the measurement of the works completed such as: modifications and amendments to design, stoppages and interruption of works, works that are accounted in direction hours, contingencies and additional work, altered working conditions, the number of staff and their qualifications, machinery on site, the altered conditions of work, and the like.

The right to enter corresponding data and observations into the construction logbook belongs to the Contractor, the Engineer and Design Engineer if he takes part in the supervision. The Engineer and the Contractor shall keep correspondence through the construction logbook concerning the above data and any other issues such as compliance with terms, obtaining necessary documents, elimination of defects, quality assessment, payments for the works etc.

The Engineer shall use the journal to give necessary instructions to the Contractor.

2.1.17 Schedule of payments

All payments shall be made according to the Schedule of Payments form, which is part of this tender.

The displayed percentages of each category apply in the whole work as well as in every section that is shown at the Price Schedule form. Partial payments can be possible only after the acceptance of the Engineer.

Concerning designs, the displayed percentages are mandatory and cannot be modified.

Concerning bridges, the displayed percentages of the Schedule of Payments table concern exclusively the way of payments for the referenced bridge. The described works of the construction phases for the bridges constitute a general description of the work and include all the works and materials and all the detailed works according to the study.

2.1.18 Time Schedule – Programme of works

The candidate Contractor shall prepare a detailed programme of work according to the schedule determined by the Employer and shall enclose it to the bid. Programme of work should provide details on the following:

- Ordering of materials and planned deliveries

- Working days for every site

- Staff and management on every site

- Basic working plans for every site

- Site arrangement

The time Schedule must be prepared by a program that supports WBS analysis and will be updated every 2 weeks. The Contractor shall inform the Engineer about the activities progress via the detailed Time Schedule.

The Contractor shall submit to the Engineer a fully detailed Construction Programme in accordance with the provision of General Condition of Contract. The Contractor shall update the Construction Programme every 2 weeks and reply it to Engineer.

Also, Time Schedule will be handled by a PC program which will support WBS Structure (for example Primavera) and must be updated every month in order the Engineer to have a monitoring tool for the progress of the works.

The Contractor shall execute the Works in logical and practical order so that they are completed within the time limits laid down in the Contract and carried out in a manner satisfactory to the Engineer.

The total time for completion of works shall be 30 months (912 days), starting from the signing of the Contract. The time schedule for this project shall include the following requirements:

- six (6) months from the signing of the Contract for the completion, submission and approval of the designs.
- twenty (26) months from the signing of the Contract for the construction of all works
- thirty (30) months from the signing of the Contract for testing and commissioning

2.1.19 Lands for the Contractor’s own purposes

It is the Contractor’s responsibility to obtain and provide suitable land for working areas, for himself, his senior staff and his junior staff, offices, workshops and all buildings, including land temporarily acquired outside the right of way together with all buildings for quarries and borrow pits, access roads thereto, all road diversions and temporary way leaves necessary for the construction of the works, whether specifically required by the Engineer or the Contract or not. The Contractor shall obtain the approval of the Engineer on the location of the proposed areas and provide a detailed layout before any work upon them is commenced.

The Contractor shall be responsible for the payment at the Contractor's charge of compensation for crops, structures and any costs in respect of any land temporarily acquired by him, for Contractor’s spoil areas, all road and waterway diversions, sites for Contractor’s accommodation, and land described in this section.

The Contractor shall not take possession of the Site, not enter any land or commence any operations until he receives formal confirmation from the Engineer. Should the Contractor enter land or commence any operations without first obtaining this confirmation he shall be solely liable for all additional costs and/or legal charges which might arise there from. The Contracting Authority shall be responsible for the assessment and payment of compensation in respect of land to be permanently acquired and incorporated in the Works within or outside the right of waytogether with all buildings, crops, trees and any other properties related to such acquisitions.

2.1.20 Facilities for the Engineer and his Staff

The Contractor shall establish / rent offices and laboratories together with equipment and furnishing for the use of the Engineer and his staff. The supervision staff offices shall be detached completely from the Contractor's own offices.

1. The Successful Tenderer shall nominate three material laboratories (ranked as a first class Laboratory equipped with all the required equipment, tools stated hereunder in addition to qualified staff) to the Engineer and Employer to select one of them within two weeks from the date of Notice to Commence.

2. Test samples should be taken from site by a qualified person in this field in the presence of the Contractor's Representative and the Engineer or his representative (assistant) and the Approved (Certified) Laboratory Representative if possible.

3. The Contractor's Representative along with the Engineer's assistant should deliver the sample(s) (to be tested) to the authorized laboratory through submittal form signed by both parties.

4. The sample should be tested in accordance with the relevant test specifications (Standard specifications) and two copies of the results (report) should be sent to the Engineer and the Contractor.

Buildings

The buildings for Constructors' staff and for Engineer accommodation (Offices, Laboratories, Store house etc.) should be prefabricated, constructed from metal (Container) or Concrete.

All prefabricated buildings shall be lockable and have double walls filled with insulating material, and an insulated ceiling at a minimum height of 2.50 metres above floor level. Floors shall be timber, or concrete with vinyl tiles, except where otherwise specified.

All windows of offices and laboratory shall be of an approved type and fitted to the satisfaction of the Engineer. Sanitary facilities shall be provided in accordance with specifications, and to comply with health regulations.

Buildings shall be painted where this finish is required by the type of construction and shall be kept maintained throughout the Contract. The Contractor shall repaint all buildings to be handed over to the Engineer immediately prior to the hand over. Painting shall be on both interior and exterior surfaces of buildings.

The area of the Site for the Engineer's offices and laboratory shall be secured with two meter high chain link fence, with one main vehicular access gate, and one emergency vehicular access gate. Access roads and hard standings shall be gravel surfaced drained and maintained, and adequate security lights provided, all to the Engineer's approval.

All fixtures and fittings shall be properly and adequately designed and constructed, both to suit the building provided and for the purpose required. The Contractor shall include at least the items and equipment referred below.

Services shall include sanitary and wastewater drainage, with septic tanks, potable water supply, 220-volt and 330-volt electricity supply and at least an international telephone line supply, together with all necessary external and internal wiring, piping and fittings.

In addition to the ordinary electricity supply for the Engineer's offices an laboratory, the Contractor shall provide, run and maintain a suitable electric generator of adequate capacity as necessary for running normally, also in case of failure or blackout of the ordinary electricity supply, the Engineer's offices with all the relevant equipment.

Any and all utility charges for sewage, water, electricity and telephone line shall be borne by the Contractor and the costs thereof are deemed to be included in his offer. No separate payment shall be made to the Contractor for such services and utility charges.

Office and laboratory for the use of the Engineer shall have heating system and shall be fully air-conditioned as will be approved by the Engineer.

Vehicles

The Contractor shall provide auto vehicles for the sole use of the Engineer's and his staff. It shall include for all dues and allowances for registration fees, depreciation, interest, indemnity and insurance. The vehicles must be third party and comprehensively insured to cover any driver. The vehicles shall be provided within 30 days from the date of signature of the Contract of the Engineer and shall be fuelled, oiled and maintained as aforesaid until the date of issue of the Taking-Over Certificate, following which they shall be returned to the Contractor.

2.1.21 Permits for works

The Contractor, at his own expense shall obtain permits required from relevant national Authorities. Such permits include inter alia permits for traffic diversions, residence and work permits, permits for radio communications, permits for installation quarries and borrow-pits, temporary disposal areas, plants and secondary structures, necessary for accomplishment the Works out-side the Site, to relocate utilities, etc.

Within 14 days of signing the Agreement the Contractor shall submit to the Employer a list of all permits required to perform and complete the Works in accordance with the agreed Construction Programme. The Employer shall render all his assistance to the Contractor to obtain all such permits, however any failure to do so shall not release the Contractor of any of his responsibilities and obligations under Contract.

The Contractor shall comply with requirements of such permits and shall give the issuing Authorities full opportunity to inspect and examine the Works or to participate in testing and checking procedures. This shall not release the Contractor of any of his responsibilities under the Contract.

No important operation of any kind, especially cutting through or closing existing roads, water and electrical conduits, or other public utility shall be carried out without the written consent of the Engineer. The Contractor shall inform the Engineer in writing in due time and not less than 7 days before commencing such works in order that the Engineer may arrange adequate supervision and safety precautions.

2.1.22 Traffic Regulation

The Contractor is responsible for the regulation of the traffic stream on all public roads that could be disturbed during the construction of the works.

At all locations where works are performed on along the railway corridor and along the anticipated access roads to and from worksites and spots, the Contractor should install all necessary traffic signage in accordance with the applicable laws and regulations for signalization, subject to approval by the Engineer, and based on the agreements and approvals from the appropriate state authorities, which the Contractor has to collect prior to commencement of works.

The auxiliary roads during the construction stage shall be built and maintained by the Contractor, in accordance with the current regulations folowing approval by the Engineer.

These Works are to be considered as part of the Contractor's site installations and will not be remunerated separately; all costs must be included in the unit rates of the works.

2.1.23 Safety and environmental protection

During the execution of the Works, The Contractor is deemed to comply the following requirements and to:

a. Prepare a Report for environmental protection to elaborate the managing of the construction sites, quarries and borrow pits;

b. allow for the provision of continuous and safe drainage of the ground and rainwater from the whole of the Site, taking into consideration of relevant technical specifications and the stipulations of any permits, so that no damage shall be caused either to the Works or its surroundings;

c. Take full responsibility for the proper disposal of sewage anywhere from within the Site, or construction waste and debris anywhere of the Works, including the Engineer's offices. The method and procedure of disposal of sewage and construction waste and debris shall strictly comply with the regulations of the relevant Authority;

d. Comply with the regulations of the Employer and the firefighting Authorities and take all necessary precautions throughout the execution and completion of the Works to prevent outbreak of fire;

e. Protect the environment on and off the Site from contamination during the execution and completion of the Works. Accordingly, collect all kinds of waste, including production and communal wastes, and transport them to a dumping place approved by the Engineer. The Contractor shall not release, or permit to be released into the air, water and land area at or in the vicinity of the Site any toxoids and harmful fluent or substance, and shall indemnify the Employer against any claims or liability arising from any breach of this obligation;

f. Make his own arrangements for provision of water, electricity and telephone observing all regulations of the appropriate authorities and bearing all expenses in connection therewith.

2.1.24 Technical Equipment and Preparation of the Construction Site

a. Before the initiation of the construction, the Contractor shall submit to the Engineer the project on organization and equipment necessary for performance of the works.

b. The anticipated mechanical equipment and the whole organization of construction must enable performance of the works thoroughly in compliance with the project requirements and these technical conditions, and with such capacity that shall enable prompt performance of the works under weather conditions favourable for construction.

c. The Employer is entitled to request modifications in the proposed project on organization of construction and the proposed equipment, should they are not in compliance with the conditioned dynamics of progress of works and these technical conditions and requirements.

d. The Engineer shall approve the starting of the works when assured that the equipment and the devices anticipated by the plan are on the site and are capable to be used for the works.

e. All rail vehicles and construction equipment operated on rail tracks must be licensed for railway operation. The drivers of the railway vehicles must hold the required licenses and qualifications which entitle them to operate vehicles on the Albanian Railway network.

2.1.25 Organisation of the construction works implementation

The Contractor shall submit a detailed program to the Engineer within 28 days after the Contract signing:

i) Site organisation and Method statement;

ii) Mobilisation and Construction Schedules;

iii) Contractor’s Equipment;

iv) Contractor’s Personnel;

v) List of Proposed Subcontractors;

The Contractor shall provide a detailed General Program including progress of the works, detailed method statement for sub-ballast / track line rehabilitation and new track line constructions, deliveries of track line components, an updated list of materials including track line components, quantities etc.

The Contractor shall provide a detailed typical daily program including possession procedures in accordance with the Traffic Management Plan.

2.1.26 Contractor’s Site facilities

a. Accommodation for Contractor's Employees

The Contractor shall - where necessary - at his own expense make his own arrangements for the housing and welfare of his own employees including erection, fitting up, and maintenance of temporary quarters and camp accommodation along with all services at the specific places of work agreed upon with the Engineer. The Contractor shall arrange for recreational facilities of the staff and labour employed on the works and he shall - for approval by the Engineer - submit plans for the entire accommodation he intends to erect before the commencement of construction.

The Contractor will organize the land for the site facilities, including the facilities for the main site office. Any costs arising from the respective land acquisition, easements, and all other related fees are deemed to be included in the contract value.

The site shall be selected in such a way as to minimize the impact on traffic, environment, or any other aspect of public concern.

All temporary quarters and camp accommodation shall be run and maintained in an efficient condition in accordance with the Health Standards over the entire duration of the Contract.

All temporary facilities must at all times be open to inspection by the Employer. Any instruction given by him for the proper cleaning, disinfection, and general maintenance in a sanitary and hygienic condition will forthwith have to be carried out by the Contractor.

Prior to any facility or building being occupied, the Contractor shall draw up a code of rules and regulations for their control which shall be submitted to the Engineer for approval.

The Contractor shall at his own cost, make arrangements for the transport of his staff and workmen to and from the site of the works - where necessary.

All facilities erected by the Contractor on site shall at his own expense from the time of their erection and during the construction, until the completion of the works be the property of the Employer and the Contractor shall not demolish or remove any buildings or part of any buildings without the written permission of the Engineer.

Upon the completion of the works, the Contractor shall remove them entirely with all drains and water mains and restore the surface of the land to its original condition to the satisfaction of the Engineer. The Contractor will hold the Employer free of any claims arising from third parties in connection with land acquisition efforts for these site facilities.

b. Contractor's Site Offices

The Contractor shall provide site offices for his representatives in accordance with the requirements and organisation of the construction program. The Central Management of Construction shall be located in the area selected by the Contractor. Other locations, if any, are subject to the approval of the Engineer.

Meeting rooms are to be provided at the main office, the location of the Central Management of Construction.

c. Sanitary Conveniences

Sanitary facilities for the use of persons employed on the works shall be provided and maintained by the Contractor to the extent to which and in such manner and at such places as shall be approved by the Engineer and the authority concerned, and all persons connected with the works shall be obliged to use them. The Contractor shall make all temporary arrangements for the proper discharge of sewage and drainage from or in connection with the works and shall maintain the same to the satisfaction of the Engineer and the Authority concerned as long as they may be required. The discharge must either be treated before running into the outfall or be collected by means of a cesspit which will be emptied on a regular basis.

The Contractor shall prohibit the committing of nuisances on the site or upon the land of the Employer or adjacent landowners. Any employee found violating this provision shall be liable to immediate dismissal and will not again be employed on the works.

d. Fencing, Lighting and Guarding

The Contractor will be responsible for the proper fencing, lighting, guarding, and watching of all the works on site until the date of completion, and for the proper provision during this very period of temporary roadways, foot ways, guards, and fences as far as the same may be rendered necessary for the works, for the accommodation and protection of the owners and occupiers of adjacent property, the public and others.

No naked light will be used by the Contractor on site otherwise than in the open air without special permission in writing from the Engineer.

The Contractor shall pay due regard to the fact that the project works will as far as possible be performed without the public services of the existing systems (telephone, electricity, water supply, sewerage) being interrupted. The permits and procedures to be obtained from the various authorities prior to the commencement of the works will have to be taken into account.

All the direct and in-direct costs arising from Contractors Facilities installation, operation during the end of project and demolition deemed by convention that are included in Contractor offer.

2.1.27 Environmental and social requirements

A. General

The Contractor shall comply with the guidelines of the Environmental and Social Impact Assessment (EIA) already completed for this project, in accordance with the requirements of the Employer.

The Contractor should also comply with the guidelines of the EBRD in this regard as well as those for resettlement and rehabilitation of the affected population.

The design should include appropriate cost-effective mitigation measures, which should form part of the project cost.

An Environmental Management Action Plan (EMAP) shall be prepared by the Contractor incorporating proposals concerning the implementation, management and monitoring of the proposed environmental components of the project.

B. Environmental Protection Plan

Within one month of his arrival on site the Contractor shall submit an Environmental Protection Plan with operational details of his proposals to the Employer and the Engineer for approval. The Plan shall comply with the approved environmental terms of the Project.

C. Environmental Officer

The Contractor shall have on his staff on Site for the duration of the Contract a designated officer qualified to promote and maintain sound environmental management during construction and specifically the implementation of the approved Environmental Protection Plan. This officer shall have authority to issue instructions and shall take precautionary measures to prevent environmental damage, including but not limited to the establishment of environmentally sound working practices and the training of staff and labour in their implementation.

D. Resettlement Liaison Officer

The Contractor shall have on his staff on site at least one individual who has had practical experience in the public consultations, management and implementation of a Resettlement Plan. The Contractor’s Resettlement Liaison Officer will be required to coordinate with the Employer and the Engineer, to assist the Employer in its duties, to implement and complete the Resettlement Plan for this project, and to maintain good public relations throughout the contract period.

E. Environmental Protection during Construction

The Contractor shall use such construction methods and shall maintain all borrow/stockpile/spoil disposal area so as to assure the stability and safety of the Works and any adjacent feature, to assure free and efficient natural and artificial drainage and to prevent erosion.

The Engineer and the Employer have the power to disallow the methods of construction and/or the use of any borrow/stockpile/spoil disposal area if in their opinion the stability and safety of the Works or any adjacent feature is endangered, or if there is undue interference with the natural or artificial drainage, or if the method or use of the area will promote undue erosion.

Borrow areas and quarries shall be sited, worked and restored in accordance with the Specifications. Spoil shall be disposed of at approved disposal sites prepared, filled and restored in accordance with the related Specification requirements.

Following excavation for the works, the Contractor shall take all steps necessary to complete drainage and slope protection works in advance of each rainy season. Erosion or instability or sediment deposition arising from operations not in accordance with the Specifications shall be made good immediately by the Contractor at his expense. The Contractor shall also take all steps necessary to complete drainage in advance of each winter rainy season in the areas excavated for borrowing materials.

Notwithstanding approval of the intended method of working, the Contractor shall at all times be responsible for constructing the earthworks in accordance with the Specifications, the Design and his working drawings.

The Project area can experience inclement weather, climatic seasonal variations, and heavy snowfall. It will be deemed that the Contractor is familiar with these conditions and has formulated his work programme considering possible loss of time due to these causes, and it shall be the obligation of the Contractor to revise his work programme and enhance his construction efforts as necessary to ensure timely completion of the work scheduled for each working season.

Where directed by the Employer, the Contractor shall establish vegetation on fill slopes, cut slopes or less, worked out borrow pits, and other areas which may include roadway shoulders and verges, spoil disposal areas, stockpile areas, quarries, access tracks, plant sites, camps, landslide scars, gullies, and stream and river banks. Prior to placing topsoil and/or establishing vegetation on embankments, all fill material not compacted to the required standards shall be removed from the side slopes.

The Contractor shall be responsible for supplying sufficient planting material to carry out all re-vegetation work and shall establish and operate plant nurseries as necessary and shall make his own arrangements for procuring cuttings, slips and seed for growing.

F. Prevention of Pollution

The Contractor shall ensure that his activities do not result in any contamination of land or water by polluting substances. He shall implement physical and operational measures such as earth dikes of adequate capacity around fuel, oil and solvent storage tanks and stores, oil and grease traps in drainage systems from workshops, vehicle and plant washing facilities and service and fuelling areas and kitchens, the establishment of sanitary solid and liquid waste disposal systems, the maintenance in effective condition of these measures, the establishment of emergency response procedures for pollution events, and dust suppression, all in accordance with normal good practice and to the satisfaction of the Engineer and the Employer.

G. Protection of Trees and Vegetation

Unless otherwise provided in the Specifications, the Contractor shall ensure that no trees or shrubs or waterside vegetation are felled or harmed except for those required to be cleared for execution of the Works. The Contractor shall protect trees and vegetation from damage to the satisfaction of the Engineer and the Employer.

The Contractor shall be responsible for obtaining any necessary felling permits and for ensuring the disposal of felled trees in accordance with prevailing regulations. No tree shall be removed without the prior approval of the Engineer and the Employer.

In the event that trees or other vegetation not designated for clearance are damaged or destroyed, they shall be repaired or replaced by the Contractor at his own expense to the satisfaction of the Engineer and the Employer.

H. Use of Wood as Fuel

The Contractor shall not use or permit the use of wood as a fuel for cooking, space and water heating in all his camps and living accommodations. Any wood so used must be harvested legally, and the Contractor shall provide the Engineer and the Employer with copies of the relevant permits if required.

I. Fire Prevention

In addition to the provision of adequate fire-fighting equipment at his offices, workshops, construction areas and other facilities to the satisfaction of the Engineer and the Employer, the Contractor shall take all precautions necessary to ensure that no vegetation along the line of the road outside the area of the permanent works is affected by fires arising from the execution of the Works.

If a fire occur in the natural vegetation or plantations adjacent to the project area for any reason the Contractor shall immediately take all measures to suppress it. In the event of any other fire emergency in the vicinity of the Works the Contractor shall render assistance to the civil authorities to the best of his ability.

Areas of forest, scrub or plantation damaged by fire considered by the Engineer and the Employer to have been initiated by the Contractor’s staff or labour shall be replanted and otherwise restored to the satisfaction of the Engineer and the Employer at the Contractor’s expense.

J. Restricted Areas

In undertaking the Works, the Contractor shall be aware that the Engineer and the Employer may not grant permission for temporary facilities including but not limited to borrow pits, quarries, and labour camps (except for watchmen) and ancillary activities in forested areas or land officially declared as forest.

The Engineer and the Employer may also prohibit or restrict the Contractor’s activities in other ecologically, culturally or historically sensitive areas, which become known to them during the course of the project. The location of any such areas shall be notified to the Contractor by the Engineer and the Employer at the earliest opportunity.

K. Relations with Local Communities and Authorities

In siting and operating his plant and facilities and in executing the Works the Contractor shall at all times bear in mind and to the extent practicable minimise the impact of his activities on existing communities.

Where communities are likely to be affected by major activities such as road widening or the establishment of a camp or quarry or extensive road closure or bypassing, he shall liaise closely with the concerned communities and their representative and if so directed, shall attend additional meetings arranged by the Engineer and the Employer to resolve issues and claims and minimise impacts on local communities.

Any problems arising from his operations and which cannot be resolved by the Contractor shall be referred to the Engineer and the Employer.

The Contractor shall be responsible for any compensation due or reinstatement necessary with respect to any damage caused by him to areas outside the Site and no separate payment will be made in this regard.

L. Water Supply for Construction

The Contractor shall make his own arrangements at his own expense for water supply for construction and other purposes. Only clean water free from deleterious materials and of appropriate quality for its intended use shall be used. In providing water the Contractor shall ensure that the rights of and supply to existing users are not affected either in quality, quantity or timing.

In the event of a dispute over the effect of the Contractor’s arrangements on the water supply of others, the Engineer shall be informed immediately and shall instruct the Contractor as to appropriate remedial actions to be undertaken at his expense.

All the Environmental requirements described in Book 8 which is part of current Tender and shall be respected by the Contractor.

Any kind of costs (direct and indirect) arise from Environmental obligations and relevant activities deemed to be included in Contractors offered prices.

2.1.28 Archaeological Survey

As per Albanian legislation, it has been decided by the Archaeological Service Agency (ASHA) that archaeological service (survey / excavation) will be carried out by the Contractor during execution of the works of the construction of the railway line.

ASHA through a Decision of the Minister of Culture and the Secretary of the National Archaeological Council, Nr. 236, dated 17.10.2018, has approved the Surface Archaeological Survey Report and the Concept of Archaeological Surveys within the Tirana-Durres-Rinas railway project.

The Albanian Railway and the Contractor hereby grant the permit for the construction and rehabilitation works of this project, but according to this Decision 236, Item 2, the Albanian Railway must enter into a three-party contract with ASHA and a licensed entity for conducting archaeological surveys according to the areas provided by the Report and Concept of Archaeological Surveys and according to the approved official tariff.

The total cost of this archaeological service is deemed to be included in the contractor's offered price.

2.2 Design Requirements

This Article analyses the design requirements for the project to be prepared by the contractor and approved by the client associated with the constructions and installations as described in relative Books of the civil and EM-works of the project. The design work to be prepared by the Contractor upon contract signing shall be at the level of Detailed Design for implementation.

The objective of the design is to provide all necessary documentation for approval that will allow the implementation (rehabilitation) of the Durres - Tirana Public Transport Terminal (PTT) railway line and the construction of the new railway connection/branch to Tirana International Airport (TIA).

The Detailed Design for Civil Works and the Preliminary Design for Signalling and Telecommunication were elaborated under Consultancy Contract No C25990/WBES-2013-03-02.

Following satisfactory completion of this Contract a new situation emerged in Domje area affecting significantly the approved configuration of the railway interchange and leading to the need for redesign of the whole interchange, between KP 25+750 till KP 28+200 of the existing line, along with the initial section of the TIA railway branch and the its' connecting line towards Durres.

A concept design has been elaborated for the new layout of the Domje area interchange, along with an Environmental Impact Assessment Report for the environmental licensing of the new alignment.

Both the design elaborated under Consultancy Contract No C25990/WBES-2013-03-02 as well as the concept design for the new configuration of the triangular railway intersection at Domje area are provided to tenderers (Section VI chapters 3 & 4), under the provision that they are deemed to be at preliminary stage design that sets out the requirements of the contract and the constraints which the tenderers have to take into consideration for preparation of their own design.

The contractor will have the obligation to deliver a detailed design which includes the civil works and signalling and communication systems for the entire project of "The Rehabilitation of Durres – Tirana Public Transport Terminal (PTT) railway line and new railway connection to Tirana International Airport (TIA)".

It is also the Contractor’s obligation to deliver the preliminary and final study (as stated in chapter 2.15 and especially in paragraph 2.15.3) for the future Electrification of the railway line, in order to define and construct all the civil works that are necessary for the future Electrification of this line (foundations of electric poles, cable trenches, earthing installations etc.).

2.2.1 Supporting Studies

Topographic surveys

A detailed topographic survey was elaborated in 2015 within the context of the Consultancy Contract as a discreet deliverable of the "existing design".

The contractor will at minimum:

- verify the deliverables of the existing topographic survey and furnish any required corrections or amendments
- update the existing topographic survey drawings to include any changes possibly materialized within the right of way of the railway line possibly occurred since the initial survey
- amend the existing topographic survey, to include the zone of the realignment of the triangular intersection in Domje along with the connections to TIA and the TIA - Durres branch

The final topographic diagrams will be geo-referenced in the same coordinates system with the system of the "existing design".

Geotechnical survey and studies

A detailed geological survey was conducted in the context of the Consultancy Contract, as a discreet deliverable of the "existing design".

A geotechnical survey was also conducted by means of boreholes:

- at regular intervals along the embankment of the existing railway line
- at areas of reported settlements of the railway line
- along the alignment of the TIA railway connection and the Domje triangular intersection
- at the locations of the new major structures

The reports of both the existing geological and geotechnical surveys and respective geotechnical study are attached in Section VI chapter 3.

Within the context of the geotechnical survey and study the contractor will:

- assure the stability of the railway embankments
- finalize the typical cross sections of the railway in the various sections
- propose any ground improvement measures and railway embankment foundation for new sections
- address the stabilization of the railway track / embankment along sections of consistent settlements / deformations
- support the design of the foundation of the railway structures

2.2.2 Design for Civil Works – Permanent way

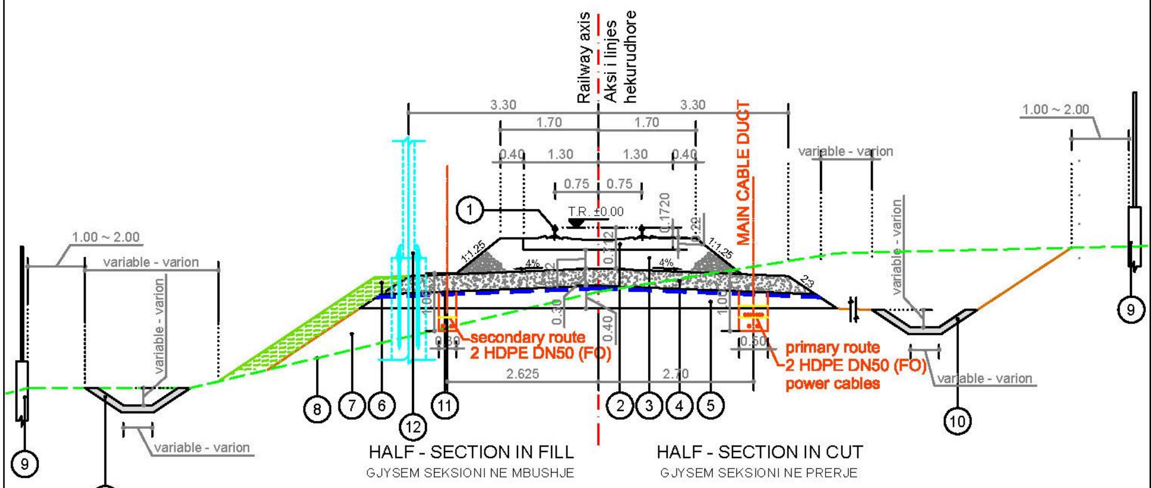
The general scope of the design is to create technical conditions on the infrastructure for speeds up to 120 kph and maximum load of D4 category (22.5 tons/axle and 8.0 tons/linear metre) of passenger and freight trains along the existing railway line, as well as the railway connection of the Tirana International Airport.

The typical cross section of the permanent way along the various sections of the project will be subject to proposal by the contractor and approval by the Client in the course of the detailed design. The typical dimensions of the cross section of the permanent way along the open line, stations and structures are presented in following schemes 1, 2 & 3.

REHABILITATION OF DURRES - TIRANA PTT RAILWAY LINE & NEW RAILWAY LINE TO TIRANA INTERNATIONAL AIRPORT TYPICAL CROSS SECTIONS

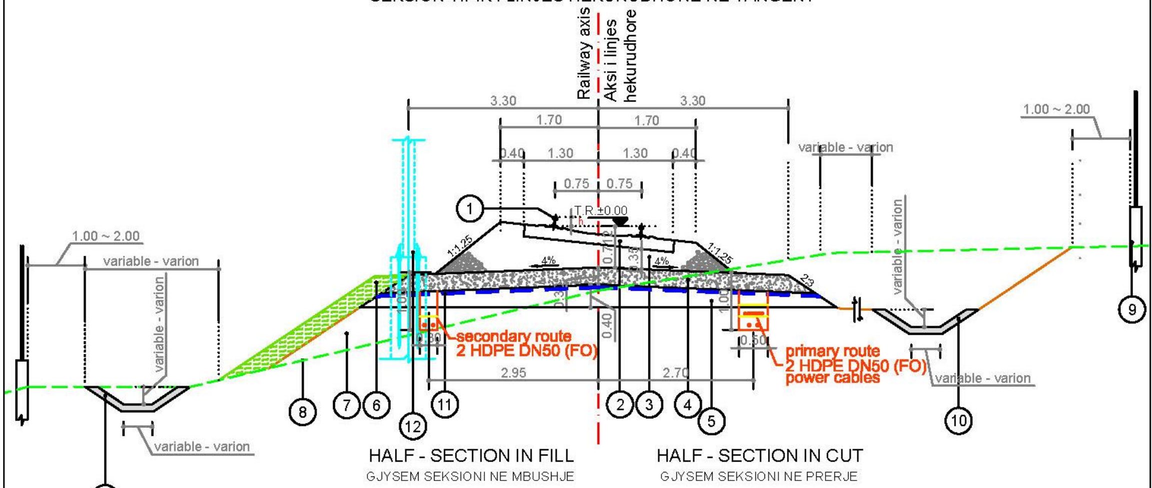
LEGEND / LEGJENDE

1. Rail S-60 kg/m - Shina S-60kg/m
2. Precast prestressed sleepers type B70
3. Ballast of 32 cm minimum thickness under the inner rail
4. Subbase 30 cm (2x15 cm)
5. Sub-grade layer of thickness ≥ 40 cm consisting of natural or crushed granular material with minimum compressibility index E_{V2}>80 MN/m² (according to geotechnical study)
6. Cover of fill embankment with top soil of 30 cm minimum thickness
7. Embankment
8. Existing natural ground
9. Fence
10. Coated or uncoated open ditch of variable dimensions
11. Non-wooven separating geotextile of minimum weight 400gr/m²
12. Electromobility pole
13. Perforated pipe



TYPICAL R/W SECTION ON TANGENT

SEKSION TIPIK I LINJES HEKURUDHORE NE TANGENT

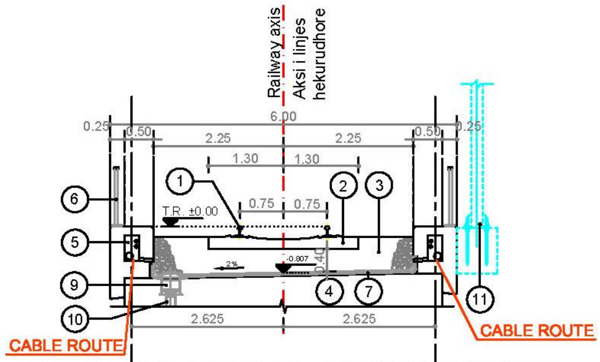


TYPICAL R/W SECTION ON CURVE

SEKSION TIPIK I LINJES HEKURUDHORE NE KURBE

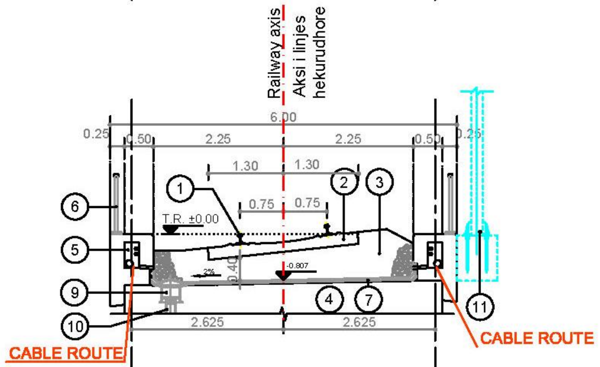
SCHEME 1

REHABILITATION OF DURRES - TIRANA PTT RAILWAY LINE & NEW RAILWAY LINE TO TIRANA INTERNATIONAL AIRPORT TYPICAL CROSS SECTIONS



TYPICAL R/W BRIDGE CROSS SECTION ON TANGENT

SEKSION TIPIK I URES SE HEKURUDHES NE TANGENT



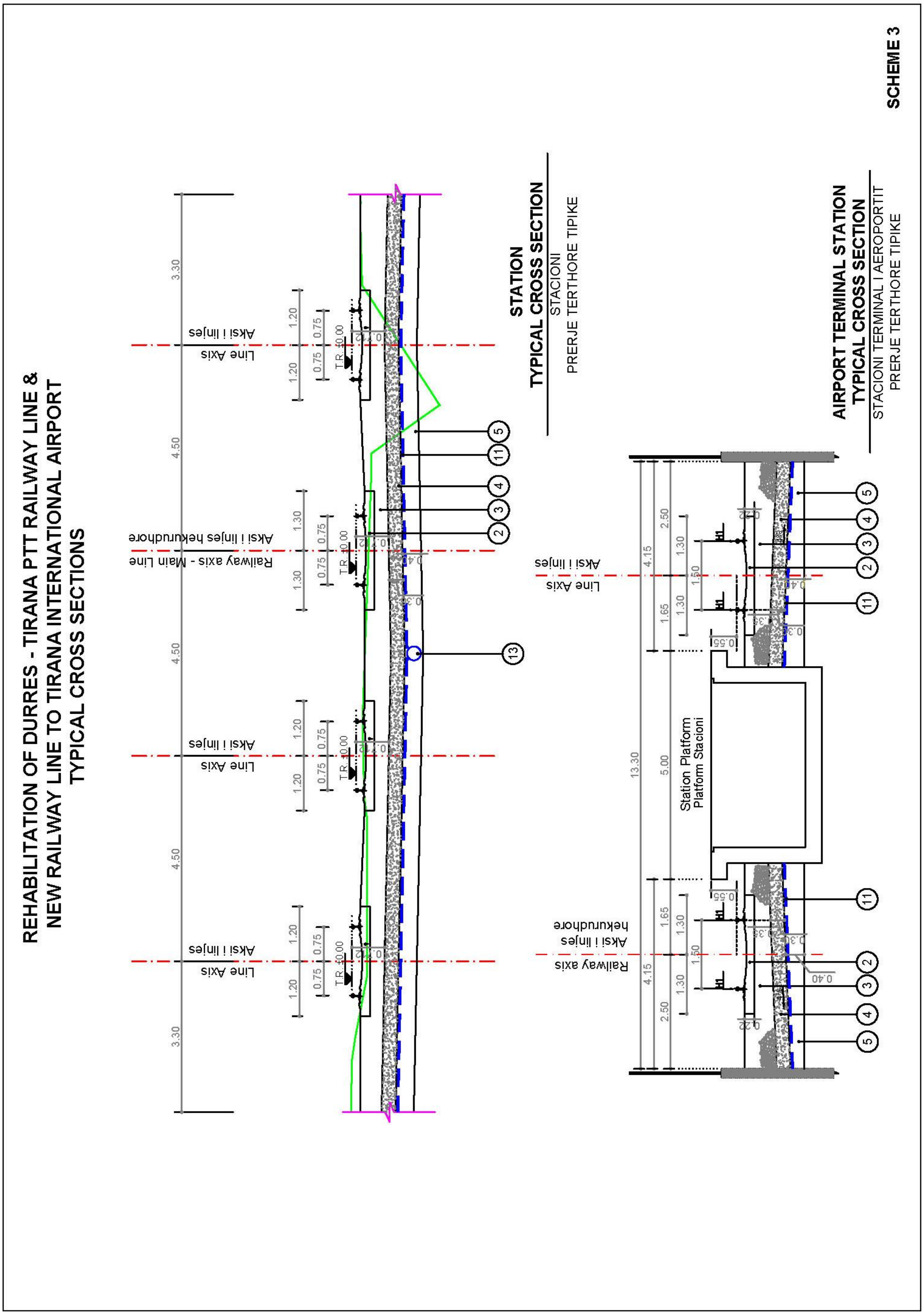
TYPICAL R/W BRIDGE CROSS SECTION ON CURVE (max cant 140mm)

SEKSION TIPIK I URES SE HEKURUDHES NE KURBE (maksimum perkulje 140mm)

LEGEND - LEGJENDE

1. Rail S-60 kg/m - Shina S-60kg/m
2. Precast prestressed sleepers type B70
3. Raiway ballast of min thickness 40 cm under the inner rail
4. Bridge superstructure concrete class C30/37 (minimum)
5. Sidewalk and cable chanel from reinf. concrete class C20/25 [inspection lids provided every 50 m. with (1) minimum on the bridge deck]
6. Guardrail of 1,00 m height for railway bridges with max height ≤12.0 m. and 1,10 m. for railway bridges with max. height >12.0μ
7. Protection concrete reinforced with wire mesh and waterproofing membrane. Minimum total thickness 6cm
8. The distance of the side walls of ballast bed from the raiway axis is defined as a general rule equal to 2.25 m.
9. Special ballast drainage points of Φ150 mm at distances according to hydraulic design (maximun distance 15 m.)
10. Drainage pipe
11. Electromobility pole

SCHEME 2


REHABILITATION OF DURRES - TIRANA PTT RAILWAY LINE &
NEW RAILWAY LINE TO TIRANA INTERNATIONAL AIRPORT
TYPICAL CROSS SECTIONS
Line Axis
Aksi i linjes
Railway axis - Main Line
Aksi i linjes hekurudhore
STATION
TYPICAL CROSS SECTION
STACIONI
PRERJE TERTHORE TIPIKE
Station Platform
Platform Stacioni
Railway axis
Aksi i linjes hekurudhore
AIRPORT TERMINAL STATION
TYPICAL CROSS SECTION
STACIONI TERMINAL I AEROPORTIT
PRERJE TERTHORE TIPIKE
SCHEME 3

1. Design data

The existing design was elaborated in the context of the Consultancy Contract No C25990/WBES-2013-03-02 "Detailed Design of Railway Line Durres-Tirana Public Transport Terminal (PTT) and of the new railway connection to Rinas Airport (TIA), is part of this Tender and the following deliverables are available to the Constructor:

- Component A: Durres – Tirana Public Transport Terminal (PTT) Railway Line
- Component C: Tirana – International Airport Railway Line

To achieve the purpose of the track design, the client will provide all existing designs, including the topographical study and the geotechnical study to the Constructor.

The Constructor is obligated to check the available data and if it is required to take additional data insitu, without additional payment, in order to ensure the quality and precision of the design.

2. Applicable Standards, Norms and Regulations

The following Standards, Norms and Regulations shall be taken into consideration:

EN 13146 - 1	Railway applications - Track: Test methods for fastening systems Determination of longitudinal rail restraint
EN 13146 - 4	Railway applications - Track: Test methods for fastening systems Effect of repeated loading
BS EN 13803-2-2006	Railway applications - Track design parameters
BS EN 13232-2-2003	Railway applications - Track switches and crossings
EN 13230-1	Railway applications - Track: Concrete sleepers and bearers – Part 1: General requirements
EN 13230-2	Railway applications - Track: – Concrete sleepers and bearers Prestressed monoblock sleepers
EN 13230-4	Railway applications - Track: – Concrete sleepers and bearers – Part 4: General requirements
EN 13232-2	Railway applications - Track: Switches and crossings – Part 2: Requirements for geometric design
EN 13232-5	Railway applications - Track: Switches and crossings – Part 5: Switches
EN 13232-6	Railway applications - Track: Switches and crossings – Part 6: Fixed common and obtuse crossings
EN 13232-8	Railway applications - Track: Switches and crossings – Part 8: Expansion devices
EN 13232-9	Railway applications - Track: Switches and crossings – Part 9: Layouts
EN 13481-1	Railway applications - Track: Performance requirement for fastening systems – Part 1: Definitions
EN 13481-2	Railway applications - Track: Performance requirement for fastening systems – Part 2: Fastening system for concrete sleepers
EN 13481-7	Railway applications - Track: Performance requirement for fastening systems – Part 7: Special fastening systems for switches and crossings and check rails.
EN 13481-8	Railway applications - Track: Performance requirement for fastening systems – Part 8: Fastening systems for track with heavy axle loads.

EN 13674-1	Railway applications - Rail: Part 1: Vignole railway rails 46 kg/m and above.
EN 13674-2	Railway applications - Rail: Part 2: Switch and crossing rails used in conjunction with Vignole railway rail 46 kg/m and above.
EN 13674-3	Railway applications - Rail: Part 3: Check rails
EN 14730-1	Railway applications - Track: Aluminothermic welding of rails - Part 1: Approval of welding processes - 2006
EN 14730-2	Railway applications - Track: Aluminothermic welding of rails - Part 2: Qualifications of Aluminothermic welders, approval of contractors and acceptance of welds - 2006
EN 15594	Railway applications - Track: Restoration of rails by electric arc welding - 2009
UIC – 505 – 1	Railway – Rolling stock construction gauge.
UIC – 712R	Railway – Rail defects.
UIC – 713	Railway – Design mono block concrete sleepers.
UIC – 860-O	Railway – Technical specifications for the supply of rails.
UIC – 861-3	Railway – 60kg/m rail profiles – Type UIC60 and 60E
UIC – 864-5	Railway – Technical specification for the supply of seat pads.
UIC – 866-O	Railway – Technical specifications for the supply of cast manganese steel crossings for switch and crossing work.

The Contractor shall use the most recent versions of the above standards, norms and regulations.

3. Deliverables

The entire study shall provide at minimum the following items:

- Technical Report, including at least:
  - description of the design and the methodology
  - Rules and Standards taken into consideration
  - Geotechnical data evaluation
  - Interfaces with other items
  - List of the materials required for the infrastructure and superstructure construction
  - Dimensions and materials for the infrastructure layers and the ballast prism
- General layout (scale 1:10000)
- Typical Layouts (cross-sections, track alignment etc.)
- Track Alignment Horizontal layouts (scales 1:1000 at open line and 1:500/1:250 at stations)
- Longitudinal layout (scale 1:1000/1:100)
- Cross-sections along open line and stations, at typical 20m intervals and at specific points when required. Cross Sections will be coordinated to present all "parallel" infrastructure elements such as platforms, service / access roads, open channels, drainage pipes network etc.

- Track component detail drawings (concrete sleepers, wooden sleepers, sleeper anchors, fishplates, rails etc.)
- Typical track alignment layouts (gauge widening layout, guard rails layout, track layout with concrete sleepers etc.)
- Detail layout for the turnouts to be used insitu
- At grade general traffic and pedestrian crossing detail drawings
- Railway fence detail drawings
- Elastic Level crossing panels detail drawings
- Railway Signs design technical report and typical drawings
- Buffer stop design technical report and typical drawings

2.2.3 Design for Civil Works – Structures

This chapter refers to the following categories of works:

- Bridges
- Culverts
- Retaining walls
- Platforms
- Canopies – Steel structures
- Roads
- Drainage

1. Design data

The following studies are part of this Tender and are available to the Constructor:

- Book 1: Civil Works
- Book 2: Major Structures
- Book 3: Culverts
- Book 4: Small Structures
- Book 7: Geotechnical Study
- Book 8: Environmental Study

The Constructor is obligated to check the available data and if it is required to take additional data insitu, without additional payment, in order to ensure the quality and precision of the design.

2. Applicable Standards, Norms and Regulations

The following Standards, Norms and Regulations shall be taken into consideration:

EN 1990	CEN (European Committee for Standardization): Basis of structural design, 2002
EN 1990	CEN (European Committee for Standardization): Basis of structural design. Annex 2: Application on bridges (normative), 2004
EN 1991-1-1	CEN (European Committee for Standardization): Actions on structures, Part 1–1: General actions—Densities, self-weight, imposed loads for buildings, 2002
EN 1991-1-4	CEN (European Committee for Standardization): Actions on structures, Part 1–4: General actions—Wind actions, 2005
EN 1991-1-5	CEN (European Committee for Standardization): Actions on structures, Part 1–5: General actions—Thermal actions, 2003
EN 1991-2	CEN (European Committee for Standardization): Actions on structures, Part 2: Traffic loads on bridges, 2003
EN 1992-1-1	CEN (European Committee for Standardization). Design of concrete structures. Part 1-1: General rules and rules for buildings, 2004
EN 1992-2	CEN (European Committee for Standardization). Design of concrete structures. Part 2: Concrete bridges: Design and detailing rules, 2004
EN 1993-1-1	CEN (European Committee for Standardization): Design of steel structures, Part 1–1: General rules and rules for buildings, 2005
EN 1993-1-5	CEN (European Committee for Standardization): Design of steel structures, Part 1–5: Plated structural elements, 2006
EN 1993-1-8	CEN (European Committee for Standardization): Design of steel structures, Part 1–8: Design of joints, 2005
EN 1993-1-9	CEN (European Committee for Standardization): Design of steel structures, Part 1–9: Fatigue, 2005
EN 1993-2	CEN (European Committee for Standardization): Design of steel structures, Part 2: Steel bridges, 2006
EN 1998-1	CEN (European Committee for Standardization): Design of structures for earthquake resistance, Part 1: General rules, seismic actions and rules for buildings, 2004
EN 1998-2	CEN (European Committee for Standardization): Design of structures for earthquake resistance, Part 2: Bridges, 2005

Platforms

AGCT	European Agreement on International Combined Transport Lines
UIC 741 O	Passengers stations. Height of platforms
TSI	Technical specification for interoperability relating to the ‘infrastructure’ subsystem of the trans-European conventional rail system (COMMISSION DECISION of 26 April 2011)
TSI	Technical specification for interoperability “persons with reduced mobility” (PRM)

Structural Steel

EN 10021	General technical delivery requirements for steel and iron products.
EN 10025	Hot-rolled products of non-alloy structural steels. Technical delivery conditions
EN 10027	Designation system for steels. Steel names
EN 10029	Specification for tolerances on dimensions, shape and mass for hot rolled steel plates 3 mm thick or above
EN 10034	Structural steel I and H sections. Tolerances on shape and dimensions
EN 10113-1	Hot-rolled products in weldable fine grain structural steels. General delivery conditions
EN 10113-2	Hot-rolled products in weldable fine grain structural steels. Delivery conditions for normalized/normalized rolled steels
EN 10113-3	Hot-rolled products in weldable fine grain structural steels. Delivery conditions for thermomechanical rolled steels
EN 10210-1	Hot finished structural hollow sections of non-alloy and fine grain steels. Technical delivery requirements
EN 10210-2	Hot finished structural hollow sections of non-alloy and fine grain steels. Tolerances, dimensions and sectional properties

Bolts

BS 3692	ISO metric precision hexagon bolts, screws and nuts. Specification
BS 4190	ISO metric black hexagon bolts, screws and nuts. Specification
BS 4395	Specification for high strength friction grip bolts and associated nuts and washers for structural engineering. Part 1 - General grade
BS 4395	Specification for high strength friction grip bolts and associated nuts and washers for structural engineering. Part 2 - Higher grade bolts and nuts and general grade washers
BS 4604	Specification for the use of high strength friction grip bolts in structural steelwork. Metric series. Part 1 - General grade
BS 4604	Specification for the use of high strength friction grip bolts in structural steelwork. Metric series. Part 2 - Higher grade (parallel shank)
BS 4933	Specification for ISO metric black cup and countersunk head bolts and screws with hexagon nuts
EN 14399	High-strength structural bolting assemblies for preloading. Part 1 - General requirements
EN 14399	High-strength structural bolting assemblies for preloading. Part 2 - Suitability test for preloading
EN 14399	High-strength structural bolting assemblies for preloading. Part 3 - System HR. Hexagon bolt and nut assemblies
EN 14399	High-strength structural bolting assemblies for preloading. Part 4 - System HV. Hexagon bolt and nut assemblies
EN 14399	High-strength structural bolting assemblies for preloading. Part 5 - Plain washers

EN 14399	High-strength structural bolting assemblies for preloading. Part 6 - Plain chamfered washers

Welding

EN 287-1	Qualification test of welders. Fusion welding. Steels
EN 440	Welding consumables. Wire electrodes and deposits for gas shielded metal arc welding of non-alloy and fine grain steels. Classification
EN 499	Welding consumables. Wire electrodes and deposits for gas shielded metal arc welding of non-alloy and fine grain steels. Classification
EN 756	Welding consumables. Solid wires, solid wire-flux and tubular cored electrode-flux combinations for submerged arc welding of non-alloy and fine grain steels. Classification
EN 757	Welding consumables. Covered electrodes for manual metal arc welding of high strength steels. Classification
EN 758	Welding consumables. Tubular cored electrodes for metal arc welding with and without a gas shield of non-alloy and fine grain steels. Classification
EN 1418	Welding personnel. Approval testing of welding operators for fusion welding and resistance weld setters for fully mechanized and automatic welding of metallic materials
EN ISO 2560	Welding consumables. Covered electrodes for manual metal arc welding of non-alloy and fine grain steels. Classification
EN 12535	Welding consumables. Tubular cored electrodes for gas shielded metal arc welding of high strength steels. Classification
EN 1011	Welding. Recommendations for welding of metallic materials. Part 1: General guidance for arc welding.
EN 1011	Welding. Recommendations for welding of metallic materials. Part 2: Arc welding of ferritic steels.
EN 1011	Welding. Recommendations for welding of metallic materials. Part 3: Arc welding of stainless steels.
EN 1011	Welding. Recommendations for welding of metallic materials. Part 5: Welding of clad steel.
EN 1011	Welding. Recommendations for welding of metallic materials. Part 6: Laser beam welding.
EN 1011	Welding. Recommendations for welding of metallic materials. Part 7: Electron beam welding.
EN (IEC) 60974	Arc welding equipment. Part 1: Welding power sources.
EN (IEC) 60974	Arc welding equipment. Part 2: Liquid cooling systems.
EN (IEC) 60974	Arc welding equipment. Part 3: Arc striking and stabilizing devices.
EN (IEC) 60974	Arc welding equipment. Part 4: In-service inspection and testing.
EN (IEC) 60974	Arc welding equipment. Part 5: Wire feeders.
EN (IEC) 60974	Arc welding equipment. Part 6: Limited duty manual metal arc welding power sources.

EN (IEC) 60974	Arc welding equipment. Part 7: Torches.
EN (IEC) 60974	Arc welding equipment. Part 8: Gas consoles for welding and plasma cutting systems.
EN (IEC) 60974	Arc welding equipment. Part 10: Electromagnetic compatibility (EMC) requirements.
EN (IEC) 60974	Arc welding equipment. Part 11: Electrode holders.
EN (IEC) 60974	Arc welding equipment. Part 12: Coupling devices for welding cables.
EN 970	Non-destructive examination of fusion welds. Visual examination
EN 1435	Non-destructive examination of welds. Radiographic examination of welded joints
EN 1712	Non-destructive examination of welds. Ultrasonic examination of welded joints. Acceptance levels

Anticorrosion Protection

EN ISO 12944	Paints and varnishes. Corrosion protection of steel structures by protective paint systems. Classification of environments. Part 1: General introduction.
EN ISO 12944	Paints and varnishes. Corrosion protection of steel structures by protective paint systems. Classification of environments. Part 2: Classification of environments.
EN ISO 12944	Paints and varnishes. Corrosion protection of steel structures by protective paint systems. Classification of environments. Part 3: Design considerations.
EN ISO 12944	Paints and varnishes. Corrosion protection of steel structures by protective paint systems. Classification of environments. Part 4: Types of surface and surface preparation.
EN ISO 12944	Paints and varnishes. Corrosion protection of steel structures by protective paint systems. Classification of environments. Part 5: Protective paint systems.
EN ISO 12944	Paints and varnishes. Corrosion protection of steel structures by protective paint systems. Classification of environments. Part 6: Laboratory performance test methods.
EN ISO 12944	Paints and varnishes. Corrosion protection of steel structures by protective paint systems. Classification of environments. Part 7: Execution and supervision of paintwork.
EN ISO 12944	Paints and varnishes. Corrosion protection of steel structures by protective paint systems. Classification of environments. Part 8: Development of specifications for new work and maintenance.
BS 5493	Code of practice for protective coating of iron and steel structures against corrosion

Drainage - Roads

a) Drainage

FHWA (Federal Highway Administration-US Department of Transportation)

Hydraulic Design Manual – Texas department of Transportation

b) Roads

EPTISA International GROUP EP, Albanian Road Design and Construction Standards

All relative BS-EN Standards

The Contractor shall use the most recent versions of the above standards, norms and regulations.

3. Deliverables

Hudraulic study

Existing “Hydrology Report” results and IDF (Intensity-Duration-Frequency) curves, as well as CN (Curve_Numbers of the unit hydrograph method) of the detailed design will be applied for the design rainfall depths and durations calculation and subsequently flows determination. Flows resulting from same catchment areas have to coincide with the aforementioned “Hydrology Report” values.

- Technical Report, including at least:
  - Rules and Standards taken into consideration
  - Hydrological Calculations and design
  - Culvert Hydraulic calculations and design
  - Bridge Hydraulic calculations and design
  - Drainage calculations and design
- General layout (scale 1:10000)
- Horizontal layouts (scales 1:1000 or 1:500)
- Longitudinal layouts (scale 1:1000/1:100 or 1:500/1:50)
- Cross-sections of open channels, pipes etc coordinated with the cross sections of the permanent way and /or roads system as applicable.
- Detail drawings of the elements (catch Basins, manholes, drainage grates, pipes etc.)

Bridges

The studies have to consider the following:

- The design will have to respect the existing expropriations.
- Expansion joints will be used at both ends of the superstructure.
- The width of the typical section of the bridges will be the minimum that shows at the existing designs.
- If the design proposes the usage of bearings enough space at the abutments must be considered for inspection and also space for every bearing for the future usage of jacks in order the bearings to be replaced.
- At both ends of the bridge (behind the abutments) it will be considered the construction of a transition slab over the appropriate backfill.
- The design will take into consideration for the seismic loads the same design ground acceleration and factors that have been calculated in the existing designs.
- The class of the materials that will be used (concrete, steel reinforcement, prestress steel, waterproofing membranes, etc) will not be less than the existing designs.
- The designs will be performed according to the Eurocode Standards regarding Loads, combination of loads, geotechnical, statical and seismic analysis and generally for every aspect of the design.

The entire study shall provide at minimum the following items:

- Technical Report, including at least:

  - Proposed Statical System (Description, layout of spans, superstructure, prestress, piers, abutments, foundations, bearings, expansion joints etc.)
  - Design Assumptions [Permanent Loads, Live Loads, Seismic Factors, Materials (Concrete, Steel Reinforcement, Prestress Steel, Reinforcement Cover), Surface Finish, Paints (Concrete, Steel)]
  - Rules and Standards taken into consideration
  - Waterproofing
  - Actions [Permanent actions (Self Weight, Prestress, Creep & Shrinkage, Settlements), Earth Pressure, Variable Actions (Live Loads, Dynamic Effects, Wind, etc), Thermal Effects, Seismic (Loads, Spectrum, Seismic Earth Pressure)]
  - Load Combinations (Permanent Actions, SLS – Characteristic Combinations, SLS – Frequent Combinations, SLS – Quasi – Permanent Combinations, ULS – EQEU, Accidental, Seismic Combinations, Checks)
  - Geotechnical Calculations - Foundations
  - Manufacturing, Precast & Steel Beams, Bearings
  - Phases of Construction, Temporary Works
  - Monitoring Requirements
  - Project Cost
  - Annexes (Table of Reports and Drawings, Excerpt of Geotechnical and Hydraulic Studies)

- Structural Analysis - calculations and design

  - Name of the Software with the description of method of analysis
  - Description of Statical Simulation (Geometry of static system, cross sections, support conditions, etc)
  - Description and graphic presentation of Loads (Permanent, Live, Seismic, Accidental)
  - Description and graphic presentation of Combination of Loads
  - Movements and settlements in critical positions
  - Diagrams of inertia forces in critical positions
  - Checks (Ultimate Limit State Design, Serviceability Limit State Design, Overall Stability) at all structural members and components (Superstrure, Foundations, Piers, Abutments, Bearings, etc)
  - Checks at steel reinforcement and prestress steel
  - The calculations would take place with the following International system of units (SI): (Force: KN, Moment: KNm, Stress: KN/m^2, N/mm^2, MPa)

- Analytical Reports of the Bill of Quantities and Budget

- Drawings

  - Part of Plan View with topography background and section along the axis (Scale: 1/500 or 1/1000)
  - Foundation (Scale: 1/100)
  - Plan View (Scale: 1/50 or 1/100)
  - Longitudinal Section (Scale: 1/50 or 1/100)
  - Typical Cross Sections (Scale: 1/50 or 1/100)
  - Elevations (Scale: 1/50 or 1/100)
  - Geometric Drawings of Piers, Abutments, Superstructure, Foundation (Scale: 1/50 or 1/100)
  - Geometric Drawings of Precast members, and steel beams (Scale: 1/50 or 1/100)
  - Reinforcement Drawings (Piles, Piers, Abutments, Slabs, Superstructure) (Scale: 1/50 or 1/100). They will contain plan view, sections and details if needed accompanied with expansion of the reinforcement and catalog with the shape, quantity and weight.
  - Prestress Drawings (Shape and Geometry of Prestress Tendons, Schedule of Tension, Details, System of tendons) (Scale: 1/50 or 1/100)
  - Details in appropriate scales for Sidewalks, waterproofing, Drainage, Bearings, Expansion Joints, cable channels, E/M boxes, etc)
  - Phases of the Construction if needed.

- All Drawings will contain Table with a description at minimum of Loads (Permanent, Live, Seismic, Accidental, Factors of Foundation), Construction Materials (Concrete Classes, steel reinforcement / tendons), Reinforcement cover for all structural members, Regulations and Standards

Culverts

- Technical Report, including at least:
  - General project data and data study geographical area
  - Basic Hydrological Data (rainfall intensity-duration-frequency curve, return period, run-off coefficient, afflux time, discharge network, etc)
  - Basic Design Principles
  - Structural Design Calculations
  - Description of the Proposed Culverts
  - Summary Table of the Culverts (Kilometer position, dimensions, Water catchment area, Discharge, maximum Height of Flow, velocity, etc)
  - Summary Table of the Trenches (Kilometer position, dimensions, maximum slopes, Discharge, maximum Height of Flow, velocity, etc)
  - Summary Table of the Drainage Ducts (Kilometer position, dimensions, slopes, Discharge, maximum Height of Flow to diameter ratio, velocity, etc
  - Project Cost
  - Annexes (Table of Reports and Drawings)

- Hydraulic Analysis - calculations and design
  - Design Assumptions (run-off coefficient, coefficient of roughness, etc)
  - Description of method of analysis
  - Rules and Standards taken into consideration
  - Calculation of discharge
  - Calculation and checks of the sizes
  - Materials of the culverts

- Analytical Reports of the Bill of Quantities and Budget

- Drawings
  - General Plan View (Scale: 1/50.000)
  - Plan View with topography background (positions of the culverts, direction of flow, water catchment area (Scale: 1/5.000)
  - Typical Sections (Scale: 1/100 or 1/50)
  - General Plan on the horizontal Plane with full presentation of the culverts, the civil works, arrangement works in streams / rivers, etc) (Scale: 1/100 or 1/50)
  - Longitudinal Sections of the Culverts, Trenches and Ducts (Scale: 1/50 or 1/100 or 1/500)
  - Details in appropriate scales
  - Plan View and Sections for the Gabbions and every kind of protection works

Platforms, Canopies

- Technical Report, including at least:
  - Proposed Statical System (Description, layout etc.)
  - Design Assumptions [Permanent Loads, Live Loads, Seismic Factors, Materials (Concrete, Steel Reinforcement, Reinforcement Cover), Surface Finish, Paints (Concrete, Steel)]
  - Rules and Standards taken into consideration
  - Waterproofing
  - Actions [Permanent actions (Self Weight, Creep & Shrinkage, Settlements), Earth Pressure, Variable Actions (Live Loads, Dynamic Effects, Wind, etc), Thermal Effects, Seismic]

- Load Combinations (Permanent Actions, SLS – Characteristic Combinations, SLS – Frequent Combinations, SLS – Quasi – Permanent Combinations, ULS – EQEU, Accidental, Seismic Combinations, Checks)
- Geotechnical Calculations - Foundations
- Manufacturing Steel Structures
- Project Cost
- Annexes (Table of Reports and Drawings)

* Structural Analysis - calculations and design
  - Name of the Software with the description of method of analysis
  - Description of Statical Simulation (Geometry of static system, cross sections, support conditions, etc)
  - Description and graphic presentation of Loads (Permanent, Live, Seismic, Accidental)
  - Description and graphic presentation of Combination of Loads
  - Movements and settlements in critical positions
  - Diagrams of inertia forces in critical positions
  - Checks (Ultimate Limit State Design, Serviceability Limit State Design, Overall Stability) at all structural members and components
  - Checks at steel reinforcement
  - The calculations would take place with the following International system of units (SI): (Force: KN, Moment: KNm, Stress: KN/m^2, N/mm^2, MPa)

* Drawings
  - Part of Plan View with topography background and section along the axis (Scale: 1/500 or 1/1000)
  - Foundation (Scale: 1/100)
  - Plan View (Scale: 1/50 or 1/100)
  - Longitudinal Section (Scale: 1/50 or 1/100)
  - Typical Cross Sections (Scale: 1/50 or 1/100)
  - Elevations (Scale: 1/50 or 1/100)
  - Geometric Drawings of the structural components (Scale: 1/50 or 1/100)
  - Reinforcement Drawings (Scale: 1/50 or 1/100). They will contain plan view, sections and details if needed accompanied with expansion of the reinforcement and catalog with the shape, quantity and weight.
  - Details in appropriate scales for waterproofing, Drainage, cable channels, E/M boxes, etc)
  - Phases of the Construction if needed.

All Drawings will contain Table with a description at minimum of Loads (Permanent, Live, Seismic, Accidental, Factors of Foundation), Construction Materials (Concrete Classes, steel reinforcement), Reinforcement cover for all structural members, Regulations and Standards

Retaining walls

* Technical Report, including at least:
  - Proposed Statical System (Description, layout etc.)
  - Design Assumptions [Permanent Loads, Live Loads, Seismic Factors, Materials (Concrete, Steel Reinforcement, Reinforcement Cover), Surface Finish, Paints (Concrete, Steel)]
  - Rules and Standards taken into consideration
  - Waterproofing
  - Actions [Permanent actions (Self Weight, Creep & Shrinkage, Settlements), Earth Pressure, Variable Actions (Live Loads, Dynamic Effects, Wind, etc), Thermal Effects, Seismic]
  - Load Combinations (Permanent Actions, SLS – Characteristic Combinations, SLS – Frequent Combinations, SLS – Quasi – Permanent Combinations, ULS – EQEU, Accidental, Seismic Combinations, Checks)

- Geotechnical Calculations - Foundations
- Project Cost
- Annexes (Table of Reports and Drawings)

* Structural Analysis - calculations and design
  - Name of the Software with the description of method of analysis
  - Description of Statical Simulation (Geometry of static system, cross sections, support conditions, etc)
  - Description and graphic presentation of Loads (Permanent, Live, Seismic, Accidental)
  - Description and graphic presentation of Combination of Loads
  - Movements and settlements in critical positions
  - Diagrams of inertia forces in critical positions
  - Checks (Ultimate Limit State Design, Serviceability Limit State Design, Overall Stability) at all structural members and components
  - Checks at steel reinforcement
  - The calculations would take place with the following International system of units (SI): (Force: KN, Moment: KNm, Stress: KN/m^2, N/mm^2, MPa)

* Drawings
  - Part of Plan View with topography background and section along the axis (Scale: 1/500 or 1/1000)
  - Foundation (Scale: 1/100)
  - Plan View (Scale: 1/50 or 1/100)
  - Longitudinal Section (Scale: 1/50 or 1/100)
  - Typical Cross Sections (Scale: 1/50 or 1/100)
  - Elevations (Scale: 1/50 or 1/100)
  - Geometric Drawings of the structural components (Scale: 1/50 or 1/100)
  - Reinforcement Drawings (Scale: 1/50 or 1/100). They will contain plan view, sections and details if needed accompanied with expansion of the reinforcement and catalog with the shape, quantity and weight.
  - Details in appropriate scales for waterproofing, Drainage, cable channels, E/M boxes, etc)
  - Phases of the Construction if needed.

All Drawings will contain Table with a description at minimum of Loads (Permanent, Live, Seismic, Accidental, Factors of Foundation), Construction Materials (Concrete Classes, steel reinforcement), Reinforcement cover for all structural members, Regulations and Standards

Roads

* Technical Report, including at least:
  - Rules and Standards taken into consideration
  - Design parameters
  - Calculations and design
* General layout (scale 1:10000)
* Horizontal layouts (scales 1:1000 or 1:500)
* Longitudinal layouts (scale 1:1000/1:100 or 1:500/1:50)
* Cross sections of service / access roads coordinated with the cross sections of the permanent way.
* Cross-sections of "independent" road links at 20m intervals and at specific points when required
* Detail drawings of the elements

2.2.4 Design of Civil Works - Employer’s Requirements

Track Design – Basic Parameters

The basic design parameters of the new railway line are:

i. Number of tracks: 1

ii. Design speed: 100 – 120 km/h

iii. Maximum value of cant: 140mm

iv. Maximum cant deficiency: 115mm

v. Type of transition curves: cubic parabola

vi. Maximum longitudinal gradient: 17‰

vii. Standard gauge: 1435 mm

viii. Continuously welded rails (CWR) for all tracks

ix. Rails UIC 60 (60E1) on mono-block pre-stressed concrete sleepers with elastic fastenings

x. Minimum geometric dimensions of typical railway cross section according to the typical cross section of the existing design

xi. Elastic fastenings Pandrol Fastclip, Vossloh or equivalent

xii. Standard sleeper spacing of 600 mm for all CWR tracks

xiii. Ballast Hardness > 16

xiv. Structural Gauge: GC

xv. Vehicle designed axle load 22,5 tons/axle and 8.0 tons/linear metre

The design shall take into consideration the TSI requirements, the geotechnical data, the operation requirements and relevant predictions for the future as well as the interfaces with the rolling stock, the signalling system, the drainage and other civil works.

Right of Way (RoW).

The rehabilitation of the Durres - Tirana PTT railway line, along with the parallel drainage system and service / access roads along the railway will be materialized within the RoW HSH property of the existing line or the RoW.aquired following expropriations

Deviation outside the existing right of way will be considered along the alignment of the Domje Railway Intersection, KP 26+000 - KP 28+200 of the existing design.

With the exemption of the connections with the Durres - Tirana railway line within the context of the Domje Triangular Railway Intersection, the railway line to the Tirana International Airport along with the parallel drainage system and service / access roads along the railway will be materialized within the zone of the existing expropriation, conduced upon the spatial requirements of the project according to the existing design.

Stations

The functional and geometric design of stations within the existing design was subject of collaboration with and final approval by the HSH pertinent directorate.

Any modification to the existing design of stations within the final design to be elaborated by the contractor will be subject to the final approval of the HSH pertinent directorate.

Turnouts of stations lines will be of the type EW 300 - 1:9, in order to allow for operational speed of 50km/hr along the deviating line.

Domje Triangular Railway Intersection

The new triangular intersection connecting the Durres - Tirana PTT line with the new line to TIA, shall facilitate all pairs of connections, i.e. Durres - Tirana PTT, Tirana PTT - TIA and TIA - Durres.

The principal line shall be the Durres - Tirana line, by being the through line in both turnouts of the branches of the Durres - TIA and Tirana PTT - TIA lines. In the turnout of the two branches towards the Airport the Tirana PTT - TIA line is the main / through line, the branch Durres - TIA being the branching line in its' both end turnouts.

Branching at the three peaks of the intersection will be facilitated by means of turnouts EW 760 1:14, to allow operating speed of 75km/hr for the branching line, a speed to be also sustained by the geometric alignment of the branches post the turnouts.

Although doubling of the Durres - Tirana PTT line is outside the scope of the present study, it should be taken into account in the design of the intersection. In the case of a future doubling of the line, by means of adding a parallel line to the at an axial distance of 4.5m, the geometry of the branches shall remain unaffected, save of the need to relocate the turnouts and introduce crossovers as necessary.

Fencing

Physical separation (fencing) is meant to ensure and / or protect the railway corridor and railway operation against:

- Wildlife crossing
- Crossing of domestic animals
- Unauthorized pedestrian use of the railway corridor
- Arbitrary vehicular crossing

The design for both the Durres – Tirana PTT and New Airport Link railway lines envisages the complete fencing of the railway line.

Exceptions, for cost mitigation reasons, will be accepted at sections where the cross – section (formation) of the line makes fencing not necessary, like in the case of embankments more than 3m or 4m high.

Two basic types of fencing will be applied for this purpose, depending on the conditions of the surrounding environment:

- one type for rural areas and in the proximity of small roads facilitating local access.
- one type for urbanized sections of the line and in the close proximity of major roads, as presented in the context of the existing design.

At grade crossings

Planning principles in the design of the accessibility system across the railway corridor are summarized as follows:

- Maintenance of all existing grade separated crossings
- Maintenance of existing authorized level crossings
- Closing of existing arbitrary level crossings on the basis of the existence of reasonable alternative routes
- Maintenance of existing unauthorized / arbitrary level crossings having no practical alternative under reasonable rerouting
- Integration of the crossings within the existing local and parallel - service road network of the railway corridor.
- Introduction of new parallel / service roads and reinstatement of existing ones as applicable
- All road level crossings facilitate both vehicular traffic and pedestrians

All crossings, vehicular and pedestrian are integrated into the signalling system of the railway featuring:

- “Automated Half Barrier” system for general traffic crossings
- Light and sound warning for the pedestrian crossings

At grade general traffic and exclusive pedestrian crossings envisaged within the context of the existing design are subject of coordination with and approval by HSH pertinent directorate, as well as part of the environmental licensing of the project.

Any modification to the approved / licensed system of vehicular and pedestrian at grade crossings within the final design to be elaborated by the contractor will be subject to the final approval of the HSH pertinent directorate as well as respective update of environmental terms and environmental licensing.

Hydraulic Studies

The basic design parameters of the civil works are:

I. return period peak discharge for culverts: 50 years

II. return period peak discharge for bridges: 100 years

Environmental Licensing

The final design to be elaborated by the contractor shall comply with the environmental licensing of the project on the basis of the existing design, namely:

- Approved Environmental Impact Assessment Study
- Approved Environmental Terms
- Approved Stakeholder Engagement Plan
- Approved Land Acquisition Framework.

Any necessary update to the existing environmental licensing framework as result of deviations of the contractor's final design from the existing design will be subject to contractor's contractual obligations within the scope, budget and time schedule of the contract.

2.2.5 Signalling – Telecommunications

1. Design data

The following studies are part of this Tender and are available to the Constructor:

- Book 5: Signalling
- Book 6: Telecommunications

The Constructor is obligated to check the available data and if it is required to take additional data insitu, without additional payment, in order to ensure the quality and precision of the design.

2. Applicable Standards, Norms and Regulations

Signalling - Telecommand

EN 50121-4	Railway applications – Electromagnetic compatibility - Part 4: Emission and immunity of the signalling and telecommunications apparatus
EN 50121-5	Railway applications - Electromagnetic compatibility - Part 5: Emission and immunity of fixed power supply installations and apparatus
EN 50122-1	Railway applications - Fixed installations -- Part 1: Protective provisions relating to electrical safety and earthing
EN 50124-1	Railway applications – Insulation coordination - Part 1: Basic requirements - Clearances and creepage distances for all electrical and electronic equipment
EN 50124-2	Railway applications – Insulation coordination - Part 2: Overvoltage and related protection
EN 50125-3L	Railway applications – Environmental conditions for equipment - Part 3: Equipment for signalling and telecommunications

EN 50126	Railway applications - The specification and demonstration of reliability, availability, maintainability and safety (RAMS)
EN 50128	Railway applications - Software for railway control and protection systems
EN 50129	Railway applications - Safety related electronic systems for signalling
EN 50159-1	Railway applications - Communication, signalling and processing systems - Part 1: Safety-related communication in closed transmission systems
UIC 738	Processing and transmission of safety information
EN ISO 9000-1	Quality management and quality assurance standards - Part 1: Guidelines for selection and use
EN ISO 9000-3	Quality management and quality assurance standards - Part 3: Guidelines for the application of ISO 9001:1994 to the development, supply, installation and maintenance of computer software
EN ISO 9001	Quality Systems - Model for quality assurance in design, development, production, installation and servicing
EN ISO 9002	Quality Systems - Model for quality assurance in production, installation and servicing
EN ISO 9003	Quality Systems - Requirements for final inspection and testing
EN 30011-1	Guidelines for auditing quality systems - Audit
EN 30011-2	Guidelines for auditing quality systems - Qualification criteria for quality systems auditors
EN 30011-3	Guidelines for auditing quality systems - Management of audit programs
-	Applicable Albanian Technical Standards
-	Albanian Signalling Regulation

Recommendation of the European Committee for Electrotechnical Standardization

CENELEC - EN 60825-1:2007	Safety of laser products - Part 1: Equipment classification and requirements; IEC 60825-1:2007 - 1994. EN 60825-1:1994 and its amendments - Note 2.1 / 1.9.2010 Article 3 (1) (a) (and Article 2, 2006/95/EO)
CENELEC - EN 60825-2:2004	Safety of laser products - Part 2: Safety of optical fibre communication systems (OFCS) - IEC 60825-2:2004); EN 60825-2:2000 EN 60825-2:2000; remark 2.1/1.9.2007; Article 3 (1) (a) (and Article 2, 2006/95/EO)
	Amendment A1: 2007 of EN 60825-2:2004 - IEC 60825-2:2004 / A1: 2006/1.2.2010;
CENELEC - EN 60825-4:2006	Safety of laser products - Part 4: Laser guards - IEC 60825-4:2006;
	Amendment A1: 2008 of EN 60825-4:2006 - IEC 60825-4:2006 / A1 2008

CENELEC - EN 60825-12:2004	Safety of laser products – Part 12: Safety of laser products - Part 12: Safety of free space optical communication systems used for transmission of information- IEC 6082512:2004); Article 3 (1) (a) (and Article 2, 2006/95/EO)
CENELEC - EN 61000-6-3:2007	Electromagnetic compatibility (EMC) - Part 6-3: Generic standards - Emission standard for residential, commercial and light-industrial environments IEC 61000-63:2006
CENELEC - EN 61000-6-1:2007	Electromagnetic compatibility (EMC) - Part 6-1: Generic standards - Immunity for residential, commercial and light-industrial environments- IEC 61000-6-1:2005

European Union standards (European Norms)

EN 300019-2	Equipment engineering (EE) – Environmental conditions and environmental tests for telecommunications equipment - Part 2-2: Specification of environmental tests – Transportation
EN 41003	Particular safety requirements for equipment to be connected to telecommunications networks and/or a cable distribution system
EN 61000-6-4	Electromagnetic compatibility (EMC) - Part 6-4: Generic standards - Emission standard for industrial environments
EN 50121-1	Railway applications – Electromagnetic compatibility – Part 1: General
EN 50121-2	Railway applications – Electromagnetic compatibility – Part 2: Emission of the whole railway system to the outside world
EN 50121-4	Railway applications – Electromagnetic compatibility - Part 4: Emission and immunity of the signalling and telecommunications apparatus
EN 50121-5	Railway applications - Electromagnetic compatibility - Part 5: Emission and immunity of fixed power supply installations and apparatus
EN 50122-1:2011/ AC:2012	Railway applications – Fixed installations – Electrical safety, earthing and the return circuit – Part 1: Protective provisions against electric shock
EN 50123-1	Railway applications – Fixed installations – D.C. switchgear – Part 1: General
EN 50124-1/A2	Railway applications – Insulation coordination – Part 1: Basic requirements, Clearances and creepage distances for all electrical and electronic equipment
EN 50126	Railway Applications – The specification and demonstration of reliability, availability, maintainability and safety (RAMS) Part 1: Basic requirements and generic process Part 2: Systems approach to safety
EN 50129	Railway applications – Communication, signalling and processing systems – Safety related electronic systems for signalling
EN 50159-1	Railway applications – Communication, signalling and processing systems. Part 1: Safety-related communication in closed transmission systems
EN 50159-2	Railway applications – Communication, signalling and processing systems. Part 2: Safety-related communication in open transmission systems
EN 55022	Information technology equipment – Radio disturbance characteristics – Limits and methods of measurement
EN 55024	Information technology equipment – Immunity characteristics - Limits and methods of measurement
EN 60849	Sound systems for emergency purposes

EN 60950-1	Information technology equipment – Safety – Part 1: General requirements
EN 61000-3-2	Electromagnetic compatibility (EMC) – Part 3-2: Limits – Limits for harmonic current emissions (equipment input current up to and including 16 A per phase)– (IEC 610003-2:2005 + A1:2008 + A2:2009)
EN 50173-1	Information technology – Generic cabling systems – Part 1: General requirements
EN 61000-6-1	Electromagnetic compatibility (EMC) – Part 6-1: Generic standards – Immunity for residential, commercial and light-industrial environments
EN 61000-3-11	Electromagnetic compatibility (EMC) – Part 3-11: Limits – Limitation of voltage changes, voltage fluctuations and flicker in public low-voltage supply systems - Equipment with rated current <= 75 A and subject to conditional connection
EN 61000-4-2	Electromagnetic compatibility (EMC) – Part 4-2: Testing and measurement techniques – Electrostatic discharge immunity test
ENV 50204	Radiated electromagnetic field from digital radio telephones. Immunity test
EN 300253 V2.1.1	Environmental Engineering (EE) – Earthing and bonding configuration inside telecommunications centres
EN 50310	Application of equipotential bonding and earthing in buildings with information technology equipment

Standards of the International Union of Railways (UIC)

UIC 750	Railway telecommunications links - Improvements to be expected from the use of telecommunications for operating purposes
UIC 753-1	technical regulations concerning international railway telephone circuits
UIC 753-2	General technical regulations governing establishment and development of communication capacity over the railway telecommunications network of UIC building components
UIC 754	Omnibus telephone circuits - Regulations for construction and equipment
UIC 755-1	Laying of telecommunications and signalling cables and their protection against mechanical damage
UIC 755-2	Protection of telecommunications staff and plant against a large earth potential due to a neighbouring electric traction line
UIC 756	Fixed and portable line-side telephones
UIC 780	Remote control of signalling installations
UIC 781	Transmission systems and methods of remote control for signalling installations
UIC 917-1	technical provisions for the international interconnected Railway data transmission networks
UIC 917-2	Maintenance of the international railway data transmission network for use by the railways
UIC 917-4	Information and instructions for the maintenance of the telecommunication lines used by the railways for the interconnection of data transmission networks

Standards of the International Electrotechnical Commission (IEC)

IEC 1508	Functional Safety: Safety related systems
IEC 529/ EN60529	Specification for degrees of protection provided by exposures (IP code)
IEC 571	Electronic equipment used on rail vehicles
IEC 60 794-1-2	Optical fibre cables - Part 1-2: Generic specification – Basic optical cable test procedures
IEC 61 643-1:2000-09	Low-voltage surge protective devices - Part 1: Surge protective devices connected to low-voltage power distribution systems - Requirements and tests
IEC 68	Environmental testing
IEC 721	Classification of environmental conditions
ISO/IEC-11801	Information technology – Generic cabling for customer premises
ISO/IEC 8877	Information technology -- Telecommunications and information exchange between systems -- Interface connector and contact assignments for ISDN Basic Access Interface located at reference points S and T

Standards of the Institute of Electrical and Electronics Engineers (IEEE)

IEEE 802.1q	Virtual LANs
IEEE 802.3x	Full Duplex Operation
IEEE 802.3z	Gigabit Task Force

Standards of the International Telecommunication Union (ITU)

E.164	The international public telecommunication numbering plan
G.652	Characteristics of single-mode optical fibre and cable
G.703	Physical/electrical characteristics of hierarchical digital interfaces
G.811	Timing characteristics of primary reference clocks
K.12	Characteristics of gas discharge tubes for the protection of telecommunications installations
K.20	Resistibility of telecommunication equipment installed in a telecommunications centre to overvoltages and overcurrents
M.1020	Characteristics of special quality international leased circuits with special bandwidth conditioning
M.20	Maintenance philosophy for telecommunications networks
M.3000 series	Overview of TMN Recommendations

Q.921	ISDN user-network interface layer 3 specification for basic call control. This Recommendation is also included but not published in I series under alias number I.451
Q.931	ISDN user-network interface - Data link layer specification. This Recommendation is published with the double number Q.921 and I.441
X.21	Interface between Data Terminal Equipment and Data Circuit-terminating Equipment for synchronous operation on public data networks.

Other standards and regulations

ISO 9001	Quality systems - Model for quality assurance in design, development, production, installation and servicing
1999/569/EC	European Commission Decision 1999/569/EC „Commission Decision of 28 July 1999 on the basic parameters for the command and control and signaling subsystem relating to the trans-European high-speed rail system
CEPT 25-09	CEPT Recommendation T/R E (Chester 1990, revised at Budapest 1995), Designation of frequencies in the 900 MHZ band for railway purposes
ERTMS COMMS	Summary of ERTMA communication requirements, EEIG document number 97E7377
VDE 08888-3	Optical fibre cables for communication systems - Part 3: Outdoor cables
VDE 0816-1	External cables for telecommunication and data processing systems - Cables insulated and sheathed with polyethylen, unit stranded - List of type designation for telecommunication cables
VDE 0815/A1	Wiring cables for telecommunication and data processing systems; amendment 1
ANSI/TIA/EIA-568-A-5	Commercial Building Telecommunications Cabling Standard
EIA/TIA 568, 568A &; TSB-40A	Standards for connecting hardware performance to 100MHz

The Contractor shall use the most recent versions of the above standards, norms and regulations.

3. Signalling Implementation Design - Preparation

All designs, tables and floor plans shall be produced in a specific dimension to be agreed upon with HSH, and all symbols, nomenclature and abbreviations shall be perfectly explained and shall comply with recognized specifications or standards relating to railway signalling symbols, cabling diagrams and nomenclature (e.g. IEC 60050-821). The encoding - numbering of all project electrification (drawings, procedures, operation and maintenance manuals, technical data) shall be agreed upon with HSH before submitting the implementation design.

Following execution thereof, the Contractor shall obtain potential complementary information on the site, with the cooperation of competent of HSH employees, and then the Contractor shall draw up the final definitive design to be submitted to the competent departments of HSH for approval. This check aims at identifying any changes to the location of signals, etc. or other special cases where the installations need to be adapted to local conditions, without modifying their key operating principles.

The Contractor shall request from HSH all information necessary for preparing the implementation design early enough. The Contractor shall be the sole person liable for any consequences suffered in connection with the implementation design resulting from his failure to request information from HSH early enough.

4. Signalling Implementation design - Deliverables

Following is an indicative, but non-exhaustive, list of the documentation comprising the implementation design and of the documentation that shall be included in the registry:

Implementation design 1

- Operating and technical data concerning all offered systems and equipment (Signalling – Telecommand – Level Crossing Systems)
- Schematic layout of the track depicting the exact location of train detection devices, turnout machines, signals, level crossings and other geographic information (e.g. determination of fouling points)
- Functional analysis of the entire electronic interlocking system:
– interlocking data/tables
– route setting data/table - start and destination of each route, along with the conditions applicable to the setting of each route
– automatic route release conditions
– route cancellation conditions
– turnout machine locking data/tables relating to an overlap
– turnout machine locking data/tables relating to lateral protection
- Functional analysis of the level crossing system and HABD
- As well as any documents in general that HSH deems necessary for describing the operation of the interlocking system and level crossing system.
- A description of the earthing – lightning protection systems
- An electromagnetic compatibility drawing
- The layout of equipment in technical rooms
- The cable routes, junction box locations, under track crossings, etc. for signalling – Telecommand system, Level Crossings and HABD system.
- The interface with telecommand (operating description, compatibility)
- Coordination drawings depicting all the different systems (including Level Crossing Systems and HABD System)
- Calculations, (e.g. of power supply)

Implementation Design 2

- An interlocking system functional analysis
- The interlocking system (operating drawings, a functional analysis to demonstrate that the system is fail safe)
- The equipment installation drawings
- Cabling for indoor and track equipment interconnections
- The installation procedures
- Manuals, drawings and installation instructions about the:
– train detection system

- turnout machines
- signals
- indoor panels and racks (interlocking systems - TCC system)
- local operating panel
- power supply systems (UPS, generator)
- cabling
- air conditioning systems
- raised floors

- Level Crossings Systems detail drawings (electrical diagrams for all components, equipment detail drawings, technical documents, earthing and bonding, lightning protection, cable routing, testing and acceptance procedures, installation instructions, maintenance manuals)
- HABD detail drawings (electrical diagrams for all components, equipment detail drawings including special sleepers, technical documents, earthing and bonding, lightning protection, cable routing, testing and acceptance procedures, installation instructions, maintenance manuals)
- The testing procedure and tables
- The quality assurance procedure
- The material transportation and storage procedure
- The handling and operation manuals
- The maintenance manuals
- The "as built" drawings for Signalling – Telecommand system, Level Crossings and HABD Systems
- The staff training procedure

All the above data are indicative of the Contractor's obligations. Upon execution of the contract, the exact list of documents to be submitted shall be determined. All documents shall be submitted in electronic format too.

5. Telecommunications Implementation Design - Preparation

All designs, tables and floor plans shall be produced in a specific dimension to be agreed upon with HSH, and all symbols, nomenclature and abbreviations shall be perfectly explained and shall comply with recognized specifications or standards relating to railway signalling symbols, cabling diagrams and nomenclature (e.g. IEC 60050-821). The encoding - numbering of all project electrification (drawings, procedures, operation and maintenance manuals, technical data) shall be agreed upon with HSH before submitting the implementation design.

The Contractor shall request from HSH all information necessary for preparing the implementation design early enough. The Contractor shall be the sole person liable for any consequences suffered in connection with the implementation design resulting from his failure to request information from HSH early enough.

The Contractor shall submit a registry of individual designs and documents, as well as a time schedule for submission thereof to HSH. The registry and the submission time schedule shall be subject to approval by HSH.

Design documents (drawings, diagrams, etc.) should be prepared separately for each station and the centre in Shkozet.

All the above data are indicative of the Contractor's obligations. Upon execution of the contract, the exact list of documents to be submitted shall be determined. All documents shall be submitted in electronic format too.

It should be clarified that the approval of drawings, etc. is aimed at bringing them in harmony with the contractual obligations and shall not relieve the Contractor of his responsibility to ensure proper construction and correct and safe operation of the entire telecommunication system, which shall be borne exclusively by the Contractor, irrespective of any approval.

6. Telecommunications Implementation design - Deliverables

Following is an indicative, but non-exhaustive, list of the documentation comprising the implementation design and of the documentation that shall be included in the registry:

Telecommunications Implementation design 1

- Operating and technical data concerning all offered systems and equipment
- Functional description and functional diagrams of the telecommunication system, as well as any documents in general that HSH deems necessary for describing the operation of the system.
- Complete technical data for the interfaces with other equipment (operating description, compatibility)
- An electromagnetic compatibility drawing
- A description of the earthing system
- The layout of equipment in technical rooms
- The cable routes, junction box locations, etc.
- Calculations, (e.g. of power supply)

Telecommunications Implementation design 2

- A functional analysis
- The equipment installation drawings
- Cabling / wiring diagrams
- The installation procedures
- Manuals, drawings and installation instructions about all equipment
- The testing procedure and tables
- The quality assurance procedure
- The material transportation and storage procedure
- The handling and operation manuals
- The maintenance manuals
- The "as built" drawings
- The staff training procedure

2.2.6 As-Built Documents

The Contractor shall keep accurate record drawings of the positions and details of all work constructed by him. These drawings shall be in the forms and to scales approved by the Engineer and shall be prepared regularly as the work proceeds.

As these record drawings are completed, they are to be handed to the Engineer and shall become the property of the Employer.

Any errors or omission in the drawings and in the as-built project submitted by the Contractor and approved and certified by the Engineer, and any defects and irregularities in the works performed according to such drawings and as-built project, shall not release the Contractor of any of his responsibilities and obligations under the contract.

The Contractor shall keep permanent records, make daily entries into and sign the work book, which shall be supplemented and certified by the Engineer. The Engineer has the right not to accept and not to certify payment of any item or part of the works if it has not been recorded in the work book. All notifications between the Contractor and the Engineer and all instructions, decisions and orders by the Engineer to the Contractor presented in the work book shall be considered as written notices, instructions, decisions or work orders. The work book is to be maintained in three copies. On completion of the works the original and one copy rests with the Engineer and one copy with the Contractor.

As a prerequisite for payment under the final payment certificate and on issuing of the taking-over certificate, the Contractor shall, at his own expense, prepare and submit to the Engineer as-built dossiers (paper and electronic form).

Content of As-built Dossier

The as-built dossier shall include:

1. The actual construction schedule.
2. Reports of the incidents, such as damage on girders during handling requiring reparation, leakage of the formwork, etc.
3. The QA plan with all the results of the tests and controls.
4. A maintenance notice including:
5. Geometrical follow-up of the structure.
6. Description of the inspection and maintenance procedures.
7. Updated drawings and calculation notes.
8. Functional and technical specifications of the equipment.
9. The implementation Design Study for Siganlling and Telecomunication Systems

2.2.7 Time Schedule for the designs made by the Cotnractor

All designs that shall be made by the Contractor shall be submitted, reviewed and approved within six (6) months from the signing of the contract. Especially, the Contractor shall submit:

- The design of civil works (permanent way, roads, stormwater drainage etc) along with any ammendements to the supporting studies (topographic surveys, geotechnical studies etc) track design study within four (4) months from the signing of the contract
- The Signalling Implementation design 1 within four (4) months from the signing of the contract
- The Telecommunications Implementation design 1 within four (4) months from the signing of the contract

The procedure of submission, review and approval of the designs made by the Contractor shall be in accordance with Clause 5 (Design).

2.3 Preliminary Works

This Article refers to the to the preliminary works which are necessary for other works associated with road constructions, track line construction and superstructures, as described in relative Books.

2.3.1 Setting out the Alignment

The Contractor must confirm in-situ the boundaries of each study, mark the route and verify the elevations, in order to achieve the beginning of the earthworks. The Contractor should highlight any deviations or obstacles (i.e. pipelines) that may occur and inform the Consulter via Deviation. At this step, the construction site, as well as the whole area that needs to be cleaned must be set out.

Every topographical work and verifications are included in the Contractor's offer.

The Contractor shall inspect the sites accompanied by Employers representatives before commencing with the works. A site survey shall be carried out to determine the type of works and work conditions at different sites. The site survey shall be based on the information from the Technical Specifications, Documents and Drawings.

2.3.2 Clearing and grubbing

1. Description

This work shall consist of removing all objectionable material from within the right of way, embankment and touch grade areas, easement areas for bridge construction; road approaches, channels and ditches, and such other areas as shown on the plans, except objects designated to remain. It shall also include the recompaction of the cleared and grubbed areas as specified in for "Foundation Preparation," in these Technical Specifications. Objects designated to remain or to be removed in accordance with other sections of the specifications, adjacent public and private property, utilities and non-highway facilities shall be protected from injury or damage resulting from the Contractors operations. Clearing and grubbing shall be performed in advance of grading operations and in accordance with these specifications.

2. Works

The Contractor, as soon as the site or part thereof has been handed over, before commencing the clearing and grubbing shall resurvey together with the Engineer the whole centreline of the alignment, locating the centreline at the ground and taking cross sections along the alignment at a imum longitudinal spacing according to design study.

In case it clarifies that levels for the natural ground in a certain area differ remarkably from what is established on the plans, the Contractor shall notify the Engineer thereof and obtain his approval to commence with the work prior to causing a change in the natural ground levels.

Within the limits specified, the area above the natural ground surface shall be cleared of vegetation growth, such as stumps, plants, brush, and all other objectionable material, except items marked by the Engineer to remain. Within the limits of clearing, the areas below the natural ground shall be grubbed to a minimum depth of twenty (20) centimeters, or as may be necessary, to remove tree stumps, roots and other objectionable material. Trees must be removed only when the Engineer approves that.

These works must be done only with the approval of the Engineer.

3. Disposal of Removed Material

Cleared and grubbed material shall not be left in or under embankments or other constructed facility. All removed materials shall be disposed off at locations outside the right-of-way and not visible from the roadway.

Burning shall be done in accordance with applicable laws and safety practices, under the constant care of competent watchmen and at such times and in a manner that anything designated to remain and adjacent property will not be jeopardized. Residue and the effects from burning shall also be removed outside the right-of-way and view from the roadway.

Disposal of removed materials at public and private sites away from the right of way shall be done at the Contractors sole expense, in accordance with all laws and regulations, after an agreement with the property owner or public agency has been fully executed. The Engineer shall be given fifteen (15) days prior notice and a written release from the property owner or public agency on whose property the materials are to be placed.

All sellable timber in the clearing area which has not been removed from the right of way prior to the beginning of construction, shall become the property of the Employer, unless otherwise provided.

2.3.3 Demolition works

1. General

Demolition works concerns:

- ungrouted masonry small buildings and fences of low resistance
- walls and masonry in grouted riprap or concrete, excluding reinforced concrete
- buildings in grouted masonry or concrete, excluding reinforced concrete
- reinforced concrete structures or part thereof including buildings, bridges and culverts, walls etc., and any kind of structure as may be directed by the Engineer, which are to be demolished or removed.

Before any works of demolition are started a detailed survey and examination of the structure shall be made and recorded by the Contractor and kept available for inspection.

The Contractor shall plan the demolition of buildings and structures with due consideration given to their location and condition.

The overall stability and possible occurrence of unbalanced thrusts shall be checked by the Contractor. All bracing members shall be identified and protected to ensure that demolition is carried out in a sequence that maintains the safety and stability of the remaining structure. At all times the methods, materials and equipment used shall accord with the need to safeguard life and other property.

The program of demolition and a detailed method statement for all elements of the work shall be submitted to the Engineer for his approval before commencement of any work.

The Contractor shall not commence any demolition work until the approval of the Engineer has been given.

2. Method of demolition

The proposed method of demolition will be such that where part of the structure is to remain, the method adopted for removal must ensure that no damage or weakening of the remaining structure occurs.

Where demolition work cannot be done safely from a part of the structure, a suitable working platform must be used. The structure shall generally be demolished in reverse order to that of construction. Steel and reinforced concrete structural members shall be supported by suitable lifting equipment and lowered to the ground or be cut into lengths appropriate to the weight and size of member before being lowered to the ground. Debris shall not be allowed to fall freely.

Generally, demolition work shall commence by removing as much dead load as possible without interfering with the main structural members. Temporary works shall be designed to carry the required loads under the most severe conditions and the Contractor shall submit his proposals for Temporary Works to the Engineer and obtain his approval before work commences.

The use of explosives is forbidden.

Any scaffolding required shall be designed and erected in accordance with the relevant standards. Erection of scaffolding shall be carried out by an experienced and competent scaffolder and it shall be of an independent tied type. The Contractor shall ensure that all necessary adjustments required to the scaffolding to ensure its stability are made as the work proceeds. Care shall be taken that the load of any debris collecting on a scaffold does not exceed the loading for the design. All measures necessary shall be taken to prevent debris from being accidentally dislodged from the platform. Scaffolding shall at all times during use be suitable for the purpose for which it is intended and shall be approved by the Engineer.

3. Preservation of property

Existing facilities which are designated or allowed to remain shall be protected from damage. Facilities which are damaged or destroyed as a result of the Contractor's operations shall be repaired or replaced by the Contractor at his own expense.

Trenches, holes, depressions and pits caused by the removal of structures and obstructions, which remain after completion of roadway excavation, shall be backfilled with embankment material as specified in "Embankment Construction," in these Technical Specifications. When trenches, holes, depressions and pits are in surfaced areas which are designated to remain undisturbed, they shall initially be backfilled with embankment materials up to the elevation of the bottom of the surfacing materials. The removed surfacing materials shall be replaced with equal or better quality surfacing materials of the same layer thickness and degree of compaction.

4. Health and Safety

The Contractor shall submit his proposals for Health and Safety to the Engineer for approval prior to the commencement of demolition work.

The Contractor shall ensure that the plant and equipment is:

i. conformant to the laws and regulations of Albanian Statutory Authority,
ii. of an appropriate type and standard having regard to the location and type of work involved,
iii. in the charge of a competent and experienced operator,
iv. maintained in good working condition at all times.

During demolition work all operators shall wear adequate protective clothing or protective equipment such as, but not limited to, safety boots, protective gloves, safety helmets, goggles, ear defenders and respirators.

Over- loading of any part of the structure by debris and materials shall be avoided. When materials or debris are lowered, care shall be taken to prevent the material swinging, falling or being projected in such a manner that it creates a danger to the safety of personnel, the public, the surrounding structure or other property of any kind.

Suitable nets, protective boardings and barriers shall be erected by the Contractor to prevent accidental harm to persons or damage to property by falling or flying materials and debris.

When mechanical plant such as cranes, hydraulic excavators and rock breakers are used for demolition care shall taken to ensure that no part of such machines can come into contact with or in close proximity to overhead or underground electricity or telephone wired or cables. The Contractor shall in sufficient time prior to the commencement of the works, inform the Statutory Authority so that the Authority may take the necessary steps for protecting or rerouting the cables.

2.3.4 Relocation of Existing Utilities and Installations

1. Description

This involves all the works for complete dislocation of the existing installations such as electric conduits, high and low voltage cables, telephone cables, water supply and sewerage pipelines, channels, etc. Complete dislocation means demounting of existing installations and their displacement with all the works necessary for reestablishing of thorough functioning of the corresponding installation, i.e., in accordance with the description of the works in the project on dislocation, as well as the instructions by the Engineer.

The work also includes acquiring of all the necessary documents and approvals from the authorized institutions and/or users of the installations.

Should during project implementation for existing underground installations the need of relocation works also arise, the Contractor has also to prepare all necessary designs in coordination with the owner of the installations and the Employer.

2. Performance

Dislocation of existing installations is done carefully and with full respect of all the necessary technical measures referring to the installation itself and the people who carry out the dislocation. Control and safety, particularly related to electrical conduits, must be thoroughly assured. The demounted materials are stored carefully for their eventual reuse.

After the demounting of the existing installations, they should be dislocated. This involves all the necessary works and materials for dislocation, i.e., up to the reestablishing of the functioning of the corresponding installation.

The mode of performance of the works is determined by the Contractor and in compliance with the project on dislocation and the instructions by the Engineer.

The total damage due to eventually improperly done work shall be covered by the Contractor.

3. Quality Control

For the quality control of the construction materials for these works, the provisions of these technical conditions shall apply. For the industrial materials, such as cables, conduits and alike, the Contractor is obliged to provide attests satisfying the conditions in the project and the requirements of the Engineer and the user of the installation.

2.3.5 Geodetic Data - Track Axis assurance

The Employer’s supervision team shall submit all geodetic data to the Contractor after awarding the Contract and the Contractor shall accept the geodetic data without remarks. The transfer of the geodetic data will be done in the following way: The Employer’s Supervision Team surveyor and the Contractor surveyor shall go on site and verify the geodetic data together. In case of discrepancy both surveyors will agree upon the correct data and will prepare minutes for that will be signed by both sides. In addition to that, both surveyors will agree upon the marking and the color of the line put on the catenary masts that will be used for verification and approval of the daily executed works.

Responsibility of Contractor in preparation and performing the phase of geodetic works consists of the following:

a. Ensure a good geodesy team and appropriate logistic
b. Ensure a good quality geodesy;
c. Equip geodesy team with modern measuring equipment, for work on terrain as well as for further data processing
d. The geodetic works will be executed with total station only
e. Ensure a maximal coordination of activities, in order to perform the necessary geodesy preparation works on time;

f. In a phase of transfer of design documentation between the Employer and the Contractor, the geodesy routes (coordinates) shall be included in the survey documentation

g. Insist on the establishment of good quality geodesy works performance and raise it on the maximal level

h. With construction works of all Contractors and subcontractors, ensure maximal coordination of activities, in order to perform the necessary geodesy preparation works on time without preventing other participants in the project to perform their activities

i. After the route shall be taken over from the Employer's Supervision team, successively by the sections, all geodetic phases should be followed by establishment of good protected survey marks by the Contractor

j. Geodetic marking (notching or markings) of permanent markings for level and axis of the , including overhead contact line masts and saving data in an adequate manner for maintenance purpose

k. dismantling the existing permanent markings if any and after finishing the renewal works shall install new permanent markings:

- at beginning of transition curve
- beginning, middle and end of curves
- end of transition curve
- beginning and end of the vertical radius for longitudinal profile changes
- kilometer permanent markings shall be in-stalled respectively
- control permanent markings for following the CWR shall be installed on the left and on the right side of the on points in the following locations:

These markings shall provide easy and efficient control of the welded in CWR. In this way, the lateral movement of the and the longitudinal movement of the rails shall be controlled at least two times per year in the period of having extreme temperatures and weather conditions.

The markings shall be installed on an axle distance of 2.5m and in order to do the measure the longitudinal and the lateral movements the rail.

2.3.6 Construction Sites

1. General

For the execution of project works (superstructure construction, tunnel works, construction of structures etc.) only during the construction project, the Contractor shall use the areas where his equipment is installed, ie. parking areas for cars, vehicles, workshops, offices, storage premises, open storage areas for deposits of small amounts of aggregates and other materials and areas for concrete plants or aggregates production, etc.

The number, size and location of the required worksites shall be determined by the Contractor taking into account the organization of the construction site and the requirements of the project timetable. The Contractor will bear all the expenses regarding the purchase or rental of these sites, if it is needed, and he will deal with all the authorizations that may be required.

The Contractor can use:

i. Areas located within the project zone
ii. Areas located near the project zone and can be available from the Employer
iii. Areas outside the project zone that can be rented by the Contractor

All the temporary premises (storage sheds, any stay booths, workshops, offices, etc.) that are required for the completion of the Project shall be constructed with the care, expenses and responsibility of the Contractor, in locations authorized by the Employer and competent authorities.

2. Security of Worksite

The Contractor is obliged not only to ensure the safe storage of any equipment, machine, tool, etc., that belongs to him or to others and is located within the worksite, but also to take all the appropriate security measures and additionally to hire security staff for this purpose (daytime guards, night guards, camera surveillance systems, etc.).

The Contractor shall keep secure materials, tools, machinery, etc., that shall have been certified and shall have not been incorporated in the project, on his own responsibility and at his expenses.

The Contractor is obliged to separate and retain the materials that have undergone quality controls in particular secure areas at his own expenses.

In case of loss, damage, destruction of material or machine, etc that belongs to the Contractor or to others, the Contractor is solely responsible for the compensation of the owner or restoration of the material, etc., without being entitled to demand any own compensation.

3. Designing of Worksite premises

All premises shall be designed, constructed and put into service in accordance with the specific requirements of the relevant regulations (Sanitary requirements, Building regulations, Fire Safety Regulations, etc.).

4. Operating and Maintenance Expenses

The operating and maintenance expenses of all worksite installations, premises of the Contractor and the Authority, all logistical expenses (costs for support staff and skilled workers, office equipment, consumables) as well as any other possible costs for the proper and safe operation of worksites shall be borne by the Contractor, who is responsible for their operation and maintenance in accordance with the applicable laws and the regulations of public order, safety and hygiene.

The Contractor shall bear the costs for the maintenance of equipment and worksites during the period of their use.

5. Electrification

The Contractor shall ensure the provision of electricity with the required wattage and voltage in the appropriate places of the site on his own responsibility, care and expenses. Additionally, the Contractor shall provide all the appropriate facilities in the construction site for temporary electricity supply, either for the case of possible delays regarding the necessary connection works done by the Electric Power Industry, or for the case of damages to the network and interruptions in the power supply during the construction works.

The Contractor is obliged to undertake all necessary actions and pay all the associated costs in order to install suitable substations and also construct the necessary networks for the transmission and distribution of electricity required during the construction works.

The electricity consumption costs during the construction shall be borne by the Contractor.

6. Telecommunication – Computer Networks

The Contractor shall ensure communication with the staff of Supervision team by both telephones and computer networks. All the expenses that arise from that (connections with mobile network operators, telephone/ computer equipment, PC peripherals etc.) as well as the costs regarding the operation and maintenance of these communication systems shall be borne by the Contractor.

7. Rehabilitation of Worksites

The Contractor is solely responsible for rehabilitation of all worksites before their delivery to the Authority (with his own care, responsibility and expenditure). All the materials, equipment and everything else installed within the worksites shall be removed after the completion of project works. The time needed for rehabilitation is defined in the Contractor's contract and the project timetable.

All relevant with Construction Sites mobilization, operation and demobilization costs are not paid separately and deemed by convention that are included in the unit rates of the Contractor's offer.

2.3.7 Quality assurance

Within 30 days of receipt of the letter of acceptance, the Contractor must provide to the Engineer a comprehensive Quality Plan.

1. Content

This quality plan must show how the Contractor will implement quality control on site in order to guarantee to the Employer that all works are performed according to the contract requirements and meet the expected quality standards.

The quality plan will describe precisely how all the phases of the work will be carried out (equipment, methods, manpower organization), who will be responsible for it (CV's of the main engineers), and how the internal control will be organized for guaranteeing the necessary quality of works. In particular, a checking team independent of the production team should check all documents issued by the Contractor. The verification of the checking must appear clearly on the documents. The quality plan shall include the model sheets for the internal controls.

The Engineer will be allowed to proceed to an external audit of the quality scheme, whenever he judges it necessary.

2. Hold Points – Method Statements

The quality plan shall include details of approval procedures, hold points and witness points, including advance notice duration. These are to be agreed with the Engineer. The minimum list of hold points is given in the table 2.3.7.1 hereafter.

Table 2.3.7.1. Hold Points	
Work Phase	Hold Points
Setting Out	– Staking out approval.
Structure Shallow Footings and Inverts	– Conformity of the bottom of the excavation: levelling, type and bearing capacity of the ground. – Conformity of the substitution backfill in case of purges.
Bridge Deep Foundations (Bored Piles)	– Acceptance of the drilling and of the reinforcement before placing. – Acceptance of the piles of a support after integrity tests. – Acceptance of the piles of a support after cut-off.
Earthing of Structures	– Measurement of the earth resistance value.
Concreting	– Approval of the plant(s). – Approval of the acceptance tests. – Acceptance of the formwork – Authorisation to concrete a part of the structure. – Authorisation to remove the formwork.
Pre-stressing	– Authorisation to stress the tendons. – Authorisation to grout the ducts.

Table 2.3.7.1. Hold Points	
Work Phase	Hold Points
Steel Works	– Authorisation to transport elements on site (acceptance of the welding and of the test assembly in workshop). – Preparation of welded joints on site. – Acceptance of the welding on site.
Anticorrosion Protection of Steel Members	– Acceptance of the QA plan for the execution in workshop. – Approval of the acceptance test in workshop. – Acceptance of the painting system before transport of the elements on site. – Acceptance of the QA plan for the execution on site. – Approval of the acceptance test on site. – Acceptance of the painting system on site.
Waterproofing	– Approval of the documentation and test results that demonstrate the conformity of the waterproofing system. – Acceptance of the waterproofing support. – Acceptance of the waterproofing layer and authorisation to implement the protection layer/wearing course.
Structure Equipment	– Acceptance of the expansion joints before fixing or sealing. – Acceptance of the adjustment of the road restraint systems before tightening and sealing/fixing of the posts. – Acceptance of the cornice sample element.
Superstructures / waterproofing	– Acceptance of the surface condition before laying the waterproofing.
Bearings	– Acceptance of the concrete beds. – Acceptance during delivery. – Acceptance of the laying.
Concrete Sleepers	– Acceptance of the concrete sleepers.
Rail Fastening System	– Acceptance of the system and its components.
Rails	– Acceptance of the rails.
Rail Weldings	– Acceptance of the materials.
Crush stones for ballast track	– Acceptance of the materials.
Turnouts	– Acceptance of the turnouts and their components.

Table 2.3.7.1. Hold Points	
Work Phase	Hold Points
Point mashines and derailers	– Acceptance of Implementation Design Studies – Acceptance of the devices and their components – Testing and Commissioning
Trackside Signals	– Acceptance of Implementation Design Studies – Acceptance of the devices and their components – Testing and Commissioning
Axle Counters	– Acceptance of Implementation Design Studies – Acceptance of the equipment – Testing and Commissioning
Interlocking equipments	– Acceptance of Implementation Design Studies – Acceptance of the devices and their components – Testing and Commissioning
Cables, Fibre Optics	– Acceptance of Implementation Design Studies – Acceptance of the factory and relevant tests – Testing and Commissioning
Level Crossings	– Acceptance of Implementation Design Studies – Acceptance of the devices and their components – Testing and Commissioning
Telecommunication equipments	– Acceptance of Implementation Design Studies – Acceptance of the devices and their components – Testing and Commissioning
CTC	– Acceptance of Implementation Design Studies – Acceptance of the devices and their components – Testing and Commissioning

3. Quality certificate

To be authorised to use the different types of materials (crushed aggregates, asphalt mixes, concrete mixes, safety barriers, cement, hydraulic limes, steel, etc.) under the present Technical Specifications, the Contractor shall produce before use to the Engineer, for each category of work, the relevant "Quality Certificates" issued by an approved Laboratory or by the Authorised Supplier.

The certificates shall contain all the data relating to the source and the identification of the individual materials or their composition, the plants or places of production, as well as the results of the laboratory tests to ascertain the characteristic values required for the various categories of work or supply in relation to the proposed proportions and compositions.

The certificates, shall be produced either if the materials are produced directly or obtained from plants, borrow pits, factories (even if run by third parties), and shall be valid for 2 years. The certificates shall however be renewed whenever they show to be incomplete or a variation occurs in the characteristics of the materials, mixtures or the production plants.

4. Preliminary tests

Prior to commencement of the works involving the use of materials in greater quantities than:

- 1,000 m^3 for aggregates and asphalt mixes,
- 500 m^3 for concrete mixes,
- 50 t for cements and limes,

The Engineer, after examining the quality certificates produced by the Contractor, shall order further laboratory control tests carried out at the Contractor's expense. Should the results of these tests differ from those of the certificates, the substandard material shall be removed from the site and replaced with material that conforms to its Quality Certificate. Testing of the replacement material shall be carried out by the Contractor to confirm conformance. For all the delays in the commencement of the works arising out of the discrepancies mentioned above and involving a delay in the contractual useful time, the penalty shall be applied under Section "Commencement and Delays" of the General Conditions of Contract.

5. Control tests during construction

The testing scheduled in Tables 2.3.7.2 and 2.3.7.3 shall be carried out by the Contractor at the site laboratory, or by other laboratory previously approved by the Engineer. The Contractor shall collect all samples from site and deliver them to the laboratory at his own cost and at the frequency given in Tables hereafter.

The samples will be collected in agreement between both parties.

Table 2.3.7.2 : Required testing frequency materials

TEST	REFERENCE STANDARD	FREQUENCY
EMBANKMENTS	CNR 23 - 1971	2000 m^3
Grain Size Analysis	AASHTO T 89 and 90	2000 m^3
Plasticity Index		2000 m^3
Proctor/CBR	CNR 69 - 1978	2000 m^3
GRANULAR SUBBASE AND BASE		
Amount of material finer than 0,075 mm	CNR 75 - 1980	1000 m^3
Sieve Analysis	AASHTO T 27	1000 m^3
Proctor/CBR		1000 m^3
Sand Equivalent	CNR 27 - 1972	500 m^3
Los Angeles Abrasion Test	AASHTO T 96	5000 m^3
Moisture Density Relationship	CNR 69 - 1978	2000 m^3
CONCRETE & ASPHALT MIXES		
Sieve Analysis	AASHTO T 27	500 m^3
Sieve Analysis of mineral filler	AASHTO T 37	500 m^3
Sand Equivalent	CNR 27 - 1972	500 m^3
Los Angeles Abrasion Test	AASHTO T 96	2500 m^3

Table 2.3.7.2 : Required testing frequency materials		
TEST	REFERENCE STANDARD	FREQUENCY
Marshall Test	CNR 30 - 1973	Daily production
Coating and stripping of bituminous mix	CNR 138 - 1987	Daily production

Table 2.3.7.3 : Required testing frequency for Works Control				
WORK	TEST	REFERENCE STANDARD	FREQUENCY	MINIMUM REQUIREMENT
Embankment layers and foundation	Density of soil in place	CNR 22-1972	1000 m^2	90% Mod. AASHTO Dens.
Sub-grade	Density of soil in place	CNR 22-1972	500 m^2	95% Mod. AASHTO Dens.
-//-	Deformation Modulus	CNR 46-1992	1000 m^2	≥ 50 N/mm^2
Sub-base	Density of soil in place	CNR 22-1972	500 m^2	95% Mod. AASHTO Dens.
-//-	Deformation Modulus	CNR 46-1972	1000 m^2	≥ 80 N/mm^2
Base	Density of soil in place	CNR 22-1972	500 m^2	98% Mod. AASHTO Dens.
-//-	Deformation Modulus	CNR 46-1972	500 m^2	≥ 150 N/mm^2
Asphalt Base	Determ.of bitumen content	CNR 38-1973	1000 m^2	≥ 3.5% wt. of agg.
Binder Course	as above	as above	1000 m^2	≥ 4.0% wt. of agg.
Wearing Course	as above	as above	1000 m^2	≥ 4.5% wt. of agg.
Asphalt Base	Density in place	CNR 40-1973	500 m^2	≥ 97 %
Binder Course	as above	as above	500 m^2	≥ 98 %
Wearing Course	as above	as above	500 m^2	≥ 98 %

Only the results obtained from said laboratories will be recognised valid by both parties; all references in respect of the present Specifications shall be made exclusively to said results.

Only the Engineer shall be authorised to vary, by written order, the frequency and type of tests during the Contract .

6. Internal Controls

The quality plan shall include details of approval procedures, hold points and witness points, including advance notice duration. These are to be agreed with the Engineer. The minimum list of hold points is given in the table 2.1.6.1 hereafter.

The Contractor will perform preliminary and parallel tests, for his own needs and for the needs of the Employer, at his own laboratories or specialised institutions. The control tests are to be carried out by the Contractor under the supervision and to the direction of the Engineer. The Contractor shall include the costs of all specified tests (preliminary, parallel and control) within the unit rates quoted. The tests are performed to verify:

- The quality of material used.
- The quality of workmanship.
- The quality of finished material.
- The quality of freshly incorporated material.

The Contractor shall place at the disposal of the Engineer, all the test results and data from the tests, in the required scope and form. The Contractor is to supply the Engineer with a copy of all test results within 24 hours of the completion of each individual test.

The tests are to be performed in compliance with the corresponding standards stated in the technical conditions. To control the quality of materials and the works, the EN standards and regulations as well as other standards and regulations stated in the technical conditions shall apply. With the consent of the Engineer, the Contractor may use the equivalent DIN, BS, NF or approved EU country standards.

Prior to the use of mechanical equipment and devices affecting the quality of the works, testing of the uniformity and the quality of the works shall be performed. The Contractor shall prepare a testing programme for the approval of the Engineer.

Based on preliminary, parallel and control tests, the Contractor shall prepare reports on the quality of the built-in material and the completed works.

2.4 Earthworks

2.4.1 General

1. Nature of works

This section deals with the excavation of road bed and ditches, the construction of embankments and the excavation for structures foundations (structural excavation). The excavations and embankments necessary for forming roadbeds, side drains, accesses, passages and ramps and the like, as well as for the construction of structures shall be executed in the forms and dimensions shown on the Contract drawings with all costs inherent to these types of works being at the full charge of the Contractor, including those for formwork and falsework, all having been considered by him in fixing the correspondent unit prices. All drains shall be constructed in accordance with the drainage drawings and schedules.

The slopes of cuts and embankments shall be constructed in accordance with the Earthworks drawings.

The Contractor shall, at his own expense, provide for all the necessary tests to be carried out in the site laboratory to establish the nature of the soils, their degree of compaction and their moisture contents for the purpose of establishing their suitability and method of working and compaction.

The soils will be characterised and classified according to Table 2.4.1.1 and the definitions of paragraph below.

Table 2.4.1.1: Classification of soils and soil- aggregate mixtures

CLASSIFICATION OF SOILS AND SOIL-AGGREGATE MIXTURES

General Classification	Granular Materials (35% or less passing 75µm) [No. 200]							Silt-Clay Materials (More than 35% passing 75µm) [No. 200]			
Group Classification	A-1		A-3*	A-2				A-4	A-5	A-6	A-7
	A-1-a	A-1-b		A-2-4	A-2-5	A-2-6	A-2-7				A-7-5 A-7-6
Sieve Analysis:											
Percent passing:											
2mm (No. 10)	50.	---	---	---	---		---	---	---	---	---
425µm (No. 40)	30.	50.	51 min.	---	---	---	---	---	---	---	---
75µm (No. 200)	15.	25.	10.	35.	35.	35.	35.	36 min.	36 min.	36 min.	36 min.
Characteristics of fraction passing No. 425µm (No. 40):											
Liquid Limit	---		---	40.	41 min.	40.	41 min.	40.	41 min.	40.	41 min.
Plasticity Index	6.		N.P.	10.	10.	11 min.	11 min.	10.	10 .	11 min.	11 min**
Usual Types of Significant Constituent Materials	Stone Fragments Gravel and Sand		Fine Sand	Silty or Clayey Gravel and Sand				Silty Soils		Clayey Soils	

General Rating as Subgrade	Excellent to Good	Fair to Poor

* The placing of A-3 before A-2 is necessary in the "left to right elimination process" and does not indicate superiority of A-3 over A-2.

**Plasticity Index of A-7-5 subgroup is equal to or less than LL minus 30. Plasticity Index of A-7-6 subgroup is greater than LL minus 30.

In executing the excavations and embankments the Contractor is to carry out, at his own care and charge, the grubbing of plants, bushes and relevant roots existing on the soils to be excavated and on those to be used for embankments as well as, in the latter case, the backfilling of holes resulting from the grubbing of the roots and plants with suitable material placed in layers of appropriate thickness, and compacted. These costs shall be deemed to be included in the tendered rates for Preparatory works.

In relation to the nature of the foundation soils of the embankments or of the road foundations in cut, the Engineer may order the adoption of provisions to prevent contamination of the layers to be laid, such as anticapillary layers with suitable granulometry or geotextile sheets, which will be paid with the relevant item of BOQ.

2. Definitions

All earthworks materials are categorised as follows:

Rock: Any material that in the opinion of the Engineer (who shall take into account the situation in which the excavation is taking place) requires for its excavation the use of blasting or compressor and tools, or steel wedges and hammer, or which cannot be effectively removed, or ripped by a track-type tractor of at least 150 brake Hp with a single, rear-mounted heavy-duty ripper or a face shovel, shall be classified as rock. The cost of excavating rock shall be included in the Contractor's tender rates and no extra payment will be made for this cost.

Common Material: Any material that can be excavated without recourse to the methods described under rock above shall be classified as common material. This includes all hard or decomposed material which can be effectively removed, or ripped by a track-type tractor or face shovel of specified horsepower of not less than 425 horsepower above.

Isolated Boulders: Isolated boulder within a mass of common material which can be bodily removed by the Contractor's ordinary earthmoving plant and suitably disposed of to the Engineer's satisfaction shall be measured as common material, otherwise, such boulders shall (if so classified by reference to rock above) to be measured as rock, and of 1 cu.m in volume in open cut and 0,5 cu.m in structural excavation.

Cut is any earthworks material gained by excavation in cuttings including side drains.

Borrow is any suitable earthworks material which, with the prior approval of the Engineer, is obtained either by over-excavation in cutting or borrow pits outside the road reserve.

Unsuitable material is any earthworks or excavated material which, in the opinion of the Engineer, is not suitable as fill and is to be removed to spoil outside the road reserve.

Unsuitable material shall include:

- material classified as A4, A5, A6, A7 according to AASHTO M145.
- unstable materials incapable of being compacted to the specified density at optimum moisture content using ordinary compaction methods for the equipment being used for compaction. Such materials may include, but not be limited to, cohesion less sand, silt, organic and highly compressible soil and sod.
- material in the sub grade, in swamps and also peat, logs, tree stumps, perishable

material and material susceptible to spontaneous combustion;

- any material which for the time being is in a frozen condition;
- any material which in the opinion of the Engineer is unsuitable for the location it is intended to be placed;
- any material which has an excessive moisture content, and which in the opinion of the Engineer cannot be dried out.

Surplus material is cut judged by the Engineer to be suitable for fill, but is surplus to fill requirements and must be removed to spoil. The Engineer shall direct whether such material shall be disposed of as overfill in embankments or shall be disposed off in authorised spoil areas outside the road reserve.

Fill is common material to a design standard, i.e. common material which when compacted to 90% of the Modified AASHTO has a minimum CBR of 5% (soaked) and which is declared by the Engineer as acceptable as fill.

Selected material is material coming from roadcut or borrow pit which when compacted, within a range of 2% of the Optimum Moisture Content, to 95% of MDD has minimum 25% CBR plasticity index not exceeding 10, a imum aggregate size of 100 mm, a imum passing to sieve No.200 of 35% and which is declared by the Engineer to be acceptable as selected sub grade fill.

Selected sub grade fill is only to be classified as selected material for the purpose of measurement and payment if it is excavated from an area different from that of the fill beneath it.

Rock fill is broken material derived from hard homogenous rock and which in the heap contains more than 25% by volume of particles larger than 200 mm in greatest dimension. All rock fill must receive the prior approval of the Engineer before use.

Commencing surface is the surface of the ground after site clearance and removal of topsoil and before any other earthworks have been carried out.

Excavated surface is the surface to which excavation is designed to be carried out.

Section Profile is the designed cross-sectional profile of the completed excavation, side drain, fill or embankment earthwork before the placement of any part of the road bed.

Sub grade is all the worked layer vertically below the road pavement and shoulders to dimensions specified Art. 4.03 and 04 or in the drawings.

Embankment is fill above or below the foundation area.

Embankment foundation area is the area prepared, after the removal of top soil, to receive the embankment.

Formation level is the projection of the interface between the top of the sub grade and the underside of the road pavement and shoulders.

Preparation of Formation includes specified activities to be carried out on a stated depth of the top of the sub grade with the object of preparing it to receive the road pavement, and to improve its density and strength.

Pavement is the whole of the pavement construction above the sub grade; the pavement is constituted with Wearing Course, Binder, Bituminous Base Course, Gravel Stone Crushed Base and Gravel Sub base or part of them.

2.4.2 General (“Wide”) Excavation

General excavations comprise those relating to excavations for the opening of the roadway, lay bys and accessory works such as, for example, the excavations for stretches of road in cuts, ground levelling, cutting of the side slopes of cuts or (road or railway) embankments, forming and deepening the foundation of the embankments, side ditches, culverts, channels, etc. as well as those for the foundation of structures executed above the horizontal level passing through the highest point of the foundation structure and laterally open on at least one side.

The horizontal level will be determined with reference to each foundation area. For the purpose of this determination the Engineer, for foundations of considerable extent, reserves the right to divide the area into parts.

The Engineer may request the execution of the general excavations by any stretch length without the Contractor being entitled to claim any compensation or increase of the relevant tendered price rate.

1. Railway/ Roadway Excavation

This work shall consist of excavating materials identified and defined by the Engineer as Roadway Excavation - or the lines and grades shown on the plans or staked by the Engineer. It shall also include excavating below grade, removing slide material, trimming slopes, slope rounding, stockpiling designated materials for future use and removing and disposing off surplus and unsuitable materials.

Material outside the planned excavation limits, which is determined by the Engineer, to be a potential slide and material which has come into the planned excavation limits shall be excavated to lines and slopes directed by the Engineer. Such excavated materials which are not declared by the Engineer to be unsuitable may be used in embankment construction.

All areas of roadway excavation, during the entire period of construction operations, shall be thoroughly drained. The excavated surfaces shall be kept smooth and sloped to side ditches until the subgrade is finished. Side ditches emptying from excavation to embankment shall be kept clean at all times and constructed to protect excavation and embankment from erosion. Damage to the work attributable to wetting through failure of the Contractor to provide adequate drainage shall be immediately repaired by the Contractor at his expense.

Excavation slopes shall be constructed in accordance with the lines and grades shown on the plans and as staked by the Engineer. All loose or overhanging material along the slopes, considered to be hazardous, shall be removed as directed by the Engineer. The plans may designate certain materials, such as specific quantities and/or ledges of rock or quantities of existing surfacing or other materials to be excavated and stockpiled for a specific purpose of future use. Such materials shall be carefully excavated and handled to exclude contamination. The stockpiles shall be neatly and compactly constructed in an approved manner.

The Contractor shall take care not to break down, loosen or damage rock below the grade shown on the plans and specified. The Contractor shall be responsible for his methods and any damage his rock excavation methods and operations may cause. All blasting shall be performed in accordance with the requirements specified in these Technical Specifications.

2. Railway/ Roadway Excavation – Unsuitable Material

When unsuitable material, as identified and the limits defined by the Engineer, is encountered it shall be excavated to the lines, grades and depths directed by the Engineer and disposed of as specified in these Technical Specifications. The excavated areas below or outside planned grades shall be backfilled as specified in these Technical Specifications.

3. Railway/ Roadway Excavation – Channel and Ditch

Before beginning excavation, the Contractor shall establish the lines, grades and cross sections required to determine how much material will be excavated, present the information to the Engineer and receive approval from the Engineer to proceed.

The Contractor shall utilize equipment, tools and methods necessary to complete the work in accordance with the plans and specifications or as approved by the Engineer.

4. Designated Materials Selected from Railway/ Roadway Excavation

When the plans or specifications designate that materials from excavation are to be stockpiled for specific future use, such materials shall be handled in a manner that precludes contamination with undesirable material. The location of stockpiles shall be identified on the Plans.

When practical and processing is not specified, such designated materials shall be taken directly from excavation to the specified point of use.

5. Railway/ Roadway Excavation in Cut Sections

In all areas of roadway excavation in cut areas, rock and other materials in the planned sub grade layer (bottom twenty (20) centimetres of the completed excavation) that do not conform to the requirements specified in these Technical Specifications, shall be excavated to a depth of twenty (20) centimeters or as may be specified. The excavated materials shall be defined as Roadway Excavation and shall be incorporated into the Embankment or disposed off as specified.

Obtaining, handling, transporting and placing of these materials shall be considered subsidiary to roadway Excavation so that no measurement or payment will be made for them on a separate basis.

Permits and Licenses: The Contractor shall be responsible for obtaining all applicable blasting permits and licenses required by the Ministry of Interior/Public Security officials.

All products and materials used for rock excavation, either explosive or nonexplosive, are subject to approval by the Engineer. Only explosives, explosive components, and detonators commercially manufactured within the previous two (2) years or the shelf life of the product, whichever is less, shall be used.

At all times, the Contractor shall keep sufficient materials (rock bolts, shotcrete, etc.) at the rock excavated sites to cope with the instructions issued by the Engineer in relation with the type of protections designated for that particular site.

Work shall be performed in a manner to minimize hazards to construction personnel.

Safety in excavating shall be the responsibility of the Contractor.

6. Disposal of Surplus and Unsuitable Materials

Excavated materials which are designated by the Engineer to be surplus or unsuitable for use in the embankment and excavated materials wasted by the Contractor for his own convenience shall be disposed of at his own cost in borrow pits, trenches, natural depressions or at other locations approved by the Engineer. Materials disposed of at locations outside the right of way may be compacted to the degree desired by the Contractor or as required by the public agency or private individual who owns the property and shall not cause any damage to abutting property. Excess rock and other excavated materials may be placed in waste banks or spread and leveled to present a neat appearance only with the approval of the property owner and the Engineer and outside the view of the highway traveler. All disposal areas shall be finished with a neat appearance with lines, grades and contours that conform to and blend with adjacent terrain and all edges shall be trimmed to a slope no steeper than one vertical to four horizontal (1 V to 4 H).

2.4.3 Structural Excavations

The structural excavations are those relating to excavations for the installation of structural works which are below the ground level, limited by vertical walls reproducing the perimeter of the foundation of the structure. All excavations shall be done according to the plans of the study.

The Contractor shall minimize, to the extent possible, the length of time that excavated areas are open. He shall be solely responsible for damages due to weather, equipment, accidents, or other causes when excavation is left open.

In areas where the excavation is adjacent to public roads and walkways, the Contractor shall erect all barricades, barriers, enclosed walkways, and warning signs necessary to restrict the exposure of the public to the excavation. Special precautions shall be taken in areas where children may play. The adequacy of all such safety measures shall be subject to the approval of the Engineer.

The excavations needed for the foundation of the structures shall be carried out down to the level which will be established by the Engineer.

The foundation bottom will be perfectly horizontal or stepped with a slight upstream batter for those works which are located on inclined slopes.

The structural excavations however executed shall have vertical walls and the Contractor shall, where necessary, sustain them with adequate sheeting and bracing, included in the structural excavation price, with any damage to persons and things from slips and falls being at his charge and responsibility.

In the event of slips or falls, it shall be the responsibility of the Contractor to restore the excavation without any right to compensations.

It shall be the Contractor's care to carry out the shuttering of the foundation cribs with the utmost precision, using material of good quality and excellent conditions, of a section adequate to the stresses to which the shuttering will be subjected, and to adopt every precaution and measure in order that the shuttering of the foundation trenches is the strongest and, thus, the most resistant, both in the interest of the good workmanship and the safety of the workers.

The Contractor is thus solely responsible for the damages which might occur to the persons and works due to deficiency or irrationality of the shuttering; in no case explosives can be used.

Where the Contractor deems it proper, the excavations may however be executed with stepped walls.

In this case the extra excavation will not be paid over and above that which is strictly necessary for the foundation of the work and the Contractor shall provide at his own care and charge to backfill, with suitable material, the voids left around the foundation of the work.

Only structural excavations carried to more than 0.20 m (20 centimetres) depth below the constant level at which the waters filtering into the foundation trenches stabilise are considered to be underwater structural excavations.

The Contractor is responsible for dewatering during construction of the foundation so that this is carried out in dry conditions and that is also deemed to be included in his offer.

The Contractor isresponsible to avoid that the water coming from the outside ponds flows in the foundation trenches; should this occur, the cost of the necessary dewatering will be totally to his charge.

In constructing the bridges it is necessary that the Contractor provides, from the onset of the works, for a permanent pumping system which shall serve to keep the works free of water infiltrating from rivers or canals.

This pumping plant should be appropriately divided into groups to meet the requirements relative to the various depths of excavation, and shall be mounted on a suitable frame to permit movement of the groups, lowering of the suction piping and any other operation relative to the pumping service.

For each worksite the Contractor shall provide, at his own expense, for the necessary connection of the plant as well as for the supply and transport to the site of the necessary electric energy, provided that the Contractor does not have the possibility and convenience to use a different type of electric energy. The plant shall be provided, under the current provisions of law concerning accident prevention, with the necessary safety devices, relieving and indemnifying free the Employer and his personnel of any responsibility regarding consequences derived from the conditions of the plant.

No concrete shall be placed prior to the approval by the Engineer of the excavation pit. Excavation shall be carried to a depth so that the bottom of excavation is approximately one hundred (100) millimeters above the formation level of foundation (level of bottom of Blinding Concrete). No further excavation shall be carried out until the Engineer has examined the excavation and certified that at the level of excavation, the design bearing pressure stated in the drawings can safely be attained. After permission to proceed with the excavation is given, the Contractor shall excavate to the formation level and place the blinding concrete immediately.

Excavations shall be carried out in compliance with the detailed design,as approved by the Engineer.

2.4.4 Structural Excavations for Culverts and Miscellaneous Structures

Excavation for culverts and miscellaneous structures shall be performed to the limits required for construction and to the depth required for bedding material or removal of unsuitable material.

When unsuitable material is encountered below foundation elevation for reinforced concrete box structures or pipe culverts, the Contractor, at the direction of the Engineer, shall excavate such unsuitable material and replace with suitable and stable backfill material. The foundation stabilization, including the degree of instability of the existing material, necessary depth of excavation, and suitability of the proposed backfill material, shall be approved by the Engineer prior to beginning the excavation.

The foundation material supporting the bedding or structure shall be Class A 1-a, A 1-b, or A 2-4 material compacted to Type 95 compaction. If the natural material does not meet the classification requirements, it shall be subexcavated a depth of at least thirty (30) centimetres and be replaced with material meeting the requirements as shown in the drawings or as directed by the Engineer. Any rock or hardened material within fifteen (15) centimetres of the bottom of the structure shall be similarly subexcavated and replaced with material meeting the classification requirements.

2.4.5 Excavation of Topsoil

1. Description

It involves excavation of the topsoil at a wide cut of the route and its transportation and dumping to an appropriately approved by the local Authorities permanent or temporary depot. The works must be done in accordance with the project, i.e., the requirements of the Supervising Engineer.

This item refers to both road and railway constructions.

2. Execution Method

The topsoil is excavated exclusively by mechanical means. Manual excavation is performed only in cases where mechanical equipment cannot operate. Bushes must be removed along with topsoil but must be separated from the topsoil prior to its usage for top soiling of the slopes of the new railway and roads.

The backfilling of the excess topsoil into the depot must be performed in such a way that prevents its mixing with non-topsoil material. In case of topsoil surplus, it is necessary to previously plan the site and the shape of the depot for its disposal.

During the topsoil excavation, water shouldn't be allowed to remain in the excavated surface in order to prevent excessive softening of the road foundation soil by soaking. Therefore, during excavation, care should be taken to provide permanent transverse and longitudinal surface drainage. Runoff water should be discharged away from the site by means of surface drainage system (i.e. drainage open channel etc.).

The areas foreseen for construction of embankments following the excavation of the topsoil according to the criteria for preparation of the subsoil should immediately be prepared and compacted and the same should be done for the first course of the embankment in compliance with the criteria for embankment construction.

The thickness of the topsoil layer that should be removed is determined by systematic observation in the course of the works. The actual thickness of the topsoil layer per section of the project is to be decided during the construction between the Contractor, the Supervising Engineer and the representative of the Project Owner.

The identification of the topsoil layer is performed on the basis of its condition, color, organic content susceptible to decay, as well as the quantity of total organic matter. If the top soil layer and the soil suitable for the incorporation of the road foundation are not possible to be visually determined, the thickness of the top soil layer is determined on the basis of laboratory testing of samples.

2.4.6 Foundation Pits

When no piles are used and structures are to rest on an excavated surface other than rock, the following shall apply:

The Contractor may excavate in open pits when:

i. Worker safety is assured.
ii. Footings can be placed in dry material away from flowing water.
iii. The integrity of the structure and its surroundings, including existing pavement is not reduced.

Care shall be taken during excavation to prevent disturbing the foundation. If ground water is encountered during excavation and a concrete seal course is not to be used, dewatering shall be commenced and shall proceed in advance of or concurrently with further excavation. The foundation shall be free of water at the time footing concrete is placed, and water control shall continue as necessary to prevent damage to the work.

If suitable foundation material has been disturbed by Contractors improper operations, the foundation shall be restored by the Contractor at his expense, to a condition at least equal to the undisturbed foundation as determined by the Engineer.

When undisturbed original material at the planned grade of the excavation does not meet the foundation material requirements as mentioned in these Technical Specifications, the Engineer shall order that the unsuitable material be removed and replaced with suitable material.

When footings or masonry are to rest upon rock, the rock shall be fully uncovered, and the surface thereof shall be removed to a proper depth to expose sound rock. The rock shall be levelled to cut to steps and roughened. Seams shall be grouted under pressure or treated as the Engineer may direct.

Where rock, in either ledge or boulder formation, or other unyielding material is encountered in one (1) portion of foundation for a concrete box culvert and a yielding material is encountered in an adjacent area of the foundation excavation for the same box culvert, such unyielding material shall be removed for a minimum depth of sixty (60) centimeters and backfilled with structure backfill.

2.4.7 Scheduling Excavation for Structures

The Contractor shall schedule the work that no excavation will be left in an exposed condition for a period greater than thirty (30) days unless otherwise approved by the Engineer. If the Contractor fails to meet this requirement, the Engineer will order the Contractor to suspend further structural excavation until the Contractors progress enables him to meet the requirement.

In areas where the excavation is adjacent to public roads and walkways, no excavation shall be scheduled to be left in an exposed condition more than fourteen (14) days unless otherwise approved by the Engineer.

2.4.8 Foundation Material

When the foundation material under Structures other than Bridges, Viaducts or Overpasses is of an unstable nature, the Engineer may direct in writing that the foundation be improved by excavating below the required elevation, and backfilling with gravel or crushed stone, slurry cement, combinations of stone and slurry cement or other suitable material approved by the Engineer.

Material excavated from the roadway, borrows pits, structure foundation or produced by processing shall be used in preparing the foundation for structures when it conforms to the following requirements:

i. Material classified by AASHTO M145 as A 1-a, A 1-b or A 2-4 and no rock fragment larger than eight (8) centimeters.

ii. Aggregate subbase or base materials conforming to the requirements in these Technical Specifications.

iii. Slurry Cement. When shown on the plans, specified in the Special Specifications or requested by the Contractor and approved by the Engineer, slurry cement may be used in preparing the foundation for structures when it conforms to the following requirements:

a) Aggregate.

Sieve Size	Percentage Passing
62.5 mm (1½ inch)	100
50 mm (1 inch)	80-100
19 mm (% inch)	60-100
9.5 mm (3/a inch)	50-100
4.75 mm (No. 4)	35-70
0.150 mm (No. 100)	5-20

b) Cement.

Cement shall be Portland cement.

c) Water.

Water shall be free from oils, salts or other impurities which would have an adverse effect on the quality of the slurry cement material.

d) Proportions.

Proportioning may be done by weight or volume. The cement content shall not be less than one hundred ten (110) kilograms per cubic meter. The water content shall be sufficient to produce a fluid, workable mix that will flow and can be pumped without segregation of the aggregate while being placed. Materials for slurry cement shall be thoroughly machine mixed until cement and water are dispersed throughout the material. Slurry cement shall be placed within forty-five (45) minutes after mixing.

e) Portland Cement Concrete, all classes, specified in these Technical Specifications.

2.4.9 Backfilling Structures

Completed structures shall be backfilled with material free from spongy or vegetable substances and rock or broken concrete over eight (8) centimeters in the greatest dimension. When pervious backfill is shown on the plans or specified, backfill material shall conform to the requirements in this section. Slurry cement backfill may be placed to backfill structures when shown on the drawings or requested by the Contractor and approved by the Engineer. No additional compensation shall be allowed when slurry cement backfill is requested by the Contractor and placed in lieu of other acceptable backfill material.

The type of material used in bedding, filling and backfilling shall conform with the details shown on the drawings or as contained in these specifications. All earth material which has loosened or collapsed into the excavation from adjacent ground, all trash, forms, and loose rocks larger than twenty (20) centimeters in greatest dimension shall be removed from the excavation before backfill begins.

Backfill material shall be placed in uniform layers and brought up simultaneously on all sides of the structure or facility. The thickness of each layer shall not exceed thirty (30) centimeters before compaction except that when compaction is done by ponding and jetting said thickness shall not exceed one (1) meter. Backfilling shall extend to the original ground or to the top elevation of any embankment, in-place or to be placed.

Backfill material may be compacted by mechanical or pneumatic tamping devices or backfill material may be placed as a slurry. Compaction equipment or methods which will displace or cause damage to the structure shall not be used.

Structure backfill shall not be placed until the structure footings or other portion of the structure or facility have been inspected by the Engineer and approved for backfilling. No backfill material shall be deposited against the back of concrete abutments, concrete retaining walls of the outside walls of cast-in-place concrete structures until the concrete has attained a strength of not less than one hundred eighty (180) kilograms per square centimeter in compression, or until the concrete has been in place twenty eight (28) days, whichever occurs first.

Backfill at the inside of bridge wingwalls and abutments shall be placed before the construction of curbs or sidewalks.

Pervious backfill material shall be placed in layers along with and by the same methods specified for structure backfill. Pervious material at one (1) location shall be approximately the same grading.

Slurry cement backfill shall be placed in uniform horizontal layers not exceeding one (1) meter in depth. Unless otherwise approved by the Engineer, the slurry shall be compacted with internal vibrators. Backfilling over or placing any material over slurry cement shall not commence until four (4) hours after the slurry cement backfill has been placed.

The cells formed by crib members of crib walls and the space between the crib wall and the limits designated for foundation excavation, as shown on the plans or specified in the special specifications, including any material being removed outside said limits, shall be backfilled with material conforming to the following gradations, quality and placement requirements:

i. Backfill placed for crib walls shall be of such character that it will not sift or flow through openings in the wall.
ii. Material classified by AASHTO M145 as A 1-a, A 1-b and A 2-4 and no rock fragment larger than eight (8) centimeters.
iii. Subbase or Base materials conforming to the requirements in these Technical Specifications.
iv. Backfilling shall progress simultaneously with the erection of the crib wall.
v. Backfill shall be so placed as to not disturb or damage the crib members, shall be placed in uniform layers before compaction not exceeding thirty (30) centimeters thickness and shall be compacted by hand tamping, mechanical compaction or other means approved by the Engineer.

Backfilling under sidewalks

The above-mentioned specifications shall apply also in case of backfilling under sidewalks.

2.4.10 Compaction of Structural Backfill

Compaction of structural backfill by ponding and jetting will be permitted when, as determined by the Engineer, the backfill material is of such character that it will be self- draining when compacted and that foundation materials will not soften or be otherwise damaged by the applied water and no damage from hydrostatic pressure will result to the structure. Ponding and jetting of the upper one and one-half meters below finished grade will not be permitted. The work shall be performed without damage to the structure and embankment, and in such manner that water will not be impounded. Ponding and jetting methods shall be supplemented by the use of vibratory or another compaction equipment when necessary to obtain the required compaction.

Structural backfill shall be compacted to a dry density not less than ninety-five percent (95%) of the maximum density. When materials such as concrete coarse aggregate are used, it shall be consolidated with two (2) passes of mechanical vibratory or plate compaction equipment.

At locations where at least one and one-half (1½) meters of material resistant to erosion caused by wind or water is placed to cover pervious material, the cover material shall be compacted to a dry density not less than ninety-five percent (95%) of the maximum density.

2.4.11 Quality Assurance Procedures

The Contractor shall sample and test foundation treatment material, structure backfill materials, pervious backfill, concrete seal course and all other materials covered by the specifications as necessary to confirm the quality of materials entering the work. Density tests, when specified, will be performed at the rate of one (1) per compacted lift. The Contractor shall furnish the test results to the Engineer within twenty-four (24) hours after completion of the test.

The Engineer reserves the right to request, at any time, duplicate samples be obtained by the Contractor for check testing performed by the Engineer. The Engineer reserves the right to enter the work at any time and sample materials entering the work and perform density tests.

When a discrepancy occurs between test results provided by the Contractor and those completed by the Engineer, work on the structure backfill shall cease until the discrepancy has been clarified.

2.4.12 Wedge Construction next to Structures

This work covers backfilling, spreading and compaction of loose material next to structures, i.e. construction of the so-called wedges. The wedges will be constructed in accordance with plans contained in the design and with these Technical Specifications.

The work must be carried out in accordance with the design, regulations, Quality Control (QC) and Quality Assurance (QA), instructions given by the Engineer and these Technical Specifications.

According to its quality, the material must correspond to materials used for base courses of pavement structures, i.e. it must be a granular stone material without binder.

The size of wedges depends on the height of the adjacent structure and the length of the approach to the structure. The front of clay fill is realized from both sides at an inclination of 1:3 towards the structure, so that the slope at the front of embankment starts from the abutment of the facility.

If the embankment next to the structure is made of stone material, the slope at the front of embankment can be realized at an inclination of up to 1:1.

If an embankment of more than 2 m is to be built above the structure, the wedge adjacent to the structure should be realized only up to 0.5 m above the structure. In such a case, the wedge may be realized using stone material ranging from 0 to 15 cm in size.

Wedges adjacent to structures are built in layers 50 cm in thickness. The compaction of material is performed using appropriate vibrating equipment, including sprinkling as appropriate. The compaction method should be such that no damage is caused to the structure and its waterproofing.

The quality control is performed by the Contractor who will in this respect test compaction level for each layer of the wedge. The deformation modulus (Ms) according to the 30 cm bearing plate method will be tested. If the counterweight cannot be used due to space restrictions, the compaction level will be tested by determining the compaction level (Sz) according to the Standard Proctor procedure. Depending on the size of wedge, at least two tests will be performed for every layer. The following criteria will be used for estimating quality of placed material:

- at the depth of more than 4.0 m below the pavement structure

Msmin. = 60 MN/m^2 or Sz min. = 97%,

- at the depth from 0.5 to 4.0 m below the pavement structure

Msmin. = 70 MN/m^2 or Sz min. = 100%,

- at the depth of up to 0.5 m below the pavement structure

Msmin. = 80 MN/m^2 or Sz min. = 100%.

If the requirement for the compaction of mechanically compacted base courses contained in road pavement structures is less than Msmin = 80 MN/m2, then they should be compacted in the gravel wedge zone to the compressibility modulus of Ms,min = 80 MN/m2 or to the compaction level of Sz,min = 100%.

2.4.13 Trench excavation and backfill

1. Description

This work shall consist of excavation of trenches for the construction of pipe for drainage, water and sanitary sewer services or other facilities shown on the plans as pipe, the construction or installation of all facilities necessary to accomplish the work, all bailing, drainage, pumping necessary to keep the trench free of standing or flowing water, sheeting, furnishing and placing bedding material, and backfilling pipe and trench, all as shown on the plans and the special specifications or as directed by the Engineer.

The Contractor shall visit the site and evaluate the geological make-up of the area for himself and base his bid prices solely on his own determination of geological conditions.

Variations in the actual volume or character of structural excavation quantities shall not be a basis for a claim for additional money or revision of bid price by the Contractor. No allowance will be made for the classification of materials regardless of their physical properties.

2. General

Pipe for drainage, water and sewer services, or other facilities shown on the plans as pipe, shall be installed in trenches excavated into previously constructed embankment or original ground.

specified in these Technical Specifications, to a minimum height sixty (60) centimeters above the outside diameter of the pipe or subgrade surface elevation which is lowest, and for a distance each side of the pipe location equal to at least ten (10) times the outside diameter of the pipe.

The trench within which the pipe is to be placed shall be excavated to the widths shown on the plans. When widths are not shown on the plans the trench shall be excavated such that the clearance from each side of the pipe will be as follows:

a. Pipe up to eighteen (18) centimeters outside diameter - fifteen (15) centimeters.
b. Pipe and pipe arches from eighteen (18) centimeters to not more than one and one-half (1.5) meters in outside diameter - thirty (30) centimeters.
c. Pipe and pipe arches greater than one and one-half (1.5) meters outside diameter - sixty (60) centimeters.

Trenches greater than one and one-half (1%) meters in depth shall be excavated with sloping sides or shored and braced at the option of the Contractor. The Contractor shall submit to the Engineer, not less than seven (7) days prior to beginning trench excavation greater than one and one-half (1½) meters in depth, detailed plans showing the design of side slopes, shoring or bracing proposed for use. The Contractor shall not begin trench excavation which is greater than one and one-half (1½) meters in depth until the Engineer has approved the plans. The Contractor shall remain responsible for satisfactory results.

Safe and suitable ladders which project at least sixty (60) centimeters above the top of the trench shall be provided for all trenches greater than one and one-half (1.5) meters in depth. One (1) ladder shall be installed in the trench for each thirty (30) meters of open trench, or fraction thereof, and so located in the trench that workmen need not move more than fifteen (15) meters to a ladder.

The bottom of the trench shall be graded according to the lines, slopes and elevations shown on the plans or directed by the Engineer, and bedding material placed and compacted. If the Engineer determines that the material in the bottom of the trench is satisfactory for pipe bedding, placement of pipe bedding material will not be required providing the existing material is loosened, regraded and compacted to form a dense unyielding foundation.

3. Scheduling

The Contractor shall schedule roadway excavation, embankment construction and installation of pipe for drainage so that they complement each other.

Embankment construction which interferes with, reduces or prevents the flow of normal or necessary drainage shall not be allowed.

Trench excavation for culvert construction shall not be left in an exposed condition for more than thirty (30) days unless approved by-the Engineer.

Trench excavation for construction of water and sewer services, sub drainage systems other than culverts, electrical conduits and other ducts shall not be more than two hundred (200) meters ahead of the pipe laying operations and shall be backfilled or covered at the end of each day. Where cast-in-place pipe construction is specified or elected by the Contractor and approved by the Engineer, the allowable minimum length of open trench at any one (1) location shall be that which is necessary to permit uninterrupted progress, but in no event, greater than five hundred (500) meters.

4. Trench excavation

The Contractor shall establish line and grade as shown on the plans and profile the original ground or embankment as directed by the Engineer.

The Contractor shall perform all excavation of every description and of whatever materials encountered to the depth indicated on the plans or specified or ordered by the Engineer. Material excavated from trenches shall be piled on one (1) side of and adjacent to the trench and maintained so that the toe of slope of the piled material is at least sixty (60) centimeters from the edge of the trench. When material excavated from a trench is piled in or adjacent to a travelled way, it shall be located to cause a minimum of inconvenience to vehicle travel. The Contractor shall minimize the length of time that trenches are open.

The Contractor shall exercise sound engineering and construction practices in excavating the trench and maintaining it so that no damage will occur to any foundation, structure, pole line, pipeline, traffic sign or signal structure, electric cable or conduit, or other facility. No act, representation or instruction from the Engineer or his representatives shall relieve the Contractor from liability for damages or costs that result from trench excavation.

Care shall be taken not to excavate below the depth specified or ordered by the Engineer, and excavation below that depth shall be backfilled with sand bedding material at the Contractors expense.

When water is encountered during trench excavations, the Contractor shall remove the water by bailing, pumping or other means necessary to permit installation of the pipe facility in a trench without ponding or flowing water. The cost of dewatering shall be considered as subsidiary to the pipe being installed.

5. Unsuitable Foundation Material

If in the opinion of the Engineer, it is necessary to adjust, correct, relocate, or in any way change the trench line and grade shown on the plans; such changes shall be made by the Contractor under the terms of these specifications.

6. Precast Concrete Pipe Culverts

Culvert pipe shall be installed in trenches excavated in a new or existing embankment in accordance with the lines and grades shown on the plans or as directed by the Engineer as specified in "Pipe Culverts," in these Technical Specifications.

Bedding for Precast concrete pipe shall be as shown on the plans or specified in these Technical Specifications. The bedding material shall be placed in more than one (1) layer.

The first layer shall be at least ten (10) centimeters thick as bedding under the pipe in the bottom of the excavation. Subsequent trench backfills layers, not more than twenty (20) centimeters thick, shall be placed around the pipe and compacted.

When belled pipe are to be installed, the bedding shall be shaped to receive the bell. All adjustments to line and grade shall be made by removing or filling with bedding material and not by wedging or blocking.

Trench backfill material shall be deposited on compacted bedding material in layers not exceeding twenty (20) centimeters loose thickness. Backfill material may be placed around and over the pipe while joint mortar is still plastic. Should the joint mortar become set before backfill material is placed around and over the pipe, placement of bedding material shall not be commenced within sixteen (16) hours of jointing the pipe. Placement and compaction of successive layers shall continue to the top of the embankment or sixty (60) centimeters above the top of the pipe, whichever is greater.

All layers of bedding material and trench backfill material shall be compacted to a dry density not less than ninety percent (90%) of the minimum dry density.

When soil cement bedding material is placed, the bedding material placed below the spring line of the pipe. The soil cement shall be compacted with internal vibrators to form a dense mass.

A dike of impervious material at least one and one-half (1½) meters in length shall be placed and compacted near the intake and outlet ends of the culvert to prevent piping.

7. Cast in Place Concrete Pipe

Cast in place concrete pipe shall be cast monolithically in a prepared trench at the locations and in accordance with the lines and grades shown on the plans.

The trench shall be excavated and shaped according to the details shown on the plans and prepared to provide full, firm and uniform support over the bottom two hundred ten (210) degrees of the pipe to be constructed.

The trench walls, from a point thirty (30) centimeters above the top of the pipe, may be sloped as required by soil conditions to provide more stability in the trench and safer working conditions.

Backfilling cast in place concrete pipe shall not begin until the concrete has developed a compressive strength of at least one hundred fifty (150) kilograms per square centimeter (kg/cm2).

The type of trench backfill material shall conform to the requirements of "Structural Backfill Materials" in these Technical Specifications.

8. Sand Bedding

Sand shall be free from clay or organic material, suitable for the purpose intended, and shall be of such size that ninety (90) to one hundred percent (100%) passes a 4.75 mm (No. 4) sieve and not more than five percent (5%) passes a 0.075 mm (No. 200) sieve.

9. Trench backfill materials

Materials excavated from the roadway, borrow pits, foundations, trenches or produced by processing shall be used for pipe bedding and trench backfilling when it conforms to the following requirements:

i. Material classified by AASHTO M145 as A 1-a, A 1-b and A 2-4 and no rock fragment larger than six (6) centimetres.
ii. Base material conforming to the requirements of "Aggregate Bases," in these Technical Specifications.
iii. Pervious Backfill conforming to the requirements of "Structural Backfill Material," in

these Technical Specifications.

iv. Other materials used in embankments construction or structure backfill as approved by the Engineer with no rock fragment larger than six (6) centimetres.

10. Quality assurance procedures

The Contractor shall sample trench bedding and backfill materials and other items entering the work as specified or required to assure that the items conform to special requirements. Density tests, where specified, shall be performed at the rate of one (1) per compacted lift. The results of sampling and testing shall be furnished to the Engineer within twenty-four (24) hours after completion of the testing.

The Engineer reserves the right to request, at any time, that the Contractor obtain duplicate samples of materials for check testing performed by the Engineer.

The Engineer reserves the right to enter the work at any time and obtain samples and perform density tests.

When a discrepancy occurs between the test results furnished by the Contractor and results from tests completed by the Engineer, the work shall cease until the discrepancy is clarified.

2.4.14 Embankment Foundation Area

Embankment foundation area shall include the full width of the area to be filled and the profile may be continuous or stepped according to the slope of the ground and the instructions that will be given by the Engineer.

Normally said profile will be established at 20 cm below ground level and will be obtained by executing the necessary scarification bearing in mind the previously ascertained nature and consistence of the soils of the sites, also with the aid of bearing capacity tests.

Where that said depth soils of groups A1, A2, A3 are encountered, preparation of the foundation will consist in the compaction of the layer below the foundation level for a thickness of not less than 30 cm, in order to attain a minimum dry density of 90% of the modified AASTHO minimum dry density determined in the laboratory, modifying the moisture content of the soils until the optimum moisture content is reached before performing the compaction.

Where instead the soils encountered at 20 cm below ground level pertain to groups A4, A5, A6 and A7 the Engineer may order the deepening of the excavations to substitute these materials with material pertaining to groups A1, A2 or A3. Said material shall be compacted, at optimum moisture content, until a minimum dry density of 90% of the modified AASHTO minimum dry density is obtained.

The original ground surface is then re-established with suitable material approved by the Engineer, duly compacted to 90% of modified AASHTO HDD.

The vegetable soil resulting from the scarification can be used for grassing the slopes if so, instructed by the Engineer.

For no reason said material can be placed to form embankments.

Concerning the compaction equipment and its use reference is made to the specifications in relation to the compaction of embankments.

On local soils particularly sensitive to the action of waters, it will be necessary to take into account the groundwater level and, for very superficial groundwater levels, arrange for appropriate drainage.

For peaty soils or whenever the Engineer deems the previous works unable to form a suitable foundation for the embankments, the Engineer will order all those interventions that in his opinion will be considered suitable for the purpose, and these will be carried out by the Contractor and paid on the basis of the relevant prices.

It is pointed out that the above applies to the preparation of the foundation of the embankments on natural soils.

Where new embankments are to be placed over old embankments for enlargement of the latter, preparation of the foundation level along the existing slopes will be provided through their benching in steps of not more than 50 cm in height, after top soil; this can be used for grassing the slopes as directed by the Engineer, having the excess material to spoil at the care and charge of the Contractor.

The excess material from the excavation of the steps beneath the turf will also be set aside, if suitable, or run to spoil, if unusable. The steps will then be formed with said excavated and set-aside material, if suitable, or with suitable material with the same characteristics required for the materials of the embankments, with the same methods of placing, including compaction.

However, the Engineer reserves the right to control the global behavior of the foundation area of the embankments by measuring the modulus Md determined with a 30 m dia. plate according to CNR 46-1992.

The value of measuring in-situ deformation modulus by plate loading tests (Md), measured at moisture conditions after compaction, at the first load cycle and in the load interval comprised between 0.05 and 0.15 N/mm2, shall be not less than 15 N/mm2.

2.4.15 Earth Cut

In the stretches in cut, after effecting the excavation of the roadbed, the subgrade of the road pavement shall be prepared; this shall be carried out, according to the nature of the soil, on the basis of the following works:

i. where the soil pertains to groups A1, A2, A3 the subgrade – sub-base layer shall be compacted to a minimum dry density of 95% of that specified, for a thickness of 20 cm minimum below pavement bottom, having CBR > 30 and minimum diameter of 100 mm.
ii. where the soil pertains to groups A4, A5, A6, A7 the Engineer may order the substitution of this soil with suitable material for a depth to be established by the Engineer.

Even in this case a minimum dry density of 95% of that specified for a thickness of at least 30 cm below the pavement layers shall be attained on the subgrade.

The global behavior of the subgrade in cut will be controlled by the Engineer by measuring in-situ deformation modulus by plate loading tests (Md) (CNR 46-1992). The value of measuring of Md, measured at moisture conditions after compaction, shall be not less than 80 N/mm2 (at the first load cycle and in the load interval comprised between 0.15 and 0.25 N/mm2).

2.4.16 Formation of Embankments

The embankments will be executed with the exact forms and dimensions shown in drawings but shall not exceed the height of the formation level.

The materials to be used to form the embankments shall be material obtained from common excavations, structural excavations or tunnel excavations pertaining to groups A1, A2, A3. Care has to be taken that the last layer of the embankment below the pavement “the sub-base or capping layer”, for a compacted thickness of not less than 0,3 m, shall be composed of soils of groups A1, A2-4, A2-5, A3 if obtainable from the excavations; otherwise the Engineer will decide whether to require the execution of this last layer with material of other groups obtained from road excavations or with materials of said groups A1, A2-4, A2-5, A3 coming from borrow pits. Concerning the group A4 materials obtained from the excavations, the Engineer may require their eventual correction before use.

For the excavated materials obtained from rock cuts for use in the embankment, if they are of a type deemed suitable by the Engineer, they shall be reduced to elements of 20 cm imum size. These rocky elements shall be evenly distributed across the embankment and cannot be used to form the top 30 cm of embankment below the road pavement (sub-base).

Concerning the material obtained from common excavations and structural excavations pertaining to groups A4, A5, A6 and A7, the possibility will from time to time be examined of running it to spoil or using it after appropriate correction.

Embankments with corrected materials can be executed upon order of the Engineer only in well-defined embankment sections, in order to control their behavior.

The excavated materials obtained from road cuts or from any other work which are in excess or unsuitable to form embankments or backfill, shall be run to spoil away from the road, at a due distance from the edges, and appropriately arranged; all expenses, including any charge for material transportation, occupation of the disposal areas and the issue of the necessary authorizations from the competent environmental protection authorities shall be at the expense of the Contractor.

Until the availability of suitable materials obtained from common excavations, structural excavations or tunnel excavations has not been exhausted, the eventual borrow pits that the Contractor would wish to open for example, to economize on transport or reworking, will be at his full charge. Therefore, the Contractor cannot claim any over prices or prices different from those tendered for the formation of embankments with materials obtained from road and structural excavations, where, these excavated materials are available and suitable.

If once the suitable excavated materials as above are exhausted, and additional quantities of material should be needed to form the embankments, the Contractor can obtain materials from borrow pits, provided that he has requested and obtained the authorization by the Engineer.

The Contractor is to indicate the borrow pits from which he intends to draw the materials for the embankments to the Engineer who reserves the right to have said materials analyzed by an approved laboratory but always at the expense of the Contractor.

Only after the approval by the Engineer to use the borrow pit, will the Contractor be authorized to utilize the borrow pit to form the embankment.

The fact that the Engineer has accepted the borrow pit does not exonerate the Contractor from testing at all times the materials which shall always correspond to those prescribed and therefore, should the borrow pit subsequently prove unable to produce suitable material for a given work, it can no longer be exploited.

Regarding the borrow pits, the Contractor, after obtaining the authorization from the competent environmental protection authorities, is to pay the relevant fees to the owners of such borrow pits and to arrange at his own expense for the secure and rapid dispersal of the waters that might accumulate in the borrow pits, avoiding harmful stagnation and damages to the surrounding properties and arranging adequately the relevant banks, according to the prescriptions of the sanitary laws and the laws on recovery of swampy lands.

Haul to any distance shall be deemed to be included in the rates of the embankment materials and no haul or overhaul will be paid, regardless of the source of materials location. Therefore, Contractor cannot claim any overprice or different price for haul or overhaul from those considered by himself in the tender for the supply of the embankment’s material price.

The material to form the embankment shall be placed in layers of uniform thickness, not exceeding 40 cm (loose).

The embankment shall have throughout all its height the required density referred to the modified AASHTO minimum dry density not lower than 90% in the lower compacted layers and 95% in the top layer (sub-grade).

Moreover, regarding the last layer of the embankment (capping layer), which will constitute the sub-base of the pavement, the in-situ deformation modulus by plate loading tests (Md) measured at the same moisture conditions of compaction, shall be not less than 80 N/mm2 (at the first load cycle and in the load interval comprised between 0.15 and 0.25 N/mm2), and it will have the characteristic and other bearing capacity according the requirements.

Each layer shall be compacted to the above-specified density, providing for prior drying of the material if too wet or watering if too dry so as to attain a moisture not different from the optimum moisture ± 2 points pre-determined in the laboratory, and always lower than the shrinkage limit for plastic soils.

The Contractor cannot continue laying the subsequent layers without the prior approval of the Engineer.

The upper surface of each layer shall conform to the camber of the finished work so as to avoid water stagnation and damages.

The construction of the embankment cannot be interrupted for any reason unless it has been given a suitable cross slope and unless the last layer has reached the prescribed density.

The Contractor shall be at liberty to choose its own compaction equipment which, however, shall be able to exert on the material, according to the type, such a compaction energy as to ensure attainment of the densities prescribed and envisaged for each category of work.

Although the choice of the compaction equipment is free, for embankment soils of groups A1, A2, A3 a dynamic-sinusoidal roller is recommended and for soils pertaining to groups A4, A5, A6, A7 compaction should be by sheep-foot tamping rollers and pneumatic tired rammers.

In the case of rock, fill, a heavy dynamic-sinusoidal type roller in recommended, and the compaction shall continue until no observable movement under the roller is observed in whichever point of the section under compaction.

Very close to the structures, which normally shall be constructed before forming the embankments, the embankment material shall be of type A1, A2, A3 and compacted with dynamic energy impact.

However, the Engineer reserves the right to order the cement stabilization of the embankments near the structures by mixing in place the cement in the proportion of 25-50 kg per m3 of compacted material. Said stabilization shall, if ordered, affect a volume of embankment whose section, according to the road centerline, can take the form of a reverse trapeze with a minor base of 2 m, a major base of 3 H, H being the height of the structure.

The material for the embankments can be placed during the periods when the weather conditions in the opinion of the Engineer are such as to not jeopardize the good quality of workmanship.

The inclination to be given to the side slopes will be that as per the cross sections shown in the project.

As the forming of the embankments proceeds, the relevant side slopes shall be covered with vegetable soils rich in humus of a thickness not greater than 30 cm obtained either from scarification of the foundation areas of the embankments or from borrow pits, and the covering shall be laid in an horizontal pattern and be compacted with suitable equipment so as to provide a regular surface.

Moreover, the side slopes shall be perfectly shaped and regularized, also with perfect profiling of the edges.

Should settlements occur in the embankments due to neglect of the rules of good execution, the Contractor will be obliged to carry out, at his own expense, the works of reinstatement, renewing where necessary also the road pavement.

The minimum tolerance for sub-grade is ± 2 cm on the cross section measured by automatic level (5 points per section of each carriageway) and by straight edge. Higher tolerance (3 cm) could be accepted by the Engineer with 10% price reduction.

2.4.17 Railway embankment

1. Classification of Materials

The improvement soil layer must be constructed with materials classified as:

- QS2 (soil with percentage of fines 5% to15%, or medium weathered rock) or QS3 (well graded soil material with percentage of fines less than 5% or unweathered rock) according to the Specifications of UIC/719R/'94 or E_2, E_3 or E_4 or as
- A-1, A-2-4 or A-2-5 according to AASHTO (Table 2.4.17.2), depending on the availability. In case of availability of materials meeting both Specifications Standards, the material with better quality characteristics should be used. In that case, the AASHTO Specifications should be employed for comparison purposes.

Table 2.4.17.1: Suitability of Soil Materials

Category	Characteristics of soil materials	Atterberg Limits	. Density during modified compaction test (kg/m^3)	CBR*	Content in organics ***	Remarks concerning their suitability for the construction of embankments
E1	maximum grain diameter D<200mm and maximum percentage in grains with diameter 200>D<150mm, 25%	LL < 40 or LL < 65 and PI > (0.6 LL - 9)	> 1600	> 3 and swelling ** < 3 %	< 2 %	Acceptable
E2	maximum grain diameter D<100mm. Percentage passing No200 sieve <35%	LL < 40	> 1940		< 1 %	Suitable
E3	maximum grain diameter D<80mm. Percentage passing No200 sieve <25%	LL < 30 PI < 10	-		0 %	Selected I
E4	maximum grain diameter D<80mm. Percentage passing No200 sieve <25%	LL < 30 PI < 10	-		0 %	Selected II
E0	Soil Material which cannot be classified to any other category					

LL Liquid Limit E 105 - 86 Method 5
PI Plasticity Index E105 - 86 Method 6
No 200 AASHTO U.S Standard Sieve Type: M-92 corresponding open dimension 0.074 mm.
* CBR California Bearing Ratio which can be determined according to the 12th method of the Soil Mechanics Laboratory Tests Specifications (E105 - 86). The samples, which have been saturated in water for 4 days, are compacted at the 90% of the minimum density of the Modified Compaction Test (Method 11, E105-86) and they have the optimum moisture. Excluding the "cemented" materials and projects in cuts, the pavement's bearing capacity CBR of the "underlain layer" should be additionally "in situ" determined.
** During CBR test
*** It is going to be determined using the "Liquid oxidation" method (AASHTO T194)

Table 2.4.17.2: Suitability of Soil Materials (AASHTO Classification)

General Classification	Granular materials (35% or less of total passing sieve No 200)							Silt – clayey materials (more than 35% passing sieve No 200)				
Group Classification	A-1		A-3	A-2				A-4	A-5	A-6	A-7	
	A-1-a	A-1-b		A-2-4	A-2-5	A-2-6	A-2-7				A-7-5	A-7-6
Sieve Analysis percentage passing % No 10 No 40 No 200	50 . 30 . 15 .	50 . 25 .	51 min. 10 .	35 .	35 .	35 .	35 .	36 min.	36 min.	36 min.	36 min.	
Material Properties Passing Sieve No 40 Liquid Limit WL (%) Plasticity Index Ip (%)	- 6 .		- N.P.	40 . 10 .	41 min. 10 .	40 . 11 min.	41 min. 11 min.	40 . 10 .	40 . 10 .	40 . 11 min.	41 min. 11 min.	
Group Index	0		0	0	4 .	4 .	4 .	8 .	12 .	16 .	20 .	
Description of Material Type based on Main Characteristics	Stone fragments fine gravels, sand		Fine sand	Silty or clayey gravel and sand				Silty soil		Clayey soil		
General Subgrade Rating	Excellent to good							Fair to poor				

A correlation between the five material categories (QS1 to QS3) of the UIC-719R-1994 Specification and the AASHTO Classes (A1 to A7) is given in the below table:

Table 2.4.17.3: Correlation between UIC-719R and AASHTO classifications

UIC-719R-1994 SOIL CATEGORY	AASHTO GROUP CLASSIFICATION
QS1 (BAD) PERCENTAGE OF FINES (PASSING NO200 SIEVE)>40%	**A4** (PASSING NO200 SIEVE)>36%, LL<40%, PI<10) **A5** (PASSING NO200 SIEVE)>36%, LL>41%, PI<10) **A6** (PASSING NO200 SIEVE)>36%, LL<40%, PI>11)
QS1b (BAD – UNFAVORABLE HYDROGEOLOGICAL CONDITIONS) QS2 (FAIR – FAVORABLE HYDROGEOLOGICAL CONDITIONS) 15<PERCENTAGE OF FINES (PASSING NO200 SIEVE)<40%	**A2-4** (PASSING NO200 SIEVE)<35%, LL<40%, PI<10) **A2-5** (PASSING NO200 SIEVE)<35%, LL>41%, PI<10) **A2-6** (PASSING NO200 SIEVE)<35%, LL<40%, PI>11)
QS2b (FAIR) 5<PERCENTAGE OF FINES (PASSING NO200 SIEVE)<15%	**A1-a** (IF PASSING NO200 SIEVE)<15%, PI<6) **A1-b** (IF PASSING NO200 SIEVE)<15%, PI<6) **A3** (IF PASSING NO200 SIEVE<10%, N.P)
QS3 (GOOD) PERCENTAGE OF FINES (PASSING NO200 SIEVE)<5%	**A1-a** (IF PASSING NO200 SIEVE)<5%, PI<6)

The improvement layer must be compacted in the 95% of the minimum density of the Modified Proctor Test. The frequency of the in-situ testing in order to ensure the desired compacted density is every 500 m^3 of compacted fill material. Plate load testing is proposed every 500 m^3 of the fill material.

The construction of sub-ballast layer, base layer and railway embankment shall be in compliance with UIC 719R and with the following properties:

Sub-ballast layer:	Ev>120 MN/m2
Base layer:	Ev>80 MN/m2
Railway embankment:	60 MN/m2 >Ev>45 MN/m2

2.5 Protection measures

All works described in this article refer to slope reinforcement measures that either are in accordance to the project's existing design or are rendered necessary during construction for the stabilization of the excavated cuts on the basis of the exposed in-situ conditions and the geological mapping and stability analyses and design submitted by the Contractor and approved by the Supervising Engineer.

2.5.1 Slope Protection in Excavations

1. Slope Protection with steel reinforced wire mesh

Slope protection in massive excavation will be implemented with mesh type MACMAT or equivalent.

The used material should improve the efficiency of the lining system by:

- Increasing the shear resistance along the soil surface;
- Providing the strength required to guarantee the equilibrium conditions;
- Minimising the stress applied directly to the geomembrane from external loadings;
- Protecting the geomembrane from puncturing damage during the soil placement;
- Allowing the growth of vegetation in order to provide an environmentally friendly aspect and an efficient UV protection to the sealing membrane.

2. Slope protection with steel reinforced GEOMAT

Steel reinforced Geomat should be made with a polymer made three-dimensional matrix extruded onto a double twisted steel woven mesh. The reinforcing steel wire mesh should comply with EN 10223-3 and the wire Zn-AI5%-MM coating with EN 10244-2, Class A. The metallic coated wire should be extruded with an additional polymeric coating.

Such a system shall operate efficiently for many years in a trouble-free manner, providing a highly efficient mechanism against erosion control events. In order to perform as described, the structure of the mat must be three dimensional with a high voids-ratio and manufactured with a profile to enable it to be filled with soil particles which must be trapped and retained within the polymeric mat and not 'on top' of it.

3. Slope protection with vegetation layer

The work involves the protection of embankment slopes, cuts and green areas that are exposed to small quantities of water by applying topsoil material and grass on the surfaces specified in the design or as requested by the Engineer.

The application of this type of protection also depends on the pedological properties of the soil. The actual executed thickness of the topsoil layer shall be determined by the Engineer.

Prior to the beginning of works on this protection, the Contractor shall ensure that the basic slope surface stability requirements are met in accordance with these Technical Specifications and to the full satisfaction of the Engineer.

Active topsoil material shall be used for this type of protection, without any twigs, roots, stone or other material that are unsuitable for the development of vegetation.

The topsoil material shall be applied from the bottom to the top of the slope. The thickness of topsoil layer is usually determined in the design. If this is not the case, the thickness for slope layer shall be 0.15 to 0.25m, and for the green area up to 0.45m.

The topsoil shall be levelled and compacted by light compaction hammers. Grass shall be sown on the finely prepared topsoil layer.

Sowing shall be done broadcast and then the surface rolled over so that the seed is set firmly in the soil. The type and mix of grass shall be selected in accordance with environmental conditions of the area to provide for the secure vegetation growth. The grass mix shall be proposed by an expert. The amount of seed shall be about 30-50g/m2, and of fertilizer about 80g/m2.

After the completion of the topsoil and grass layer, the surfaces must be tended until final growth. The contractor shall water the sown surfaces until the grass fully grows, and, if necessary, cut the grass once or twice.

The Contractor must submit for the approval of the Engineer the results of analyses regarding the proper selection of grass and fertilizer types, as well as the quality control results for seeds. The seed producer's compliance certificates must be submitted for approval to the Engineer. The surfaces protected by topsoil material and grass shall be taken over on the basis of quantity of surface under grass of uniform density, fresh color and healthy appearance, subject to the approval of the Engineer.

2.5.2 Retaining Gabion Walls

Gabions should be baskets made of hexagonal double twisted wire mesh, produced in compliance with the Directive 89/106/EEC. They should have the EC mark in compliance with ETA-09/0414 provided with Product Certification.

Gabions should be filled with stones at the project site to form flexible and permeable, monolithic structures such as riverbank protection and channel linings for erosion control.

In order to reinforce the structure, all mesh panel edges should be selvedged with a wire having a greater diameter.

Steel wire mesh

The double twisted steel wire mesh used in the production of Gabions should have mechanical characteristics higher than the ones suggested from EN 10223-3. Tests should be implemented in compliance with EN 15381, Annex D.

Wire

The steel wire used in the manufacture of the gabion should be heavily zinc coated soft temper steel.

All tests on wire must be performed prior to manufacturing the mesh.

a. **Tensile strength:** The wire used for the manufacture of gabions shall have a tensile strength between 380-550 N/mm^2, in order to increase the tensile resistance of the finished product, according to EN 10223-3. Wire tolerances are in accordance with EN 10218 (Class T1).

b. **Elongation:** Elongation shall not be less than 10%, according to EN 10223-3. Test must be carried out on a sample at least 25 cm long.

c. **Zinc coating:** Minimum quantities of zinc should meet the requirements of EN 10244-2.

d. **Adhesion of Zinc:** The adhesion of the zinc coating to the wire should comply with EN 10244. The wire should not flake or crack while rubbing it with the bare fingers, when it is wrapped six turns around a mandrel having four times the diameter of the wire.

2.5.3 Geotextiles

Description

Geotextiles are used for the protection of the subgrade of railway line works to separate soil layers having different physical properties (grading, consistency, density). They shall be manufactured of synthetic or other fibres, as a thin permeable membrane, and shall satisfy the requirements stipulated in the present clause. Separation geotextiles shall be used, according to the project's design, to permanently prevent migration of the fine soils in the gravel base and avoid mixing of the two materials.

The non-woven Geotextiles are mandatory for use.

Performance

The manufacturer's specifications of the proposed material must be submitted by the Contractor for the approval of the Supervising Engineer.

Out of the total quantity of the geogrids to be used, the Supervising Engineer shall retrieve arbitrarily, in the presence of the Contractor, five samples which will be tested at a "authorized laboratory". The proposed material can only be incorporated in the construction after the confirmation of the material characteristics and the approval of the Supervising Engineer.

Geotextiles shall be protected from eventual mechanical or chemical effects during transport, storage, placement and covering. Geotextiles bound to be damaged by exposure to light shall be continuously covered until placement. Exposure to light shall not exceed five hours.

Overlapping at the locations of geotextile sheets splices shall be not less than 300 mm.

The geotextile sheets shall be laid on surfaces free of protrusions or bumps, with no sharp edges or angles that may damage the geotextile during placement and covering or during operation.

Placement of the geotextile shall be effected in a way ensuring its continuous contact with the surface it is laid on, without voids or protrusions. Immediately after placement, the geotextile shall be covered with a protective layer of material, and until completion of such protective layer, no piece of equipment or vehicle likely to damage the geotextile, shall be allowed to circulate on unprotected surfaces.

Samples of geotextiles shall be kept clean and dry until testing. Prior to evaluation of pore dimension and tensile strength, the samples shall be brought to a "state of equilibrium" at 20 ± 20 and relative humidity 65 ± 5%. Dry specific density of the geotextile shall be given in g/m2.

The desirable weight per unit area as described in related Book and measurement according to the test EN 965.

2.5.4 Waterproofing using Bituminous Coating

Where the project drawings so require or when the Engineer deems it proper, the extrados of the vaults of artificial tunnels and other structures, including bridges, viaducts, underpasses, etc. shall be waterproofed by means of bituminous coatings, if the structure is to be covered.

Concrete elements in contact with the soil shall be coated with bituminous coating (coal tar). The coating consists in a de-acidified tar, hot bitumen or an emulsion of de-acidified bitumen. The compound of the bituminous coating is to be submitted for the Engineer's approval. 3 layers shall be laid. The total minimum thickness is 1 mm.

The above waterproofing characteristics are to remain unaltered:

i. Between the operating temperatures which may occur in the area and, however, always between -15°C and +60°C;

ii. Under the action of thermal changes and mechanical stresses which may occur when laying pavements or other upper layers.

Tests and quality controls and possible efficiency tests shall be foreseen.

The materials to be used and the methods of application will be as follows:

i. cleaning of surfaces: a good cleaning with compressed air and removal of the larger irregularities is imperative; differences in level should be not greater than 0,5%; the surfaces shall have at least 28 days curing and be dry;

ii. primer: this will be formed by the application of about 0.5 kg/m2 of bituminous mass similar to that of the web, to be cold applied (in water emulsion or with solvent 50%);

iii. type of web: the web will be plants formed, of 3-4 mm overall thickness, of which at least 2 mm is bituminous mass; weight of backing shall be not less than 250 g/m2; the joints between two consecutive webs shall be overlapped at least 10 cm and shall be accurately sealed with flame and metal spatula;

iv. Resistance to punching of the web: not less than 10 kg;

v. tensile strength: 60 kg/5 cm minimum.

The greatest care shall be exercised in applying the terminal parts of the webs to prevent infiltration of water beneath; the Engineer may request the use of a greater quantity of bituminous mass to be spread on the primer for a band of at least 1 meter along these points, or other similar measures to ensure water tightness.

2.5.5 Repair of concrete surfaces

This item concerns all the necessary works and materials in order to present any kind of cracks exist on concrete surfaces and the measurements to be taken for concrete and reinforcement repairs.

1. Cleaning

A good cleaning with compressed air and removal of the larger irregularities is imperative.

2. Anticorrosion protection of reinforcement bars

The material to use is a surface applied mixed corrosion inhibitor, suitable to penetrate the surface of concrete structures and then migrate to and protect the steel reinforcing bars embedded in the concrete. It must also protect a spectrum of metals, including carbon steels and galvanized rebar. Concrete that already exhibits corrosion of its reinforcing steel should also be treated with the material in order to reduce further corrosion and extend the service life of the structure.

3. Crack repairs

A high strength epoxy Resin Injection Resin, sealer and adhesive shall be used for cracking repair.

For material implementation the concrete surfaces must be clean, sound and preferably dry. The crack or void to be grouted or the concrete to be sealed or bonded may be dry or damp but must be free of standing water. For optimum performance in terms of penetration and adhesion, surfaces are best dry.

Removing dust, laitance, grease, curing compounds, impregnations, waxes, foreign particles and loose friable materials using suitable techniques, including sandblasting or power wire brushing.

Surfaces, cracks and voids must then be cleaned, by suitable means, such as blowing clean with oil free compressed air or vacuuming to remove all penetration or bond inhibiting material.

For material application the Industrial Guides for the product mast be followed insitu.

2.5.6 Waterproofing of the extrados of artificial tunnels and other structures

Where the project drawings so require or when the Engineer deems it proper, the extrados of the vaults of artificial tunnels and other structures, including bridges, viaducts, underpasses, etc. shall be waterproofed by means of:

a. bituminous coatings, if the structure is to be covered;

b. elastic membranes, when the structure is to remain uncovered.

For bridges and similar structures such as viaducts, underpasses, overpasses, etc.; the waterproofing layers, besides being nearly totally waterproof, shall be so designed and executed as to have:

a. high mechanical resistance, especially to rip in relation to the site traffic and the works subsequent to the laying of the waterproofing layer;

b. deformability, meaning that the material shall follow the deformations of the structure without cracking or breaking away from the support, maintaining practically unaltered all the impermeability and mechanical resistance characteristics;

c. chemical resistance to the substances which may be found in solution or suspension in the permeation water.

In particular account shall be taken of the presence in solution of the chlorides employed as antifreeze agent;

a. durability, meaning that the waterproofing material shall retain its properties for a duration not inferior to that of the pavement, taking into account the eventual effect of fatigue for the repetition of loads;

b. compatibility and adhesiveness in respect to both the underlying materials and the overlying materials (pavement);

c. other required characteristics concern easiness of placing under different climatic conditions and the possibility for easy local repair.

The above waterproofing characteristics are to remain unaltered:

a. between the operating temperatures which may occur in the area and, however, always between -15°C and +60°C;

b. under the action of thermal changes and mechanical stresses which may occur when laying pavements or other upper layers.

1. Waterproofing Layer with cement slurry

This specification describes the coating of substrates with a non-vapor barrier, protective waterproofing, polymer modified, Portland cement slurry.

The manufacturer of the specified product shall be ISO 9001 certified and have in existence a recognized ongoing quality assurance program independently audited on a regular basis.

Environmental Conditions: The material shall not be applied if it is raining or snowing or if such conditions appear to be imminent. Minimum application temperature 40ºF (5ºC) and rising.

Protection: Precautions should be taken to avoid damage to any surface near the work zone due to mixing and handling of the specified material.

Surface must be clean, sound, and free of surface contaminants. Dust, laitance, grease, oils, curing compounds, form release agents and all foreign particles shall be removed by mechanical means. An open-textured, sandpaper-like surface is ideal. All surfaces must be saturated surface dry (SSD), with no standing water at time of application.

Mixing: Under normal circumstances, full quantities of both components shall be mixed together, a slurry consistency shall result. For a trowel able consistency only 90% of component A shall be used. Mix in a clean container by slowly adding the powder component to the liquid component and mixing with a slow speed (400-600rpm) drill and mixing paddle.

Coating Application: Apply trowel, notched trowel, stiff bristle brush, or spray equipment. Material shall be worked into the prepared surfaces, filling all pores and voids. For brush grade: Apply first coat, with horizontal brush strokes and leave to harden (4 to 8 hours). Apply second coat with vertical brush stokes. For trowel consistency: Apply the first coat with a notched trowel and leave to harden (4 to 8 hours). Apply the second coat with a flat trowel. For spray application: Use a hopper gun spray equipment, textured sprayer (e.g. Texspray E110c by Graco), or a rotor/stator pump equipment. Allow the first coat to harden (4 to 8 hours) prior to the application of the second coat. As soon as the mortar layer starts to set, a uniform surface with a fine sponge or a plastic trowel.

When applying the coating, the application shall never stop until the entire surface has been coated. The application shall always stop at an edge, corner, or joint. A previously coated film shall never be let dry; always coat into a wet film. The coating shall be applied at a 45o angle to an edge, corner, or joint. The uncured polymer-modified Portland cement coating can be cleaned from tools with water. The cured polymer-modified Portland cement coating can only be removed mechanically. The finished work and work area shall be left in a neat, clean condition without evidence of spillovers onto adjacent areas.

2. Waterproofing material for Joints

Waterproofing material for joints shall be a plasto-elastic, neutral hardening mastic, based on a (thixotropic) high-quality modified bitumen/rubber composition and shall contain additives, filler and a nonflammable solvent.

A clean, dry and dust free substrate is recommended. For special applications and/or on wet substrates an adhesion test is advised.

The material can be applied with a handgun or a compressed air gun. A clean spout is important for a uniform dose and a smooth finish. In order to obtain adequate adhesion on a wet substrate, it is important that the distance between substrate and spout is as small as possible and not more than 3 mm, so that the initial adhesion is obtained by displacing the water. When compressed-air guns are used (for the sausage-packing) the piston and the cylinder have to be greased properly. The material must be applied in strips or spot wise, so that the solvent is able to evaporate easily. It should be ensured that there is adequate ventilation during use. Immediately after applying the material, the adhesion is sufficient to resist a low load. Maximum strength is obtained after curing by evaporation of the solvent. The final adhesive strength is strongly dependent on the type and nature of the bond. Any residue can be cleaned by dissolving in a solvent.

The material shall not be stored in direct sunlight or near a source of heat. Ambient temperature during application is recommended to be between +5oC and +40oC.

2.5.7 Concrete surfaces paint

Primers shall be of a type recommended by the manufacturer.

The minimum age of the concrete of the support shall be 2 weeks before application.

Waterproofing shall not be applied to any surface until the Contractor is prepared to follow its application with the placing of the protective covering and backfill within a sufficiently short time that the membrane will not be damaged by men or equipment, exposure to weathering, or from any other cause. Damaged membrane or protective covering shall be repaired or replaced by the Contractor at his or her expense. Care shall be taken to confine all materials to the areas to be waterproofed and to prevent disfigurement of any other parts of the structure by dripping or spreading of the primer.

Preformed membrane waterproofing systems shall consist of a primer applied to the prepared surface, a single layer of adhering preformed membrane sheet and a protective cover.

Prior to applying the primer, an oil resistant construction paper mask shall be taped or held with an adhesive to any deck areas which will later be covered by expansion joints. The membrane seal and asphalt concrete shall be placed continuously across such paper masks. The mask and the preformed sheet shall be cut at or near the expansion joint.

The primer shall be applied in one coat at the rate recommended by the supplier, usually 200 to 250 g/m2. Primer shall be applied to the entire area to be sealed by spray or squeegee methods. All primers shall be thoroughly mixed and continuously agitated during application. Primers shall be allowed to dry to a tack free condition before placing membrane sheets.

2.5.8 Riprap

Ripraps shall be constructed as described, according to the instructions of the Engineer, for foundation of railway embankment. Nominal riprap classes are shown in the following table:

Nominal Riprap Class by Median Particle Diameter		d_{15}		d_{50}		d_{85}		d_{100}
Class	*Size (m)*	Min	Max	Min	Max	Min	Max	Max
I	0.15	0.094	0.132	0.145	0.175	0.198	0.234	0.305
II	0.23	0.140	0.198	0.216	0.267	0.292	0.356	0.457
III	0.30	0.185	0.267	0.292	0.356	0.394	0.470	0.610
IV	0.38	0.234	0.330	0.368	0.445	0.495	0.584	0.762
V	0.46	0.279	0.394	0.432	0.521	0.597	0.699	0.914
VI	0.53	0.330	0.470	0.508	0.610	0.699	0.826	1.067
VII	0.61	0.368	0.533	0.584	0.699	0.787	0.940	1.219
VIII	0.76	0.470	0.660	0.724	0.876	0.991	1.168	1.524
IX	0.91	0.559	0.800	0.864	1.054	1.194	1.410	1.829
X	1.07	0.648	0.927	1.016	1.232	1.384	1.638	2.134

2.6 Road Works and ancillary Works

2.6.1 General

The Specifications rely on British Standards and are in common use in EC countries.

The Contractor shall make an exact survey (visual, deflection and some cores) of the pavements at the beginning of the Contract, to assess their characteristics. In areas where the proposed pavement will overlay the existing pavement the Contractor will carry out a Falling Weight Deflectometer survey, in accordance with HD 29/94, at 100m intervals to assess the existing road condition. Cores will be taken at 1km intervals to assess layer types and thickness. In areas with poor deflection or that are severely distressed the core interval will be reduced to 500m. The Contractor shall then determine the required overlay thickness and adjust the proposed road profile accordingly.

For all existing structures, where demolition takes place, the Contractor shall survey the sub-base for the new structures to compare the bearing capacity with the requirements listed below.

The test frequencies mentioned hereafter should be considered as a minimum.

The following materials shall be used for the overall new pavement structure of road.

Course	Thickness	Type of material	. particle
Wearing	4 cm	AC	14 mm
Binder	6 cm	AC	14 mm
Bituminous Base	15 cm	AC	20 mm
Crushed base	30cm	Crushed Material	40mm
Subbase (capping layer),	30cm	Natural or unbound	75mm

For existing structures, the bearing capacity of the existing sub-base shall be evaluated.

If the characteristics are adequate, it will not be reconstructed.

2.6.2 Removal or Breaking up of Existing Pavement Surface

Prior to the commencement of road construction, the Contractor may be required to remove or break up the existing road pavement surface as directed by the Engineer.

1. Breaking up existing pavement surface (if any)

Where the road structure below the pavement is satisfactory the existing bituminous surface layers shall be broken up and scarified, and any concrete road edging shall be removed and disposed of, all to a manner approved by the Engineer. Care shall be taken to ensure that the breaking up is confined to the bituminous layers and concrete edging and that the underlying layers are not damaged. Any voids caused by the removal of the concrete edging shall be filled with granular base course material. The resulting surface shall then be dry rolled with a heavy sheepsfoot, grid or other suitable roller to ensure that no lumps or large particles of pavement remain.

2. Removal of existing pavement (if any)

Where directed by the Engineer the existing pavement layers shall be excavated and removed for disposal for use as fill in the lower parts of embankments as directed or approved by the Engineer.

3. Preparation of Formation

Before construction of the new pavement is commenced the formation shall be prepared as specified i.e a compaction to 95% BS Compaction (heavy) a CBR of minimum 15% (soaked) to a depth of 300mm immediately below the formation level, or such other depth as directed.

2.6.3 Subbase Course

This Section covers the procuring, furnishing and placing of approved soil, natural gravel, processed gravel, or crushed gravel on top of the prepared formation, or as directed by the Engineer and construction of a subbase in accordance with these requirements.

1. Materials

Only approved material shall be used in the construction of the sub-base. Subbase material shall be obtained from borrow areas, stone pit quarries or from such other source as the Engineer approves during the construction. The material shall consist of natural sands, gravels, crushed rock, crushed concrete or well burnt non plastic shale.

Oversize aggregate (> 75 mm) in the material may be crushed or screened out before placing, or it may be broken down on the road, or removed after placing of the formation, provided that whatever method is employed, the oversize material is removed to the satisfaction of the Engineer. Note: -material used in the Pavement Layers must be freeze resistant to –20deg.

The materials shall conform to the following requirements after compaction:

Table 2.6.3.1: Sub-base requirements after compaction-CBR/PI

Sub-base Characteristic	
CBR (1-day cure, 4 day-soak test) of material compacted at the in place density, with a moisture contact during compaction within 1.5% of the Optimum Moisture Content, minimum: at in place density minimum:	45%
Plasticity Index (P.I.) imum:	6%

If the occurrence of natural materials does not conform to the above requirements, the Engineer may require that the natural gravel be admixed with materials from different borrow sources in such proportions as he may direct in order to obtain a suitable mix.

Where natural gravels are not suitable and where mixing is not considered satisfactory, the Engineer may direct that the natural gravel be crushed, screened or crushed and screened, to improve its grading and strength. Such crushing/screening shall be termed "mechanical modification".

The Contractor may offer stabilization as an alternative if it results in savings in the Contract Price and is approved by the Engineer.

No additional payment shall be made for any required mixing and or mechanical modification. The rates tendered shall include full compensation for mixing, crushing, screening or mixing and crushing and screening the material including all labor, plant, fuel, handling, processing, stockpiling if necessary, loading for transport to point of final use and for disposing of any material screened out and discarded. The rates shall also include for development of the quarry, fencing, etc. as required, and construction and maintenance of haul roads.

2. Acceptance of Subbase

Before constructing the pavements, The Contractor shall assess the bearing capacity of the sub-base, by proposing one of three types of measurements, for approval by the resident engineer.

The assessment shall be done for both ways in sections of 1 km, consisting in 20 control points, 1 every 50 m. The specification must be met for 95% of the control points of the section.

- CBR (4 day soak test) ≥ 45 %
- deflection by Benkelman beam ≤ 150 / 100 mm
- Md by in-situ plate loading test ≥ 80 MPa (N/mm^2)

If the subbase is inadequate, alternative pavements will be designed by the Contractor for approval of the Engineer.

3. Construction

Placing and compaction shall be as specified below.

- *Natural material*: The material shall be placed, spread, broken down, watered and compacted over the full width of the layer and oversize material shall be removed.

If after testing sections fall below the required specifications the Contractor shall scarify those sections, add the required material to achieve the correct quality and recompact the material. The Contractor's rates shall include for the possibility of such work.

- *Mixing*: When mixing is ordered, the materials shall be dumped in windrows on the formation in the proportions laid down by the Engineer, and then spread by means of motor grader, disc harrow, rotary mixer or other plant over the full width of the layer to the satisfaction of the Engineer, and compacted as specified.

If, after testing, sections fall below the required grading, the Contractor shall scarify those sections, add the required material to achieve the correct grading, and recompact the mixed material. The Contractor's rates shall include for the possibility of such work.

- *Mechanical modification*: Where mechanical modification is required, the materials shall be crushed in a suitable crushing plant set off the road, preferably near the stone pit or quarry area. The modified material shall then be dumped on the road, spread away from the area on which it has been dumped in such a manner as to minimise segregation of the various sizes of aggregate in the material and compacted as specified.

- *Protection and maintenance:* The Contractor shall protect and maintain the completed sub-base at his own expense.Maintenance shall include immediate repairs to any damage or defect which may occur and shall be repeated as often as is necessary to keep the sub-base continuously intact. However, every effort must be made to avoid delay. The next layer must be placed within 15 days.

Repairs shall be made in a manner to ensure restoration of an even and uniform surface.

4. Tolerances

Tolerances shall be in accordance with these Technical Specifications.

5. Testing

Testing shall be carried out in accordance with these Specifications.

2.6.4 Base Course

1. Crushed gravel base and shoulders

This Section covers the procuring, furnishing and placing of approved crushed rock or crushed suitable alluvial gravel/stone as base course and shoulders as shown on the drawings or as directed by the Engineer in accordance with the requirements of this specification.

The terms soil binder, soil aggregate, natural soil, crushed base, crushed gravel, loose soil or gravel, soil or gravel as used in these Specifications shall be considered as equivalent and should mean natural gravel.

a. Materials

The Contractor is responsible for the finding and proving of sources and borrow areas for the use as crusher-run material for base course and shoulders. All sources, quarries and the material quality shall have the approval of the Engineer prior to use.

Only approved material shall be used in the construction of the base and shoulders.

The material shall be obtained from the approval stone pit or quarries or from such other sources as the Engineer may approve of during the course of construction.

Coarse aggregate in the material shall have a imum dimension of 50mm. Oversize aggregate shall be screened out before placing, providing that whatever method is employed the oversize material is removed to the satisfaction of the Engineer.

b. Properties of aggregate and specification

For stabilised, cement, bitumen and non-stabilised base course and shoulders the material shall conform to the following requirements:

- Unbound materials for base course, shoulders and stabilised base;
- Base and shoulders shall use the same gravel.

Table 2.6.4.1: Base course material and composition

Characteristic	Specification	Frequency
1-Constituent material		
Aggregates (crushed)		
Los Angeles	< 30	1/ supplier
Micro Deval	< 30	1/ supplier
Sand equivalent (cleanness)	< 65	1/supplier
2-Composition for unbound base		
imum particle size	37 mm	1/500 m
26.5 mm sieve	84 - 94%	"
19.0 mm sieve	72 – 84	"
9.5 mm sieve	51 – 67	"
4.75 mm sieve	36 – 51	"
1.18 mm sieve	18 – 33	"
0.3 mm sieve	9 – 21	"
0,075 mm sieve	5 -12	"
tolerances on sieves >6 mm	3%	after definition of
tolerances on <6 mm sieves	2%	after definition of
Optimum moisture content	according to	1/ mix

Table 2.6.4.2: Specifications for Base Course

Plasticity Index (P.I.)	0
Flakiness Index	35 imum on the size fraction passing the 13.2 mm. sieve and retained on the 9.5 mm sieve
Aggregate Crushing Value of approved base course (ACV)	29 imum
CBR at 100% BS compaction (heavy) density	80% minimum (1 day cure, 4 day soaking)
Plate Bearing Test	≥150N/mm^2

c. Specifications for Shoulders

Specifications for shoulders shall be as for base course above except for the plasticity index (PI) which shall exceed 5 but not be greater than 15.

d. Construction

Placing and compaction shall be as specified.

2. Bituminous stabilized base

Bituminous stabilized base course shall consist of soil aggregate and bituminous material uniformly mixed as hereinafter specified and placed on a previously prepared surface.

a. Material

Soil binder shall be taken from an approved source and shall be subject to such requirements regarding grading, plasticity index or other properties as ordered by the Engineer.

The type of bituminous material shall normally be 50/70 penetration straight run bitumen unless otherwise directed by the Engineer and shall comply with the specified requirements.

The mineral constituents for each mix shall be combined in such proportions that the resulting mixture will comply with the requirements as specified. The bitumen content (solubility in benzol) shall be 4.5 - 5.0%. For tendering purposes only, anominal percentage of bitumen of 5 percent shall be considered. In calculating percentages of aggregates of the various sizes bituminous material is excluded.

The stability of the completed mixture, as determined by means of the Marshall apparatus, shall have a value of not less then 300 kg at 60°C.

b. Methods of construction

The methods of construction shall be as specified for premix bituminous surfacing with the following amendments:

The mixture shall leave the plant at a temperature sufficient for workability under prevailing conditions. However, the temperature of the mixture when laid shall not be less than 130°C.

The total compacted thickness of bituminous-stabilised base course shall be as shown on the Drawings or as directed by the Engineer. The base course shall be constructed in 2 layers of not more than 60 mm compacted thickness.

If any one or more layers of the bituminous base course become coated with dust, dirt, or other foreign material, such materials shall be thoroughly swept off to the satisfaction of the Engineer. If in the opinion of the Engineer the surfaces are not clean enough from dust, dirt, or other foreign material, a tack coat shall be applied between the layers of the bituminous base course or between the completed base course and the surface course.

3. Stabilized base

This work shall comprise the furnishing of natural soil or gravel and approved stabilising agent as shall be approved by the Engineer, all in accordance with this specification and in conformity with the lines and grades and dimensions shown on the Drawings of the detailed study or as may be directed by the Engineer.

a. Material

The stabilising agent shall be one of the following agents;

- Ordinary Portland Cement (2.5%).

Stabilising agents shall comply with these Specifications.

From the time of purchase to the time of use, all stabilising agents shall be kept under proper cover and protected from moisture.

Consignments of these materials shall be used in the same sequence as they are delivered on the works. Stocks which may have been stored on the site for longer periods than three months shall not be used in the work, unless otherwise authorised by the Engineer.

Natural gravel shall be taken from an approved borrow-pit or quarry and shall be subject to the requirements regarding grading as specified and hardness of A.C.V = 29% imum or other properties as ordered by the Engineer.

Different amounts of stabilising agent should be incorporated into different samples and the decision on the appropriate amount of stabiliser to use in the field will be taken to comply with the following specifications.

The CBR achieved at 100% BS Compaction (heavy) shall be a minimum of 150% (3- day cure, 4-day soak test when using cement) in moisture range of 3%. The unconfined compressive strength of 100 mm dia. and 200 mm height samples will be minimum 17 kg/cm^2 at the same compaction energy, curing, soaking conditions and moisture range.

After provisional approval of borrow-pit or quarry of natural gravel, the materials used on the road shall conform to the samples originally presented or approved and to the amounts of stabilised agent as decided by the Engineer. The grading and the hardness of the materials as placed shall be tested and the materials shall be rejected where the above specified requirements are not met.

The Engineer need not approve otherwise suitable borrow-pits presented by the Contractor, if other suitable borrow-pits or quarries with materials requiring lower amounts of stabilising agent are available within a distance of 10 km.

The carriageway plus the thickness of the base on each side shall only be stabilised.

Prior to stabilising the carriageway the shoulders shall be constructed with the same aterial as described.

2.6.5 Placing and compaction of subbase, base and shoulders

This Section describes the work of placing materials in subbase, base, and shoulders including the processing and compacting of the materials and such items of work as may be specified, all in accordance with the requirements of this specification.

1. General

Compaction shall be carried out in a series of continuous operations over the full width of the layer concerned, or half width where approved by the Engineer and provided the Contractor is able to produce a satisfactory center line joint, and the length of any section of a layer being compacted shall whenever possible be between 300 and 500 meters. The thickness of any one layer, when measured after compaction, shall conform to the requirements specified, but shall in no case exceed 300 mm.

Any new layer of less than 75 mm in compacted thickness shall be bonded to the previous layer by scarifying the latter to a depth of not less than 75 mm.

2. Preparation

The material to be compacted shall be thoroughly spread over the width and depth of the layer by means of scarifies, or other suitable equipment and all stone, or lumps with a dimension larger than 50 mm for sub-base and stabilized base, 37.5 mm for unsterilized base, shall be broken down or removed, all to the satisfaction of the Engineer.

3. Watering

Any water required before the material is compacted, shall be added to the material in successive applications by means of water tankers fitted with proper sprinkler bars and capable of applying the water evenly and uniformly over the area concerned.

The water shall be thoroughly mixed with the material to be compacted by means of rotary mixers, motor graders or other suitable equipment. Mixing shall continue until the required amount of water has been added and until a uniform mixture is obtained before compaction is commenced.

The material shall be compacted to the specified density at the optimum moisture content for BS Compaction (heavy) with an allowable tolerance of plus 1/2% or minus 2% of moisture by weight of dry material. Should the material be too wet, due to rain or any other cause, it shall be harrowed and allowed to dry out to a moisture content conforming to the above requirement before compaction proceeds.

The Contractor shall provide at his own expense the necessary staff and equipment for controlling moisture content and for ensuring that specified compaction requirements are being adhered to.

4. Methods

Compaction shall be carried out by means of smooth wheeled road rollers, vibratory rollers, or pneumatic tyred roller; the types of rollers to be used and the amount of rolling to be done shall be such as to ensure that specified densities are obtained.

During compaction the layer shall be maintained to required shape and cross-section, and all holes, ruts and depressions corrected by frequent blading with motor graders.

5. Requirements

The density requirements shall be for all materials shall be 95% of B.S. heavy compaction.

Check tests will be carried out by the Engineer and the Contractor shall re-compact at his own expense any section on which the specified densities have not been obtained or on which the moisture contents at the time of compaction varied from the optimum moisture content by more than the tolerances specified.

6. Tolerances

- *Construction*: The finished surface shall be within + 20 mm and - 20 mm of the specified level, providing variation from the specified grade does not exceed 0.1% over a 30-metre measured length.

The finished cross-section when tested with a straight edge normal to the road centre line over the full width or traffic lane, shall not deviate from the bottom of the straight edge by more than 10 mm, or with a 3 m straight edge parallel to the road centre line by more than 6 mm.

The average thickness of material in any length or section of road, measured from before and after levels, or from test holes, shall not be less than the specified thickness and in no case shall the measured thickness be less than 90% of that specified. The average width shall be equal to, or greater than the specified width.

- *Compaction*: The Contractor shall be deemed to have complied with the density requirements providing 95% of the density tests per section give results equal to or greater than the specified density, and providing no single test result falls below a value 2% lower or higher than the specified relative density.

The compaction shall be tested using density measurements on section of 1 to 2 km, with at least one (1) point of control every 100m per carriage way.

7. Weather limitation

It is the Contractor's responsibility to schedule paving outside periods of frost or heavy rain.

In no case shall compaction of pavement layers be done when the ambient temperature is 2°C or may fall below 2°C within 24 hours following compaction.

2.6.6 General Requirements for Bituminous and Asphalt Concrete Surfacing

This Section covers the materials, methods of construction and requirements common to the construction of all bituminous surface treatments specified in this Specification.

1. Laying standards

In a general way, all courses will be subject to a validation of the site equipment and its layout, and of the main results (temperatures, density, levelling,) on the first section laid ('reference day'). Acceptance of this section will be decided by the resident engineer and will be necessary before the continuation of the works.

Table 2.6.6.1: Bituminous and Asphalt Concrete Surfacing Specifications-Laying

Characteristic	Specification	Frequency
temperature of laying	> 130°C	4 / day and 1 at every interruption (phase)
temperature of transport	>140 °C	1 / truck
void content	according to mixed material 4% < Voids < 9% to be obtained in 98% of control points	one control section of 1000 m or 1/ day including minimum 10 measurements using Troxler, Humboldt or equivalent device
void content, density	as above	measured through cores every 500M apart from the "reference values" (see remark)
Width	± 5 cm of theoretical width to be	every 50 m

	obtained in 95% on control points	
Levelling	± 3 cm on sub base to be obtained in 95% of control points ± 2 cm on bituminous layers to be obtained in 95% of control points	every 50 m

Table 2.6.6.2: Bituminous and Asphalt Concrete Surfacing Specifications-Thick./surface

Characteristic	Specification	Frequency
Thickness*	± 2 cm on the overall thickness of bituminous layers, to be calculated through levelling	every 100 m
Surface roughness	overall evenness of surface layer, to be measured through a 3 m straight edge in Length < 5 mm , in Width < 3 mm to be obtained in 95% of control points	every 100 m
Surface texture	Sand patch test >0.8 mm to be obtained in 95% of control points	every 100 m

Remarks:

- For easy density measurements, following as soon as possible the laying, the Contractor shall use nuclear devices (Humboldt, Troxler,..) or equivalent. These devices must be calibrated at the beginning of each course.
- The density device is to be calibrated during the "reference day", where at least 20 measurements with the device will be correlated with 10 cores. Afterwards, cores are only used at every 500m, to cross check density.
- *Tolerances in thickness for wearing course and binder are ±8 mm.

2. Materials

   a. Bituminous binders

Bitumen and bituminous emulsions shall comply with the requirements of Section 2.

The type and grade of bituminous binder to be used shall be specified under the appropriate Section of this Specification for each type of bituminous surface treatment.

   b. Aggregates

Aggregates shall comply with the requirements of Section 8.

   c. Stockpiling of aggregate

Sites for the stockpiling of aggregate shall be prepared in such a manner that no grass, mud, dirt or other unsuitable material will be included when the aggregates are loaded for use.

Access to stockpile sites shall be prepared and maintained in such a way that no dirt is conveyed by vehicle wheels on to the area to be surfaced while aggregate is being transported to or from the stockpiles. Each stockpile shall be approved at least 18 days prior to use of material in construction.

Stockpiles shall be so sited that they will not be exposed to excessive contamination with dust arising from construction traffic on the road or access roads. Aggregates contaminated to such an extent that it contains more than the allowable percentage of material passing the 0.075 mm sieve shall not be used for surfacing.

3. Plant and equipment

a. General

All plant and equipment used on the works shall be suitable for the purpose intended, of adequate rated capacity, maintained in good working condition, and shall be operated by experienced operators.

All plant and equipment that will be operated on the road during construction of the surface treatment shall be free of any binder, fuel or oil leaks and no refuelling or servicing of any equipment will be allowed to take place while such equipment is on the road.

b. Bitumen distributor

A pressure sprayer shall be used for the distribution of bituminous materials on the road surface. Distributors operating on a constant pressure or constant volume system shall be fitted with a low speed speedometer, which shall be kept in efficient working order at all times.

The distributor shall be so designed as to be capable of re-heating bitumen to the correct temperature, to show the temperature accurately at all times by a fixed thermometer, and to maintain the temperature within the limits for spraying during a period covering a spraying operation.

The distributor shall be fitted with a dial gauge contents indicator, and also with a calibrated dip stick.

The distributor shall be provided with adequate means for protection against whirling spray.

c. Rollers

Sufficient rollers of each type shall be available on the works to maintain progress.

d. Pneumatic-tyred rollers

Pneumatic-tyred rollers shall be a self-propelled type equipped with smooth pneumatic tyres of uniform size diameter. The mass of the roller shall not be less than 15 tonnes.

The wheels of the roller shall be so spaced that one pass of the roller will provide one complete coverage equal to the rolling width of the machine. The total operating weight and tyre pressure may be varied by the Engineer at his discretion.

e. Flat steel wheel rollers

Flat steel wheel rollers shall be self-propelled three wheel or tandem rollers of 12 tonnes mass and shall be equipped with suitable devices for cleaning and moistening the wheels.

f. Rotary broom

An approved rotary broom, complete with towing-vehicle fitted with smooth pneumatic tyres, shall be available at all times on the works.

g. Miscellaneous equipment

Sufficient equipment for handling and hauling aggregate and binder shall be provided to ensure prompt and continuous covering of bituminous material as specified.

The Contractor shall have available all the necessary ancillary equipment and hand tools to carry out the work efficiently.

4. Heating bituminous binders

a. Limits

Bituminous binder shall be heated to a temperature between the following limits:

Table 2.6.6.3: Bituminous and Asphalt Concrete Surfacing Specifications-Limits

			Spray Temperature	
Type of binder	Lower Limit	Upper Limit	Fan	Swirling Spray
Bitumen 50/70	165°C	190°C	175°C	185°C
60% bitumen emulsion	37°C	50°C	45°C	50°C
MC 30 cutback	40°C	60°C	50°C	55°C
MC 70 cutback	65°C	90°C	80°C	90°C

Binders which have been heated to temperatures higher than the upper limits given in the above table shall not be used and shall be removed from the site. The recommended spraying temperature is also indicated and every endeavour shall be made to maintain the spray temperature to within a range 5°C above or below the recommended temperature.

b. Protection of kerbs, channels, etc.

Where kerbs, channels, manholes, or other vulnerable items are encountered they shall be protected from the spray application by sticking black plastic sheeting to the kerbs, channels or manholes with suitable adhesives.

The use of sand, mud, cement, bags, etc. for covering such items shall not be permitted. Any kerbs, channels, manholes, etc., which are dirtied or otherwise damaged shall be replaced or cleaned to the satisfaction of the Engineer by the Contractor at his own expense.

c. Rates of application and tolerance

All bituminous binders and aggregate used in the bituminous surface treatment shall be applied at the rates of application as determined by the Engineer after tests on the materials proposed for use, within a tolerance of plus or minus 5% of the specified rate.

The nominal rates of application of bituminous binders given surface treatment shall be applied at the rates of application as determined by the Engineer after tests on the materials proposed for use, within a tolerance of plus or minus 5% of the specified rate.

The nominal rates of application of bituminous binders given in further sections shall, unless otherwise specified, be measured at spraying temperatures. The nominal rates of application to be used on site shall in all cases be as directed by the Engineer.

Where the expressions "net bitumen" or "net bitumen quantity" are used elsewhere in these Specifications for specifying application rates for binder, they shall be taken to mean penetration grade bitumen plus the volatiles normally present therein, but excluding any water, emulsifier or volatile oils added to manufacture bitumen emulsions or cutback bitumen.

d. Dust control

Any deviations and construction roads shall be kept watered and damp during all surfacing operations and all dust removed from surface before any material is applied.

2.6.7 Bituminous prime coat

This Section covers the supply and application of bituminous priming material to a prepared base course, in accordance with this Specification.

a. Materials

- Bituminous material

Each type of bituminous material for use in the prime coat shall conform to the requirements.

The priming material shall be directed by the Engineer according to the texture of the surface to be treated.

- Mineral aggregate

Mineral aggregate used for blinding the primed surface shall consist of crushed rock or river sand, with 100% passing the 6.7 mm sieve and not more than 2% passing the 0.075 mm sieve. The aggregate shall be clean, hard dry, and free from excessive dust.

It shall contain no clay, loam, organic or other deleterious matter.

b. Weather limitations

Weather limitations are to be in accordance with paragraph 2.5.6. The decision on whether or not to apply the prime coat under specific weather conditions shall rest with the Engineer.

Spraying of prime coat may not be undertaken when the ambient road temperature is expected to fall below 15°C immediately prior to commencing the application of prime nor if the ambient road temperature is expected to fall below 5°C during the breaking period of the binder.

Priming of cement stabilised base may not be undertaken during winter season when frost occurs during the breaking period of the prime and when temperature falls below or is likely to fall below 15°C and 5°C mentioned above.

Prime may not be used as a curing membrane over stabilised base under same seasonal and temperature conditions.

c. Preparation of the base course

Not longer than 24 hours before spraying, the base shall be boomed and cleaned of any loose or hard surface crust layer created during slushing compaction work by means of a rotary broom and hand brooms. A light spray of water shall be uniformly applied to the base immediately before the application of the prime if so ordered by the Engineer. If the water is over applied, the base shall be allowed to dry until a uniform damp surface is obtained. No prime coat shall be sprayed on a base saturated with water.

d. Application of bituminous priming material

Bituminous material shall be applied by means of a distributor at the rate of 1.00 litre per square metre or as directed by the Engineer, and at the recommended temperature for the product.

When necessary to provide for traffic, the prime coat shall be applied in lanes of approximately one-half the width of the completed surface. A lane of prime coat shall be applied, allowed to penetrate for not less than 4 hours, then covered with blinding material if required and opened to traffic before the bituminous material is applied to the adjacent lane. In covering the first treated lane a strip at least 300 mm wide shall be left uncovered where the two lanes join, to permit a slight overlap of the bituminous material.

Where traffic can use deviations the prime coat shall be sprayed evenly over the full width of the base course in one or more lanes and shall be left undisturbed for a period of not less than 2 days.

The total width of primed surface shall be 300 mm wider than the specified width of the final surfacing and the edges of the prime shall be parallel to the centre line of the road.

e. Maintenance and opening to traffic

The Contractor shall be fully responsible for any damage to the base course for opening to traffic. He shall repair all defects, at his cost, as directed by the Engineer.

Traffic shall not be permitted on the surface until the bituminous material has penetrated to a minimum of 5 mm, and dried, and in the opinion of the Engineer will not pick up under traffic. Where the completion of the final surface is delayed and the over long periods, the Contractor shall spread the minimum quantity of coarse sand or crusher fines over the primed areas at least 2 days after the prime coat has been applied to avoid picking up, and traffic shall be allowed to use areas so treated.

Potholes which may develop shall be carefully backfilled with premixed material and compacted to the satisfaction of the Engineer. Any areas containing an excess or deficiency of priming material shall be corrected by the addition of sand or bitumen as directed by the Engineer. All the repair work in such case will be deemed to be included in the Contrast rates by the Contractor.

2.6.8 Bituminous Tack Coat

A tack coat to assist in bonding between layers shall only be applied as and where directed by the Engineer. It shall consist of a light application of diluted bitumen emulsion spread evenly over the surface to give not more than 0.3 kg per square meter of residual bitumen. All terms described at previous paragraph 2.6.7 are also valid here.

2.6.9 Precast Concrete Units

1. General

For all the precast elements under the present section, the control of the characteristic compression strength of concrete after 28 days of curing shall be performed by taking, from each batch, a sample from which 4 cube specimens of 5 cm side shall be obtained, and the average failure strength of the 4 specimens shall be assumed as the compressive strength of all the batch.

The sample-taking and testing operations, to be carried out at the Engineer's care and at the Contractor's expense, shall be performed in agreement by both parties with the issue of a relevant report signed by the Engineer and the Contractor. Should the strength resulting from the tests be inferior to the required value, the batch will be rejected and shall be removed from the site.

No one batch subjected to control can be placed in the permanent work until the positive results of the tests will have been made known.

2. Slope Ditches

The slope ditches shall consist of precast concrete units measuring 50x50x20 and of 5 cm thickness, in accordance with the project drawings. The units shall be in vibrated concrete having a minimum cubic strength after 28 days of curing of not less than 25 N/mm2. Taking of the samples to form the specimens will be made at the rate of 1 piece for each batch of 500 pieces or a lesser number of pieces.

The slope ditches shall extend along all the slope, from the side ditch to the shoulder. The Contractor shall undertake the execution of the excavation for siting the concrete units giving to the excavation the same shape as the unit and duly compacted to avoid the settlement of the individual units.

At the toe of the lowest elevation unit, i.e. at the edge with the diversion, where no suitable anchorage structure exists, the Contractor shall sink into the ground two 24 mm dia. steel bars of 0.80 m minimum length.

These will be sunk into the ground to a minimum length of 60 cm so that they can project from the ground by about 20 cm. Similar anchorages shall be established at every three channel units in order to prevent the ditch from slipping. The top of the slope ditches taking off from the road surface shall be connected to the pavement through a special inlet in precast or cast-in-situ concrete of class 250.

The shaping shall be such that the water does not find obstacles and thus does not create other paths for water movement.

3. Precast concrete side ditches and diversions

Side ditches and diversions shall consist concrete of pre-cast vibrated concrete units having a minimum side ditches 28 days cubic strength of 30 N/mm2 and reinforced and with 12x12 cm welded-mesh net with 5 mm dia. Steel diversions strands.

Taking of the samples to form specimens will be made at the rate of 1 ditch- piece for each batch of 100 or a lesser number of pieces. Trapezoidal or L-shaped pieces in accordance with the related project drawings and dependent on whether they are to line earth ditches and diversions or L-shaped ditches, shall have a thickness of 6 cm and be shaped at the heads to provide an indentation.

The units shall be installed on a bed of compacted dry material, ensuring that in no place there are voids which would compromise the strength of the ditches.

Installation shall include also the plastering of the joints with ordinary cement-mortar in the proportion of 500 kg/cum.

4. Precast concrete kerbs

This work involves procurement of all necessary materials, transportation and installation in place of precast kerbs, made of concrete C30/37 and placed on a concrete base C16/20.

The shape and the size of the precast concrete kerb are defined by the project. Precast concrete kerbs are made, according to the detail in the project, on a base of concrete C16/20 and are placed at a distance, with an expansion joint of 10 -15 mm which is filled with cement mortar.

5. Precast concrete paving slabs

Regarding the workmanship and quality of the concrete, general specifications for concrete works shall be applicable.

The geometric shape, dimensions and color of the paving slabs must completely be compliant with the Project.

The Engineer must carry out acceptance of the paving slabs prior to their installation into the footways.

It is advised that there is a rigid edge restraint on all sides of the pavement, which can be an appropriate kerb hunched in concrete, an existing structure or a rigidly fixed parameter course. It is also essential that during the construction all joints are fully filled with the correct grade of jointing sand and the joints are inspected and topped up as required immediately after construction and for the future life of the pavement. The jointing material shall prevent water ingress into the pavement layers and potential deterioration of the sub-base layers underneath.

All materials used and installation methodology should fully comply with the requirements of BS 7533-4.

6. Precast concrete paving units

Precast concrete paving units shall be delivered to site in steel banded, plastic banded, or plastic wrapped cubes capable of transfer by forklift or clamp lift.

Paving units shall be unloaded at job site in such a manner that no damage occurs to product. Sand shall be covered with waterproof covering to prevent exposure to rainfall or removal by wind. Covering shall be secured in place.

Precast concrete paving units shall be solid concrete paving units complying with ASTM C 936 and resistant to freezing and thawing when tested according to ASTM C 67, made from normal-weight aggregates.

- Compressive Strength: 55 MPa average with minimum 50 MPa.
- Absorption: 5% average, with maximum of 7%.
- Pigment in accordance with ASTM C 979.
- Manufacture materials in individual layers on production pallets.

- Manufacture materials to produce solid homogeneous matrix in produced unit.

Units shall be sound and free of defects that would interfere with proper placement of unit or impair strength or performance of construction. Minor cracks incidental to usual methods of manufacture, or chipping resulting from customary shipment and delivery shall not be deemed grounds for rejection.

Bedding and joint sand shall be clean, non-plastic, free from deleterious or foreign matter.

Sand shall be natural or manufactured from crushed rock. Limestone screenings or stone dust shall not be used. When concrete pavers are subject to vehicular traffic, sands shall be as hard as practically available. Grading of sand samples for the bedding course and joints shall be done according to ASTM C 136. Bedding sand shall conform to the grading requirements of ASTM C 33 and joint sand shall conform to grading requirements of ASTM C 144.

Subgrade preparation, compacted density and elevations shall conform to the specifications. Compaction of the soil subgrade to at least 95% Standard Proctor Density per ASTM D 698 is recommended. Higher density or compaction to ASTM D 1557 may be necessary for areas subject to continual vehicular traffic. Stabilization of the subgrade and/or base material may be necessary with weak or saturated subgrade soils. The Engineer should inspect subgrade preparation, elevations, and conduct density tests for conformance to specifications. Location, type, installation and elevations of edge restraints shall be verified around the perimeter area to be paved. The base shall be dry, uniform, even, and ready to support sand, pavers, and imposed loads. Beginning of bedding sand and paver installation means acceptance of base and edge restraints.

Sand shall be spread evenly over the base course and screeded to a nominal 25 mm thickness, not exceeding 40 mm thickness. Screeded sand should not be disturbed. The bedding sand shall not be used to fill depressions in the base surface. Paving units shall be free of foreign materials before installation. Joints between paving units on average shall be between 2 mm to 5 mm wide. Gaps at the edges of the paved area shall be filled with cut paving units or edge units. A low amplitude, high frequency plate vibrator shall be used to vibrate the paving units into the sand. The paving units shall ve vibrated, sweeping dry joint sand into the joints and vibrating until they are full. This will require at least two or three passes with the vibrator. Do not vibrate within 1 m of the unrestrained edges of the paving units. All work to within 1 m of the laying face must be left fully compacted with sand-filled joints at the completion of each day. Excess sand shall be swept off when the job is complete. Final surface elevations shall not deviate more than 10 mm under a 3 m long straightedge. Surface elevation of paving units shall be 3 to 6 mm above adjacent drainage inlets, concrete collars, or channels. Contracts shall reapply sand as necessary to paver joints for a period of 90 days after completion of work.

2.6.10 Road Signs

This Section covers the provision of material, manufacture, transport and erection of road signs as directed by the Engineer.

1. Materials

The plate shall be of aluminum sheeting and shall comply with the requirements of BS 1470.

The steel supporting posts shall be 60 mm nominal bore eight-gauge tubing to comply with the requirements of BS 1387.

Where steel posts are used with aluminum faces, the correct fastenings shall be employed to avoid corrosion at the contact points.

The aluminum supporting posts shall be of extended aluminum sections to suit the sign face manufacture and shall comply with the requirements of BS 1474.

The concrete for the anchor block formation shall be normal mix 1 : 4 : 8/40.

Paint shall be according the local regulation in force and shall approved by the Engineer. The Contractor shall, before ordering the paint, submit to Engineer for his approval the manufacturer's specification.

The reflective material of the signs shall be class CL2 on the main carriageway, and CL1 on the approach roads.

2. Manufacture of road sign faces and supports

Road sign faces shall be manufactured from metal plate, as described and to the dimensions, patterns and colours directed on the drawings.

Road signs shall be of approved manufacture, and if required the Contractor shall supply to the Engineer details of the methods of production.

All welding of steel work shall be carried out in accordance with the standards laid down in BS 1856, BS 693 or BS 5135, whichever is applicable.

The sign supports and backs of sign faces shall be painted in grey.

3. Storage and handling

All road signs or portions of road signs shall be so handled and stored to prevent any permanent deformation, or damage to painted surfaces.

All unpainted surfaces and metal work shall be protected against corrosion.

Any damaged signs shall be repaired or replaced at the Contractor's expense.

4. Erection of road signs

Road signs shall be erected in the positions indicated by the Engineer.

Excavations for the erection of road signs shall be of sufficient size to allow proper setting of the sign and adequate backfilling. The excavations are to be backfilled with 1 : 4 : 8/40 nominal mix concrete, unless otherwise directed by the Engineer.

Road signs shall be erected as shown or directed by the Engineer. During erection the metal work shall be firmly bolted and protected in order that no buckling or damage is caused erection, or by the equipment used for erection.

All welding done during erection shall comply with the requirements for welding during manufacture.

5. Protection and maintenance

All places where paint work has been damaged during erection shall be made good by the Contractor at his own cost to the satisfaction of the Engineer.

The Contractor shall protect the completed road signs against all damage (fair wear and tear excepted) until they are finally accepted by the Employer, and he shall maintain the road signs until the maintenance certificate is issued. Damage or defects caused by faulty workmanship or negligence shall be made good by the Contractor at his own cost to the satisfaction of the Engineer.

6. Roadside indicators (delineators)

The item includes execution, supply and erection of delineators which serve to provide visual assistance to drivers about alignment of the road ahead, especially at night.

Delineators are placed with catadiopres and vertical barriers. They consist of three segments: Central segments (directional) which connect and tie one another, while at the beginning and at the end end segments are placed (male and female). Catadioptres made of retro-reflecting material are installed on segments.

Delineators are made of high-density polypropylene (HDPP) and are yellow. The sizes of central segment are 988x242x80. Delineators have vertical directional barriers at the distance of three meters. Vertical barriers are double-sided in red and white color, size 155x680.

Linear - delineator shall be placed per location plan and detailed drawings from the Design.

The Contractor shall prove delineator quality, prior to its placing, by a test, which is to be presented to the Engineer for approval.

2.6.11 Road Markings

This Section covers the application of traffic markings on the completed road surface where indicated by the Engineer and as prescribed in the specification.

1. Equipment

The equipment shall consist of an apparatus to clean the road surfaces, a mechanical road painting machine and all additional hand operated equipment necessary to complete the work.

The mechanical road marking machine shall be so designed that it will be capable of painting the road markings to a uniform width sides within the tolerances specified and apply the reflecting glass beads at the same time.

2. Materials

- Raw material to be used on road marking shall be especially for it, on the required quantity of reflectivity and stability and all above-mentioned characteristics shall ebe in compliance with European Standard. The delivery of marking paint shall have an approval certificate , which includes laboratory tests.
- Reflective paint of glass spheres type mixed in preliminary with normal paint, not reflective shall have contents of titan bioxide for white and yellow paint.
- Constituent liquid shall be of synthetic resine basis.
- Glass spheres in paint content shall have no colour and a diameter from 0.006 mm to 0.30 mm meanwhile constituent quantity of their weight in paint shall be not less than 33%.
- The Contractor shall hand over a quantity of 1 kg paint and make use of it ,including technical specifications of the factory.
- The Employer maintains the right to test a sample from the paint party which is used in any moment.

3. Weather limitations

Road marking paint shall not be applied to a damp surface or when the relative humidity exceeds 80% or at temperatures lower than 10°C.

4. Surface preparation

Road markings shall be applied to bituminous surfaces only after proper time has elapsed to ensure that damage will not be caused to the painted surface by volatile substances evaporating from the bituminous surfacing. In no case shall road markings be applied until at least 7 days after the completion of the bituminous surfacing.

Before the paint is applied, the surface shall be clean and dry and completely free from any soil, grease, oil, acid or any other material which will be detrimental to the bond between the paint and the surface. The portions of the surface where the paint is to be applied shall be properly cleaned by means of brooms or compressed air if required. Surfaces which cannot be cleaned satisfactorily by compressed air, shall be scrubbed down with a 10% water solution by weight of tri-sodium phosphate or a similar preparation approved by the Engineer.

After the surface has been scrubbed down, the solution shall be washed off with water and the surface protected while drying.

5. Setting out of road markings

The lines, symbols, figures or marks shall be set out by means of paint spots of the same colour as the proposed final lines and marks. These spot marks shall be at such intervals as to ensure that the road markings can be accurately applied, and in no case shall they be more than 1.5 m from each other.

The dimensions and position of road markings shall be as directed by the Engineer or as specified in the Legal Notice described above.

6. Application of paint

The paint shall be applied as figures, signs, letters, symbols, broken or unbroken lines or other marks as required.

Where the paint is applied by means of a machine it shall be applied in two layers or as specified. Before the road marking machine is used on the permanent work, the satisfactory working of the machine shall be demonstrated on a suitable site which is not part of the permanent works. Adjustments to the machine shall be followed by further testing. Only when the machine has been correctly adjusted and the use thereof approved by the Engineer after testing, may the machine be used on the permanent work.

Paint shall be applied without the addition of thinners.

Where painting is done by hand it shall be applied in two layers and the second layer shall not be applied before the first layer has dried out sufficiently.

The road marking paint shall be applied at a nominal rate of 0.8 litre (or 1350g) per square metre or as directed by the Engineer.

7. Application of reflecting beads (ballotini)

The reflecting glass beads shall be applied by the road marking machine during the application of the paint in one continuous operation. The rate of application of the reflecting beads shall be 0.4 kilogram per litre of paint or such other rate as may be indicated by the Engineer.

Machines which apply the beads by means of gravity only shall not be used. The beads shall be sprayed onto the paint layer.

8. General requirements

Lines on curves, whether broken or unbroken, shall not consist of chords but shall closely follow the correct radius.

Any road markings which do not comply with the requirements shall be repaired by the Contractor at his own cost. Rejected road markings shall be removed in such a way that the markings will not show up again later.

9. Tolerances

The completed paint work shall have a neat appearance, with sharply defined edges and the road markings shall be within the tolerances specified below.

- Width: width of lines and other markings shall not deviate from the specified width by more than 5%.
- Position: the positions of lines, letters, figures, arrow and other marking shall not deviate from the specified position by more than 20 mm.
- Edges of lines: the edges of longitudinal lines shall not deviate from the true edge by more than 10 mm in 15 m.
- Broken lines: the lengths of segments of broken lines in the longitudinal direction shall not deviate from the specified length by more than 150 mm.

10. Protection

After the application of paint, the road markings shall be protected against damage by traffic or other causes. The Contractor is responsible for the erection, placing and removal of all warning boards, flags, barricades and other protective measures which may be necessary.

11. Faulty workmanship or material

If any material not complying with the requirements is delivered on the site or used in the work or if any substandard work is carried out, such material or work shall be removed, replaced or repaired as required by the Engineer at the Contractor's own cost. Paint which has been splashed or dripped on the surfacing, kerbs, structures, or other such surfaces, shall be removed by the Contractor at his own cost.

2.6.12 Fences

1. Simple fence

Metallic fencing with zinc eutectic alloy protection and aluminum 1.2m high, with vertical fitters which consist in steel sheet section U.

The mesh will be fixed in the vertical fitter by joints into the holes especially opened in the column. Stretching wires will be joined in each vertical fitter and they will be withdrawn by suspenders in the main column.

The Mesh will be electrowelded with a protection coating consisting in a zinc eutetic alloy protection and alluminium (5%) – cerium and lantanium, dettached meshes with dimensions, upside-down distributed in the following way: advisable 25 mm, n1 mesh 50 mm high, n.5 meshes 100 mm high, n.4 meshes 75 mm high, n.6 meshes 50 mm high. Horizontally, opening is constant 50 mm, total height of the mesh 120 cm.

Wire diameter 2.20 mm.

Tolerances of wire diameter according to norms UNI EN 10218

Electrowelded mesh according to norms CEN-EN 10223-4 .

- Stretch Wires: They shall be made of steel with diameter 3 mm with a protection coating consisting in a zinc eutetic alloy protection and alluminium anticipated for three horizontal mesh positions: in the top, in the center and in the bottom.
- Joint Wire: with a protection coating consisting in a zinc eutetic alloy protection and alluminium (5%) – cerium and lantanium with diameter 2 mm required for binding all the meshes with stretch wires.

2. Railway fence, ASCO type or equivalent

Railway steel fence, ASCO type or equivalent consists of the following, according to DIN EN 10025:

- Interpenetrated grating of height 1460mm and with mesh 129x125 mm, vertical bearing bars 25/3 mm, horizontal interpenetrated bars of diameter 6mm and plates 25/5 mm for the connections with columns
- Columns, placed per 2 meters, of section 60/8 mm and height 1560mm
- Two inox antitheft Bolts for the connection of the grating to the column

All the above-mentioned materials shall be 15 kg per meter and hot galvanized according to DIN 50976.

2.6.13 Illumination System

1. Standards

The standards and technical specification are according UNI 10439 to respect the quality of the road illumination. In any case the minimum standards shall comply with the local Albanian standards in force.

Measures for reduction and prevention of lighting pollution shall be adopted.

2. Equipment

Pole mounted 1x250 or 2x250 Watt high pressure sodium lamps will be installed. The location and number of lighting points to be installed are shown on the drawings.

The lamp lighting fixture shall be of the cut-off type. The Illumination system will include:

- zinc plated metallic pole with one or two branches for lighting, height 9.40 m;
- protection grade IP65 and isolation class II ;
- sodium high pressure bulb 250W,230V;
- grounding and lightning protection;
- Concrete Pit 40x40x40cm

3. Earth grounding

The installation shall be complete with grounding: deep zinc plated grounding rod will be connected to the metallic parts by earthing cable 1x10 mmsq.

The following tests are to be performed:

- check of equipment;
- insulation tests as per Standards;
- functional tests;
- check of the average illumination level.

4. Electric connection

The low voltage cabling will be realized according to the CEI Standards. The electric supply will be installed with flexible copper cable unipolar and/or multipolar XLPE with rubber insulator EPR according CEI standards.

The Low voltage cables shall have a minimum cross section 4x6mm2 as cable to connect and to supply the illumination ‘s pole. The deviations to supply the lighting bulb shall be 3x1.5mm2.

The cables will be installed inside of PVC conducts DN 75mm: maximum 70% of pipe area will be dedicated to the cables.

5. Power Supply

The illumination system will be controlled and protected by switchboards, situated lengthwise the road, and will be supplied in medium voltage (10/6KV network managed by Kesh).

A transformer 20 KVA (10/0.4 Kv) will be installed on pole on correspondence of any roundabout.

The following shop tests shall be carried out at the Manufacturer’s Plant:

- general inspection;
- temperature rise (one transformer of each size);
- power frequency overvoltage;

- winding resistance;
- output voltage and voltage ratio;
- insulation resistance;
- no-load and copper losses;
- tanks sealing efficiency.

The following site test shall be carried out:

- general inspection;
- bushing sealing efficiency;
- insulation test;
- check of auxiliary circuits;
- voltage test;
- earthing connection control.

2.7 Permanent Way

2.7.1 General provisions

The construction of the superstructure of the railroad should be carried out in accordance with the provisions of Regulations for norms and standards for design and construction of the superstructure of railway lines.

The superstructure of the permanent way should include all elements over the upper surface of the earth bed (rails, sleepers, fastenings, ballast, etc.).

The implementation of the permanent way construction includes delivery and assembly works for rails, sleepers, fastenings, ballast and other additional elements, included in the design. An inseparable part of the superstructure works is the dismantling or rehabilitation works, where an already laid superstructure exists.

The Employer hands over the superstructure design for execution of the permanent way works. Any further designs, work-shop drawings or computations needed by the Contractor for the preparation or implementation of works must be provided by the Contractor. This documentation will have to be submitted by the Contractor timely in advance to works execution to the Engineer for approval.

2.7.2 Rail Axis Alignment in situ

Securing the rail axis will be as follows:

- By punching two piles (rail piles) vertically and upright on either side of the rail axis.
- In tunnels, bridges, station platforms etc. the alignment is secured by aluminium blades nailed or welded on either side of the axis of the double rail tracks, at points indicated by the supervising engineer. Blades' dimensions are 100x300x2.5mm.

The materials will be supplied by the Contractor from trade.

The rail axis securing work includes:

- Cutting – transport and distribution of materials in situ.
- Topographical works
- Fixing the blades (on bridges, inside tunnels etc)

- Mounting the Secure point (fooling point)
- Coating the metal securing elements

The Contractor delivers topographical calculations issue (system of adjustment, geometric leveling) and tables of coordinates in conventional and digital form. The topographical surveys are delivered in conventional (scale 1/1000) and digital form (.DWG files)

The distance between the securing points (piles) and the rail axis is 3.00 m.

The distance between the piles along the rails is:

- Alignments: 50m
- Curves: 10m

Piles are obligatory mounted at the beginning, the end and in the middle of parabolic arcs and curves.

The height of every pair of piles in each section is 25cm and +5 cm above the final level of the rail track.

In curves, the level of the highest rail track is considered as rail height.

The pile is punched in the ground at 0.40 m depth, into a hole diameter of above 40cm and then filled with concrete C12/15.

The securing point for the alignments is at the same altitude with the final elevation height of rail track foot. For curves, the securing point is at the same altitude with the final elevation height of the internal rail line. In curves, the cant will be stated.

The piles coating is done in three phases. The first is coating with anti-corrosive material and before the punching, two more coats with oil paint will follow. The color of the pile varies by position:

- Alignment and circular arc: down black, up white
- Parabolic arcs: down black, up red
- Vertical arrows: down black, up blue

The blade coating is done in three phases. Before they are mounted, both sides of the blade are painted with anti-corrosive coating and then with white oil paint. After they are mounted, their color varies by position:

- Alignment and circular arc: down black, up white
- Parabolic arcs: down black, up red
- Vertical arrows: down black, up blue

2.7.3 Rails

All rails, which are planned to be laid on the open route, and at the main tracks in stations, should be of the type 60E1 (UIC 60). Exceptions may be allowed after providing design justification and obtaining the approval of the Construction Supervision Body and the Contracting Board.

All rails on the open route and the delivery and dispatch tracks in stations should be new and delivered directly from the manufacturer or supplied by the Contractor.

The Construction Supervision Body shall be entitled to attend at the factory all processes of production and testing, as well as the entire course of manufacturing.

The material used for the rails should be alkaline-oxygen steel or steel from electric arc furnaces, vacuum degassed. In the case of electric arc steel, a device for secondary arc treatment is mandatory.

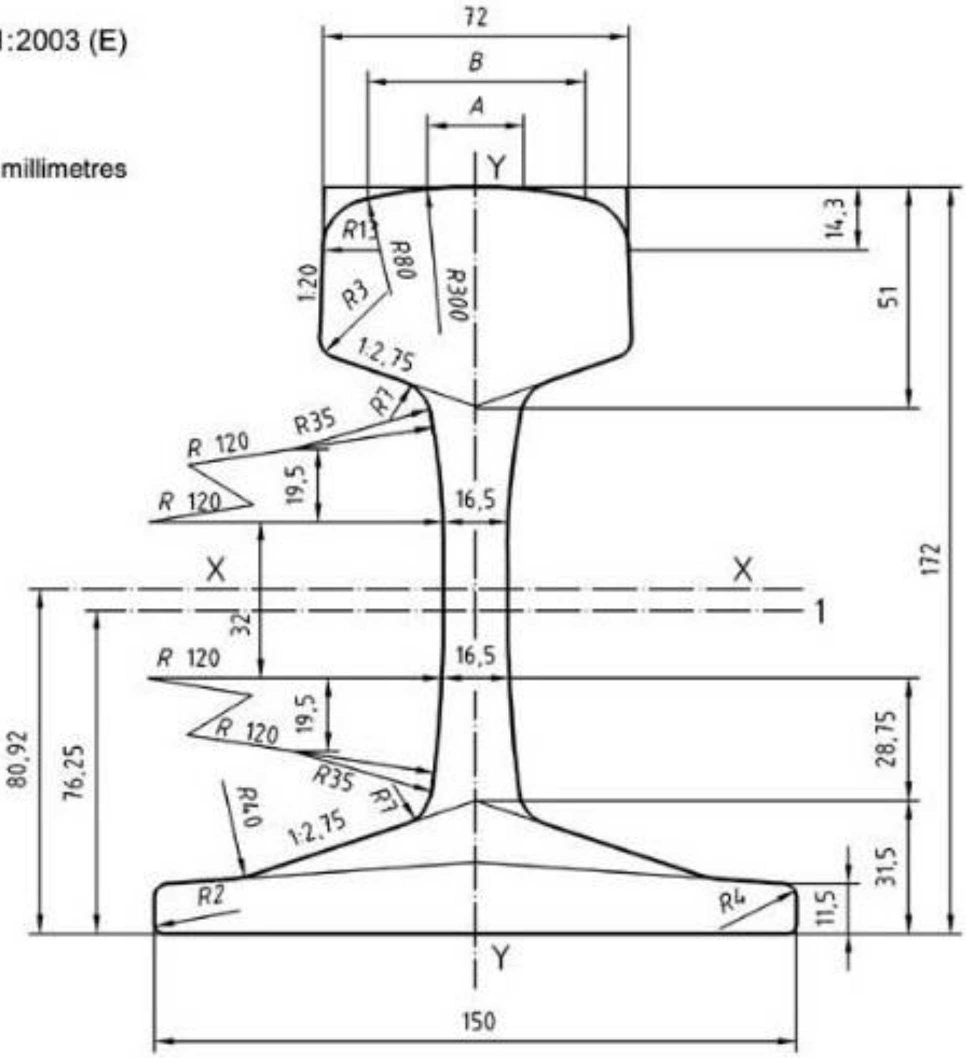
Before the start of the production of rails, the Contractor should submit for approval to the construction supervision body details of the essential and fundamental characteristics of the steel and the processes of rail production. They should not be changed during the implementation of the contract.

The producer of rails must apply an independently approved audited quality management system meeting the requirements of ISO 9001 or equivalent.

All new rails along the main railway, within the stations and the spans must be ground into the railway after the completion of the construction works and prior to the commissioning of the site.

EN 13674-1:2003 (E)

Dimensions in millimetres



Key

1 Centre line of branding

Cross-sectional area	:	76,70	cm^2
Mass per metre	:	60,21	kg/m
Moment of inertia x-x axis	:	3038,3	cm^4
Section modulus - Head	:	333,6	cm^3
Section modulus - Base	:	375,5	cm^3
Moment of inertia y-y axis	:	512,3	cm^4
Section modulus y-y axis	:	68,3	cm^3

Indicative dimensions : A = 20,456 mm
B = 52,053 mm

Figure 1: Shape and dimensions of the cross profile of rail type *60E1 (UIC 60)*

Parameters of the rail

The proposal of the bidder must contain a master profile of the rails to be delivered in performance of the Contract.

The primary rails that shall be used in order to create parts of 90m long-welded rails, should be at least 18m long. Rails to be delivered under the Contract are not allowed to have any openings for extensions. Rails with openings and hardened edges are not allowed to be used.

The standard length of the rails that will be integrated in the laying of the track line must be not shorter than 90.00 m for construction of continuous welded railroad.

The flatness of the body (“Body” is that part of the track that is at least at a two meters distance from the two face edges of the track) of the rail must be as follows:

- The vertical flatness of the body of the rail on a base of 3.00 m must not exceed 0.4 mm.
- The horizontal flatness of the body of the rail (measured from 5 to 10 mm under the point of measurement of the rail gauge at the side of the rail’s head) on a base of 1.50 m should not exceed 0.6 mm.
- The flatness of the rail ends (rail ends are those two parts of the track that are on a distance of up to 2.00m from any of the two face edges of the track) must be as follows:
- The vertical flatness of rail ends on a base of 1.50 m must not exceed 0.5 mm.
- The horizontal flatness of rail ends on a base of 1.50 m must not exceed 0.7 mm.

The residual stress in the produced rails must not exceed 250 N/mm2 in the zone of the rail heel.

In view of checking any adverse defects and for other purposes all racks must be checked with ultrasonic device and equipment for flows in the rail heels.

The mass of a rail having length of 1.00 m must be compliant with UIC 860.

All dimensions of the cross section of the rail must have margins complying with the UIC Fiche 860.

Rail marking

All rails must be marked in accordance with UIC 860 (9th edition from January 2008), point 1.3.1- Mandatory marking (in metrical system).

In addition, all rails must have the following embossed symbol: the month of production written in Roman figures.

Test and acceptance

- The representatives of Contracting Authority shall be entitled to monitor the method of production and attend all tests related to the rails intended for supply hereunder, as well as to inspect the results from such tests.
- The representatives of the Contracting Authority shall be entitled to conduct all the necessary checks in the premises of the producer in order to verify that the production is strictly compliant with the conditions.
- The monitoring/checks must be carried out in such a manner as not to obstruct the normal production operations without any justifiable reasons.
- All expenses related to the visits of the representatives of the Contracting Authority to the producer of the rails shall be on the account of the Contractor.
- The Contractor shall inform and invite the Contracting Authority to the acceptance of each batch of rails at least 30 days prior to the anticipated date of the commencement of the roll forging.

- Prior to the commencement of the production the Contractor shall, on its own account, submit to the Contracting Authority for approval drawings of all gauges necessary for checking the geometric parameters of the rails.
- Prior to the commencement of the first roll forging the Contractor must provide to the Contracting Authority two sets of "masculine" and "feminine" gauges, corresponding to the theoretical contours of the cross section of the rails along with two sets of gauges for plus and minus limits, in accordance with the aforementioned imum margins.
- These gauges must be marked after their approval on the part of the Contracting Authority and one set of all gauges is to remain property of the Contracting Authority throughout the performance of the Contract.
- Only the gauges marked with the symbol of the Contracting Authority shall be deemed valid for the purposes of all inspections and checks.
- The tests to be carried out in order to prove the quality of the steel and of the rails must include, inter alia, also tensile strength tests, macroscopic tests, Brinell hardness, breaking tests, fatigue tests, tests of residual stress in the rail heel .
- The nature of these tests, the test samples, the scope of the tests, the obtained results and control tests must comply with UIC 860 and must fall within the range of the specified margins.
- All tests and the results thereof that are not specified in the said UIC or in these specifications, must promptly and prior to the commencement of the production of the rails be proposed by the Contractor and are subject of approval on the part of the Engineer and of the Contracting Authority.

Warranty Period

The warranty period should be 5 years as from the delivery date of the rails.

Cutting of rails

Rail cutting will be required in the following cases:

- When necessary to set a rail in the road with a length smaller than what was delivered.
- When there are visible defects or cracks in the rail’s end.
- When the ends of the rails that are to be welded have bolt openings, which should be removed.
- When neutralizing rails on the road, which have begun to display temperature tension and strain.

The cutting of the rails can be done using a butane-oxygen, propane-oxygen or acetone-oxygen cutting torch. The cutting spot should be well cleaned of rust and other pollutants. The surface of the cut should be perpendicular to the longitudinal axis of the rail. It is mandatory to use a cutting guide (fixator) and a template. After cutting, the surface of the cut should be cleaned from deposits with the help of a steel brush, hammer and file.

Transition rails

Transition Rails are used in any case that from Rail UIC60 it is necessary to continue with Rail of lower profile, in this case S49. Those units are factory-produced and are welded together. The length of the heavier rail (60E1) cannot be less than 8.40 m, while the length of the lighter one (S49) – 6 m.

2.7.4 Sleepers

Characteristics

The main characteristics of the prestressed concrete sleepers are:

- Wheel gauge 1435 mm
- Type of rails 60E1
- Inclination of the rail heels 1:20
- Operation speed 120 km/h
- Length at open line 260 cm
- Length at stations 240 cm
- Weight ≤ 300 kg
- Height under rail 214 mm
- Concrete brand B70
- Rail-to-concrete fastening Pandrol Fastclip, Vossloh or equivalent

Sleepers must be delivered by the Contractor.

Materials for the manufacture of concrete sleepers, and tests of materials and of finished sleepers shall comply with the relevant standards EN 13230-1, EN 13230-2, EN 13230-4, December 2002 as a minimum requirement. Sleepers manufactured to other codes may be quoted provided equivalent or better quality is anticipated. In such a case, the manufacturer shall enclose the approved regulations to which such sleepers were designed and manufactured together with the conditions and criteria for sleeper testing and acceptance.

The manufacturer shall submit a description (Section 8, EN 13230-1) of all acts, functions, resources, procedures and access to the necessary equipment and appliances, which should prove compliance of the concrete sleepers to be delivered with the requirements.

Other Requirements

a) The tenderer shall guarantee the functionality of sleepers for a 50-year long service life, which means that in that period the sleepers shall be under full strength for both minimum and minimum loads.

b) The manufacturer shall submit a statement on his capability to supply at least 1000 pieces of concrete sleepers for either rail type (60E1/49E1), on demand in any exceptional and extraordinary events that may occur on the Employer's side.

c) Over the bridges with 30 meters span or more, there shall be installed monoblock prestressed concrete sleeper without fastening, type B70 93.1/93, 260cm length, weight 342/348 kg, (German Standard - main track sleeper for gripping/guard rail). These type of sleepers (without fastening) are mandatory to be used at bridges, due to the need of having sleepers for guard rails.

d) For the purpose of connecting individual Signaling & interlocking devices to rail, the method needed to attach any wiring tubes to concrete sleepers shall be examined. The manufacturer shall provide a sketch of possible modes of attaching the tubes that contain Signaling and telecommunication wires to concrete sleepers.

e) The Employer shall demand to inspect the division in which the quoted concrete sleepers will be manufactured. The Manufacturer shall then prove sufficient production capacity to supply the required quantities of concrete sleepers within the terms set forth and his capability to supply products of the required quality or better than required herein.

f) The tenderer shall submit documentation issued by a railway administration stating that the proposed sleepers had satisfactory performance over railway line with mixed traffic at ≤ 160 km/h and axle load of 250 kN.

2.7.5 Elastic rail fastenings for concrete sleepers

1. General provisions

Rail	Type 60E1
Axle load	22,5 tons
Speed	120 km/h
Minimum radius	150 m
. longitudinal gradient	20‰
Rail gradient	1:40
Assembly static stiffness	>70 kN/mm
Assembly dynamic stiffness	>80 kN/mm
Impact load attenuation	>15%
Electric insulation	>5kΩ
Clamping force	>14kN
Creep resistance	>7kN
Track gauge	1435mm
Rail-to-concrete fastening	PANDROL or equivalent

They should be used with prestressed concrete sleepers in sections equipped with modern centralization and security installation.

The railroad assembly should be performed by moving the spring bracket from the position of the preliminary assembly on the rail with no rotation of the rail whatsoever.

If the fastening contains coach screws, then they will be anchored into replaceable plastic dowels with openings for water drainage on the bottom part of the concrete sleeper.

If the fastening is with coach screws, then they do not should be subject to any lateral force.

The rail fastening system should be protected against tilting/rotation of the rails and hypertension of the spring elements.

2. Rail pads

The rail pads should be manufactured according to UIC 864-5 standard.

3. Shape

The surfaces in touch (contact) with the rail and the sleeper can be either flat or smooth or shaped in a certain way.

4. Size

Sizes should be according to the drawings procured by the supplier of the overall rail fastening system.

5. Fastening system guarantee

The guarantee should be according to the UIC standards for each of the elements offered.

6. Fastening system design study

The Contractor shall deliver to the Engineer documentation and relevant designs to approve that elastic fastening system is suitable to withstanding track line longitudinal and transversal forces in compliance with dynamic track behavior.

7. Testing and acceptance

The Construction Supervision Body should be authorized to monitor the manufacturing method and to attend all tests related to all railway fastening systems and to check the results obtained from such tests.

The Construction Supervision Body should be authorized to perform all necessary tests in the manufacturer's facilities to guarantee that production is strictly coordinated with the agreed conditions.

The Contractor should inform and invite the Construction Supervision Body for acceptance at least 30 days prior to the agreed production program launch date.

Laboratory test procedures and performance requirements of the elastic fastening systems are subject to the European Standards EN 13146 and EN 13481 as a minimum requirement, respectively.

2.7.6 Switches (Turnouts)

The supply of a steel set implies the manufacture and delivery of complete switch (switch device with tipping mechanism, manual switch mechanism with adjoining carrier, switch point lamp with semaphore signal, switch locking mechanism, intermediate rail section, frog and check rails); all baseplates with accessory fastening materials (including sleeper screws/bolts, nuts, washers and rail pads under rail foot and pads between baseplates and bearers) in any switches area; baseplates for special sleepers with fastenings in those adjoining track stretches that precede and extend beyond a switch as far as the plain track sleepers of the connecting tracks.

The supply of prestressed concrete bearers implies the manufacture and delivery of sets of bearers including special sleepers in those adjoining track stretches (transition track panels) that precede and extend beyond each switch.

The rail identification 'rail 60 E1' is according to EN 13674-1, formerly type UIC 60. The basic requirements for this type of switches are:

- Track gauge: 1435 mm
- maximum speed on the straight section 100 - 120 km/h
- maximum speed on the railway deviation: 40 km/h
- Rail type: 60E1
- Turnout sleepers type concrete/wooden sleepers
- Rail fastenings with elastic components
- Concrete bearers at 600 ±100 mm spacing
- Rail joints suitable for the subsequent fitting of insulated or welded joints with gaps in one third of sleeper spacing (undrilled rail ends)
- Designed to enable the installation of Signaling and interlocking devices, switches setting machines and switches heating units.

Switches shall be welded to form continuously welded rails (CWR). All temporary rail joints shall be achieved by means of rail clamps.

Switches shall be delivered complete with sleepers and long sleepers at switches for connection to the open track sections with fastenings and joining materials and other steel parts such as switch locking mechanisms and baseplates made of material compliant with the requirements specified.

The material for fastenings and joints, as well as all machined ironware shall be protected against corrosion.

The delivered switches must be implemented from entirely new railway materials.

a. Switch blade part

The profile of the switch blade rails should be Zu1-60.

The spring part of the switch blade rail profile should be connected with the standard rail profile through a frontal electro-contact welding with melting the rail terminals.

The shoulder rail should be with an internal IBAV fastening system or similar.

In the tongue part, there should be a devise that will procure minimal distance in the narrowest section (60 mm) between the shoulder rail and the tongue. It should be Spring Setting Device or similar.

b. Interim part

The interim rails should be made of steel grade 900A according to UIC 860. The fastening system should be according to the technical fastening specification.

c. Crossing frog part

The tip of the heart is of Mn 13 material according to UIC 866 where the terminal surfaces should be blast tempered to at least 320 HB with two converging rails of 900A material according to UIC 860, electro-contact welded or cast in a monobloc fashion from Mn 13 manganese steel with 4 blast tempered - at in the least 320 HB electro-contact welded in workshop conditions - converging rails.

d. Check rails

The check rails should be of the UIC 33 type with steel of grade 1100 (according to the UIC standard) with M22 fastening elements and double spring discs.

The check rail should be fitted on supports, should be 20 mm higher than the head of the running rail. It should be constructed so that the furrow (groove) can be regulated with plates. The connection of the check rail should be executed with a type M22 bolt and a double spring disc and a material with strength class of 5.6.

Between the rails and the pads, there should be plastic.

e. Sleepers for the switches

The sleepers for the switch should be with a cross section with the following parameters: width approx. 300 mm; height aprox.220 mm. A set of sleepers should be according to the scheme provided by the manufacturer.

Guarantee

The guarantee, which should be presented for the invested materials and the installation of the switches, is 3 years from the date of installation and at minimum, 4 years from the date of inspection (acceptance) at the factory-supplier.

2.7.7 Ballast

1. Description

The ballast prism is an element of the superstructure of the permanent way, which transfers to the main ground base the stress/load from the sleepers. It also possesses a high level of elasticity and resistance. It creates an opportunity for correction in the vertical or horizontal situation of the permanent way during routine maintenance.

The prism shaped ballast is made of crushed stone.

2. Technical requirements

The deliveries shall be successive and follow the schedule of works and the schedule of deliveries.

a) The Contactor shall attach to the Employer a test certificate on the physical and mechanical properties of samples of rock and crushed stone issued by an accredited laboratory to this tender.

b) Stone crushing technology shall ensure high and uniform quality of delivered crushed stone.

c) The following rocks are specified for stone crushing:

- igneous: basalt, porphyry, diabase, gabbro, syenite, quartzite and granite
- sedimentary: various tough limestone and silicate grey sandstone
- metamorphic: gneiss, granulite and amphibolite.

d) Rock mass used for stone crushing must satisfy the following criteria:

- originate from compact deep layers in open quarries
- be dense, tough, clean from earth, clay, loam, organic matter, dust and all other less valuable or harmful matter and to be resistant to weather conditions.

3. Conditions for crushed stone supply

a) The quality of rock mass and crushed stone shall be determined by testing:

- physical-mechanical properties of rock
- physical-mechanical properties of crushed stone

b) The quality grading of crushed stone by grain size shall be according to category A, table 1, paragraph 6.3, EN 13450 Grain size distribution of crushed stone shall be determined by sieving on square sieves of the following opening sizes: 63 mm, 50 mm, 40 mm and 31.5 mm according to EN 933-1 The dimensions of the crushed stone grain must be within the stated scope in each delivery. Each producer/supplier shall be bound to submit the grain size distribution curve for the crushed stone delivered.

c) Crushed stone grains for ballast in railway track shall have sharp edges, be closest to cubic shape and as uniform in size as possible. The contents of other grain shapes (plates, pieces of various shapes) may reach minimum 25% of the total grains. The flakiness index of the grains shall be less or equal to 15 according to table 4, EN 13450. Particle length shall be according to category B, table 6, EN 13450.

d) The producer shall check the mechanical and physical properties of rock and crushed stone as well as all the physical-mechanical properties of crushed stone aggregates against the criteria specified in this specification. Test results shall be kept by the producer/supplier and made available to the Employer's authorized representative.

e) The content of fine particles shall be according to category B, table 2, paragraph 6.4, EN 13450.

f) The physical properties of the crushed stone aggregates to be used as railway ballast according to EN 13450 shall meet the following:

- Resistance to fragmentation (Los Angeles coefficient) shall be according to category LARB 14, table 7, paragraph 7.2, EN 13450.
- Resistance to wear (Micro Deval coefficient) shall be according to category MDERB 11, table 9, paragraph 7.3, EN 13450.

4. Organization of acceptance of crushed stone

a) Produced crushed stone shall be tested in the quarry-based laboratory or any other accredited laboratory to be agreed upon the producer/supplier and Employer with the attendance of the producer/supplier and the Employer's authorized representative.

b) The acceptance of crushed stone shall take place at the place of delivery. Crushed stone may be accepted only if the producer possesses a suitability test certificate issued by an accredited laboratory proving that the specific quantity of crushed stone to be delivered was produced in compliance with the technical requirements and that all requirements indicated in this specification regarding the physical and mechanical properties for the crushed stone to be delivered, are fulfilled. Such a certificate shall be provided by the Contractor.

c) Crushed stone shall be taken over on truck and measured on certified weighbridges.

d) The weight of crushed stone shall be rounded down to the closest 50 kg down (or cubic meter in case the supplier has no weighbridge), regardless of humidity at the take-over.

e) When measuring the crushed stone aggregates by volume (cubic meters) the material to be delivered shall be stock-piled and the volume shall be measured applying proven and appropriate surveying methods to be agreed by the supplier and Employer. The volumes measured shall be converted to weight by applying a factor (unit weight) to be determined as the mean of five (5) unit weight values resulting from measuring the volumes and weights of material contained in five (5) trucks.

f) All quantity measurements shall be witnessed by the Engineer.

g) After the acceptance, a shipping document will be compiled, one copy given to the Employer's authorized representative and the other retained by the producer/supplier. The shipping document for each shipment of crushed stone shall include:

- name and address of producer
- name and address of supplier (name of quarry and rock origin)
- contract number and description of goods
- date of production
- category of crushed stone
- certificate on crushed stone quality control
- quantity for shipment (tons or m3) .
- date of delivery
- name of the receiving party
- destination
- mode of transport
- degree of contamination of vehicles (in %).

5. Testing

The following samples are taken in order to carry out tests:

- From the place of production – in order to prove compliance with origin of the material;
- From the transport vehicles (by a testing kit (crate) from one transport vehicle) – when testing an occurred worsening of quality;
- From the ballast prism of the railway line (with a gravel fork, a small shovel or steel frame) – when testing an occurred worsening of quality.

Tests are carried out:

- during the initial geological studies at the quarry;
- with every newly discovered rock type;
- every two years;
- When requested by the Client.

Delivery of the crushed stone for railway lines is accepted in batches according to volume (in cubic meters by measuring the ready figures or loaded on a transport vehicle) or according to mass.

During quality control tests of the crushed stone, a minimum of five incremental samples are taken from a single batch. The mass of one test sample must not be smaller than 50000 g. The samples are taken every 3 wagons or, in case of transportation with motor vehicles – every 5 vehicles.

2.7.8 Fill with crushed stone material between and along the tracks on stations

1. Description

Service pathways are constructed in station areas, to be used by the personnel during maintenance and operation. In connection with that, the area between the ballast prism of the tracks and around them is laterally filled with drainage material. The upper surface (10-15 cm) is formed and levelled using a finer-grain material up to the level of the sleeper.

2. Technical requirements

The materials, which will be used in this layer, must be crushed stone with grain size similar to the material used in base layer.

The material should not contain clays, micas, graphite slate, clay sands and marl particles.

The laying of the crushed gravel must be done between two layers, where each of them is compacted along the whole width with suitable tamping devices.

The main characteristics and properties of the material must be tested before the start of construction.

2.7.9 Track Ballast prism construction

This work concerns the ballast prism construction and includes the unloading and placing of the crushed stone of specified grading into tracks and switches. This work should take place in two stages as described below.

1st stage: unloading of ballast by vehicles

This Item refers to the unloading of track ballast of 25±2cm thickness and width defined by the designs on ready embankment. In unit price of work all the following expenses are included:

- Loading of ballast in all kinds of vehicles of transportation

- Transfer at any distance from the temporary deposition place in the construction site
- The machinery lay time
- The in-situ unloading
- Screening to the desired thickness
- Slight condensation by vibratory sleeper or other suitable machine
- The manual formation of the section

The ballast track screening will be according to the typical cross section of the study. This is the 1st level of ballast prism profiling.

2nd stage: Discharging Ballast by train

Ballast discharging on already placed ballast prism (1st level of prism construction) is performed by train (locomotive composition –appropriate number of ballast wagons).

In unit price of the work all the following expenses are included:

- Loading on trucks and transport of the ballast from the temporary ballast storages to the position of the ballast screening train.
- Loading on the ballast screening train
- Lay time of all cars and machinery
- Transfer of the ballast at any distance by the ballast screening train (locomotive machine – ballast wagons)
- The screening of the ballasted track from the ballast screening train to successive passages (passes), with supplement of the necessary track ballast and for as many passages required, according to the approved study.
- The cost of the labour quality control tests
- The expenses of the machinery operation (ballast screening train, traction unit etc.)
- The wage costs (operators, supporting staff)

The Contractor before the integration of the ballast to the track shall shift the ballast, if required, so that their grain size is suitable or/and wash it.

2.7.10 Track Ballast tamping, profiling and Stabilization

In the course of track adjustment, neither the formation, installations nor fixed objects may suffer damages. Tracks and switches shall be lifted to their designed level gradually (not more than 5-7 cm at each consecutive run of the machinery) by constantly packing the track to prevent deformations under train vehicle passes.

The final adjustment of tracks and switches by alignment and reference level then packing, levelling and compacting ballast shall be done with appropriate machines (heavy track machinery only). For bringing the switches to their final levels and lines according to the design and tolerances special heavy ballast tamping rolling machinery shall be used able to perform more delicate and precise tamping operations in the turnout areas.

During these works, no damage or deformation may occur on the track grid.

To prevent settlements of the newly installed tracks under future vehicle traffic and achieve the final packing of the crushed stones of the ballast under the sleepers the track shall be stabilized by introducing preload with a dynamic vibratory machine. The required preload shall be introduced by means of dynamic frequency oscillations in the range of 0 to 45 Hz and a force of 0 to 350 kN.

The used heavy-duty machinery for track works and the method of track construction shall be approved by the Engineer.

2.7.11 Continuous Welded Rails (CWR)

1. General provisions

The continuously welded track will be constructed of rails 60E1 for the whole length of the open track and for main and secondary tracks in the stations, including adjacent switches;

A track with long-welded rails shall mean a track of rails with such a length, that even when the maximum or minimum temperature for the respective climate zone is reached, the middle part of the rail should always remain stationary (fixed).

Breathable ends are the two end segments of the long-welded rail track, which change their length under the influence of temperature changes.

2. Temperature intervals

Temperature of the application of long-welded rails means the track temperature measured upon the completion of the fixing during the final assembly of the attachments.

Neutral rail temperature means the temperature at which the long-welded rails do not have temperature stresses.

Temperature range for application of long-welded rails means this interval determines the temperature limits within which the long-welded rails may be laid down without prestressing (artificial extension of the rails).

Neutralization of the stress in the rails means the release of the temperature stresses occurred in the rails.

The admissible temperature range for the application of long-welded rails is 17.5 – 27.5 °C.

3. Length of the rails used on the track with long-welded rails

The primary rails that shall be used in order to create parts of 90m long-welded rails, should be at least 18m long. Rails with openings and hardened edges are not allowed to be used.

After the transportation of the rails to the site, they will be welded to each other using a mobile welding machine to the lengths of 360-810 m, depending on the daily progress of the work.

Transportation of long rails from the base to the site should be carried out by a specialized rolling stock, providing the necessary security.

4. Stress release of the CWR by hydraulic Tensioners

By using hydraulic tensioners, the rail track is forced to expand at a certain length, corresponding to its released temperature, something that the rail normally obtains when its temperature reaches the release temperature (rail without internal stresses).

The temperature of the releasing rail should not be lower than 0^{o} C. In special cases of need and after the approval of the Employer, the release is permitted at temperature up to -5^{o} C.

In this case, the necessary measures for the welding should be taken.

- Fixed Points: At both ends of the released part of the line, fixed points should be temporarily created either by tightening the ligaments, in length of about 40m, or if it is necessary by using 80 sleeper anchors, between each sleeper, at each end of the released rail. As a fixed point a welded turnout or a continuous rail segment to a CWR could be used.
- Checkpoints:The changes in rail length are checked at specific control points, selected on the rail sleeper or bedplate that distant 60m for alignment and up to 30m for curves with radius less than 800m.

After the calculation of length change for each control point, the rails should have zero stresses.

For this to be done starting from welding the joints of the rails should relax and by putting rollers below the rails and lightly hitting them with a mallet, the free expansion should be eased.

2.7.12 Rail welding

1. Standards

- EN 14730-1, Railway applications – Track – Aluminothermic welding of rails – Part 1: Approval of welding processes
- EN 14730-2, Railway applications – Track – Aluminothermic welding of Rails – Part 2: Qualification of aluminothermic welders, approval of Contractors and acceptance of welds
- EN 14587-2 (Railway applications – Track – Flash butt welding of rails – Part 2: New R220, R260, R260Mn and R350HT grade rails by mobile welding machines at sites other than a fixed plant)

When connecting the rails in long rail threads, two main methods of welding are used:

- Flashbut welding
- Aluminothermal welding.

Before carrying out the welding, the ends of the rail are cut if they show openings or defects. Before installing the casting shapes, it is necessary to check the thermal gap, which should be 24-27 mm. After carrying out the welding, the rails are sanded, traces of sand are being removed and mineral oil is applied.

The allowed tolerance of the welding spot, measured with a meter-long ruler, is as follows:

- For surface of rolling – from +0.35 to – 0.2 mm.
- For edge of the surface of rolling – from 0 mm to – 0.3 mm

2. Welding of switches

All switches should be welded both along the straight line and along the branches. Welding of switches with R< 300m is not permitted.

Before welding, the railway switches must first be well-regulated and levelled. It is necessary to check for the correct function of the elements. Welding must begin from the inner towards the outer parts, where the rail point is welded last.

The made welding’s, marked as per regulations, are controlled and documented as dictated by the “Technical conditions for testing and delivery of weldings”.

Measuring the amount of work is done on per welding basis, while payment for carrying out each welding (unit) includes the full set of corresponding activities up to the delivery and acceptance of the completed welding.

3. Aluminothermal Welding of the rails

Welding of a workpiece of rails, type UIC 49 or 60E1 on line, for any length of rail (up to 90m), hardness 90kg/mm2, by aluminothermic method of Railltech or Elektro-Thermit technology or equivalent, used in EU network for high speed lines, according to technical instructions of the aluminothermic weldings of the network and the specifications of the manufacturers includes the following works:

- Dismantling of the track on either side of the welding at length of 8 sleepers
- Cutting the rail with saw to create the required clearance and full elevation and horizontal matching of the rails using alignment devices.
- Creation of a pit for positioning components
- Welding
- Grinding the welds after 25 min.
- Fastening of the track to its previous position
- Final grinding of the weld (finishing) after the final settlement of the track

- Weldings shall be performed according to the specifications of the manufacturers of the welding parts.

Weldings presenting visually poor bonding of the tracks, lack of steel to the rail's head, cracking to the body of the track, enclosure of corundum or sand, appearing of small or large holes on the surface, black spots and blisters around the seam of the foot, detachments of metal on the head or foot and fallen weldings will be rejected.

The restoration costs of any failures in the welding charge the Contractor. Restoration costs include cutting of the defective welding, cutting the rail at length over 6m, the settlement so that two joints of appropriate range to be created, the performance of two new weldings and the cost of the material.

Proper alignment of the weldings will be documented by an appropriate recording chart (elevational and horizontal) of daily statement on which the corresponding number of charts will be attached.

The price includes the cost of purchasing all the required machinery, consumables for the weldings and grindings, as well as any other charge due to traffic load of the tracks, laytime of the vehicles and cars.

4. Flash butt Welding of the rails

These specifications refer to the welding (one piece) of two rails, of any length and type (S49, 60 E1) with the special Flash-butt welding machine, performed on a platform or in open line.

The offered price includes all costs of materials (except rail costs), machinery (welding machine, grinding etc.) and transport, including their lay times, the costs of the tools, fuels, lubricants etc, operators, drivers and technicians required for the preparation and execution of the welding. The price also includes any required space rental for the construction of platform and the construction itself for rail welding in area chosen by the Contractor and approved by the Authority, the costs for the construction of helping lines, the dismantling and removal of any new platforms and helping lines at the end of all operations.

Furthermore, the offered price includes all costs of the following works - pre-works – actions required for the complete and skillful performance of the welding

- The loading of the rails from storage, the transport and unloading on the embankment or the platform, at any distance.
- The rails' placement on rollers of the embankment or platform and the constant supervision and regulation in order to achieve absolute elevation alignment of the rails.
- Grinding the edges of each rail, at length of at least 50cm, to the body and the front for the removal of any surface oxidation, so as to achieve the required electrical conductivity.
- Complete horizontal and vertical matching of the rails and theirs welding, in order to create a continuous rail of at least 150m.
- Cutting the excessive welding material and grinding of the welding for the complete restoration of the rail section. (a welding is considered grinded when measured with a 1m ruler, presents ± 0,3 mm deviation regarding the increase of the range, zero (0) deviation regarding the downsizing and altitudinal deviation ± 0,3 mm or 2± 0,3 mm if measured at the end of the ruler for elevation and -0.2 mm for immersion)
- Loading and unloading of rails in each implementation stage and their transport to the appropriate position.
- Temporary storage, with parallel displacement of the welded rails of 90 m up to 162m, in parallel position to the edge of the embankment, in order to perform the pre-screeding of the ballast.
- The costs of quality control tests of all welding works. The quality of the weldings shall be documented by an appropriate recording chart of daily statement on which the corresponding number of charts will be attached.
- The construction of a temporary platform for the welding, charging the Contractor
- The final grinding of the welding (finishing) after the settlement of the track

The flash butt welding machine of the Contractor shall be approved by a Railway Network of the E.U. and the Authority.

The welding by a mobile flash butt welding machine in open line shall be approved by the Authority after the detail presentation of the method, especially regarding the quality assurance of the welding, which should follow the same qualitative terms as above.

2.7.13 Laying of track devices

This specification applies to the installation works of track devices in-situ. The term “track devices” refers to turnouts, crossings and crossovers.

The work of laying any type of track devices, as specified in the design includes:

- Loading the track devices’ parts on a vehicle from the position of temporary deposition, transportation from any location and unloading of the turnouts to their final position by any means of the Contractor and in a manner that ensures the integrity and smooth operation of the devices.
- The construction of any required working floor level, on which the track devices will be assembled.
- Removal of any existing ballast at the laying position of the device to achieve the proper high level of the device in relation to the respective tracks.
- Assembling of the track devices parts (in case of crossover, the transitional rails are included) either in situ or in temporary position. It should be noted that in case of assembling in storage area, stacking of up to three turnouts on each other is permitted.
- The integration of the device with the track in either side by required aluminothermal weldings (internal welding). At the welding points the necessary gap shall be left and the binding shall be by the appropriate means (i.e. clamps) of the Contractor until the welding is done.
- The supply of the welding parts for the internal weldings of the track device, according to the Provider of the device.
- Any required chocking of the turnout (the supply of chocks charges the Contractor) in a manner that the idling passing of 20km/h of the railway vehicles is safe, shall be during the construction of the project.
- Collection of surplus materials after the completion of works and their transfer to an area indicated by the Authority.
- The quality control of the work including the recording of the geometry of the device by suitable equipments of the Contractor and the submission of the corresponding report.

2.7.14 Friction buffer-stops for trains

1. Delivery of friction buffer stops for trains

The purpose of the buffer devices is to achieve emergency stop of the rolling stock in case of emergency. As per the design, the delivery of a buffer unit, comprised of a rivet construction of rail rods, is planned for. The type of the rails is S49 or 60E1. Other second-hand rails can also be used for this purpose.

Energy absorbing buffer stops shall be provided at terminal or bay platforms.

The selected type of buffer-stop and its design shall consider the following factors:

- Factors influencing speed and force of impact;

– Types of rolling stock.

– Minimum and maximum train weights.

– Approach gradient.

– Identified likely track adhesion conditions, including the effect on braking performance of the weather and the covering or otherwise of the track.

– Signalling arrangements and sighting distances.

– Permissible speed on the approach to the buffer stop.

– Lighting conditions.

- Other factors;

– Space required for movement of the buffer stop.

– Rolling stock coupling systems.

– Requirements for insulated rail joints and electrical insulation of the buffer stop.

- Numbers of trains proposed to use the line.
- Any running lines, structures, walking routes, or other areas of risk behind the buffer stop.

The impact speed to be used in design calculations shall be determined following an assessment of the relevant factors listed above. The determined impact speed shall be not less than 10 km/h.

Buffer stops shall be designed to arrest the full range of trains between the heaviest and lightest using a track without risk of serious injury to people on the train. Trains shall be brought to a controlled halt from the determined impact speed with an average retardation rate not exceeding 0.15g (1.47 m/s2). Where site constraints make it unavoidable, lightweight trains may be subjected to higher retardation rates, but the average retardation rate for any train shall not exceed 0.25g (2.45 m/s2).

2. Mounting of buffer stops for trains

Mounting of the prepared delivered construction will be done on site by fixing it to the railway with bolts.

2.7.15 Prefabricated rubber elements for level crossings

Basic requirements for a prefabricated crossing design and quality of materials

Basic conditions for the permanent way in level crossing area:

- Rails 60 E1
- Length of concrete sleepers 260 cm
- Rail pads synthetic,
- Guide groove along running rail 70 mm

Basic Conditions for Synthetic Flooring Elements:

- Material: Vulcanised rubber
- Base material (core) Hardness:70 ± 8 Shore
- Density: 1.15 ± 0.04 g/cm
- Tensile strength > 2N/mm²
- Elongation at breakage > 40%
- Cover-plate:

- Hardness: 67±5 Shore
- Density: 1.15 ±0.015 g/cm³
- Tensile strength: > 8.5
- Elongation at breakage > 100%

- Electrical resistance: > 250000Ω
- Satisfactory loading capacity and resistance to heavy road vehicle loads and traffic derived from the design technical data attached;
- Resistance to aggressive substances which are common in road and railway traffic;
- Upper surface ribbed and suitably treated to prevent sliding of road vehicles;
- Weight of individual flooring elements up to 150 kg;
- Width of inner plates 600 mm;
- Length and height of flooring, as well as shape shall be adjusted to the quoted elements of permanent way in the crossing zone;
- Guide groove along the inside of the running rail, 70 mm wide, properly made to retain the width permanently;
- Reliable inter-connecting and fastening of individual flooring elements;
- The synthetic flooring shall be delivered with full set of connecting and fastening accessories and tools for assembly and disassembly of the flooring.

Basic requirements for typified reinforced concrete supports for the flooring:

- Typified reinforced concrete supports for flooring
- Shape of the support: T-curbstone;
- Concrete quality: ≥ 45 according to DIN 1045 or equiv.
- Surface smooth, free of holes and cracks.

Special Conditions for level crossings with regard to the On-site Conditions:

The drawings of the level crossing geometry for each level crossing that will be fitted with synthetic flooring elements by the type of flooring for railway – road crossings at certain points along the railway line shall be taken by the manufacturer from the detailed track overhaul designs available at the Employer's office.

Technical Inspection and Provisional Acceptance:

Provisional acceptance shall be based on the production documentation and test schedule and program submitted with the tender as well as the specifications herein.

The warranty period requested by the Employer shall be 5 years after the date of installation.

2.7.16 Chainage markings

The distance from the start towards the end of the railway line is marked with Chainage markers (milestones) and Hectometre markers at every 1000/100m, measured by the axis of the track so that the markings with even numbers are placed on the right side, while the odd numbered ones – on the left side. The markings are concrete blocks with dimensions 70±4 cm / 20±1 cm / 15±0.5 cm, where 40 cm of their length are dug into the ground, while the remaining 30±1 cm are above elevation terrain. Each concrete block must bear the initials of the respective hectometre or kilometre on one of the two broad sides, drawn with weatherproof black paint. The distance of these markers to the railway axis must be more than 2.50 m.

2.7.17 Signs for horizontal and vertical curves

With signs for horizontal and vertical curves are marked the following detailed points of each curve:

- TS (tangent spiral)
- SC (spiral curve)
- CS (curve spiral)
- ST (spiral tangent)
- MC (middle curve)
- TC (tangent curve)
- CT (curve tangent)
- BVC (beginning vertical curve)
- CVC (central vertical curve)
- EVC (end vertical curve)

The horizontal markings are placed at each curve along the length of the railway line, on the inside, while the vertical curves – on the right side, at a distance of 2.50m of the axis of the track. The material for implementation of the markings is a rail thread type S49. Each marker bears the initials of the detailed point of the respective curve, drawn on the broad side of the rail (its heel) with weatherproof paint. The rail lies over a concrete foundation, where 40 cm are embedded in the foundation and 40 cm are above it.

2.7.18 Control markings for monitoring of rail displacement

The control points are meant for measuring of the longitudinal and cross displacements over a continuous welded railway. These markings are placed: on the locations of change of the vertical alignment gradient; in sections, where trains have to halt; at locations where the temperature of the rail experiences sudden changes (entrance and exist of tunnel, deep cuts); before and after switches; before and after bridges; in the zone of the breathing end of the continuous welded railway.

These markings are placed on both sides of the tracks over a stable base. They are mounted outside the gauge profile of the maintenance machines. The material for the manufacture of the control signs is rail thread type S49 or similar over concrete foundation. The dimensions of the elements and the depth of the foundation are provided in the annexed detail for control marking in scale 1:50 and 1:20 in the superstructure design.

2.7.19 Gradient pointers

The gradient pointers mark the location of the change of the gradient of the vertical alignment of the railway line and show the gradient and the length of the vertical alignment arm. The same are placed on the right side of the line with a mounted sign – vertical to the axis of the track.

When the tip of the white field is pointing upwards, the gradient is climbing and the opposite is true when the tip of the sign is pointing downwards, the gradient is descending. When the line is in the horizontal, the sign is rectangular. The dimensions of the element and the depth of the foundation will be approved by the Engineer.

2.7.20 Dismantling old tracks and insulated joints

The Item includes dismantling old tracks of rail with any kind of sleepers in crushed stone ballast and insulated joints with rail cutting in the course of dismantling of the existing track, loading, haulage up to 35 km, unloading, dismantling and stacking of the material at the collection site according to type and usability degree. During dismantling of track on wooden or concrete sleepers after the removal of crushed stone ballast, track fastenings are loosened to free rails and sleepers which are taken out of the track work and stacked along it pending further removal.

The demolition of the existing line should be done in block spans (sleeper and rail) with an approximate length of 25-30m. The dismantled material shall be stored properly in deposits in order to be used in future track maintenance.

These demolished blocks of rail and sleepers will be placed in different areas on the RW stations along the railway corridor Durres – Tirana. The exact location for the storage of the dismantled material shall be defined from HSH immediately after the awarding of the Contract with the Contractor.

2.7.21 Dismantling old switches (turnouts)

The Item includes dismantling old switch types with wooden or concrete sleepers in crushed stone ballast, with rail cutting in the course of dismantling of the existing track, loading, hauling within 35 km distance and stack after having first marked the sleepers and metal parts for different types.

During dismantling of track on wooden or concrete sleepers after the removal of crushed stone ballast, rail fastenings are loosened to free rails and sleepers which are taken out of track and stacked along it pending further removal.

The dismantled material shall be stored properly in deposits in order to be used in future track maintenance in locations that shall be defined from HSH immediately after the awarding of the Contract with the Contractor.

2.7.22 Dismantling guard/check rails

The Item includes dismantling of the existing guard rails from tracks on wooden or concrete sleepers in crushed stone ballast.

During dismantling of track on wooden or concrete sleepers after the removal of crushed stone ballast, rail fastenings are loosened to free rails and sleepers which are taken out of track and stacked along it pending further removal.

2.7.23 Removal of existing crushed stone ballast

The work includes the excavation of crushed stone material from the existing ballast prism, without separation of clean crushed stone, loading, and haulage regardless of the distance.

The selection of work technology for crushed stone material excavation should respect the following:

- conditions in which the works are executed (daily or complete track obstruction)
- possibility of usage of certain machines
- deadlines for execution of the excavation
- excavation rationing

Using the above stated elements as well as other moments which can influence the selection of work technology the Contractor shall select the optimal technology for excavation.

Excavations of ballast material should be performed following the cross-sections and geometry defined in the design, namely, following the requirements of the Engineer with usage of special line side machines or classical construction digging machines.

Selected and excavated crushed stone material is loaded into haulage vehicles, hauled and stored at a temporary dump.

2.7.24 Track assembling and laying on concrete and wooden sleepers with elastic rail fastenings

The Contractor shall lay track and switches in compliance with approved regulations and instructions as well as the detailed design and contract specifications.

The Contractor shall prepare a time schedule for laying tracks, switches and other works on the basis of the permanent way design and fully observing the date of completion in the contract and other milestones he shall mobilize necessary resources to ensure compliance. Such a schedule shall be submitted to the Engineer for approval.

The list of machinery and workforce needed for the adopted methodology and schedule of works shall be submitted to the Engineer by the Contractor. Prior to superstructure laying, the formation reference level and grades and the center line alignment shall be checked and recorded in the Minutes and comments if any shall be attended to prior to commencement of works.

The method of track laying shall primarily depend on the Contractor's equipment, plant and technology. Track laying technology shall not cause any damage to the formation or any deformation of the track work. The track work can be formed in two ways:

- By laying assembled track lengths (rails, sleepers and track fastenings)
- By laying sleepers with track fastenings and follow that by rail laying.

If track panels are assembled on site, it shall be important to avoid distortion or deformation in the operations of handling (loading, transport and unloading).

The track and switches shall be laid as accurately as possible to the designed and staked centre line to minimize later level and line adjustments in track tamping operations. Should the track be moved along a horizontal line any deformation of the track work and damages to the substructure shall be avoided. Regardless of track and switches laying methodology it will be necessary to prevent damage to the subgrade and permanent way. Only the methodology that guarantees quality and gauges may be implemented.

The laying of track and switches may commence only upon full completion of the substructure works and after the technical acceptance of these works. Temporary works in an interim phase needed for traffic operations shall be in strict accordance with all respective regulations on traffic safety. During the assembly and laying of switches care shall be taken to prevent damage or deformation.

2.7.25 Railway Current Earthing Installations

All works must be implemented taking into provision the future electrification of the railway line with AC current.

The Contractor shall implement all necessary protection measures for the larger metal components, such as steel structures or reinforced steel structures, or structural components with a horizontal extension parallel to the track line, which are 2 m in length or longer, be located in the overhead system zone and/or the current collector zone. All necessary earthing installations are to be provided, which make it possible in the course of a future electrification of the railway line to directly connect these structural components to the return conductor which will also be provided in the future electrification project.

Smaller conductive parts such as supports for railway barriers, traffic signs on separate posts, parts which are only stored temporarily (e.g. spare rails along tracks), do not have to be earthed, as long as these parts do not support or contain any electrical equipment and as long as they do not form a conductive connection to the earth, such as a pipeline. The latter require additional measures to prevent the occurrence of inadmissible voltage transmission.

System components, which contain electrical equipment such as signal posts, lighting posts, railway barrier motors, etc. are to be earthed within the bounds of an extended overhead system zone of 5 m.

These earthing installations shall always be single railway earthing installations.

Minimum diameters and material

With railway earthing conductors, minimum diameters of 50mm² for copper conductors and 160mm² for steel conductors shall be observed.

With precast concrete elements, instead of strip earthing conductors, round steel bars with a minimum diameter of 16mm, are also admissible. Railway earthing conductors, which are made of steel, have to be galvanized, with a minimum zinc coating of 70μm.

If the earthing conductors are placed in concrete, galvanization will not be necessary, pro-vided that the earthing conductors are completely covered in concrete and the minimum thickness of the concrete cover amounts to 50 mm.

Connections:

The connections of the earthing conductor to the track and to system components which require earthing, need to be visible and accessible. Railway earthing conductors are in general to be implemented in compliance with ED 5412 and are not to be marked separately.

Connections between railway earthing conductors, which consist of steel-cored aluminum conductors or copper conductors, shall be made with suitable compression connectors.

Connections between railway earthing conductors which consist of steel, or connections to reinforcement, are generally to be welded. The welding seam is in general required to have a total minimum length of 100mm (e.g. 2 x 50mm) and a minimum thickness of 4mm. Railway earthing conductors should be welded to the main reinforcement - if possible. With respect to welding, it is to be ensured that in a one-meter section of railway earthing conductors or return conductors, a welding length of 100mm to different reinforcing bars of the main reinforcement is available.

If welding to the reinforcement is not admissible, as would be the case with precast concrete elements, which are subject to dynamic loads, the railway earthing conductors are to be tied to the reinforcement, with wires placed at maximum intervals of 30 mm.

If placed in concrete, cross clamps, as specified in ED 6417, are admissible for connections of railway earthing conductors made of strip steel. For bolted connections M16 threads are to be used in general.

Earthing connections

For the transition zone concrete-air of concrete/reinforced concrete structures and structural components, earthing connections shall be in compliance with ED 6409.

Installation

Railway earthing conductors are to be installed in a way which provides the greatest possible protection against mechanical and chemical influences. The railway earthing conductors shall be installed in such a way that they will not be damaged, when works are performed on the track system, and especially on the ballast. Outside the ballast, the earthing conductors are to be placed 20 cm below the ground surface as stated in ED 410.

If required, e.g. if laid under pavement, concrete, asphalt, etc., the earthing conductors are to be installed in such a way, e.g. by placing them in pipes with sufficient clear width, that they can be checked or inspected and replaced in case of damage. Placing the earthing conductors into pipes may not adversely affect the efficiency of earthing measures, e.g. electrical potential.

If placed in concrete, a minimum concrete cover of 50 mm is to be provided for the earthing conductors and return conductors, except for the earthing connections.

ED 5414 describes several ways of connecting the earthing sockets with the concrete formwork. If the earthing socket is not screwed to the concrete formwork, adequate measures are to be taken to prevent cement water from entering the treaded hole, e.g. by masking or by sealing the hole.

A serial connection of system components, which require earthing, is generally forbidden. If there is no other option, a continuous collecting circuit is to be installed. The components, which are to be earthed are to be connected to this collecting circuit.

Acceptance of earthing measures in civil engineering structures and building structures

Before the approval for concreting works is given, the Engineer will be required to carry out a documented acceptance procedure to confirm that the earthing works have been per-formed correctly and professionally. The following aspects shall be included in the acceptance protocol:

- Project title
- Object or structural component
- Drawing number of the detailed drawing specifying the earthing measures
- A check list, which outlines the correct and professional implementation of
- Earthing straps (this includes checking of location, material and state)
- Earthing sockets (this includes checking of location, material and state)
- Armoured hoses (this includes checking of location, patency of hose (no blockage), material and dimension)
- Connections, including checking of quality, length and number of weldings
- Miscellaneous;
- Date of acceptance
- Signature of Contractor and of Employer (site supervision)

2.7.26 Acceptance of works

The completed works shall be finally accepted by a Commission constituted pursuant to the Law on Planning and Construction. Representatives of the Contractor and the Engineer shall be obligated to attend the acceptance. Prior to the acceptance, the Contractor shall make the necessary documentation, measuring instruments, tools and workers to assist in inspection and measurements available to the Commission.

The acceptance shall be done visually on-site and directly by means of the specified modes of inspection, measurement and evaluation and the main tasks of the Commission shall be to:

- check the compliance of the works with the design and approved technical regulations
- to identify, record and remedy any non-compliance
- to check the quality of works by each element
- to assess whether the track condition (safety and suitability for commercial operation) matches the designed speed and axle loads,
- to keep records on inspections, measurements and assessment.

The acceptance of the finished works shall be sought by the Contractor in a written notice sent to the Employer via the Engineer. The Engineer shall, within 3 days after the receipt of such a notice, verify by a visit to the site that the works were completed and the necessary documentation is available which means that the acceptance procedure can start. Upon the Engineer issuing an opinion, the Employer shall ask the authority in charge to constitute a Commission. The Chairman of the Commission shall set the date for the beginning of the acceptance procedure and shall notify the Employer and the Contractor thereof.

Acceptance documentation

The main documents to be inspected by the Commission include: Works contract, permits and approvals for construction, detailed designs, price schedules, quantity surveys, as-built drawings, material quality records, daily Construction journal and the construction book kept during the works, summary of works by kinds and quantities, records on continuous rail welding with quality test certificates and accepted welds for CWR, certificate on measuring tools calibration and, documents on the inspection of the track with inspection track geometry recording vehicles or railcars with all of the above to serve as the basis for the final acceptance of works.

Tolerances

- track gauge
  - standard 1435 mm ±3 mm for the speeds up to 160 km/h
- rail levels in tangent track
  - for the speeds up to 100 km/h ± 4 mm
  - for the speeds from 100 to 160 km/h ± 2 mm
- cant in curvatures
  - for the speeds up to 160 km/h ± 2 mm
- for horizontal track position (lateral offset)
  - for the speeds up to 100 km/h ± 5 mm
  - for the speeds from 100 to 160 km/h ± 3 mm
- for track twist (transverse error in height at 1000 mm spacing)
  - for the speeds up to 100 km/h ± 2 mm
  - for the speeds from 100 to 160 km/h ± 1 mm

2.8 Drainage

2.8.1 Trench drains

The trench drains shall be filled with drains riprap or river mixed rubble, placed on a bed of concrete of the foundation type; the subsurface draining hollow shall be constructed with open-jointed cement pipes or galvanized perforated steel pipes.

The riprap and pebbles shall be placed by hand with the necessary precautions to avoid successive settlements. The coarser material shall be used to form the lower layers and the finer material for the upper layers.

The Engineer shall order the tamping with washed sand of the already established backfill. The eventual cover with earth shall be appropriately settled. The river mix, to be used in forming the drains, shall be clean and free from foreign and earthy materials, of mixed grading with exclusion of the materials passing 0.4 mm sieve.

2.8.2 "Geotextile" filter drains

In very fine soils or on pavement side filter drains, drainage can be obtained with the use of a "geotextile" side filter in polyester or propylene. The material to be used shall be approved by the Engineer.

The various "geotextile" pieces shall be sewn together to form the lining of the drain; should the sewing not be made, the pieces shall be overlapped by at least 50 cm.

The lower part of the "geotextile" pieces in contact with the bottom of the drain trench and for a height of at least 20cm on the sides, shall be impregnated with hot bitumen (or rendered fluid with appropriate solvents not affecting the support) at a minimum rate of 2 kg/m2. The impregnation can be made before the installation of the "geotextile" in the trench or also after its positioning in place. The "geotextile" shall protrude outside the trench in a quantity needed for its double overlapping on the top of the drain (twice the width of the trench).

The lined trench shall subsequently be filled with coarse material even crushed, cleaned and screened, retained at the 10 mm a bed passing to 70 mm sieve. The material shall fully fill the cavity so as to make the "geotextile" adhere as much as possible to the walls of the trench. After completing the filling the "geotextile" protruding from the top shall be overlapped and covered with pressed earth.

2.8.3 Kerbs and Gutters

1. Description

This Work shall consist of the construction of Portland cement concrete kerbs, kerbs and gutters, gutters in accordance with the specifications and in conformity to the locations, lines, grades, and typical sections shown on the plans or established by the Engineer.

2. Materials
    - Concrete: Portland cement concrete shall conform to the requirements of concrete in these Technical Specifications.
    - Reinforcing Steel: Reinforcing steel shall conform to the requirements of "Reinforcing Steel" in these Technical Specifications.
    - Preformed Expansion Joint Filler: Preformed expansion joint filler shall meet the requirements of AASHTO M-33.
    - Mortar: Mortar shall conform to the requirements of these Technical Specifications.
    - Bedding: Bedding material shall conform to the requirements of these Technical Specifications.

3. Construction requirements
    - Precast Channelization and Bridge Kerb

– Casting Kerb Sections: Kerb sections shall be hydraulically pressed into approved molds under conditions of controlled temperature and humidity. Section shall be water or steam cured until the concrete attains one hundred (100) percent of specified strength. Kerbs shall have a clean finish with smooth surfaces. Segregation, honeycombing or broken corners will not be allowed, and remedial measures will not be accepted.

– Installation: Kerbs shall be placed to the lines shown on the plans or established by the Engineer. The Contractor shall mark the location where each section is to be placed and the marks shall be approved by the Engineer prior to beginning mixing operations. No kerb sections shall be placed over longitudinal or transverse joints of the pavement surface.

– Final acceptance of the kerbs will be given by the Engineer only after proper incorporation in the Work.

- Cast in Place Portland Cement Concrete Kerbs, Combined Kerbs and Gutters

– Subgrade: The subgrade for concrete kerb, gutter, combined kerb and gutter, and cast-in-place concrete base shall be excavated to the grades and sections shown on the plans. If the section is not indicated, the width to be excavated shall be thirty (30) centimetres each side of the outside edges of the kerb or gutter. The subgrade shall be of uniform density as approved by the Engineer. When required by the plans or ordered by the Engineer, the foundation shall be sub-excavated a minimum of one hundred fifty (150) millimetres and the material replaced with bedding material. The bedding material shall be compacted to meet the requirements of Type 95 compaction as specified in these Technical Specifications. All foundation shall be rolled or compacted to provide a smooth surface and shall be approved by the Engineer and moistened before placing concrete.

– Forms. Stationary Side Form Construction: Forms for edge kerb or header kerb constructed monolithically with concrete pavement or base course shall be of steel. Forms for all other types of kerb and gutter shall preferably be of steel but, with the permission of the Engineer, may be of wood for kerb or gutter of nonstandard section or when small quantities are involved.

- Placing Concrete: Edge kerb and header kerb shall be constructed monolithically with pavement. Immediately after finishing, the pavement area where the kerb is to be constructed shall be cleaned of all laitance and roughened. The concrete shall be placed, consolidated, and shaped with a steel template conforming to the section shown on the plans. Concrete for other types of kerbs and gutters shall be placed upon the previously prepared and moistened subgrade. The concrete shall be consolidated with an approved internal type vibrator. The surface shall be shaped by use of a steel template to produce the section shown on the plans. The edges shall be rounded with edgers to form the radii indicated on the plans.
- Contraction and Construction Joints for Kerbs and/or Gutters: Joints shall be constructed at the intervals and places shown on the plans. All joints shall be of the type and materials and conform to the dimensions shown on the plans.
- Finish: The exposed surfaces shall be finished full width with a trowel and edger. The top face of kerbs shall receive a light brush finish. Within twenty-four (24) hours after the concrete is placed, the forms of the roadway face of kerbs shall be removed and the concrete given a light rubbed finish.
- Curing: Kerbs and/or gutters shall be moist cured until stripped and finished, and then cured in accordance with Specifications.
- Removal of Forms: Forms may be removed as soon as practical, as long as no damage results to the kerb or gutter. Required finishing shall be performed immediately followed by application of curing compound.
- Backfilling: The area adjacent to kerbs and/or gutters shall be backfilled with approved material to the top edges of the kerbs or gutters or to the elevation shown on the plans. The backfill shall be placed and compacted in accordance with Type 95 compaction as defined in these Technical Specifications.

  - Precast Portland Cement Concrete Kerbs and Combined Kerbs and Gutters

- Subgrade: The subgrade for the concrete base shall be as specified above.
- Forms: Forms shall be approved and constructed of steel fiberglass or other durable material. All forms shall be sufficiently strong and rigid and securely supported to obtain a finished product correct to the shape and dimensions required. Forms shall be cleaned before each use.
- For radii of twelve (12) meters or less, forms shall be curved and kerbs, kerbs and gutter or gutter of appropriate radii shall be used. The use of straight units shall not be permitted. Precast concrete kerb may be constructed by the use of approved extrusion or other specially designed equipment, provided the finished kerb is true to the dimensions shown on the plans and the concrete is properly consolidated and finished to the required surface texture.
- Placing Concrete: All concrete shall be placed, consolidated, and shaped to the section shown on the plans. The concrete shall be consolidated with an approved vibrator. Edges of precast kerb shall be rounded as shown on the plans.
- The method used in placing concrete shall be such as to produce a uniformly dense concrete element.
- Unless otherwise shown on the plans or directed by the Engineer, the concrete base shall be not less than one hundred fifty (150) mm thick and of a width that will allow for a one hundred fifty (150) mm wide backing, to be poured upon completion of placing the units.
- The sand-cement mortar bedding shall be not less than twenty (20) mm thick. After kerbs, kerbs and gutter or gutter have been laid, a continuous concrete backing not less than one hundred fifty (150) mm wide shall be poured against the units. For kerbs abutting earth or aggregate surfaces the backing shall be to a height of fifty (50) mm below the top of the kerb. For kerbs abutting surfaces to be filled or paved, the backing shall be to a height which permits laying of tiles or similar surface. The top of the backing shall be battered downward from the back of the kerb to a height of fifty (50) mm.

– No pavement layer shall be laid against kerbs until such time as the backing has cured and backfilled.

– Unless otherwise shown on the plans or directed, joints between precast units shall be five (5) mm wide and grouted as specified. Joints shall be tooled to produce a smooth circular section not more than three (3) mm deep.

– Formed, exposed surfaces need not receive additional finishing except when air bubbles or other surface flaws require correction as determined by the Engineer.

– Curing: Precast kerb sections shall be cured in accordance with the provisions of these Technical Specifications using membrane, water, or steam curing.

– Removal of forms: Forms may be removed from elements cast at the site as soon as practical as long as damage results.

4. Quality assurance procedures

The kerbs and gutters shall be inspected sampled, tested and evaluated in accordance with the specifications and test methods referenced in these Technical Specifications.

2.8.4 Catch Basins, Manholes, Inlets and Drainage Grates

1. Description

This Work shall consist of the furnishing and installing of precast or cast-in-place catch basins, manholes, inlets and outlets, including metal frames, grates, and covers, in accordance with the plan details and these specifications, at the locations and to the lines and grades shown on the plans or established by the Engineer.

2. Materials
   - Concrete: Concrete shall conform to the requirements of "Portland Cement Concrete" in these Technical Specifications.
   - Reinforcing Steel: Reinforcing Steel shall conform to the requirements as specified in these Technical Specifications.
   - Structural Steel: Structural steel shall conform to the requirements as specified in these Technical Specifications.
   - Cast Iron: Gray-iron castings shall conform to AASHTO M 105, Class 25S. Castings shall be manufactured to conform to the sizes and dimensions shown on the plans.
   - Test Specimens: Two (2) test specimens shall be cast for each casting that will be subjected to traffic loads. The specimens may be cast attached to or separate from the casting. Specimens shall be of such size that a bar nineteen (19) millimetres in diameter and twenty (20) centimetres in length can be machined from each specimen.
   - Steel Castings:

– General: Mild to medium-strength steel castings shall conform to AASHTO M 103. Unless otherwise shown on the plans or specified, castings shall be Grade 65-35 fully annealed in accordance with ASTM E 44. Steel castings shall conform to the dimensions, sizes and sections shown on the plans.

– Test Specimens: Two (2) test specimens shall be cast for each casting. Test specimens shall be of such size that a bar nineteen (19) millimetres in diameter and twenty (20) centimetres in length can be machined for each specimen.

   - Bedding Course; Bedding Course material shall conform to the requirements of these Technical Specifications.
   - Precast Concrete Manholes: The Contractor may use any type of precast concrete manhole segments provided that they have been approved by the Engineer. Alternative type which he proposes to use.
   - Manhole Frames and Covers: All manhole frames and covers may be of local production and shall be of grey cast iron, of heavy-duty design (forty tons test load) and on tensile strength conform to ASTM A48-76 Class 30A or better. Frames shall have a square base seventy-five (75) centimetres per side, a height of fifteen (15) centimetres, and

have a clear circular opening of sixty (60) centimetres diameter. Covers shall be circular, and shall be equipped with a locking device, have prising slots, lifting holes and non-skid pattern top. The total weight of frame and cover shall be two hundred (200) kilograms minimum.

- Safety Steps and Hand Bars: Safety steps and hand bars shall be manufactured of twenty (20) millimetres diameter mild steel deformed reinforcing bars and hot dip galvanized in accordance with ASTM A 153.
- Catchbasins: Catchbasins shall be precast and constructed of concrete, cast in steel watertight forms, thoroughly cured, all as detailed on the drawings and specified. Such units shall be cast in a casting yard prepared and fitted for this purpose at least three (3) weeks before they are used. Catchbasin shall be set on a fifteen (15) centimetres base of concrete.
- Catchbasin Frames and Grates: All catchbasin frames and grates shall be of heavy duty design (25 tons test load). The type shall be as indicated on the drawings.
- Those for use on asphalted streets shall be of a grey cast iron and shall conform to DIN 1213. Frames and grates shall be square. The total grate opening shall be 1250 cm2 minimum made up of rectangular opening three (3) centimetres wide at the top and slightly tapered (opening downward). The frames shall be fifteen (15) centimetres high and shall have a clear basin. The total weight of frame and grate shall be one hundred fifty (150) kilograms minimum.
- Pipe Runners: The dimensions of the pipe runner standard and alternate design plates, size and length of bolts and nuts are to be checked and submitted to the Engineer for approval. They shall be compatible with the type and size of pipe runner adopted from the standard plan tabulation.

3. Construction requirements

- Alternate Designs: Unless otherwise designated, concrete manholes, catch basins, and inlets may be precast or cast-in-place at the option of the Contractor. Alternate designs may also be proposed for inlet frames and grates. Such designs shall be minimally equivalent to the specified design with respect to strength, hydraulic capacity, and other functional parameters. Alternate designs shall also be similar to the specified design in above ground appearance after installation. The approval of alternate designs for concrete manholes, catch basins, or inlets shall not result in increased costs for the construction of these or any related items.
- Excavation and Backfill: Excavation and backfill shall conform to the requirements of "Structural Excavation and Backfill" in these Technical Specifications. When required by the plans or ordered by the Engineer, the structure shall be installed on a bedding course of the thickness shown on the plans or ordered by the Engineer. The bedding course shall be compacted to Type ninety-five (95) compaction.
- Concrete Construction: Precast and cast-in-place concrete construction shall conform to the requirements of "Concrete Structures" in these Technical Specifications.
- Masonry: When so indicated on the plans, brick or concrete block masonry may be used for the walls of catch basins, manholes, or inlets. Masonry manholes may be constructed circular, with an inside diameter which is equal to the greater of the inside dimensions indicated on the plans. When masonry is used for square or rectangular structures, the inside dimensions of the structure shall be of the dimensions shown on the plans, unless ordered otherwise by the Engineer. The mortar for masonry shall be as specified in "Mortar" in these Technical Specifications.
- Placing Castings: Castings shall be set in full mortar beds or otherwise secured as shown on the plans and approved by the Engineer. Casting shall be set accurately to correct elevations so that no subsequent adjustment will be necessary.
- Welded Grates and Frames: Welded steel grates and frames shall be constructed in accordance with the plans and shall be galvanized. Frames or anchor bolts shall be set and firmly secured in place to grade before placement of concrete.
- Cleaning: All catch basins, manholes, inlets and outlets shall be thoroughly cleaned of any accumulation of silt, debris or foreign matter of any kind and shall be free from such accumulations at the time of Provisional and Final Handover.
- Manholes: Manholes, of precast concrete shall be constructed in accordance with the drawings. Channels in the bottom of the manholes shall be smooth and semi-circular in shape conforming to the inside of the adjacent pipe sections. Changes in size and grade of the channels shall be gradual and even. Manholes shall be constructed so that the top

of the frame and cover is at road grade unless otherwise directed by the Engineer. The final position of the cover at the finished grade shall be attained by the installation of at least two courses of brick. Precast concrete sections or rings used for all manhole construction shall have lengths of thirty (30), ninety (90) and/or one hundred twenty (120) cm conforming to BS 556: Part 2: 1972. The sections shall be of reinforced concrete, cast in steel watertight forms, thoroughly cured, all as detailed in the drawings. Precast concrete units except where otherwise specified, shall be bedded and jointed with cement mortar of one-part cement to three parts fine aggregate, true to line and level shown on the drawings, each unit being firmly pressed into position and the joints flush pointed as the Work proceeds.

2.8.5 Drainage Pipes

1. Description

This Work shall consist of furnishing pipes of the type and sizes provided on the plans or in the proposal in accordance with the requirements of these specifications and installing such pipe at the locations shown on the plans or designated and in conformity with the established lines and grades. The Work shall include the furnishing and construction of such joints and connections to other pipes, catch basins, walls, etc., as may be required to complete the Work, as shown on the plans or directed, together with granular filter material and construction fabric, if required.

2. Materials
   - Plastic Pipe: Plastic pipe shall be plastic conforming to ASTM 3033 or ASTM 3034 for polyvinyl chloride (PVC) or high-density polyethylene (HDPE).
   - Perforations: All pipes may be perforated except sections specifically designated as non-perforated by the Engineer. Perforations may be circular holes or slots at the option of the Contractor. However, different filter requirements shall apply to each plastic pipe circular perforations shall be between five (5) millimetres and ten (10) millimetres in diameter arranged symmetrically in a minimum of four (4) rows parallel to the axis of the pipe. All rows shall be in the lower half of the pipe but no row shall be closer than forty (40) grads to the invert. Perforations in each row shall be a minimum of ten (10) centimetres centre to centre. Plastic drainage pipe slotted perforations shall be between one and five tenths (1.5) millimetres and three (3) millimetres in width, and twenty-five (25) to forty (40) millimetres in length measured on the inside of the pipe. Perforations shall be in two (2) rows, parallel to the axis of the pipe on each side of the invert. Each row shall be approximately fifty (50) grads from the invert. Perforations shall be spaced between twenty (20) and thirty (30) times the average slot width along each row.
   - Granular Filter Material: Granular filter material for pipe underdrain with circular perforations or slots greater than three (3) millimetres average width shall meet the requirements of and conform to one of the gradations in these Technical Specifications.
   - Geotextile Fabric: If the granular filter material is installed in trenches, the filter material shall be conformed to these Technical Specifications.

3. Construction requirements

   - Perforated Sections: Trenches for perforated drainage or underdrain sections shall be excavated to a width equal to the outside diameter of the pipe plus three hundred (300) millimetres, and to a minimum depth of approximately one hundred fifty (150) millimetres below the grade established for the flow line of the pipe, unless otherwise directed.

When geotextile fabric is required, it shall be of enough width to accommodate the periphery of the granular coarse aggregate backfill filter material section plus a minimum thirty (30) centimetre lap. The fabric shall be placed in the trench before any filter material with the centre of the fabric in the bottom of the trench. After installation of the bedding, pipe, and remainder of the filter material, the fabric shall be lapped at the top and the installation backfilled as required.

A minimum one hundred fifty (150) millimetres bedding layer of granular filter material shall be placed and compacted in the bottom of the trench for its full width and length. Pipe of the size specified shall be embedded firmly in the bedding material with perforations down and the pipe sections joined securely with the appropriate coupling bands or joint filler. The high end of pipe installations shall be closed with suitable plugs to prevent entry of soil materials.

After the pipe installation has been inspected and approved, granular material shall be placed to a minimum height of three hundred (300) millimetres above the top of pipe. The remainder of the trench shall be backfilled in accordance with "Trench Excavation and Backfill" in these Technical Specifications.

- Nonperforated Sections: Trenches for nonperforated sections for connections and outlets shall be excavated to the same width and depth required for perforated sections or as ordered by the Engineer. Pipe shall be laid in the trench with all ends firmly joined by applicable methods. After inspection of the pipe installation by the Engineer, the trench shall be backfilled in accordance with "Trench Excavation and Backfill" in these Technical Specifications.
- Granular filter material will not be required for nonperforated sections unless specified on the plans or ordered by the Engineer.

2.8.6 Drainage for structures and road surface

This Work shall consist of furnishing and installing gullies and channel grates and frames for collecting surface water. The gullies and channel grates and frames may be of cast iron or cast steel with or without integral cast hoppers. In the absence of integral cast hoppers, fabricated uPVC or GRP hoppers will be necessary.

The Contractor shall submit, as early as possible, details of all drainage material and components he proposes to use for the approval of the Engineer. No material or component shall be incorporated in the Works without written approval of the Engineer.

The Work shall also consist of installing permeable backing and weep pipes to earth retaining structures, weep and backfilling with selected free draining granular material to the line and extent indicated on the plans.

Gullies and channel grates and frames shall conform to the requirements of BS 497 Amendments PD 6398 (1968) and AMD 554 (1979) and they shall be Grade A (BS 497). Alternatively, drainage gullies shall be of heavy-duty design of the type(s) indicated on the plans, made of structural steel or gray cast iron to conform to AASHTO M105, Class No. 25 S, or equivalent.

Integral cast hoppers shall be of the same grade and quality as the gullies or channel grate and frame. Fabricated uPVC or GRP shall be to the approval of the Engineer who may require material and load testing before giving approval.

Cast iron pipes shall conform to the requirements of BS 78 Parts 1 and 2 and spun iron pipes to BS 1211. Steel pipes shall conform to the requirements of BS 3534.

Pipes of synthetic material for general drainage use shall be approved pipes of polythene, polypropylene, or polyvinylchloride. Un-plasticized polyvinylchloride pipes shall conform to the requirements of Class 2 and 3 ASTM D3333 or BS 3506; alternatively, PVC pipes and sleeves shall comply with DIN 8062 and 150.R/161 and fittings shall comply with ISO/DIN 4422, 10 bars class.

Miscellaneous metal items, including supports, accessories, fittings, fixtures, embedded items, hangers, and strips, shall conform to AASHTO M183, ASTM A207, A42 and AASHTO M164, as applicable. All ferrous items shall be hot dip galvanized after fabrication, in conformance with AASHTO M111 and ASTM A153.

Concrete surface primer shall be cut-back asphalt conforming to ASTM D41 and waterproofing asphalt shall conform to ASTM D 449, type A.

Non-shrink grout shall be as approved by the Engineer.

Joint sealants shall be as specified in these Technical Specifications.

Drainage pipes and gullies shall be laid to the lines and levels and bedded, laid, jointed and protected, all as shown on the drawings or as established by the Engineer. (Top elevation of the gullies shall be five (5) to ten (10) millimeters below the surface of the asphalt).

Weep holes shall not be placed within 40mm of any reinforcement and shall be cleaned to permit the free flow of water on completion of the work.

Drainage pipes shall be on completion cleared of all foreign matter and the interior surface left smooth.

When drainage pipes are cast into concrete structures, the Contractor shall take adequate precautions to prevent any displacement of the pipes during the concreting operation.

Drainage pipes shall be tested for water tightness and the test procedure shall be agreed with the Engineer. Where drainage pipes are located within the cellular parts of a bridge deck where access after completion of the deck is limited, then the installation and testing of the pipes shall be completed and accepted by the Engineer before the deck construction is allowed to proceed to the stage where free access will be available.

2.9 Steel Structures

2.9.1 Scope

The fabrication and erection of all structural steel work shall be under the constant supervision of competent and experienced personnel. All workmanship shall be in accordance with the best modern workshop practice and only skilled workers trained and experienced in steel fabrication and erection shall be employed.

2.9.2 Materials and Process Requirements

All structural steel shall be of grade S355 N or S355 M unless if otherwise referred to design study. The steel grade for studs is S275 quality J2G3, in compliance with EN 10025 and EN 10027.

The steel plates shall be marked in order to be easily identified in the workshop during the frame construction.

Before assembling, ultrasonic controls shall be performed in the workshop to guarantee the absence of rolling defects. Corresponding mill certificates shall be supplied to the Engineer in duplicate to confirm the mechanical and chemical properties.

1. Storage of Materials

Structural steel work whether plain or fabricated shall be stored above ground on platforms, skids or other supports and in such a way as to prevent pools of water forming on the surface. It shall be kept free from dirt, grease and other deleterious material and shall be protected as far as is practicable from corrosion. The time limits for outside storage of unpainted or primed steel work shall be as recommended by the Manufacturer.

2. Fabrication

Fabrication shall be in accordance with the requirements of BS 5400 Part 6. Rolled material, before being processed, must be straight or flat. Straightening or flattening, where required and where permitted by the Engineer, shall be accomplished by a process not harmful to the material.

The Contractor shall submit to the Engineer for his approval shop drawings with calculations as appropriate and the Contractor shall not commence fabrication until written approval has been given by the Engineer. Such approval shall not relieve the Contractor of any of his responsibilities under the Contract.

The components of various members of the structure shall be placed in jigs of approved design and all welding shall be carried out in accordance with terms below and to the satisfaction of the Engineer. Every precaution shall be taken to prevent distortion.

The order, manufacturing controls and delivery conditions shall be in accordance with the requirements of EN 10021.

3. Preparation of Edges and Ends of Plates

Edges and ends shall be either:

- Left as rolled, sawn, machine cut, machine flame cut.
- Hand flame cut and ground to a smooth profile.
- For stiffeners and gussets not exceeding 12 mm thick, sheared and subsequently ground to a smooth profile.

Where ends of stiffeners are required to be fitted, they shall be ground to be in contact with the flanges over 80% of the area of stiffeners.

Cutting by shearing is not allowed for steel grades higher than 280 MPa. Oxygen cutting defects shall not exceed a 0.5 mm depth. When the oxygen cutting shows an internal defect of the steel plate, the element shall be rejected. Edges of the pieces that are to be painted shall be rounded.

All the accessory elements or cuttings necessary to ensure the lifting, the handling, the welding on site or the adding of secondary elements, shall be shown on the drawings and calculated.

After cutting of plates, one of the following requirements shall be satisfied:

- Hardness of the cut edge shall not exceed 350 HV 30 of EN ISO 6507-4 “Metallic materials. Vickers hardness test. Tables of hardness values”.
- Cut edge is incorporated in a weld;
- Material from the edge is removed by machining or grinding to demonstrate that the hardness of the edge is less than 350 HV 30 of EN ISO 6507-4.
- Edge is softened by an approved heat treatment and is shown to be free from cracks by crack detection procedures.
- Material is grade S275 steel according to EN 10025 (formerly grade 43 of BS standards) and is not greater than 40 mm thick, and the edge preparation is by machine flame cutting.
- Provision for thermoforming:
- Linear or punctual heating of the steel plates is allowed providing that the temperature remains lower than 750°C, up to 40 mm of thickness for steel grade S355 (M or N). For greater thicknesses, the temperature shall remain lower than 600°C. This method is allowed only if it is executed in accordance with a procedure foreseen in the QA plan and validated by a test. The procedure includes the description of the execution method, the indication of the maximal temperature and control means of this temperature. The test record shall indicate the effective temperature reached and the operator name. The procedure is valid only for the operator that performed the test.
- Thermoforming of the steel plates with temperature above 580°C is not allowed.

4. Welding

Welding shall be permitted only where shown on the drawings and the agreed shop drawings. All welding operations shall comply with the requirements of EN 1011.

The details of all welds shall be arranged to achieve the most satisfactory welding procedure. The details of the welding procedure shall be submitted to the Engineer for his approval and no welding may commence without the prior approval of the Engineer. No departure from an approved procedure may be made without the further agreement of the Engineer. Welding procedure details to be submitted to the Engineer shall include:

- Welding position.
- Fusion face preparation.
- Pre-heat.

- Electrode make, type and size and mechanical properties.
- Number and arrangement of runs.
- Welding current.
- Arc energy.
- Method of back gouging and sealing.
- Proposed methods of quality control and testing of welds.

Welding shall be carried out under the supervision of an experienced and competent Engineer. The welders shall be tested in accordance with the requirements of EN287-1 to the satisfaction of the Engineer prior to the commencement of the work.

The certificates of conformity to the flux and electrode standards, and the receipt certificates 3.1.B of the wires, in accordance with EN 10204 “Metallic materials. Types of inspection documents” shall be presented to the Engineer

Where required by the Engineer, the Contractor shall carry out procedure trials of the welding procedure.

Welding equipment and accessories shall comply with the requirements of EN (IEC) 60974 and shall be used in accordance with the manufacturer’s instructions. The welding equipment shall be capable of maintaining at the weld the current and voltage specified by the manufacturer and in accordance with the welding procedure.

The electrodes shall be selected with regard to the quality of the material to be welded, for optimum performance with the welding procedures and shall comply with the requirements of EN ISO 2560. All electrodes shall be stored in their original packets in a dry and preferably heated place adequately protected from the weather and shall be handled with care and in accordance with the manufacturer’s instructions. Electrodes and fluxes that show signs of moisture, damage or deterioration shall not be used.

Welds shall be subject to non-destructive examination and testing as specified in the relevant standards (EN 970 and EN 1712).

Welded fabrication and weld quality shall comply with the requirements of the American Welding Society Specification ANSI/AWS DI.1.81 Section 9 Part D.

Stud shear connectors shall be subject to the following tests:

The fixing of studs after being welded in position shall be tested to the satisfaction of the Engineer by striking the side of the head of the stud with a 2 kg hammer.

Any stud selected by the Engineer shall be capable of being bent by striking the side of the head of the stud with a 6 kg hammer until its head is displaced laterally a distance of approximately 0.25 times the height of the stud from its original position. The stud weld shall not show any signs of cracking or lack of fusion. Satisfactory studs shall not be bent again.

Studs whose welds have failed the tests given in (a) and (b) shall be replaced according to a procedure to be agreed with the Engineer.

5. Bolting

Black Bolts: All mild steel bolts, washers and nuts shall be of the grade as specified on the drawings and shall comply with the requirements of BS 4190, BS 4933 or BS 3692 as appropriate.

All holes shall be drilled, or drilled small and reamed, and shall be clean cut without torn or ragged edges. The holes shall be perpendicular to the member and not more than 2 mm larger than the nominal diameter of the bolt.

In all cases where the full bearing area of the bolt is to be developed the bolt shall be provided with a steel washer under the nut to avoid any threaded portion of the bolt being within the parts bolted together. Tapered washers of the correct angle of taper shall be provided under all bolt heads and nuts bearing on beveled surfaces.

High Strength Friction Grip (HSFG) Bolts: High Strength Friction Grip bolts shall comply with the requirements of BS 4395, Parts 1 and 2, and shall be used in accordance with the provisions of BS 4604, Parts 1 and 2.

HSFG bolts, nuts and washers shall be supplied cadmium plated to BS 3382 to a thickness of 5 microns and shall be stamped or otherwise marked with a suitable and permanent mark and the Contractor shall obtain the written approval of the Engineer to the proposed marks before commencement of the work.

Each HSFG bolt shall be supplied complete with its nut screwed on. Washers may be supplied on the bolt or separately, and bolts and washers shall be packed in the manufacturer's works and delivered to Site in waterproof containers and stored under cover in these containers until required for use.

The method of tightening HSFG bolts shall be either the part turn method, the torque control method or with the use of load indicating washers in accordance with the following:

HSFG BOLTS COMPLYING WITH STANDARD	PERMISSIBLE METHODS OF TIGHTENING
BS 4604 Parts 1 and 2	1) Part turn for bolts M16 and above. 2) Torque control. 3) Load indicating washers
BS 4604 Part 2 (Higher Grade (Parallel shank)	1) Torque control. 2) Load indicating washers.

Whatever method of tightening is adopted, the Contractor shall supply to the Engineer full details of the procedures to be adopted which shall be in accordance with the requirements of BS 4604, together with details of the tools and equipment he will be using on site and the tests to be carried out to determine the load/torque/shank tension characteristics of the tools, bolts and the load indicating washers. No bolting shall commence until the Contractor has carried out sufficient site tests to confirm the load/torque shank tension characteristics of the tools and bolts to the satisfaction of the Engineer.

In the case of torque control tightening methods, calibration of the equipment shall be carried out daily before commencing bolting operations in accordance with the requirements of BS 4604.

Where load indicating washers are used, they shall be of a type approved by the Engineer and used in accordance with the manufacturer's instructions. The general requirements of BS 4604 shall apply to the assembly and use of HSFG bolts with load indicating washers including check testing to confirm the minimum shank tension is being achieved.

HSFG bolts that have been slackened off after final tightening by any method shall be removed, discarded and replaced at the Contractors expense.

6. Transportation, Handling and Erection

Erection shall generally be in accordance with BS5531 "Code of practice for safety in erecting structural frames". Structural steel shall be handled with care at all times and in such a manner as not to cause damage to the steel work or its protective coatings.

The Contractor shall submit to the Engineer for his approval drawings and calculations and details showing his proposed methods for transport, handling and erection of structural steel work including all equipment, temporary supports and bracings required to ensure stability and safety during erection. The Contractor shall erect the steel work, remove the temporary supports and do all the work required to complete the works in accordance with the drawings and the specification. The work shall be carried out in such a manner that structure or the foundations and any part injured, overstressed or disfigured shall be removed and replaced or rectified as instructed by the Engineer at the Contractor's expense.

For the lifting cranes, the Contractor shall transmit to the Engineer a verification report established by a qualified organization attesting the conformity of the equipment with regulations.

The steel work shall be temporarily erected at the fabrication works and be subject to inspection by the Engineer before being dispatched to site.

Drift pins will be allowed only for bringing together the several parts of the structure and shall not be used in such a way as to distort the work or enlarge the bolt holes.

Bolts in site connections shall not be finally tightened until sufficient of the structure is properly plumbed, aligned and levelled and no subsequent straining into position will be allowed. Finally, all bolts and connections shall be systematically checked and tightened.

7. Testing of Steel Work by the Engineer

The Engineer may nominate a testing authority to inspect the works and conduct such tests as he may consider necessary to test compliance with the specifications. Where required, test samples of welds shall be prepared, free of charge, by the Contractor for testing.

8. Process Control

Welds shall be regularly inspected and tested by the Contractor in terms of his obligations described in terms above regarding process control. This shall include visual inspection of welds to ensure that there is no undercutting, no uneven lengths, no porosity, no evidence of cracking and that full fusion has been achieved. If required by the Engineer, cores containing welds and adjacent parent material shall be cut out in doubtful areas. The cores shall be polished and examined and the hole made good.

9. Jacking

The steel frame shall be supported by temporary bearings during assembly and concreting of the slab, after which the deck may be jacked into place. Temporary bearings are mandatory to avoid damage to the permanent bearings during the concreting of the slab and the jacking operation.

The power of the equipment for jacking operation shall provide a safety coefficient at least equal to 1.5 with respect to the maximal expected reaction, all curvature and asymmetrical effects taken into account.

During the jacking operations, the displacement of the various jacks shall be continuously monitored. The extent of the displacements shall be compatible with the maximal transverse and longitudinal differences allowable in the deck, as determined by the calculations presented in the appendix to the jacking procedure.

On a same bearing line, a device shall be provided to indicate, during all the jacking operations, the deck displacement and the deck reaction.

2.9.3 Steel Guardrails and metal parapets

1. General

The steel guard-rails shall be erected along appropriate stretches of the highway edges and along the median divider strip of the four-lane roads or highways as directed by the Engineer.

The metal parapets and protection fencing shall be erected on the structures.

The guard-rails and parapets shall have containment level H3 to withstand vehicular impacts and a nearly constant property of absorbing impact without fracturing.

2. Characteristics of steel guard-rails

Guard-rails shall consist of a series of support posts in metal section on which is mounted, with appropriate spacers, a metal horizontal strip.

The geometrical and technical characteristics of guard-rail and their unit component are shown on the drawings or directed by the Engineer.

The Engineer may order a greater depth or other construction measures to ensure an adequate anchorage of the posts in soils of poor consistency; he may also vary the spacing between the posts.

In special cases, upon request of the Contractor and with the approval of the Engineer, support posts may be anchored to the ground by means of a base in concrete Class C 25 and of a size as established by the Engineer.

The connection of the strips one to the other and to their support posts, with the use of metal spacers, shall ensure, as much as possible, the continuous beam function of the system, and the connection systems (bolts and slot-cover plates) shall impede the slippage of the strips due to expansion of the holes.

All guard-rail metal components shall be in hot deep galvanized steel of at least S-235 quality, with a quantity of zinc not less than 300 g/m2 for each face and complying with UNI Standard 5744/66.

The systems of connection of the strips to the support posts shall permit the alignment to be resumed both during installation and in the event of settlement of the soil, permitting a vertical movement of more or less 2 cm and a horizontal movement of more or less 1 cm.

The strips and the systems of connection to the posts shall be such that the guard-rails can be installed along curves of 50 m minimum radius without having to use any special pieces or shapes.

Each stretch shall be completed with appropriately profiled curved terminal pieces, of similar material as used for all the strips.

The guard-rails to be placed in the median strip green areas shall consist of a double row of guard-rails of the type described heretofore, with their support posts positioned in line with the same cross sections.

The median strip guard-rails shall have similar characteristics as the lateral guard-rails; however, special care shall be adopted for the terminal pieces of closure and of connection of the two strips, which shall have a curved shape to be approved by the Engineer.

In this respect it will be noted that the Engineer may request a different arrangement (burying of the heads) with no variation in the Schedule prices.

The aforementioned minimum characteristics and installation systems concern structures which do not necessarily bind vehicles within the carriageway (embankments and trenches devoid of permanent lateral obstacles).

For bridge or viaduct guard-rails, for median divider strips and/or in the presence of permanent lateral obstacles, dangerous curves, steep slopes, water or other adjacent roads or railways, different and more adequate structural solutions shall also be adopted, such as increasing the density of the support posts and the use of stronger support posts.

Refractory devices of not less than 50 square centimeters shall be installed at not more than three strips center distance.

3. Characteristics of metal parapets and protection panels

The metal parapets and protection panels to be erected on the structures consist of a series of vertical support posts in metal section, a median horizontal strip, connected to the posts by spacers, a metal tubular handrail placed at not less than 1 m and a protection panel with an height not less than 2,5 m from the level of the finished pavement.

The parapets shall be constructed, for what concerns hot rolled steels, with S-235 type, whereas for the other types of steel or metal reference shall be made to the correspondent UNI Standards or other approved standards.

Parapet support posts shall be in an appropriately profiled one-piece steel section and, for the lower part holding the strip, the strength characteristics shall be similar to those required for the guard-rail support posts.

The distance between support posts shall be as shown in the relevant Schedule item. However, the Engineer reserves to furnish, for each structure, a drawing showing the parapet assembly scheme to be observed by the Contractor.

The support posts shall normally be inserted, to the necessary depth, into special anchorage holes provided or to be provided by the Contractor, on the structures and sealed with adequate mortar to the satisfaction of the Engineer.

The holes shall be executed as directed by the Engineer as also the restatement of the disrupted areas.

The strip shall be of the same type as that used for the guard-rail and shall be installed at the same height as that of the guard-rail from the finished pavement level, even if the distance between the posts is less.

The intermediate steel tube and the handrail, of not less than 45 mm external diameter and of 2.4 mm min. thickness, shall be anchored to the same support post as the horizontal strip.

All metal parts of the parapet shall be in steel construction to at least S-235 and subjected to hot galvanization by the bath method. The minimum quantities of zinc shall be 300 grams per square meter and for each face; controls on the quantities of zinc shall be performed in accordance with the procedures under ASTM No. A 90/53 and UNI 5744/66 Standards.

Refractory devices of not less than 50 square centimeters shall be installed at not more than every three support posts on the average.

The protection panels shall consist of a series of mesh panels 30x30 Φ3 in steel construction to at least S-235 and subjected to hot galvanization by the bath method.

2.10 Concrete and Reinforcement

2.10.1 Plain and Reinforced Concrete

1. General terms

The concrete grades which are defined in design study follow EN 206.

Before commencing the casting of each structure, the Contractor shall submit in due time for examination by the Engineer:

- the results of the preliminary study of mixes, carried out for each type of concrete whose class is shown in the static calculations of the works included in the tender in order to prove that the strength of the proposed concrete will not be inferior to that required by the project. Said study, to be carried out at an approved laboratory, shall also indicate for each class: nature, source and quality of the aggregates, the final grain size, type and cement content, water/cement ratio, type and proportion of eventual additives, type of mixing plant, expected value of consistency measured with the Abrams' cone, evaluation of workability of the concrete, systems of transport, casting and curing.
- The examination and verification by the Engineer of the designs of the works and the certificates of the preliminary qualification studies in no way relieve the Contractor of the legal and contractual responsibilities, being established that, notwithstanding the checks carried out by the Engineer during the works, the Contractor shall legally be solely and directly responsible for the works; hence the Contractor shall be held responsible for the inconveniences of whatsoever nature, importance or consequence that might occur.
- Furthermore, the Contractor shall submit for examination by the Engineer the projects of the temporary works (centring, arching, framework, rib, falsework and construction equipment), before concreting works commencement.

The Engineer will authorize commencement of casting of the concrete only after receiving from the Contractor the certificates of the preliminary qualification studies under point b) issued by said approved laboratory and after performing the appropriate checks, including further laboratory tests, as indicated by these Specifications.

2. Components

Cement: Cement used for concrete shall be as follows:

- Common cement Portland or Portland cement with quick solidification
- Furnace Portland Cement – Cement which contains strong air concentrations, various substances, re-powdered material or, which is contaminated, or unsuitable shall be refused and removed with no delay from construction site.

The cement shall be transported either in closed sacks, on which it is written the name of manufacturer and production date, or as a massive mass on approved transporters.

No part of any delivery shall be used without being approved. Damaged or defective cement shall be removed immediately from construction site.

Every part of cement delivery shall be tested from the manufacturer before the delivery and before use, attested copies of tests' result shall be sent before its use. For each delivery of 50 MT samples of up to 5 kg may be required to be taken.

The Cement shall be delivered to the construction site in sufficient quantities so as to ensure that concreting works are not suspended or interrupted.

The tests shall be repeated on a same consignment where doubts should arise as to degradation of the qualities of the cement due to any whatsoever reason.

If required by the Engineer or the drawings, Sulphate Resisting Portland Cement shall comply with BS-4027.

Aggregates: Material for fine aggregates shall consist in fine sand or powder, or their mixture. Material for the rough portion of aggregate shall have cubic shape and no edges. The Aggregate shall be in conformity with requirements of BS 882.

Index of stone crack shall not exceed 35 according to the definition by BS 812 Part I.

Taking of samples and aggregates' testing shall be made in frequent intervals as specified in BS 812 and as required. Also, on construction site, the following tests shall be made in conformity with BS 812.

Rough aggregates:

- Density and absorption of water.

Fine aggregates:

- Sieve analysis
- 10% tenuity

Rough aggregate (natural): Rough aggregates of nominal size of 10, 14, 20 or 40 mm, shall be selected in conformity with the requirements given on Table 3.9.1.1. A rough aggregate shall be the natural gravel, factionary gravel, factionary rock or their combinations.

Rough aggregates shall chemically be hard inerts, with limited porosity and should not contain granulated stones, coal or organic impurities or others which may cause reinforcement corrosion or strength digression and concrete endurance. The quantity of blowing out substances shall not exceed the following limits, in percentage, against weight:

–	Clay waste in the sieve 20 mm	– 0.40
–	Clay in total	– 0.70
–	Mild red oxide	– 0.25
–	Coal	– 0.25
–	Soft or fractioned rock particles	– 2.50
–	Graphite	– 0.25
–	Total as above left in the sieve 20 mm	– 1.00
–	Above Total	– 1.50
–	Clay Concentrations	– 0.25
–	Thin or lengthy sections with a length greater than 5 times average thickness	– 15.00 –
–	Material which goes through sieve no. 2.00	– 0.50

Table 2.10.1.1: Rough Aggregate for Concrete, Size Requirements

Sieve Size	Size 40mm	Nominal 20mm	Nominal 16mm	Aggregate 10mm
(mm)	Percentages according to weight			
50	100			
40	95-100	100		
25				
20	50-95	95-100	100	
16			95-100	
13				100
10	20-40	35-65	45-30	85-100
6	<5		<10	10-30
2.36		<10		<10

Fine aggregate: Fine aggregates shall be levelled in conformity with requirements as given on Table 2.10.1.2. Fine aggregates shall consist in hard and solid rock particles, except when fine and rough aggregates are produced simultaneously and from the same operations from gravel natural deposits, fine aggregate may contain fractioned rock particle of the same nature and quality with the one which is produced from normal operation of fractioning and separation of materials over stipulated size.

It should be chemically inert, hard or with limited porosity and not contain clay or coal or other impurities which may cause corrosion or may damage strength and concrete endurance. The quantity of blowing out substances shall not exceed the following limits, in percentage, against weight:

- Lignite coal 0.25
- Material which goes through sieve 200 2.00
- Other Substances (such as clay, chemical alkalis, smooth particles, fractions,
- alone or combined 2.50

Fine aggregate shall not harmful quantities of organic impurities.

When proved by colorimetric test of sodium hydroxide, the aggregate should not produce a color which is darker than standard color of solution, on condition that the Engineer may authorize in written form, the use of an aggregate which gives a darker color than the standard one if the tests of grout strength determine it as acceptable.

Table 2.10.1.2: Fine aggregate for Concrete, Size Requirements

Sieve (mm)	Percentage according to weight
10	100
6	95-100
2.36	75-100
1.18	55-100
0.6	30-60
0.3	5-30
0.13	<10

Water: Water shall be obtained from well-defined sources which supply water with characteristics approved by the Engineer, and free of oil, acid, alkali, earthy and vegetable substances, etc. Soundness, time setting, and mortar strength tests can be ordered by the Engineer in comparison with distilled water.

The water shall be added in the least possible quantity in relation to the required strength and the degree of workability of the concrete, considering also the water contained in the aggregates so as to observe the envisaged water/cement ratio.

All water used for the mixing of concrete, grouts or mortar, curing of concrete and for the washing down of construction joints shall meet the requirements given in Table 2.10.1.3:

Table 2.10.1.3: Water Purity

	Mixing	Curing	Washing
Total Dissolved Solids	2000ppm	-	2000ppm
Suspended Solids	2000ppm	-	2000ppm
Halides	≤500ppm	≤500ppm	≤500ppm
Sulphates SO_3	≤1000ppm	-	≤1000ppm
Alkali HCO_3/CO_3	≤2000ppm	-	≤1000ppm
Acidity (pH)	6.5 – 8.5	6.5 – 8.5	6.5 – 8.5

- Testing of Water

Tests on the purity, soluble sulphate, chloride or other chemical content, sediment and pH value shall be carried out at such times as the Engineer may direct. The Contractor shall arrange for the dispatch of samples of water to an approved testing laboratory and for the testing required. Sampling and testing shall be witnessed by the Engineer.

Addictives & Admixtures: The Engineer will decide whether the additives (hardeners or retarders) proposed by the Contractor can be used or not, based on the information available from previous works or experimentation.

Additives and admixtures shall be approved by the Engineer prior to their use and shall not in any way affect the quality of concrete.

Except where specifically required no materials of any description shall be used in any concrete mix other than aggregates, cement and water without the written instruction or approval of the Engineer in each case.

The Contractor should note that the description of any proposed admixture by trade or brand name will not be sufficient when proposing such admixture for the approval of the Engineer. In order to save delay, the Contractor should submit the fullest possible description of the chemical composition of any admixture, together with its ‘shelf life’ and details of storage and handling requirements. He should also submit details of its anticipated effect on the mixes in which its use is proposed. If appropriate, the Contractor should also provide details of how the mix proportions are to be varied to produce the required characteristic strength and rate of strength gain.

The Engineer will call for trial batches of concrete to be prepared to demonstrate the effect of the proposed admixtures both on the fresh concrete and on the hardened concrete before giving his approval. He may also lay down additional requirements for the control of the use of such admixtures.

Admixtures shall not be used which produce concrete that are more porous, have inferior surface structure, or are more susceptible to humidity or temperature movement than the corresponding concrete grade made without admixture. Admixtures that affect the density of the concrete, such as air-entraining agents, may be permitted provided strict control is maintained over the amount of entrained air.

Notwithstanding any previously given approval, the Engineer may withdraw such approval at any time with respect to any mix containing admixtures if, in his opinion, the performance of the admixture under actual Site conditions is not completely satisfactory.

- Supply and Storage of Admixtures

Admixtures for concrete shall comply with BS 5075 unless otherwise Specified or agreed.

All admixtures to be used in dose forms shall be supplied in containers or packages marked with the recommended dosage for each type of mix in which they are to be used.

Admixtures shall be stored strictly in accordance with manufacturers' recommendations and precautions shall be taken during delivery and storage to prevent damage to or adulteration of admixtures. This may include cleaning off sediment from the bottom of a storage tank, regular stirring, etc.

Cement replacements shall be stored and handled in accordance with the requirements as specified for cement.

Any cement containing admixtures shall be supplied in bags or containers clearly marked to show the nature and quantity of such admixtures and shall be stored separately from any other type of cement.

- Use of Admixtures

Any admixture used in any concrete mix shall only be used at the rate of dosage or in the proportions previously approved by the Engineer, all in accordance with the manufacturer's instructions and within the manufacturer's recommended ambient temperature range.

The halide content of any admixture shall not exceed 500ppm.

Any batch of concrete which has received an incorrect dose of an admixture or which shall show deterioration after placing as a result of incorrect use of admixtures shall be broken out or otherwise replaced without charge to the Contract.

Liquid admixtures or powder admixtures that are to be used as solutions shall be dispensed by an appliance fixed to the mixer, which measures weight, volume or dosing time and is provided with a recorder. This appliance shall be accurately calibrated, and the calibration and dosage shall be checked at regular intervals or as directed by the Engineer. All such admixtures shall be dispensed with the mixing water.

All admixture dispensers shall be thoroughly cleaned before commencing each day's work and at every interruption to the work.

Where admixtures are to be used in bulk form, these shall be weigh-batched as is provided in this Specification for the batching of cement.

Powder admixtures to be used in dose form shall only be allowed if premixed and used as solutions and then only if the premixing procedure has been previously approved by the Engineer.

Trial mixes shall be undertaken together with additional trial mixes showing the effect of overdosing and under dosing of the concrete mix.

- Chlorides

Under no circumstances shall calcium chloride or chloride-based admixtures be used in any concrete mix, grout or mortar unless otherwise specified.

- Corrosion Inhibitor

The use of proprietary corrosion inhibitors, whether specified or not, shall be subject to the written agreement of the Engineer. Their prime function shall be to form a protective film on the reinforcing steel.

Proprietary corrosion inhibitors shall be added to the concrete in accordance with the recommendations of the manufacturer. The dosage and rate of application shall be established by the Contractor following consultation with the admixture manufacturer and shall be confirmed to the Engineer in writing.

- Fibres

The purpose of fibre addition to the concrete mixture is to provide resistance to scaling and spalling from salt re-crystallization in splash, spray and tidal fluctuation zones of the structure. Product submittals must be supported by British Board of Agreement Certificates or other independent certifications approved by the Engineer. The certificate shall confirm product characteristics and successful project history. Fibres must be composed of virgin polypropylene and may either be monofilament or fibrillated, provided that the selected fibres do not adversely affect the capillary absorption properties of the mixture (i. e. their use does not increase the capillary index, above the value obtained from the control mixture). Optimal fibre dosage in terms of effect upon workability, effect upon strength, and effect upon capillary properties shall be determined by making comparative tests of companion specimens from the proposed mixture, both with and without fibres, to be submitted to the Engineer prior to mixture verification. In addition, the following criteria shall be confirmed as part of the mixture verification phase:

- Strength tests on standard laboratory specimens of fibre concrete shall be in full compliance with the strength requirements of this specification.
- Slump tests of fibre concrete shall be at least 50 mm, and the concrete shall be highly mobile when vibration is introduced.
- The capillary index, Ic, determined from capillary suction tests of fibre concrete carried out on 3 test specimens from 3 individual, field-cured, cube specimens (either 100 or 150mm sizes at 7 days age) shall be in accordance with this specification.

- Silica Fume

The use of silica fume, whether specified or not, shall be subject to the written agreement of the Engineer. Its prime function shall be to form a protective film on the reinforcing steel.

Silica fume admixture shall be the dry compacted form. The silica fume manufacturer shall submit a certificate of quality stating that the silica fume meets the following criteria:

– SiO2	– 90% Min.
– C1-	– 0.5% .
– L.O.I.	– 6% .
– Moisture	– 2% .
– Specific Surface	– 20m2/gram
– Bulk Density	– 500-700kg/m3

The silica fume shall be non-crystalline as determined by X-ray Diffraction. The dosage and rate of application shall be established by the Contractor following consultation with the admixture manufacturer and shall be confirmed to the Engineer in writing.

- Fly Ash

Fly ash shall comply with BS EN 450 and have the following properties:

Loss on Ignition	≤ 3.0%
SiO2	≥ 50.0%
Al2O3	≥ 30.0%
CaO2	≤ 5.0%

SO_3	≤ 1.0%
Cl	≤ 0.01%
Available Alkalis as Na_2O	≤ 1.50%
Particles larger than 45 microns	≤ 12.0%

- Super Fine Ash (SFA)

Super Fine Ash shall be assessed according to BS EN 450 with the following modifications given below:

Loss on Ignition	≤ 0.5% at 950oC
SiO_2	≥ 50.0%
Al_2O_3	≥ 30.0%
CaO_2	≤ 5.0%
Fe_2O_3	≤ 5.0%
SO_3	≤ 1.0%
Cl	≤ 0.01%
Available Alkalis as N_2O	≤ 1.50%
Particles larger than 25 microns	≤ 1.0%
Particles larger than 11 microns	≤ 10.0%

3. Controls of the acceptance strength of the concrete:

The concrete classes used in the Works shall comply with the drawings and for each Class of concrete such as C a/b:

a - represents cylinder compressive strength (N/mm^2)

b - represents cubic compressive strength (N/mm^2)

As soon as practicable after the commencement of the Contract, the Contractor shall produce in writing, for the Engineer's approval, his proposals for all concrete mixes of the grades set out in this Specification, stating proportions of all constituent materials, including admixtures, workability, etc.

The Contractor must note that ample time should be allowed for testing and obtaining the approval of the Engineer for all mixes, as provided below, before commencing the mixing of concrete for the permanent works on the Site.

Prior to the use of any concrete mix in the Works the Contractor shall either:

A. Prepare trial mixes for each different concrete mix to be used. Preparation and testing of trial mixes shall be carried out in the presence of the Engineer, if he so desires.

For each trial mix three separate batches of concrete shall be made using the materials approved for use in the Works and, unless otherwise approved, under full-scale production conditions. If for any reason it is not possible to make any trial mix under full-scale production conditions, then it may be made in a laboratory but only with the express permission of the Engineer and under such conditions as he may lay down.

Particular attention shall be given to the water/cement ratio and workability of these trial mixes. The free water content of all the aggregates used shall be accurately determined by drying or other approved means before the mixing begins in order to give an accurate measure of the free water/cement ratio.

The consistency of each trial mix concrete batch shall be measured by the Slump Test using the equipment and method given in BS EN 12350-2. The slump shall have a tolerance of ±25mm or ± 1/3 the required value, whichever is the greater. In hot weather conditions graphs of slump v time since adding the water to the mix and slump v concrete temperature shall be prepared for use in production testing.

If the slump is not within the permitted tolerance of the value specified, the proportions of the mix shall be adjusted accordingly, and new trial batches shall be made. Both the ambient temperature and the temperature of the fresh concrete shall be noted when each slump test is made.

For two of the trial mix batches a total of six 150mm cubes shall be made. These test cubes shall be made, cured and tested in accordance with the provisions of BS 1881-108.

Unless otherwise directed by the Engineer, three of the six test cubes shall be tested for compressive strength at 7 days and three at 28 days. The third trial mix shall consist of twelve cubes; three cubes being tested at each of 3, 7, 14 and 28 days.

or

B. If ready-mixed concrete is used, the Contractor may submit appropriate existing data as evidence of satisfactory previous performance for target mean strength, current margin, workability, water/cement ratio and rate of gain of strength.

The compressive strength of a trial mix shall be considered satisfactory if the following requirements are met:

a) The nine cubes from the three batches of a trial mix that are tested at 28 days age shall have an average compressive strength not less than

$1.2 \times f_{cu} + 5$

where: f_{cu} is the required characteristic strength in N/mm²

b) The compressive strength of each of the nine individual cubes tested at 28 days age shall not be less than

$1.2 \times f_{cu} - 2.5$

where: f_{cu} is defined above

In the event that the value of the cubic characteristic strength (Rck) obtained on the specimens subjected to tests at the site laboratory is inferior to that required in the static calculations and in the project drawings approved by the Engineer, the Engineer may decide to order the interruption of the concrete casting of the structure concerned pending the results of the tests carried out at the official laboratory.

Should the value of the Rck obtained on the specimens subjected to the official laboratory tests again be lower than that indicated in the static calculations and in the project drawings or an acceptance control condition not having been observed, it will be necessary to carry out, at the care and charge of the Contractor:

a) a theoretical and/or experimental verification of the structure concerned by the non-complying concrete on the basis of the reduced strength of the concrete, and
b) a check of the characteristics of the concrete already placed through complementary tests, either by taking specimens of hardened concrete already placed, or with other investigation means.

These controls and checks shall form the object of a supplementary report providing evidence that, notwithstanding the constraints and load assumed for the structures, the tested Rck is still compatible with the stresses set forth in the project, according to the requirements of the current provisions of law (including requirements for seismic conditions).

If the report is approved by the Engineer, that volume of concrete will be calculated on the basis of the value of the characteristic strength found and paid according to the new established Class.

In the event that the Rck is not compatible with the stresses foreseen in the project, the Contractor shall, at his own care and charge, demolish and reconstruct the structure or adopt those measures which, proposed by the Contractor, to become operative shall have to be formally approved by the Engineer.

No compensation or payment shall be due to the Contractor where the Rock shall be found to be greater than that indicated in the static calculations and in the drawings approved by the Engineer.

The Engineer reserves the right to take samples of concrete also from structures already built and cured, or to conduct on finished works, reinforced or not, non-destructive compressive strength measurements, by means of a sclerometer or other equipment.

4. Workability

Concrete shall be of such consistency that it can be readily worked into the corners and angles of the formwork and around reinforcement without segregation of the materials or bleeding of free water at the surface. On striking the formwork it shall present a face which is uniform, free from honeycombing, surface crazing, or excessive dusting, and which shall not, in the opinion of the Engineer, be inferior to the standard specified.

To satisfy the Engineer that the workability of the proposed mixes is adequate for the requirements of the Specification, the Contractor shall carry out a series of workability tests on the preliminary trial mixes. The tests shall be carried out in accordance with BS EN 12350, or such other procedure as may be approved by the Engineer. The samples to be tested shall be obtained from the batches used for the preliminary test cubes.

In addition, the Contractor shall supply for each of the qualities of concrete a section of formwork complete with reinforcement fixed in position and generally representative of the sections commonly to be employed in the Works. The capacity of this trial section of formwork shall be at least half a batch of concrete, but in any case, not less than half a cubic meter. The formwork shall comply with the requirements specified. The mounds shall be filled in the presence of the Engineer with concrete of the same mix and batch from which the preliminary test cubes are made and shall be compacted in the same manner and with the same equipment as are proposed for the Works. This procedure shall, if necessary, be repeated with modified mixes until the appearance of the concrete after striking the mound is acceptable to the Engineer, after which it shall be used as the standard for that quality.

5. Alteration of Mix Proportions

If during the period of the Contract the Contractor wishes to alter the proportions of any mix or any constituent of the mix or the source of any constituent, he shall obtain the prior permission of the Engineer in each case.

Additionally, if experience shows that any previously approved mix when used in the Works is inconsistent with satisfying the requirements of this Specification, then the Engineer may withdraw approval for this mix and direct the Contractor to produce an alternative. In either case the Engineer may require that additional trial mixes for the altered mixes be made and tested, all in accordance with the requirements of the preceding Clauses.

6. Minimizing the Risk of Damaging Alkali-Silica Reaction:

The Contractor shall submit to the Engineer for approval his proposals for minimizing the risk of alkali-silica reaction which shall be one of the sets of requirements given in Clause 1.4 of BS 5328-2:1997 (incorporating Amendments 1 & 2). Low reactivity aggregate types referred to in that standard are listed in Table 2.10.1.4 for ease of reference.

Table 2.10.1.4: Aggregate Types Considered to be of Low Reactivity

(After BRE Digest 330 - 1997)

Andesite	Marble
Basalt	Microgranite
Chalk (1)	Quartz (2)(4)
Diorite	Schist
Dolerite	Slate
Dolomite	Syenite
Feldspar (2)	Trachyte
Gabbro	Tuff

Gneiss	Air cooled blast furnace slag (BS 1047)
Granite	Expanded clay/shale/slate
Limestone (3)	Sintered pfa

(1) Chalk is included in this list since it may occasionally be a minor rock type in concrete aggregates

(2) Feldspar and quartz are not rock types but are discrete mineral grains occurring principally in fine aggregates.

(3) Excluding silicified limestone.

(4) Not quartzite and not micro-crystalline or crypto-crystalline quartz.

Table 2.10.1.5: Minimum rate of sampling for assessing conformity

<table>
<tr><td rowspan="3">Production</td><td colspan="3">Minimum rate of sampling</td></tr>
<tr><td rowspan="2">First 50 m3 of production</td><td colspan="2">Subsequent to first 50 m^3 of production [1]</td></tr>
<tr><td>concrete with production control certification</td><td>Concrete without produ-ction control certification</td></tr>
<tr><td>Initial (until at least 35 test results are obtained)</td><td>3 samples</td><td>1/200 m^3 or
2/production week</td><td rowspan="2">1/150 m^3 or
1/production week</td></tr>
<tr><td>Continuous [2] (when at least 35 test results are available)</td><td></td><td>1/400 m^3 or
1/production week</td></tr>
<tr><td colspan="4">1. Sampling shall be distributed throughout the production and should not be more than 1 sample within each 25 m3.
2. Where the standard deviation of the last 15 test results exceeds 1,37 σ, the sampling rate shall be increased to that required for initial production for the next 35 test results.</td></tr>
</table>

7. Mixing of Concrete

Mixing Plant: Concrete shall be mixed in mechanical mixers. The type and manufacture of these mixers, together with all associated plant, shall be subject to the approval of the Engineer.

Where small quantities of high-grade concrete are required the Contractor shall, if the Engineer so requires, provide small, portable, covered pan mixers of approved type for this particular work.

Such covered pan mixers shall only be used as the Engineer may direct and all the conditions covering the mixing of concrete for large scale concreting shall apply to any mix prepared in pan mixers.

Mixers shall be maintained within the manufacturer’s tolerances, with particular attention to mixing blade clearances and sizes, throughout the period of the Contract and any mixer or plant that is not so maintained or is faulty in any respect shall be removed from the work.

Mixing Requirements: The minimum size of the batch shall not exceed the minimum rated capacity of the mixer as stated by the manufacturer and as stamped on the mixer and the batch size shall not be less than 75% of such minimum.

Mixing shall begin immediately after the cement has been added, either to the water or aggregate, and shall continue until there is a uniform distribution of the materials and the mass is uniform in color and consistency or as directed by the Engineer. In any event, concrete shall be mixed for at least the period and at the drum speed specified by the manufacturers of the mixer.

The entire contents of the mixer shall be removed from the drum before materials for a succeeding batch are placed in it. The solid materials composing a batch shall be deposited in the mixer in accordance with the manufacturer's directions for use.

Within 30 minutes after the introduction of the mixing water to the cement and aggregate, or the cement to the aggregate, the concrete shall be placed in its final position in the forms, except that this period may be extended with the prior permission of the Engineer provided the weather conditions are favorable and the concrete is continuously agitated in an approved purpose-built supply vehicle or an approved retarding admixture is included in the mix.

If any mixer is out of operation for more than 20 minutes, it shall be thoroughly cleaned out together with all the handling plant, before any further concrete is mixed. All mixing and handling plant shall be thoroughly cleaned out before concrete, using a different type of cement or admixture, is used.

Hand Mixing: Normally hand mixing of concrete will not be allowed, but where the total quantity is small, the mixing may be done by hand but only with the express permission of the Engineer.

For hand mixing the quantity of cement for any given concrete mix shall be increased by ten per cent and not more than one quarter of a cubic meter shall be mixed at one time. The water/cement ratio shall not exceed that approved for the particular class of concrete concerned. Hand mixing shall not be permitted for any structural concrete or where there is a particular requirement for the concrete to be durable.

8. Transportation of Concrete

The contents of the mixer shall be discharged in one continuous operation and the concrete transported in such a manner that there shall be no segregation of its constituents. If, in the opinion of the Engineer, any segregation of the concrete materials has taken place during transport, the concrete shall be again turned over and mixed just before it is finally placed in position. No water shall be added to the concrete between the time of mixing and placing except on the written instructions of the Engineer.

Whilst being transported from the mixer to the site of placing, all concrete shall be properly protected from contamination by dust or sand and from excessive moisture gain or loss from rainfall or high temperature, and all equipment used shall be purpose-made for the correct transportation of concrete.

The Engineer has the power to reject concrete batches not complying with the prescribed requirements.

9. Casting of Concrete

Preparation for Placing: In preparation for the placing of concrete, all construction debris and extraneous matter shall be removed from the interior of forms. Standing water on areas to receive concrete shall be removed before concrete is placed. All exposed reinforcement shall be free from loose rust, scale and windblown salts and spray.

Placing of concrete shall not be commenced until the Engineer has inspected and passed the formwork or other areas to receive concrete and any reinforcement, cast in fixings etc., against which the concrete is to be placed. Any approval so given shall not relieve the Contractor of any of his responsibilities under the Contract.

Where concrete is to be cast against an existing concrete face, that face shall have been prepared to expose the aggregate and all loose particles removed. This surface shall be wetted prior to receiving concrete. This preparation shall be subject to inspection by the Engineer.

Placing of Concrete: Concrete shall be placed in the shortest possible time after mixing is completed and before it has taken an initial set. It shall be placed as close as possible to its final position to avoid segregation of materials and displacement of reinforcement.

Normally concrete may be deposited with a minimum free fall of 1.5 meters without the use of pipes, providing suitable measures are taken to prevent segregation and premature coating of upper reinforcing steel. When pipes are used, they shall, as far as is practicable, be kept full of concrete during placing and their lower ends shall be kept buried in the newly placed concrete. In certain circumstances greater heights than 1.5 meters may be allowed but only with the written authority of the Engineer following trials to establish the effect on the concrete.

Chutes may also be used and shall be of steel or steel lined. They shall be constantly kept clean from coatings or hardened concrete or other obstructions. Chutes shall be set at such an angle that neither does the concrete stick to them nor does it become segregated.

Concreting of any section or unit of the work shall be carried out in one continuous operation and no interruption of the concreting will be allowed without the approval of the Engineer.

In cases where the approval of the Engineer is obtained and where delays of more than one hour occur between successive concreting when, in the opinion of the Engineer, the previously placed concrete has had time to harden, the resulting joint shall be treated as a Construction Joint. The previously placed concrete shall be cut back to a vertical and/or horizontal face and the joint face treated as required in these Technical Specifications.

Compaction of Concrete: After concrete has been placed it shall be thoroughly compacted by mechanical vibration applied by immersion vibrators or, for surface finishing on thin slabs, approved surface vibrators or vibrating tampers. Vibrators shall only be used by competent operatives properly trained in the handling of the particular equipment in use on the Site.

Immersion vibrators shall run at a frequency of not less than 120 Hz when immersed. The active part of the vibrator shall be fully immersed while in use and vibration shall be of sufficient duration and intensity to compact the concrete thoroughly but shall not be continued at any one point to the extent that segregation occurs. Vibrators shall not be used to transport concrete in the forms. Vibrators shall be manipulated so as to work thoroughly the concrete around the reinforcement and embedded fixtures and into the corners and angles of the forms. Vibrators shall not be applied directly, or through the reinforcement, to sections or layers of concrete which have hardened to the degree that the concrete ceases to be plastic under vibration.

Every care shall be taken to see that reinforcement and fittings attached to the shutters are not disturbed and that no damage is caused to the internal face of the shutters when using immersion type vibrators.

Vibration shall be supplemented by such spading as is necessary to ensure smooth surfaces and dense concrete along form surfaces and in corners and locations impossible to reach with the vibrators.

The Contractor’s attention is drawn to the importance of achieving a high degree of compaction in order to produce as dense a concrete as possible, but not over vibrating concrete against shutters thus causing an increase in the water/cement ratio local to the shutter.

Where casting against existing concrete surfaces compaction should be ensured by local use of vibration to remove pockets of air that may be trapped, especially under horizontal surfaces.

Setting Concrete: After the initial set of the concrete the forms shall not be jarred, and no strain shall be placed on the ends of reinforcing bars which project. Adjacent works, which may cause vibrations to be transmitted to any setting concrete, may be ordered to be stopped at the discretion of the Engineer.

Records of Concrete Placing: The Contractor shall keep a record of the date, time, shade air temperature, mix temperature, mix type and quantity and place of deposition for all concrete used in the Works and records of the samples taken and shall permit the Engineer to inspect these at any time.

Hot Weather Concreting: In hot weather conditions, specific arrangements shall be agreed with the Engineer for controlling the temperature of fresh concrete. These arrangements shall include night or early morning working, prior cooling and/or shading of reinforcement and forms, shading of aggregate stockpiles, and shading of placed concrete from direct rays of the sun. The Contractor shall further note that the times quoted for mixing and placing and the frequency of cleaning of equipment may have to be modified in hot weather. Covering or other protection of concrete during transport may also be necessary. Trials shall be carried out to determine the adequacy of the control measures and the workability of the fresh concrete under those conditions.

Chillers shall be used to cool the mixing water. Ice shall not be used. The difference between the temperatures of the chilled water and the cement shall not exceed 40oC.

The Contractor’s attention is drawn to the recommendations of American Concrete Institute Standard ACI 305R-91, “Recommended Practice for Hot Weather Concreting” and of CIRIA Special

Publication 31 “The CIRIA Guide to concrete construction in the Gulf region”.

Unless otherwise directed by the Engineer, all items of equipment covered by this Clause shall be painted white to minimize solar heat absorption.

Protection Against Rainfall: The Contractor shall provide adequate cover as necessary to protect concrete whilst being placed against damage from rainfall.

The Engineer has the power to prescribe, where and when he deems it necessary, that pouring of concrete be carried out in one continuous operation thus avoiding resumptions and the Contractor cannot claim any extra payment even in the event that the work has to be carried out in continuous shifts and also on holidays. Where the concrete is cast in the presence of water the necessary measures shall be adopted to prevent the cement and fine materials from being washed out of the concrete, thus jeopardizing its normal consolidation.

The cost of these measures shall be borne by the Contractor.

10. Curing of Concrete

General Requirements: The Contractor shall ensure that curing is carried out such that thermal and plastic cracking of the concrete does not occur. Particular attention shall be given to the curing of concrete containing cement replacement material.

Until a period of seven days has elapsed from the time of placing the concrete, the concrete shall be kept protected against loss of moisture, rapid temperature change, rain and flowing water, mechanical injury, contamination by airborne dust and sand, drying winds and surface heating by the sun’s rays. This period may be varied at the direction of the Engineer.

Following the completion of the above period, a further period of controlled drying out will be required as directed by the Engineer. This may require that covers, sand layers and the like be kept in place for longer than the 7-day minimum curing period otherwise specified.

The Contractor’s attention is drawn to the recommendations of the American Concrete Institute Standard ACI 308-92, “Standard Practice for Curing Concrete”. The Contractor shall provide the necessary equipment and check for conditions in which plastic cracking is likely to occur (Ref. ACI 305R-91).

The Contractor’s attention is particularly drawn to the importance of start curing as early as possible after placing concrete and maintaining full curing procedures throughout, as specified and directed.

Any concrete which exhibits plastic settlement or plastic or drying shrinkage cracking or which has not been properly cured is liable to rejection by the Engineer.

Curing Methods: All methods to be used for curing and protection of freshly placed concrete must receive the prior approval of the Engineer. These methods shall include the use of curing membranes, water, covers, shades and any other precautions that are required to protect concrete elements from the effects of wind, solar radiation and ambient temperature extremes such that the Contractor can ensure satisfactory curing of the concrete. Precast concrete shall be placed and cured in shaded areas that are shielded from the wind. The following curing approaches are allowed:

- Severe Exposure Mixes. Curing methods shall consist of wet curing combined with impervious sheet membranes.
- Other Mixes. Curing of other mixes shall use wet methods, curing compounds or other techniques that are in compliance with this Specification.
- Temperature Protection. Special attention shall be given to temperature protection measures as outlined previously. These provisions shall be incorporated within the method statement for curing all concrete mixtures.

Water Curing: Where water curing is adopted, the concrete shall be covered with sacking, hessian, or other absorbent material, or a 75mm layer of sand, kept constantly wet for 7 days and, where directed by the Engineer, also covered with plastic sheeting to reduce loss by evaporation. Where timber formwork is maintained in place, the timber shall be kept wet and where possible loosened to provide water to the face of the concrete. Water for curing shall comply with these Technical

Specifications requirements. Care shall be taken to ensure that the temperature of all water used at all stages of the curing process is as close as possible to that of the concrete being cured.

Curing Membranes:

- Liquid Membranes: Where used, curing membranes shall be of resin based white reflective type and shall be sprayed on the surface of the concrete as soon as all free water has evaporated from the surface, except where provided for below. In the case of formed surfaces, where formwork has been eased or struck before seven days have elapsed from the date of placing concrete within them, the curing membranes shall be applied immediately after the formwork has been removed. In every case the rate of coverage and method of application shall be according to the manufacturer’s instructions. Where a surface treatment is to be applied to the concrete (e.g., a surface hardener) a curing membrane shall only be used if it is compatible with the surface treatment.

- Sheet Membranes: Where used, sheet membranes shall consist of either of the following:

I. Impervious paper consisting of two sheets of construction grade paper glued together with bituminous material. Following initial wetting the sheet is held firmly to the concrete surface.

II. Plastic sheeting, minimum thickness 100µm. The concrete is kept continuously wetted by the application of water under the sheet.

Use of Covers: Curing of concrete surfaces may be carried out by sealing with opaque, reflective plastic sheeting held in close contact with the surface of the concrete and forming an airtight fit around the element being cured. The sheeting shall form a continuous seal and be without tears or holes. If necessary, the Contractor shall provide frames for the plastic sheeting so that the covers can be placed over deck slab pours immediately after the concrete has been floated off and before the brush finish is applied.

Such frames can be removed as soon as the concrete is strong enough to support the plastic sheeting without leaving an impression in the concrete surface.

Wetting of Formed Surfaces: Formed surfaces shall, to compensate for any surface drying that has occurred and as soon as the form is removed, be sprayed with water and allowed to reach a uniformly damp appearance before continuing with curing.

Curing of Concrete in Hot Weather: When the daytime ambient temperature is greater than 250oC or at such other times as the Engineer may direct, for example, when there is a hot dry wind or low relative humidity, curing shall proceed as detailed below. Any necessary repairs or finishing processes shall be carried out as soon and as quickly as possible, only exposing a small area at any one time.

(a) Large Flat Areas, e.g. Slabs (Preferred Method)
  - Immediately after the required surface finish is applied, cover the concrete surface with polythene sheeting/wooden frames to minimize evaporation. All gaps at sides and ends must be filled in to avoid wind-tunnel effects.
  - When the surface can carry weight, replace the frames by a layer of damp hessian covered by polythene sheet. The hessian must be kept continuously damp for 7 days, (i.e., not wet/dry cycles), and suitable weights must be used to keep the polythene in place.
  - After 7 days wet curing, 7 days cover-only curing is required.

(b) Alternative Method for Large Flat Areas (if potable water is in scarce supply)
  - As item (a)(i) above.
  - When the surface can carry weight, apply white-pigmented resin-based curing compound as per the manufacturer’s instructions. No curing compound shall be sprayed on construction joints.
  - Cover with dry hessian for 14 days.

(c) Flat Surface with Starter Bars
- Shade the whole area from sunshine before concreting commences, leaving enough room for personnel/placing access, and ensuring that no gaps are left in the sides/ends which would allow wind-tunnel effects.
- As soon as concreting is complete, cover the top surface with damp hessian, (which is to be kept continuously damp for 7 days) and a layer of polythene.
- Maintain cover-only curing from the 8th to the 14th day.

(d) Vertical Surfaces
- Leave formwork in place for at least 24 hours and keep continuously wet, then, after removing the forms, immediately wet the surface and cover the sides with damp hessian (which is to be kept continuously damp for 7 days) or curing compound (as item b)(ii) above), both of which are in turn to be covered by polythene.
- Maintain cover-only curing from the 8th to the 14th day.

Thick Sections: The Contractor's attention is drawn to the need to take special precautions, such as careful planning of construction joint locations, to limit the build-up of heat in thick sections of concrete, particularly during hot weather.

Temperature Protection: The excessive temperature of concrete during hydration has a significant impact on the durability of concrete and is responsible for the development of early age cracking. The control of temperature differential during hydration is critical to quality control. Generally, the concrete temperature should not exceed 60oC however temperature differentials are equally important both in respect to thin and massive sections.

The Contractor shall ensure that all measures to achieve the limits set out in Table 2.10.1.6.

Table 2.10.1.6: Hydrating Concrete Temperature Limits

Risk	Ambient Temperature(1)	Protection Measures	Time at Risk (Hours)	
			At Temperature	At Differential Temperature
Low	Cool	None	15 – 30	60
Low	Hot	None	15 – 30	60
Medium	Cool	Insulation (2)	24 – 48	120
Medium	Hot	Reflective covers	24 – 48	120
High	Cool	(3)	-	-
High	Hot	(3)	-	-

Notes

(1) Cool implies mean daytime temperatures for the duration of the curing period unlikely to exceed 30^{o}C. Hot implies mean daytime temperatures for the duration of the curing period consistently above 30^{o}C.

(2) To be agreed with the Engineer. Minimum 50mm.

(3) To be agreed with the Engineer. The proposed methods shall achieve the following limits; temperature $\leq 60^{o}$C; differential temperature $\leq 15^{o}$C.

Curing Notices: Curing notices shall be exhibited for each concrete pour, stating the time and date when the concrete was placed, the date for last wet curing and the date for completing of cover curing.

Curing of Repairs: All concrete repairs shall be cured in accordance with this Section of the Specification.

11. Concrete Grades

The grades of concrete to be used in the Works shall be as shown in Table 2.10.1.7, unless otherwise directed by the Engineer.

Where concrete is classified with respect to its compressive strength, Table 2.10.1.7 for normal-weight and heavy-weight concrete apply. The characteristic compressive strength at 28 days of 150 mm diameter by 300 mm cylinders (fck,cyl) or the characteristic compressive strength at 28 days of 150 mm cubes (fck,cube) may be used for classification.

Table 2.10.1.7: Compressive strength classes for normal and heavy-weight concrete

Compressive strength class	Minimum characteristic cylinder strength $f_{ck,cyl}$ (N/mm^2)	Minimum characteristic cube strength $f_{ck,cube}$ (N/mm^2)
C8/10	8	10
C12/15	12	15
C16/20	16	20
C20/25	20	25
C25/30	25	30
C30/35	30	37
C35/45	35	45

The Contractor should prove to Engineer that the concrete insitu is suitable (or equivalent) to use in reference to Design Study demands.

Additives could be used under the approval and supervision of the Engineer. The Additives shall be comply with EN 934/2.

12. Construction Joints

Construction joints shall be located as shown in the Drawings, or as designated by the Contractor subject to the approval of the Engineer.

Concreting shall be carried out continuously up to construction joint level, the position and arrangement of which shall be as indicated on the drawings or as approved by the Engineer.

Construction joints shall be prepared by removing fines from the surface of the joint while the concrete is still green, but not earlier than 3 hours after the concrete has been poured.

The normal method of concrete surface preparation at horizontal construction joints shall be air/water jetting; the time for this operation shall be determined by site tests.

The surface shall be roughened with a high-pressure air-water jet to remove laitance and to expose clean sound aggregate, but not so as to undercut the edges of the larger particles of aggregate.

After roughening, the concrete surface shall be washed and rinsed until there is no trace of cloudiness in the wash water.

If the surface of a lift is congested with reinforcing steel and is relatively inaccessible, or if for any other reason the Engineer considers it undesirable to disturb the surface of a lift before final setting has taken place, surface roughening by means of air-water jets may not be permitted and the use of light bush hammering may be required. The operation shall be continued until all unsatisfactory concrete and all laitance, coating, stains, debris and other foreign materials have been removed.

Before casting, the surfaces which have been thus treated shall be thoroughly cleaned; excess water shall be eliminated and a layer of mortar (approximately 30 mm thickness) shall be applied.

The following lift shall be immediately cast over this connecting layer of mortar.

Vertical construction joints shall be cleaned by light bush hammering.

In water-retaining structures, at all construction joints, PVC or rubber waterstops shall be provided, to the approval of the Engineer.

13. Expansion Joints

Expansion joints shall be formed either in elevation or in foundation, in structures to be executed with cast concrete, to avoid irregular and unforeseen cracks of the structures due to the concrete effects of temperature, shrinkage and eventual structures settlements.

Said joints shall be formed at intervals and in appropriately selected positions taking into account also the particular characteristics of the structure (foundation benching, adjoining of new to old concrete structures, etc.)

The joints will be obtained by placing, prior to concrete casting, special partition of suitable material to be left in place so as to create discontinuity surfaces (plane, graded, groove and tongue, etc.) rising to the surface according to continuous or broken rectilinear lines.

Width and conformation of the joints will be approved by the Engineer.

The joints as described above shall be executed at the care and charge of the Contractor, such cost having been entered in the price item for each class of concrete.

In the event that the design envisages that the joint be fitted with a special watertight or cover element, the price item in the BOQ will include, together with the supply and installation of these special elements, all the particular duties that will be required for the final, workmanlike disposition of the joint.

The manufactured elements for water tightness or cover of the joints may be: elastomers of ethylenic structure (styrene butadiene), of paraffin structure (bitile), of complex structure (silicone polyurethane, poliossipropilene, poliossichloropropylene), by the so- called protected ethylenic elastometers (neoprene) or else by polyvinyl chloride.

Also the use of sealers can be envisaged; the sealers can be made of oleoresinous, polymerizable elastometer based bituminous-silicone substances or polysulphides. They shall assure water tightness, elasticity under the envisaged deformations, a perfect adherence to the walls, obtained also by means of suitable primers, not flowing under the highest temperatures and not rigid under the lowest, maintaining their characteristics as described above for the longest possible time after employment.

No oblique joints forming acute dihedral angles (wing wall, oblique bridge abutment, etc.) can be executed. In these cases it is always necessary to modify the acute dihedral angle so as to form with the external surfaces of the structure dihedral angles not inferior to a right angle with plane faces of adequate width in relation to the imum diameter of the aggregates used.

14. Drainage Holes

For earth retaining structures provision shall be made for a sufficient number of appropriately positioned holes for evacuation of percolating waters.

The holes shall be obtained by inserting in the concrete mass prior of casting tubes of circular section or other sections in PVC or similar material.

For the formation of the holes the Contractor is not entitled to the payment of any supplementary amount, being the relevant Price item for concrete works, inclusive of all costs and supplies to give a workmanlike finished work.

Preparation of holes, chases, grooves, recesses, etc.

It will be the precise obligation of the Contractor to provide in due time during the execution of the works whatever is indicated in the construction drawings or successively ordered from time to time by the Engineer, concerning holes, chases, grooves, recesses, etc. in the slabs, ribbing, pillars, walls, etc. for lodgings of cables, parapet, wall plates, signs, parts of equipment, etc.

The relevant cost is included and compensated for in the unit rates and therefore, all the consequences for the non-execution of the preparations will be to the entire charge of the Contractor both with regard to breakages, demolitions and reconstruction of structures of the Contractor's responsibility and with regard to eventual works for adaptation of fittings or plants, delays, additional supplies of materials and the additional labour, required by the suppliers, if any.

15. Mass Production – Prefabricated elements

The documentation to be submitted to the Engineer relative to concrete elements not cast on the site shall demonstrate the full compliance of the prefabricated element to the requirements of these specifications.

The prefabricated units shall be constructed under the supervision of a qualified person employed by the Contractor. The Contractor shall take samples and carry out tests and production controls on the finished materials with the methods and within the time periods set forth in these Specifications. A copy of the test certificates shall be submitted to the Engineer.

Each consignment of prefabricated units shall be accompanied also by a certificate of origin signed by the producer, and by the technician responsible for the production as set forth in the previous paragraph. The certificate shall guarantee that the manufactured unit conforms to the characteristics required by the project and approved by the Engineer.

Each consignment of prefabricated units shall be accompanied by special instructions indicating methods of transport and erection, as well as the characteristics and limits of use of the units.

Prefabricated units shall be stored in a manner such that additional bending stresses in the units are prevented. The accumulation of trapped water and deleterious matter in the units shall be prevented. Care shall be taken to avoid rust staining, efflorescence and the effects of salt spray.

Prefabricated units shall be lifted or supported only at designated lifting and support points.

Units shall be handled and placed without impact. At all stages of construction, units shall be properly protected to prevent damage to concrete surfaces especially arises and other features.

Unless otherwise detailed on the Drawings or directed by the Engineer, manufacturing of prefabricated units shall be strictly within the tolerances specified below:

a) Length

Up to 3m ±6mm

3 to 4.5m ±9mm

4.5 to 6m ±12mm

Additional for every subsequent 6m ±6mm

For beam-type sections the length shall be the major dimension of the unit. For slab-type sections the above tolerances for length shall apply to the two major dimensions (i.e. side length).

b) Cross Section

imum tolerance of ±6mm

These tolerances shall apply to the two minor dimensions of beam-type sections and to the thickness only for slab type sections.

c) Straightness or Bow (deviation from Intended Line)

Up to 3m ±6mm

3 to 6m ±9mm

6 to 12m ±12mm

Additional for every subsequent 6m ±6mm

d) Squareness

When considering the squareness of a corner, the longer of the two adjacent sides being checked should be taken as the base line. The shorter side should not vary in its distance from a perpendicular so that the difference between the greatest and the shortest dimensions exceeds:

Length of shorter sides

Up to and including 1.2m 3mm

Over 1.2m but less than 1.8m 5mm

1.8m and over 6mm

For the purpose of this requirement any error due to lack of straightness should be ignored; squareness should be measured with respect to the straight lines which are most nearly parallel with the features being checked. When the nominal angle is other than 90° the included angle between check lines should be varied accordingly.

e) Twist

Any corner should not be more than the tolerance stated from the plane containing the other three corners:

Up to 600mm wide and up to 6m length 6mm

Over 600mm wide and for any length 12mm

f) Flatness

The imum deviation from a 1.5m straight edge placed in any position on a nominally plane surface should not exceed 5mm.

g) Camber

The variation in camber between closely associated units should not be greater than 6mm for units up to 4.5m in length, nor 9mm for longer units, and should be visually close-matched wherever possible.

h) Reinforcement

Reinforcement shall be fixed in accordance with the drawings and these Technical Specifications.

i) Position of Connecting Bolts and Other Devices

The position of individual connecting bolts, bolt holes, projecting steel or other devices in any associated group should be within 6mm of its true position in the group in which they are cast. The longitudinal location of any such group or of any individual device should be within 6mm of its true position in the unit in which it is cast, provided that such tolerance does not adversely affect the proper assembly of the whole structure.

Notwithstanding the above requirements for tolerance, the overall dimensions and shape of any prefabricated unit shall not be such as to prevent the proper erection of that unit in conjunction with any other unit, steelwork or insitu construction.

All finished units, whether erected in position or not, which do not comply with the Drawings and Specifications shall be removed and replaced with new items to the Engineer's satisfaction.

Reasons for rejection of units shall include the following:

No cracked or repaired units will be acceptable

No units shall have broken edges whether reinforcement is exposed or not.

No units shall have any reinforcement with concrete cover not complying with these Specifications.

No elements shall have a surface finish inferior to that indicated on the drawings and defined in these Specifications.

No units outside the dimensional tolerances shall be acceptable.

Once the above conditions are met, the prefabricated units can be accepted without any further examinations or controls except random controls which can be required by the Engineer.

Copy of the certificate of origin shall be attached to the report of the Engineer.

16. Ready – mixed concrete

Ready-mixed concrete is allowed for use concrete provided that it conforms entirely to the conditions of these Specifications.

It is also obligatory to take samples for the control tests on the sites of use at the time of casting to ascertain that the strength of the concrete is not inferior to the minimum design strength.

The Contractor remains solely responsible vis-à-vis the Engineer for the use of ready- mixed concrete in the works forming the object of the tender and undertakes to observe and make observe all the legal provisions regarding the materials (aggregates, cements, etc.) as well as the preparation and transport of the concrete from the place of production to the construction site, which in relation to the methods and times of transport to the site, may undergo even significant quality alterations.

17. Special provisions for ordinary reinforced concrete

The conditions are hereby stressed of the section relative to the plain and reinforced concrete relative to mixes concerning the obligation for the Contractor to ordinary subject to the prior approval of the Engineer, in the reinforced required number of copies, the construction drawings concrete and the static calculations of the reinforced concrete structures and of the centering and support reinforcement prepared by a qualified structural engineer, as well as the relevant BOQ.

The examination or verification by the Engineer of the submitted designs and calculations in no way relieves the Contractor of his legal and contractual responsibilities, being established that, notwithstanding the controls carried out by the Engineer, the Contractor remains solely and fully responsible for the works; he will thus be held responsible for all inconveniences of any nature, importance and consequence that might occur.

In placing the structural reinforcements in the forms appropriate precast concrete spacers shall be used.

Where the reinforced concrete structures are constructed near sea coastlines or in areas where waters with aggressive components are present (selenious, sulphurous, carbonic waters, etc.), the following conditions shall be observed:

- the aggregates of the concrete shall be of suitable continuous grain size so that the external layer of the concrete covering the steel reinforcement is impermeable. Furthermore, the aggregates shall be abundantly washed with fresh water so that all chlorides and sulphates are completely removed. For the same reason the mix water shall be limpid and fresh and free from said harmful substances;
- the concrete shall be made as described above
- Immediately after removal of the formwork, the whole external surface of the structure shall be treated with an extremely fluid cement grout to be applied and uniformly spread with a brush, after accurate filling of the uneven surfaces with a rich cement mortar.

The worksite report shall show the date of beginning and end of the concrete casting and of formwork removal. Should the casting be carried out during the winter season, the Contractor shall record daily the minimum temperatures desumed from a special thermometer exposed on the worksite.

The tendered prices are intended to include for all costs of compilation of the building documents, the load and stability tests of the structures as well as the cost of the tests of the materials to be used in the construction and the costs of sampling and surveys.

During the execution of the works the Engineer will be entitled to order the observance of all those precautions, limitations and conditions of any kind he will deem necessary in the interest of the regularity and safety of traffic by which the Contractor shall abide without being entitled to claim any payment of whatsoever nature and kind other than what set forth in the BOQ and relevant Price Schedule.

18. Finish and Repair of Concrete

The quality of finish, without additional rubbing-up, repair etc., shall be as described in Table 2.10.1.8 here below and detailed on the Drawings.

Table 2.10.1.8: Concrete finishes

Type	Description	Typical locations
U1	Unformed surface; tamped level, wood floated (by hand or machine), steel trowelled (by hand or machine).	Slabs receiving no further surfacing; surfaces over which liquid flows; tops of exposed walls.
U2	Unformed surface; tamped level and wood floated by hand or machine.	Slabs beneath water level; floors receiving surfacing such as tiling.
U3	Unformed surfaces; tamped level by board or mechanical tamper, struck off level.	Top of foundations; slabs receiving screed finishes.
F1	Formed surface; F2 finish achieved but all blemishes removed by rubbing down; alternatively use of high quality plywood forms with means of absorbing excess moisture.	Structural members within a building.
F2	Formed surface; finish achieved using close jointed timber, steel or plywood forms; grout fins removed, blow holes filled and fully rubbed down.	Walls, beams, columns and underside of slabs exposed to view.
F3	Formed surface; finish achieved using timber board or steel panel forms; grout fins removed after stripping	Walls, beams, columns and underside of slabs not exposed to view.
F4	Formed surface; exposed aggregate or other architectural feature, as detailed on the Drawings.	Members forming a defined feature in a structure.

If any portion of the exposed concrete should prove unsatisfactory on removal of the formwork, it shall be cut out and made good as directed by the Engineer, all at the Contractor's expense. Sufficient of this face concrete shall be removed to coincide with the panels in the formwork so that no patching effect occurs. No plastering of concrete surfaces shall be allowed. At the discretion of the Engineer, board marks or minor discontinuities on exposed faces may be removed by rubbing down with Carborundrum, and small surface voids or minor porosities may be filled by rubbing down with cement concrete. Treatment shall be carried out after removing the formwork, but in any case, only after the Engineer has examined the facework.

Edges to joints shall be machine-cut to a "V" shape (to a width and depth of 30 mm) before repair work is carried out.

Concrete repairs shall be carried out by methods suitable for the extent and dimensions of the holes to be made good by using one or more of the following materials:

- epoxy concrete or epoxy resins in mixes of designated grading;
- steel mesh gunite;
- epoxy mortar (epoxy resin and sand).

For the surface finish of repairs, where the exposed surface is in view:

- paint to surface of concrete face (to limits within designated discontinuity) with a mixture of Portland cement and water-based glue (Vinavil or similar).

Repairs of imperfections in formed concrete shall be completed within 24 (twenty-four) hours after removal of formwork.

19. Tolerances

Finished concrete surfaces shall be within the tolerances given in Table 2.10.1.9. The formwork, method of placing, vibration procedures etc. shall be selected to ensure compliance with these tolerances.

Table 2.10.1.9: Tolerances on finished concrete

Structure, type, position	Type of irregularity	Tolerance (mm)					
		U1	U2	U3	F1	F2	F3
Buried walls, foundation slabs, columns, beams	Departure from alignment	NA	NA	±10	NA	NA	±10
	Variations in cross-section dimensions	NA	NA	NA	NA	NA	±10
	Abrupt	NA	NA	±5	NA	NA	±5
Exposed walls, columns, beams	Departure from alignment	±5	±5	NA	±3	±3	NA
	Variations in cross section dimensions	NA	NA	NA	±2	±3	NA
	Abrupt	±1	±3	NA	±1	±1	NA
Exposed slabs	Departure from alignment	±5	±10	NA	NA	NA	NA
	Variations in cross-section dimensions	±3	±5	NA	NA	NA	NA
	Abrupt	±2	±3	NA	NA	NA	NA

NA=Not applicable

20. Prestressed concrete structures

- Description

This Work shall consist of furnishing and placing precast, pretensioned, Portland cement concrete members or post-tensioning cast-in-place concrete structures in accordance with details shown on the plans and as specified in these Technical Specifications.

This Work shall include the furnishing and installation of all items necessary for the prestressing system to be used, including but not limited to prestressing and reinforcing steel, ducts, anchorage assemblies and grout used for pressure grouting ducts. The Work also includes curing, storing, transporting and erection of precast pretensioned members complete and in-place. For cast-in-place post-tensioned concrete the term "member" as used in this Section shall be considered to mean the concrete which is to be post-tensioned.

- Prestressing system approval

The Contractor shall submit to the Engineer for review and approval working drawings of the prestressing system proposed for use. For initial review, six (6) sets of such drawings shall be submitted. The Engineer shall return one (1) approved set or one (1) set with corrections and modifications. After modification, six (6) sets showing any required corrections shall be submitted for final approval. Working drawings shall be submitted sufficiently in advance of the start of the affected work to allow time for review by the Engineer and correction by the Contractor of the drawings without delaying the approved programmed commencement of the Work. Such time shall be proportional to the complexity of the work but, in no case, shall such time be less than two months.

The working drawings of the prestressing system shall show complete details and substantiating calculations of the method and materials the Contractor proposes to use in the prestressing operations, including any additions or rearrangement of reinforcing steel and any revision in concrete dimensions from that shown on the plans. Such details shall outline the method and sequence of stressing and shall include complete specifications and details of the prestressing steel and anchoring devices, working stresses, anchoring stresses, stress-strain curves of the prestressing steel, anticipated gauge pressures, cable profiles, elongation of prestressing cables, type of ducts and all other data pertaining to the prestressing operation, including the proposed arrangement of the prestressing steel in the members.

The designs shall be prepared and signed by a qualified Contractor's Structural Engineer who has been approved in advance by the Engineer.

Approval of working drawings and other submittals does not absolve the Contractor of the responsibility for any of his Contractual obligations. No additional payment will be made to the Contractor for any changes required as a result of reviews or approvals.

The Contractor shall submit for approval experience records and qualification details of all the Contractor's key structural design, fabrication, installation, and quality control personnel who will be working on the prestressing and concrete operation. Once approved, the Contractor shall not change or substitute any of the personnel without the prior approval of the Engineer.

All criteria covered by this Section on submittals and approval shall also apply to any subcontractor intended to be employed respective to prestressed concrete work.

- Materials

Concrete: Concrete shall be controlled, mixed and handled as specified in these Technical Specifications, unless otherwise specified herein or on the drawings. Class shall be as indicated. Concrete for prestressed work shall be designated having a 28-day cylinder test compressive strength of not less than five hundred (500) kilograms per square centimeter. Early concrete compressive strength analysis shall be performed during concrete mix design procedure.

Concrete & Prestressing Reinforcement: Concrete & prestressing reinforcement shall be in accordance with these Technical Specifications unless otherwise specified herein or on the drawings.

Duct Enclosures: Duct enclosures shall be rigid ferrous metal galvanized and mortar tight. Ducts shall be fabricated with either welded or interlocked seams. Galvanizing of the welded seam will not be required. Ducts shall have sufficient strength to maintain their correct alignment during placing of concrete. Joints between sections of duct shall be positive metallic connections which do not result in angle changes at the joints. Waterproof tape shall be used at the connections. Ducts shall be bent without crimping or flattening. Transition couplings, connecting said ducts to anchoring devices need not be galvanized.

When approved by the Engineer, ducts shall be of the flexible, corrugated type, delivered to the site on large diameter wooden drums. Ducts shall be protected from rusting, damage, oil, or any other deleterious matter.

All ducts or anchorage assemblies shall be provided with pipes or other suitable connections for the injection of grout after prestressing. Joints in adjacent ducts shall be staggered by at least thirty (30) centimeters.

Provide ducts with an inside diameter at least ten (10) millimeters larger than the nominal diameter of a single wire, bar, or strand tendon. For multiple wire, bar or strand tendons, provide a duct cross-sectional area at least two (2) times the net area of the prestressing steel.

Ducts for prestressing steel when bars are used shall have a minimum inside diameter ten (10) millimeters larger than the diameter of the bars to be used.

Anchorages: All anchorages shall be approved cast anchorages complying with the requirements of

BS 5557 or approved equivalent specifications and capable of securing the permanent type anchoring device. All anchorages and couplers for post-tensioning shall be capable of holding the prestressing steel at a load producing a stress of not less than ninety-five (95) percent of the specified ultimate tensile strength of the prestressing steel. The coupling of tendons shall not reduce the elongation at rupture below the requirements of the tendon itself. Couplers and coupler components shall be enclosed in housings long enough to permit necessary movements. Couplers for tendons shall be used only at locations specifically indicated or approved by the Engineer.

Couplers shall not be used as points of sharp tendon curvature.

Anchorage devices shall have a minimum clear concrete or grout coverage of fifty (50) millimeters in every direction. Alternate corrosion protection methods for anchorages shall be shown on the shop drawings submitted by the Contractor.

The prestressing force shall be effectively distributed to the concrete by means of an approved anchoring device. Any allowance for draw-in of the tendon during anchoring shall be in accordance with the Engineer's instructions, and the actual slip occurring shall be recorded for each individual anchorage.

When headed wires are used, the outside edge of any hold for any prestressing wire, through a stressing washer or through an unthreaded bearing ring or plate, shall not be less than six (6) millimeters from the root of the thread of the washer or from the edge of the ring or plate.

If loop tendon anchorages are used, they shall be enclosed in ducts for their entire length.

Grout: The Grout shall conform to the following requirements:

- Portland Cement and Water.
- maximum water cement ratio: 0.45
- Initial Set of 3.5 MPa with a 161 mm2 probe according to AASHTO T 197 or equivalent of BS 5400.
- Minimum compressive strength per AASHTO T 106 or BS 5400.
  i. Three days: 23 MPa
  ii. Seven days: 30 MPa
  iii. Twenty-eight days: 35 MPa

The grout shall be mixed for a minimum of two minutes and until a uniform consistency is obtained. The pumpability of the grout shall be determined in accordance with the US Corp of Engineers Method ASTM C 939 or BS 5400. The efflux time of the grout sample immediately after mixing shall not be less than eleven (11) seconds. The flow cone test does not apply to grout which incorporates a thixotropic additive.

Admixtures, if used, should impart the properties of low water content, good flowability, minimum bleed and expansion if desired. Its formulation should contain no chemicals in quantities that may have harmful effect on the prestressing steel or cement. Admixtures containing chlorides (as C1 in excess of 0.5% by weight of admixture), fluorides, sulphites and nitrates shall not be used.

Aluminum powder of the proper fineness and quantity or other approved gas evolving material which is well dispersed through the other admixture may be used to obtain five (5) to ten (10) percent unrestrained expansion of the grout.

All admixtures should be used in accordance with the instructions of the manufacturer.

- Equipment

Equipment shall conform to the requirements specified in the Contractor's Program of Work as approved by the Engineer.

Equipment for effectively distributing the load from anchoring devices to the concrete shall be such that the final unit compressive stress on the concrete directly underneath the plate or assembly does not exceed twenty (20) MPa.

Jacks used to stress tendons shall be equipped with either a pressure gauge or a load cell for determining the jacking stress.

- The pressure gauge shall have an accurately reading dial at least one hundred fifty (150) millimeters in diameter and each jack and its gauge shall be calibrated as a unit with the cylinder extension in the approximate position that it will be at final jacking force, and shall be accompanied by a certified calibration chart.
- The load cell shall be calibrated and shall be provided with an indicator by means of which the prestressing force in the tendon may be determined. The range of the load cell shall be such that the lower ten percent (10%) of the manufacturer's rated capacity will not be used in determining the jacking stress.

Grouting equipment shall be capable at a pressure of at least seven (7) kilograms per square centimeter (0.669 MPa). Grouting equipment shall be furnished with a pressure gauge having a full-scale reading of not more than twenty (20) kilograms per square centimeter (2.07 MPa). Reciprocating pumps or equipment that produces a pulsating flow shall not be used. Grouting equipment shall be thoroughly washed with clean water at least once every three (3) hours during the grouting operations and at the end of use each day. Unless waived by the Engineer, a complete grouting plant for immediate use in case of emergency or breakdown of the equipment in operation shall be available on stand-by.

When vents are required, standby flushing equipment capable of developing a pumping pressure of eighteen (18) kilograms per square centimeter and/or sufficient capacity to flush out any partially grouted ducts shall be provided.

Grout injection pipes shall be fitted with positive mechanical shutoff valves. Vents and ejection pipes shall be fitted with valves capable of withstanding the pumping pressure.

- Contactor quality control procedures

Contractor Quality Control Procedures shall conform to the requirements mentioned in these Specifications. Contractor Process Control Sampling and Testing of prestressing bars and wires shall conform to the requirements of ASTM A 416, A 421or BS 5400 and as follows:

- Samples from each size and each heat of prestressing bars, from each manufactured reel of prestressing steel strand, from each coil of prestressing wire and from each lot of anchorage assemblies and bar couplers to be used shall be furnished and tested by a testing laboratory approved by the Engineer. With each sample of prestressing steel wires, bars or strands furnished for testing, there shall be submitted a certification stating the manufacturer's minimum guaranteed ultimate tensile strength of the sample furnished.
- All materials for testing shall be furnished by the Contractor at his expense. The Contractor shall have no claim for additional compensation in the event his work is delayed awaiting approval of the materials furnished for testing.
- All bars of each size from each mill heat, all wire from each coil, and all strand from each manufactured reel to be shipped to the site shall be assigned an individual lot number and shall be tagged in such a manner that each such lot can be accurately identified at the job site. Each lot of anchorage assemblies and bar couplers to be installed at the site shall be likewise identified. All unidentified prestressing steel, anchorage assemblies or bar couplers received by the site will be rejected.
- The following sample materials and tendons, selected by the Engineer from the prestressing steel at the plant site, shall be furnished by the Contractor to the Engineer for check testing well in advance of anticipated use:

  iv. For wire or bars, one two (2) meters long sample and for strand, one and five tenths (1.5) meters long sample of each size shall be furnished for each heat or reel.

  v. If the prestressing tendon is a bar, one two (2) meters long length shall be furnished and in addition, if couplers are to be used with the bar, two one (1) meter lengths of bar equipped with one coupler and fabricated to fit the coupler shall be furnished.

- For prefabricated tendons, the Contractor shall give the Engineer at least ten (10) days' notice before commencing the installation of end fittings or the heading of the wires. The Engineer will inspect end fitting installations and wire headings while such fabrication is in progress at the plant and will approve the required testing of the materials before they are shipped to the site.

- No prefabricated tendon shall be shipped to the site without first having been released by the Engineer, and each tendon shall be tagged before shipment for identification purposes at the site. All unidentified tendons received at the site will be rejected.
- The release of any material by the Engineer shall not preclude subsequent rejection if the material is damaged in transit or later damaged or found to be defective.

- Storage and handling

All prestressing steel shall be protected against physical damage and rust or other results of corrosion at all times from manufacture to grouting or encasing in concrete. Prestressing steel that has sustained physical damage at any time shall be rejected. The development of visible rust or other results of corrosion shall be cause for rejection, when ordered by the Engineer.

Prestressing steel shall be packaged in containers or shipping forms for the protection of the steel against physical damage and corrosion during shipping and storage. A corrosion inhibitor which prevents rust or other results of corrosion shall be placed in a corrosion inhibitor carrier type packing material, or when permitted by the Engineer, may be applied directly to the steel. The corrosion inhibitor shall have no deleterious effect on the steel or concrete or bond strength of steel to concrete. Packaging or forms damaged from any cause shall be immediately replaced or restored to original condition.

The shipping package or form shall be clearly marked with a statement that package contains high-strength prestressing steel, and the type of corrosion inhibitor used, including the date packed.

Prestressing steel for post-tensioning which is installed in members prior to placing and curing of the concrete, shall be continuously protected against rust or other corrosion, until grouted, by means of a corrosion inhibitor placed in the ducts or applied to the steel in the duct. The corrosion inhibitor shall conform to the requirements specified herein.

Precast prestressed members shall be transported in an upright position, and points of support and directions of the reactions with respect to the girders should be approximately the same during transportation and storage as when the member is in its final position. In the event that the Contractor deems it expedient to transport or store members in other than this position, it shall be done at his own risk.

Care shall be taken during storage, hoisting, and handling of the precast units to prevent cracking or damage. Units damaged by improper storing or handling shall be replaced by the Contractor at his expense.

- Construction requirements

Formwork: Formwork and casting beds shall be designed to withstand all pressure due to compaction of concrete and also all stressing induced during prestressing operations. The forms shall be constructed such that shortening of member during prestressing shall be permitted and resistance to relative movement of member shall be minimized. Side and bottom surface forms shall be constructed without joints or with joints smooth and flush with the surface. The requirements in these Technical Specifications shall also apply.

All exposed edges shall be chamfered, and chamfer strips secured in place to prevent movement during subsequent operations.

All forms shall be thoroughly coated with form release agent prior to each casting. The reinforcing steel shall not be contaminated by form release agent.

Shoring: Adequate shores, shoreheads, rakers, trusses and other suitable form supports shall be provided as necessary to prevent deflection of forms and non- prestressed members.

Shoring or form supports shall not be removed until sufficient prestressing has been applied enabling the member to carry all dead loads including forms, and all anticipated construction loads.

Concrete and Reinforcement: All work involving concrete and reinforcement shall be carried out in accordance with all the requirements mentioned in these Technical Specifications or as shown on the drawings.

Concrete shall not be placed in the forms until the placing of reinforcement, conduits, anchorages, and prestressing steel has been inspected and approved by the Engineer.

Prestressing Steel: Prestressing steel for pretensioning which is installed in members prior to placing and curing of the concrete, may be continuously protected against rust or other corrosion, until grouted, by means of a corrosion inhibitor placed in the ducts or applied to the steel in the duct. The corrosion inhibitor shall conform to the requirements specified herein.

Any time acceptable prestressing steel for pretensioning is placed in the stressing bed and is exposed to the elements for more than thirty-six (36) hours prior to encasement in concrete, adequate measures shall be taken by the Contractor, as approved by the Engineer, to protect said steel from contamination or corrosion.

When steam curing is used, prestressing steel for post-tensioning shall not be installed until the steam curing is completed.

When acceptable prestressing steel for post-tensioning is installed in the ducts after completion of concrete curing, and if stressing and grouting are completed within ten (10) days after the installation of the prestressing steel, rust which may form during said ten (10) days will not be cause for rejection of the steel. Prestressing steel installed, tensioned and grouted in this manner, all within ten (10) days, will not require the use of a corrosion inhibitor in the duct following installation of the prestressing steel. Prestressing steel installed as above but not grouted within ten (10) days shall be subject to all the requirements in this Specification pertaining to corrosion protection and rejection because of rust.

Whenever electric welding is performed on or near members containing prestressing steel, the welding ground shall be attached directly to the steel being welded.

Anchoring Devices and Load Distribution: The load from the anchoring device shall be distributed to the concrete by means of apparatus that will effectively distribute the load to the concrete.

Such approved devices shall conform to the following requirements:

- The final unit compressive stress on the concrete directly underneath the anchoring plate or assembly shall not exceed two hundred (200) kilograms per square centimeter but shall also not exceed ninety (90) percent of the ultimate strength of the concrete at time of post-tensioning.
- Bending stresses in the anchoring plates or assemblies induced by the pull of the prestressing steel shall not exceed the yield point of the material or cause visible distortion in the anchorage plate when one hundred percent (100%) of the ultimate load is applied as determined by the Engineer. Should the Contractor elect to furnish an anchoring device of a type which is sufficiently large and which is used in conjunction with a steel grillage embedded in concrete that effectively distributes the compressive stresses to the concrete, the steel distribution plates or assemblies may be omitted.

Where the end of a post-tensioned assembly will not be covered by concrete, the anchoring device shall be recessed so that the ends of the prestressing steel and all parts of the anchoring devices will be at least fifty (50) millimeters inside of the end surface of the members, unless a greater embedment is shown on the plans. Following post-tensioning, the recesses shall be filled with concrete conforming to the requirements for the structure and finished flush.

Ducts: Ducts enclosures for prestressing steel shall be accurately placed at the locations shown on the plans or approved by the Engineer and securely fastened in place to prevent movement.

After installation in the forms, the ends of ducts shall at all times be covered as necessary to prevent the entry of water or debris. If prestressing steel is to be installed after the concrete has been placed, the Contractor shall demonstrate to the satisfaction of the Engineer that the ducts are free of water and debris immediately prior to installation of the steel.

All ducts over one hundred twenty-two (122) meters long shall have vents placed within one and eight-tenths (1.8) meters of the high points in the duct profile so that spacing of vents does not exceed one hundred twenty-two (122) meters. Vents shall be thirteen (13) millimeters minimum diameter standard pipe or suitable plastic pipe. Connections to ducts shall be made with metallic or plastic structural fasteners. Plastic components, if selected, shall not react with the concrete or enhance corrosion of the prestressing steel, and shall be free of water-soluble chlorides. The vents shall be mortar tight, taped as necessary, and shall provide means for injection of grout through the vents and for sealing the vents. Ends of vents shall be removed twenty (20) millimeters below the roadway surface after grouting has been completed.

Pretensioning Procedures: All prestressing steel shall be pretensioned by means of hydraulic jacks so that the force in the prestressing steel shall be not less than the value shown on the plans.

Unless otherwise specified or shown on the plans, the average working stress in the prestressing steel shall not exceed eighty percent (80%) of the specified minimum yield point stress of the prestressing steel. The maximum temporary tensile stress (jacking stress) in prestressing steel shall not exceed ninety percent (90%) of the specified minimum yield point stress of the prestressing steel. The prestressing steel shall be anchored at stresses (initial stress) that will result in the ultimate retention of working forces of not less than those shown on the plans, but in no case shall the initial stress exceed seventy percent (70%) strength of the prestressing steel.

Working force and working stress will be considered as the force and stress remaining in the prestressing steel after all losses, including creep and shrinkage of concrete, elastic compression of concrete, creep of steel, losses in post-tensioned prestressing steel due to sequence of stressing, friction and take up of anchorages, and all other losses peculiar to the method or system of prestressing have taken place or have been provided for.

Prior to construction, the Contractor shall submit calculations to check concrete stresses based upon the approved system of prestressing and anchorage for approval.

The formula and friction coefficient used in calculating friction losses in tendons shall be in accordance with AASHTO or BS specifications, subject to approval.

Post-Tensioning Equipment and Procedures: The post-tensioning process as applied to post-tensioned members shall be so conducted that tension being applied and the elongation of the prestressing steel may be measured at all times.

Prior to placing of forms for closing slabs of box girder cells, the Contractor shall demonstrate to the satisfaction of the Engineer that either the prestressing steel is free and unbonded in the duct, or, if prestressing steel has not yet been placed, that all ducts are unobstructed.

Prior to post-tensioning any member, the Contractor shall demonstrate to the satisfaction of the Engineer that the prestressing steel is free and unbonded in the duct.

Post-tensioning forces shall not be applied to cast-in-place concrete until at least ten (10)

Days after the last concrete has been placed in the member to be post-tensioned and until the concrete complies with one of the following requirements:

- When the concrete is designated by compressive strength, the concrete compressive strength shall have reached the strength shown on the plans at the time of post-tensioning.
- At least twenty-eight (28) days shall have elapsed since the last concrete to be post-tensioned has been placed.

Unless otherwise indicated on the plans, the tendons in continuous post-tensioned

Members shall be tensioned by jacking at each end of the tendon.

For patented prestressing systems, the manufacturer's procedure and instruction shall be strictly complied with.

Tensioning shall be done with approved jacking equipment. Hydraulic jacks shall be equipped with accurate pressure gauges at least one hundred fifty (150) millimeters in diameter. The combination of jack and gauge shall have been calibrated within the last twelve (12) months. A certified calibration chart, graph, or table showing this calibration of the jack and gauge combination shall be furnished to the Engineer. The range of calibrations must encompass the range of required forces indicated on the shop plans.

The jacking equipment shall be capable of simultaneously stressing all wire, strands, or bars for each individual tendon, unless otherwise approved.

Tendons shall be stressed in accordance with the approved sequence as indicated on the approved shop drawings. If the Contractor chooses to deviate from the approved sequence, the Contractor shall resubmit the shop drawings for approval. The sequence shall not cause stresses in excess of the maximum allowable stresses shown on the plans.

Tendons shall be preloaded to twenty percent (20%) of their total jacking force. Accessible dead-end anchors shall be inspected by the Engineer for adequacy before completing the post-tensioning of the tendon.

The following procedure shall apply to groups of similar tendons. (The same duct type, the same prestressing steel size, similar path, and similar length.)

After the first three (3) tendons are pulled to the jack force stipulated on the approved shop drawings, stressing shall stop until an evaluation of jacking forces and elongations can be completed by the Engineer as described herein. The actual measurable elongations from these first three (3) tendons are to be compared to the calculated measurable elongations. If the three (3) actual measurable elongations are not within eight percent (8%) of the calculated measurable elongations, the tensioning shall stop, and the tendons and elongations shall be evaluated by the Engineer. If each of the actual measured elongations is within eight percent (8%) of its calculated measurable elongation, the following procedures shall apply:

(1) Determine the following factor:

$$5/8 + 1/8\,\frac{\text{Tendon 1 AE}}{\text{Tendon 1 CE}} + 1/8\,\frac{\text{Tendon 2 AE}}{\text{Tendon 2 CE}} + 1/8\,\frac{\text{Tendon 3 AE}}{\text{Tendon 3 CE}}$$

Where "AE" is the actual measured elongation observed in the field and "CE" is the calculated measurable elongation for each tendon. This factor multiplied by the calculated measurable elongations for the tendons remaining to be tensioned will be the new base elongations for the remainder of the member tensioning.

(2) Acceptance of any remaining tendon will be made if that tendon elongation is within five percent (5%) of the new base elongation at the required jacking force.

(3) If a tendon's measurable elongation is five percent (5%) more than that of the new base elongation, then the tendon will be evaluated and will be subject to rejection.

(4) If a tendon's measurable elongation is less than the new base elongation by more than five percent (5%), the tendon may be overjacked to eighty percent (80%) of its ultimate strength, and it may be jacked from either end. If this yields an elongation within five percent (5%) of the new base elongation, the tendon will be accepted; otherwise it will be evaluated and will be subject to rejection.

A broken or damaged strand is cause for rejection of the tendon. If rejected, the strands in the tendon will be evaluated by the Engineer for reuse.

Where dead end anchorages and tendons are accessible, the anchorage system and length of projecting prestressing steel shall permit jacking with the same jacking equipment that was used on the live end.

Tendon projections at the live end and accessible dead ends shall not be cut off until all post-tensioning is completed and accepted.

The use of water-soluble oil is an accepted method for loosening bound tendons.

The Contractor shall keep full and detailed record of all tensioning operations, including the measured elongations, pressure gauge or load cell readings and the amount of pull-in at each anchorage. Copies of these records shall be submitted to the Engineer within twenty-four (24) hours of each tensioning operation.

Bonding and Grouting: Post-tensioned prestressing steel shall be bonded to the concrete by completely filling the entire void space between the duct and the tendon with grout carried out not sooner than two (2) hours and not later than forty-eight (48) hours after completion of the stressing operations and in accordance with Section 10.4.2.2.1 in the AASHTO Bridge Standard Specifications Division II - Construction (Protection of Steel After Installation) or BS 5400.

Grout shall consist of Portland cement and water and may contain an admixture if approved by the Engineer.

Water shall be first added to the mixer followed by cement and admixture. The grout shall be mixed in mechanical mixing equipment of a type that will produce uniform and thoroughly mixed grout. Retempering of grout will not be permitted. Grout shall be continuously agitated until it is pumped.

The quality of the grout shall be approved by the Engineer. The efflux time of a grout sample immediately after mixing shall not be less than eleven (11) seconds.

Grouting equipment shall be furnished with a pressure gage having a full-scale reading of not more than twenty (20) kilograms per square centimeter.

Standby flushing equipment capable of developing a water pumping pressure of fifteen (15) kilograms per square centimeter and of sufficient capacity to flush out any partially grouted ducts shall be provided.

All ducts shall be clean and free of water and deleterious materials that would impair bonding of the grout or interfere with grouting procedures.

All grout shall pass through a two (2) millimeter (No. 10) sieve prior to being introduced into the grout pump.

Grout injection pipes shall be fitted with positive mechanical shutoff valves. Vents and ejection pipes shall be fitted with valves capable of withstanding the pumping pressures.

Leakage of grout through the anchorage assembly shall be prevented by positive mechanical means.

Grout shall be pumped through the duct and continuously wasted at the outlet until no visible slugs or other evidence of water or air are ejected and the efflux time of ejected grout is not less than eleven (11) seconds. The outlet valve shall then be closed, and the pumping pressure held for a minimum of ten (10) seconds. The valve at the inlet shall then be closed while maintaining this pressure. Valves shall not be removed or opened until the grout has set.

When hot weather conditions would contribute to quick stiffening of the grout, the grout shall be cooled by approved methods as necessary to prevent blockages during pumping operations.

When temperatures below two degrees Celsius (2oC.) will prevail during and following the placement of grout, the Contractor shall provide adequate means to protect the grout in the ducts from damage by freezing or other causes.

The surfaces of concrete against which concrete encasement over anchorage assemblies is to be placed shall be abrasive blast cleaned and clean aggregate exposed after grouting of the ducts has been completed.

Vents shall be sealed consecutively in the direction of flow and the injection tube shall be sealed under pressure until the grout has set. The filled ducts shall be protected to the satisfaction of the Engineer, to ensure that they are not subjected to shock or vibration for one day and that the temperature of the grout in them does not fall below three (3) degrees Celsius (3oC) for at least three (3) days after its injection. Two days after grouting, the level of grout in the injection and vent tubes shall be inspected and made good, if necessary.

The Contractor shall keep full and detailed records of grouting, including the date each duct was grouted, the proportion of the grout and any admixtures used, the pressure, details of any interruptions and topping up required. Copies of these records shall be submitted to the Engineer within three (3) days of grouting.

Where required by the Engineer, the Contractor shall provide facilities and attendance for the radiographic testing of ducts.

Workmanship. Pretensioned & Post-tensioned Members: The following Table 3.9.1.10 contains dimension tolerances that will be used by the Engineer as a guide for acceptance of pretensioned and post-tensioned members. The Contractor shall make every effort to furnish acceptable members of uniform high quality that are within these dimensional tolerances. Any member not within these tolerances is subject to rejection depending on the effect of the deficiency on the structural adequacy and visual quality of the member in the completed structure as determined by the Engineer.

Table 2.10.1.10: Prestressed Concrete Member Tolerances

Description	Tolerance
I Box Beams & Slab Units Length	 +/- 19 mm
Width (overall)	+/- 6 mm
Depth (overall)	+/- 6 mm
Depth (top flange)	+/- 13 mm
Depth (bottom flange)	+/- 13 mm
Width (web)	+/- 10 mm
Sweep(1) Up to 40 ft. (12 m) member length 40 to 60 ft. (12 to 18 m) member length Greater than 60 ft. (18 m) member length	 +/- 6 mm +/- 10 mm +/- 13 mm
Variation from end squareness or skew Horizontal Vertical	+/- 10 mm +/- 13 mm, . +/- 13 mm
Camber variation from design camber	+/- 3.1 mm/3 m +/- 13 mm, .
Differential camber between adjacent members of the same design	0.75 inch . (6.2 mm/3 m, 19 mm .)
Position of Strands: Individual Bundled Position from design location of deflection points For deflected strands	 +/- 6 mm +/- 6 mm +/- 510 mm
Position of plates other than bearing plates	+/- 25 mm
Tipping and flushness of plates	+/- 6 mm
Position of inserts for structural connections	+/- 13 mm
Position of handling devices: Parallel to length Transverse to length	 +/- 150 mm +/- 25 mm

(1) Variation from straight line parallel to centerline of member

Description	Tolerance
I Beams- Length	+/- 8 mm/m, +/- 25 mm .
Width (overall)	+/- 10 mm, 6 mm
Depth (overall)	+13 mm, 6 mm
Depth (flanges)	- 6 mm
Width (web)	+10 mm, - 6 mm
Sweep(1)	3.1 mm/3 m
Variation from end squareness of skew	+/- 16 mm/m, +/- 25 mm .
Camber variation from design camber	+/- 3.1 mm/3m +/- 13 mm, . 24 m length +/- 25 mm, . over 24 m length
Position of strands: Individual Bundled Position from design location of deflection points for deflected strands	 +/- 6 mm - bundled +/- 13 mm +/- 510 mm
Position of plates other than bearing plates	+/- 25 mm
Position of bearing plates	+/- 16 mm
Tipping and flushness of plates	+/- 6 mm
Tipping and flushness of bearing plates	+/- 3 mm
Position of inserts for structural connections	
Position of handling devices: Parallel to length Transverse to length	 +/- 150 mm +/- 25 mm
Position of stirrups: Longitudinal spacing Projection above top	 +/- 50 mm +/- 19 mm
Local smoothness(2)	+/- 6 mm in 3m any surface

(1) Variation from straight line parallel to centreline of member

(2) Does not apply to top surface left rough to receive a topping or to visually concealed surfaces.

Description	Tolerance
I Box Beams and Slab Units - Position of stirrups:	 +/- 25 mm

Longitudinal spacing Projection above top	+/- 6 mm, -19 mm
Tipping of beam seat bearing area	+/- 3 mm
Position of dowel tubes	+/- 16 mm
Position of tie rod tubes: Parallel to length Vertical	 +/- 13 mm +/- 10 mm
Position of slab void: End of void to center of tie hole Adjacent to end block	 +/- 13 mm +/- 25 mm
Local smoothness(1)	+/- 6 mm in 3 m any surface
Post-Tension Members- Position of post tensioning ducts	 +/- 6 mm
Position of tendon anchorage bearing plates	+/- 6 mm

(1) Does not apply to top surface left rough to receive a topping or to visually concealed surfaces.

- Segmental bridge deck construction

Where bridge decks are pre-cast in segments and assembled in position for gluing and stressing, the Contractor shall satisfy the Engineer that his proposed construction method will achieve the required standard of workmanship and finish in the time available. Wherever match-casting of segments is required this shall be obtained by the use of long-line method. The length of the forms to achieve a satisfactory long-line system of match casting shall be approved by the Engineer.

The Contractor is required to submit details of all his forms, falsework, and pre-casting factory, and his method of lifting, transporting, assembling, supporting, threading cables, gluing, and stressing the pre-cast units before commencement of any work for the approval of the Engineer.

- Epoxy Adhesives in Segmental Bridge Deck Construction

Epoxy Adhesive Suppliers: The epoxy resin adhesive shall be supplied by an approved manufacturer. It shall be made up and packaged by approved formulators and comply with the requirements of AASHTO M235 for Type VI epoxy resin adhesive, BS 5400 or meet the compression shear and flexure tests as outlined in this Paragraph.

The material shall be supplied in accurately measured packs with the pack containing the hardener clearly distinguished by both size and labeling. The pack containing the resin shall be large enough to permit the addition of the hardener. Resin and hardener shall be pigmented with dissimilar colors to indicate when even mixing has been completely attained and to produce an even gray color to match the concrete.

Each batch of resin mixed shall be tested for setting by compression and shear tests as described below or in AASHTO M235 / BS 5400. No permanent prestress shall be applied to a joint until the epoxy has achieved the required strength. Should these tests show that the resin is not setting the joint should be broken and the resin removed. Set resin shall be removed by grit blasting.

Further tests may be requested by the Engineer at various times to ensure that the material as mixed is complying with the Specification.

All the instructions of the manufacturer and/or the formulator shall be submitted to the Engineer for agreement. Such agreed instructions shall be adhered to in all respects.

The supplier shall carry out a program of testing to verify the acceptability and compatibility of epoxy Bonding Agents for segmental construction after consultation with the Engineer on the range of temperatures and work cycles that are to be considered in the tests. The Engineer may require the tests to be witnessed either in person or by an approved independent authority.

Flexure and Compression Test Specimens: Six (6) test specimens shall be cast for each joint which shall measure forty by forty by one hundred sixty (40 x 40 x 160) millimeters. The Contractor shall carry out flexure and compression tests at six (6) hours as described below. The cost of these samples and tests will be deemed to be included in the rates.

Flexure Strength Test: The specimens described above are to be supported at a distance of one hundred (100) millimeters and a single load applied to the center until failure occurs (Test in accordance with DIN 1164). The load is increased at the rate of one (1) km/5 sec.

Compression Strength Test: Prisms of forty by forty by eighty (40 x 40 x 80) millimeters which have passed the flexure strength test are used to determine the compressive strength. The surface area of the punches shall be forty by forty (40 x 40) millimeters. The loading speed shall be ten (10) km/5 sec.

Shear Test: Test with lapped metal strips of agreed dimensions. The Contractor shall inform the Engineer in writing in advance the name of the Engineer who will be supervising the mixing and application of the epoxy resin. Containers which are opened or mixes made without the presence of the Engineer will be rejected.

Mixing shall be carried out in a mechanical mixer and shall continue until a uniform color is achieved. A continuous check shall be kept on the temperature of the mix.

Any constituent which has exceeded its shelf life will be rejected.

Surface Preparation: The interfaces of the units shall be lightly grit blasted before erection to remove laitance. Before applying epoxy, the interfaces must be clean and free from laitance or any bond breaking material. Any oil or grease which may be harmful shall be removed. The surface shall have no free moisture.

Application of Epoxy: Application shall begin immediately as or after a batch has been mixed. Application shall be to both interfaces to a nominal thickness of two (2) millimeters with a spatula or by hand. No epoxy may be applied after the specified pot life. Epoxy is not to be applied within twenty-five (25) millimeters of any duct.

Preliminary Prestress: Immediately after the interfaces are covered (or coated) with epoxy, the unit shall be brought into position and the preliminary prestress applied. This preliminary prestress is to be just sufficient to start squeezing epoxy resin out of the joint. The amount of prestress required will depend on the formulation of resin chosen by the Contractor. If this operation is not completed within the contract time of the first batch of epoxy to be applied, the units shall be moved apart. All the epoxy on both interfaces shall be removed with spatulas and an approved solvent. No epoxy may be applied to the joint until twenty-four (24) hours after a solvent has been used. The contact time shall be reckoned from the end of the pot life unless the manufacturer's instructions direct otherwise. All excess epoxy shall be cleaned off from the outer faces of the webs and the soffit in such a way as not to smear the concrete face.

Records of Jointing: The Contractor shall keep a record of each joint with the following details:

- Joint Number
- Date and Time of jointing
- Batch number of resin and hardener
- Weather conditions (temperature and humidity) continuously recorded
- Results of tests

- Composite slab construction

Where in-situ concrete deck is cast to act compositely with pre-cast beams, the beams shall be installed to correct line and level, starting from the outer most beam and working inward progressively. When the beams are laid side-by-side just before erection, the difference in soffit level between beams shall nowhere exceed six (6) millimeters. Where permanent soffit shutter are used, they shall be to the approval of the Engineer and they shall be fixed securely so that there is no movement or grout loss during deck concreting.

The in-situ concrete deck over any one span shall be poured in one continuous operation and shall be placed in such a sequence that the advancing edge of the freshly deposited concrete over the full width of deck or between longitudinal construction joints is approximately parallel to the deck supports. Lateral displacement of beams shall be prevented during the placing of in-situ concrete.

2.10.2 Formworks, Falseworks and Centering

1. General

For execution of these temporary works, whether of fixed or moving type, in a vertical or horizontal direction, as well as for the installation of prefabricated structural elements, the Contractor may adopt the system, materials and equipment he deems most suitable or more convenient to him provided that they satisfy the conditions of stability and safety, care being taken for the perfect execution of the construction details.

In the design and execution of the falsework and centering the Contractor shall observe the rules and constraints that may be imposed by the responsible Authority and persons concerning the respect for particular plants or structures existing in the areas affected by the new construction.

The dismantling operations shall be carried out with the agreement of the Engineer.

In the construction of the falsework and centering of any type the Contractor is to adopt the appropriate measures so that in all points of the structure the lowering can be simultaneous.

In the design and execution of the falsework and centering the Contractor shall also observe the rules and directives eventually imparted by the competent Authority concerning the occupation of the watercourses crossed or concerning the spaces to be left free in case of road and railway overpasses.

2. Bridge structure Falsework

Detailed plans for falsework and centering shall be prepared by the Contractor and submitted to the Engineer for approval. No Work shall be started until the plans are approved in writing. The Contractor shall submit to the Engineer for approval at least one month before commencing work, details of his proposed system of falsework, including detailed drawings and calculations. Falsework shall be capable of temperature changes without causing damage to the concrete.

Notwithstanding any approval of falsework design by the Engineer, the Contractor will not be relieved of his responsibility for the adequacy and correctness of the design, manufacture and assembly of the falsework. Falsework and centering shall be designed and constructed to support the total anticipated dead and live loads, including wind loads, during all stages of construction, with a deflection not to exceed two thousandths (0.002) of the falsework span. The Contractor shall submit calculations to support this requirement for all spans over three (3) meters and other spans if requested by the Engineer. On concrete bridge deck replacement works the Contractor shall submit calculations showing that shoring is not required including actual falsework calculations when the deck removal thickness is fifty (50) millimeters or greater.

Any embankment or backfill, whether permanent or temporary, required to support falsework shall meet the quality and compaction requirements of "Backfilling of Structures" in these Technical Specifications. In situ material shall not be used to support falsework unless it is approved by the Engineer with respect to its load bearing capacity.

In situ material approved for use to support falsework shall be compacted to Type 95 Compaction as determined by requirements in these Technical Specifications.

Falsework and centering supports shall be designed and constructed to provide the necessary rigidity to support all loads placed upon it without appreciable settlement or deformation. Falsework columns shall be supported on concrete, wood, or metal bases to distribute the loads to the underlying material. The size of the bases shall be based on the supporting capacity of that material. If necessary, supporting material shall be removed, replaced, or recompacted to enable it to support the falsework. Falsework shall not be supported on any part of the structure, except the footings, without the written permission of the Engineer. The number and spacing of falsework columns, the adequacy of sills, caps and stringers, and the amount of bracing in the falsework framing shall be subject to approval of the Engineer.

All timber shall be of sound wood, in good condition, and free from defects that might impair its strength. If the vertical members are of insufficient length to cap at the desired elevation for the horizontal members, they shall preferably be capped, and frames constructed to the proper elevation. Ends of the vertical members shall be cut square for full bearing to preclude the use of wedges. If vertical splices are necessary, the abutting members shall be of the same approximate size, the ends shall be cut square for full bearing, and the splices shall be scabbed in a manner approved by the Engineer.

The Contractor shall compute the estimated amount of settlement and deflection of the falsework due to placement of the concrete. Provisions shall be made in the falsework for this settlement and/or deflection so that the completed structure will conform to dimensions and grades shown on the plans. The Engineer will check and approve the Contractor's computations. Wedges or screw jacks shall be used in all falsework construction and shall be so placed that they can be adjusted to give proper form alignment. The Contractor shall provide means for adjusting forms at any time prior to concrete placement. If screw jacks are used, they shall be adequately braced and secured in such a manner that will prevent tipping of the jacks in any direction.

The Contractor shall provide means for accurately measuring settlement in falsework during placement of concrete and shall provide a competent person to monitor the settlement and initiate corrective action when necessary.

The Engineer may refuse permission to proceed with other phases of the Work if he deems the falsework unsafe or inadequate to properly support the loads to which it will be subjected.

3. Falsework Design

   - The falsework design drawings shall show the stresses and deflections in all load supporting members and anticipated total settlement of falsework footings and joint take-up. Anticipated settlements shall not exceed twenty-five (25) millimetres. The maximum deflection used in the design of the falsework shall be 1/500 of the falsework span, irrespective of the fact that the deflection may be compensated for by camber strips.

   - The design of falsework shall be based on the use of loads and conditions which are no less severe than those described in this section. The stresses listed are based upon the use of undamaged, high quality materials and such stresses shall be reduced by the Contractor if lesser quality materials are to be used. The Contractor is responsible for the proper evaluation of his falsework materials and design of the falsework to safely carry the actual loads imposed.

   - The vertical design load for falsework shall consist of the sum of dead and live vertical loads and an assumed horizontal load.

– Dead loads shall include the weight of concrete, reinforcing steel, forms, and falsework. The weight of concrete, reinforcing steel and forms shall be assumed to be not less than two thousand six hundred (2,600) kilograms per cubic meter for normal concrete and not less than twenty-one hundred (2,100) kilograms per cubic meter for lightweight concrete.

– Horizontal pressure shall be based on an assumed unit weight between fourteen hundred (1,400) and twenty-four hundred (2,400) kilograms per cubic meter depending on the rate of placement and the effect of retarding admixture, as approved by the Engineer.

– Timber dead load is eight hundred (800) kilograms per cubic meter. The dead load of timber forms may be assumed at fifty (50) kilograms per square meter for members smaller than one hundred fifty (150) millimeters by one hundred fifty (150) millimeters. Dead load for steel and steel forms shall be seven thousand eight hundred fifty (7,850) kilograms per cubic meter. The weight of any other forming materials shall be specified on the drawings.

- Live loads shall consist of the actual weight of any equipment to be supported by falsework applied as concentrated loads at the points of contact and a uniform load of not less than two hundred forty-five (245) kilograms per square meter applied over the area supported plus eleven hundred (1100) newtons per meter at the outside edge of deck falsework overhangs.
- The total vertical design load for falsework is the sum of the vertical dead and live loads. A total vertical design load of not less than forty-eight hundred (4800) shall be used.
  - The assumed horizontal load to be resisted by the falsework bracing system shall be the sum of the actual horizontal loads due to equipment, construction sequence or other causes and an allowance for wind; however, the assumed horizontal load to be resisted in any direction shall not be less than two percent (2%) of the total load for falsework up to ten (10) meters high. The falsework shall be designed so that it will have sufficient rigidity to resist the horizontal load prior to the placement of concrete.
  - The entire bridge superstructure cross-section, except railing, shall be considered to be placed at one time except as provided herein. Girder stems and connected bottom slabs, if placed more than five (5) days prior to the top slab, may be considered to be self- supporting between falsework posts at the time the top slab is placed, provided that the distance between falsework posts does not exceed four (4) times the depth of the portion of the girder placed in the first pour.
  - Falsework footings shall be designed to carry the load imposed upon them without exceeding the estimated soil bearing values and anticipated settlements.
  - Foundations for individual towers when the maximum leg load exceeds one hundred thirty-three (133) kilonewtons shall be designed and constructed to provide uniform settlement under all legs of each tower under all loading conditions.
  - If the concrete is to be post-tensioned in the field, the falsework shall be designed to support any increased or readjusted loads caused by the prestressing forces, as shown on the plans.
  - The falsework design drawings shall include the following minimum information:
- Type and grade of structural materials.
- Allowable material stresses in bending, compression, and shear.
- Modulus of elasticity, "E".
- Stress factors if used for short term duration loading (timber only).
- Summary of critical tower leg loads and locations on falsework drawings.
- Weight of deck finishing machine and wheel or support spacing.
- References for load data used for standardized falsework components.
- Specification references for design criteria.
- The bearing value of the soil as determined by the Contractor when footing type foundations are to be used.
  - Falsework design shall be based on the current edition of one of the following applicable specifications. However, it shall be based on AASHTO Specifications if highway traffic is to be supported.

AASHTO	American Association of State Highway and Transportation Officials, Standard Specifications for Highway Bridges.
AISC	American Institute of Steel Construction, Manual of Steel Construction.
ACI	American Institute of Steel Construction, Manual of Steel Construction.
NFPA	National Forest Products Association, National Design Specifications for Wood Construction.

AITC American Institute of Timber Construction Manual.

- The maximum loadings and deflections used on jacks, columns, brackets, joists, and other manufactured devices shall not exceed the manufacturer's recommendations.
- Connection details shall be so designed that structural shoring members are secure for all loading conditions.
- For identified grades of steel, do not exceed the design stresses (other than stresses due to flexural compression) specified in the Manual of Steel Construction as published by AISC.
- When the grade of steel for structural shapes cannot be positively identified, do not exceed the design stresses, other than stresses due to flexural compression, specified in the AISC Manual for A36 steel or the following:

– Tension, axial and flexural 150 Megapascals (MPa)

– Compression, axial (L/r . = 120) 110,000-2.62(L/r)2 kilopascals (kPa)

Where:

L = the unsupported length of the column (mm)

r = the corresponding least radius of gyration of the section (mm)

– Shear on the gross section of the web of rolled shapes 100 MPa

– Web crippling for rolled shapes 180 MPa

- For all grades of steel, do not exceed the following flexural compression design stress.

Compression, flexural (1) = $\frac{82750}{Ld/bt}$ MPa

Note (1): Not to exceed one hundred fifty-two (152) MPa for unidentified steel or steel conforming to ASTM A36. Not to exceed (0.6)F_y for other identified steel.

Where:

L	=	The unsupported length
d	=	The least dimension of a square or rectangular column or the width of a square of equivalent cross-sectional area for round columns or the depth for beams.
b	=	the width of the compression flange.
t	=	the thickness of the compression flange.
r	=	the radius of gyration of the member.
F_y	=	the specified minimum yield stress for the grade of steel used.

- When timber is used as falsework the allowable maximum design stresses and loads listed below are based on the use of undamaged, high-quality material. If lesser quality material is used the allowable stresses and loads shall be reduced accordingly.
- The following maximum stresses and loads shall not be exceeded in falsework design using timber:

Compression perpendicular to the grain = 3100 kilopascals

Compression parallel to the grain (1) = <u>3309</u> megapascals

$(L/d)^2$

Note (1): Not to exceed 11 megapascals.

Where:

L = Unsupported length

d = Least dimension of a square of equivalent cross-sectional area for round columns

Flexural stress = 12.4 megapascals

Note:Reduced to 10 megapascals for members with a nominal depth of two hundred (200) millimeters or less.

Horizontal shear = 1300 kilopascals

Axial tension = 8.3 megapascals

Modulus of elasticity (E) for timber - 11.7 gigapascals

imum axial loading on timber piles - 400 kilonewtons

- Design timber connections according to the stresses and loads allowed in the National Design Specification for Wood Construction, as published by the National forest Products Association except:
    1) Reductions in allowable loads required therein for high moisture condition of the lumber and service conditions do not apply.
    2) Seventy five percent (75%) of the tabulated design value as the design value of bolts in two member connections (single shear) shall be used.
- Falsework spans supporting T-beam girder bridges shall be limited to four and three-tenths (4.3) meters plus eight and one-half (8.5) times the overall depth of T-beam girder.

4. Bridge Structure Forms

Forms shall be mortar tight and sufficiently rigid to prevent distortion from pressure of the concrete and other loads incidental to the construction operations, including vibration.

Forms shall be constructed and maintained to prevent the opening of joints due to shrinkage of lumber. They shall be designed to permit easy removal without injury to the concrete. Form lining such as smooth, exterior grade plywood or other approved material shall be used for all exposed formed surfaces. The Contractor shall submit samples, specifications, and other pertinent information to the Engineer and secure his written approval prior to use of the form lining.

Form lining material shall not bulge, warp or blister, nor shall it stain the concrete. Form lining shall be used in the largest practicable panels to minimize joints. Small panels of the lining material shall not be permitted. The joints in the lining shall be tight and smoothly cut. Adjacent panels of form lining shall be so placed that the grain of wood will be in the same general direction. Thin metal form lining will not be permitted unless they are in new condition and firmly backed.

Undressed lumber of uniform thickness may be used for backing or form lining. Wooden plywood, of adequate thickness, which is properly supported to meet the above requirements, may be used alone in lieu of the lined forms specified herein.

Forms shall be maintained after erection to eliminate warping and shrinkage. They shall be checked for dimensions and condition immediately prior to the placement of concrete.

The Engineer may at any time require the revision or reconstruction of forms and may refuse permission to place concrete within the forms until they are satisfactorily constructed. If, at any period of the Work during or after placing the concrete, the forms shown signs of sagging or bulging, the concrete shall be removed to the extent directed by the Engineer, the forms brought to the proper position, and new concrete placed. No allowance will be made to the Contractor for such extra Work.

Metal forms may be used and are subject to the same requirements and approvals specified for wood forms. The specifications for wood forms with respect to design, mortar tightness, filleted corners, beveled projections, bracing, alignment, removal, reuse and oiling, also apply to metal forms. The metal used for forms shall be of such thickness that the forms will remain true to shape. All bolt and rivet heads shall be countersunk.

Clamps, pins, or other connecting devices shall be designed to hold the forms rigidly together and to allow removal without injury to the concrete. Metal forms which do not present a smooth surface or do not line up properly shall not be used. Care shall be exercised to keep metal forms free from rust, grease, or other foreign matter. Under such circumstances the continuance of use of the metal forms will depend upon satisfactory performance and their discontinuance may be required at any time by the Engineer. Steel panels or panels with metal frames and wood or combination facing which leave permanent impressions or ridges will not be approved.

The inside of all forms shall be oiled with a light, clear, paraffin base oil that will not discolor or otherwise injure the surface of the concrete. The oiling shall be done where possible after the completion of the forms and prior to placement of reinforcement.

Unless otherwise directed, the exterior side of all forms exposed to the sun shall be painted with an approved, good quality, high gloss white oil base enamel prior to placing concrete. When complete coverage is not obtained with one (1) coat, the Engineer will order additional coats as he deems necessary to obtain complete coverage. Forms shall be repainted when ordered by the Engineer.

Form joints shall be closed by moistening the forms with water prior to concrete placement. Forms that are to be reused shall be thoroughly cleaned and reoiled and, if necessary, shall be reconditioned by revision or reconstruction. Unsatisfactory lumber will be condemned by the Engineer and shall be removed from the site.

The width and thickness of the lumber, the size and spacing of studs and wales shall be determined with due regard to the nature of the Work and shall be sufficient to ensure rigidity of the forms and to prevent distortion due to the pressure of the concrete.

Forms bolts, rods, or ties shall be made of steel. Ties may be the type which permits the major part of the tie to remain permanently in the structure. They shall be held in place by devices attached to the wales capable of developing the strength of the ties. The Engineer may permit the use of wire ties on irregular sections and incidental construction if the concrete pressures are nominal and the form alignment is maintained by other means.

Form ties will not be permitted through forms for handrail. Pipe spreaders shall not be used unless they can be removed as the concrete is placed, as determined by the Engineer.

Wood or metal spreaders shall be removed as the concrete is placed. Where the bottom of the forms is inaccessible, the lower form boards shall be left loose or other provisions made so that the extraneous material may be removed from the forms immediately before placing the concrete.

Unless provided otherwise on the plans or directed by the Engineer, all exposed edges shall be beveled by using dressed, mill-cut, triangular molding, having twenty (20) millimeter sides. All curved surfaces shall be formed with approved plywood or steel.

Placement of reinforcing steel shall not begin on any part of a structure until the location, alignment, and construction of forms and falsework are approved by the Engineer for that part of the structure. The Contractor shall conduct all surveyed and dimensional checks required by the Engineer to verify the adequacy of the forms and falsework. The forms shall be clean and free of all debris before concrete is placed.

Prior to the placement of bridge deck concrete, the Contractor, using the approved screed or finishing machine, shall check and verify, in the presence of the Engineer, the elevations, minimum cover over the reinforcing steel, and total thickness of the deck. The verification process shall cover the entire surface of the deck with minimum intervals between checkpoints of three (3) meters in both the lateral and longitudinal direction. Placement of bridge deck concrete shall not begin until the screed, location of screed rails, reinforcing steel, and deck forms are approved by the Engineer.

The Contractor shall submit to the Engineer all details of formwork, liners, joints, and other materials together with fabrication drawings, details of the working practices and the procedures he proposed to use for obtaining approvals before any fabrication work begins. No formwork shall be brought to the site without the prior approval of the Engineer. Adequate time shall be allowed by the Contractor in his program for these approvals.

Formwork for bridge structures shall comply with the following requirements in respect of finish.

Formwork shall be lined with a material approved by the Engineer to provide a smooth finish of uniform appearance. This material shall leave no stain on the concrete and shall be so joined and fixed to its backing that it imparts no blemishes. It shall be of the same type and obtained from only one source for any one structure. The Contractor shall make good any imperfections in the finish as directed by the Engineer.

Embedded metal parts will not be permitted.

The Contractor shall submit to the Engineer all details of formwork, liners, joints, and materials including fabrication drawings and stating procedures involved in the use of formwork for approval before commencement of any work on fabrication. No formwork shall be brought to site without the prior approval of the Engineer. Adequate time shall be allowed by the Contractor in his program for these approvals after consultation with the Engineer.

The Concrete shall be uniformly leveled and screeded to produce a plain or ridged surface as described in the Contract.

Surfaces which are to receive deck waterproofing shall be finished to an accuracy such that when tested with a three-meter-long straightedge, the maximum depression shall not exceed five (5) mm.

The inside surfaces of all forms shall, except for pavement formwork, or unless otherwise agreed by the Engineer, be coated with a release agent approved by the Engineer. Release agents shall be applied strictly in accordance with the manufacturer's instructions and shall not come into contact with the reinforcement. Different release agents shall not be used in formwork to concrete which will be visible in the finished work.

Immediately before placing concrete, all forms shall be thoroughly cleaned out.

If the required finish has not been attained in the Work, as determined by the Engineer, the Contractor shall promptly carry out as his expense all remedies required by the Engineer to obtain the specified finish. These may include grit blasting followed by the application of polyester or epoxy paint. Where such remedial action is ordered by the Engineer, the entire exposed surface shall be so treated, irrespective of whether the defective areas are localized or extensive.

5. Removal of bridge structure forms and falsework

All formwork shall be removed without damage to the concrete. Forms used to support the deck of box girders and forms in hollow abutments or pieces may remain in place when no permanent access is available into the cells. Where it is intended to re-use formwork, it shall be thoroughly cleaned and made good to the satisfaction of the Engineer prior to re-use.

To facilitate finishing, forms on handrails, ornamental Work, and other vertical surfaces that require a rubbed finish, shall be removed as soon as the concrete has hardened sufficiently that it will not be injured, as determined by the Engineer. Formwork shall be constructed so that the side forms of members can be removed without disturbing the soffit forms. If props are to be left in place when the soffit forms are removed, these props shall not be disturbed during the striking.

In determining the time for the removal of forms, consideration shall be given to the location and character of the structure, weather, and other conditions influencing the setting of the concrete.

If field operations are not controlled by beam or cylinder tests, the following periods, exclusive of days when the temperature is below ten degrees Celsius (10oC), for removal of forms and supports shall be used as a minimum:

Arch Center	21 days
Centering Under Beams	14 days
Supports Under Flat Slab	14 days
Floor Slabs	14 days
Vertical Walls Over Three (3) Meters	3 days
Columns Over Three (3) Meters	3 days
Top Slab Box Culverts	14 days

If high early strength cement is used, the time limits may be decreased as determined by the Engineer. Special notes on the plans relative to the removal of forms and falsework under arches, continuous spans, and other special structures shall have precedence over the above time limits for removal of forms and falsework.

When field operations are controlled by cylinder tests or any other approved control tests, the removal of forms, supports, and housing, and the discontinuance of heating and curing may begin when the concrete is found to have the minimum percentage of the specified twenty-eight (28) day compressive strength contained in Table 2.10.2.1, provided further that in no case shall supports be removed in less than seven (7) days after placing the concrete except for vertical walls and columns over three (3) meters as shown above (3 days).

Table 2.10.2.1:Minimum required percentage of specified 28 day strength (fc)

Structural Element	Percentage of Specified 28-Day Strength
Columns and wall faces (not yet supporting loads)	50
Mass piers and mass abutments (not yet supporting loads) except pier caps	50
Sidewalk on bridges Sidewalk forms shall, in all cases, be released before the main girder and slab forms are released	70
Box girders	80
T-beam girders, slabs, cross-beams, caps, pier caps not continuously supported, struts, and top slabs on concrete box culverts	80
Trestle slabs, when supported on wood stringers	70
Slabs, when supported on steel stringers or prestressed concrete girders	70
Pier caps continuously supported	60
Arches	90
Rail bases, traffic railings and median barriers*	40

Methods of form removal likely to cause overstressing of the concrete shall not be used. Forms and their supports shall not be removed without approval. Supports shall be removed in such a manner as to permit the concrete to uniformly and gradually take the stresses due to its own weight. In order to determine the condition of column concrete, forms shall be removed from columns before releasing supports from beneath beams and girders.

Arch centering shall be struck, and the arch made self-supporting before the railing or coping is placed. This precaution is essential in order to avoid jamming of the expansion joints and variations in alignment. For filled spandrel arches, such portions of the spandrel walls shall be left for construction subsequent to the striking of centers, as may be necessary to avoid jamming of the expansion joints.

Centers shall be gradually and uniformly lowered in such a manner as to avoid injurious stresses in any part of the structure. In arch structures of two or more spans, the sequence of striking centers shall be specified or approved.

Any remedial treatment to surfaces shall be agreed with the Engineer following inspection after removing the formwork and shall be carried out without delay. Any concrete surface which has been treated before being inspected by the Engineer, shall be liable to rejection. Defects that will need repair, when removal of entire defective portions is not directed by the Engineer, shall also include crazing, cracks, spalls, pop outs, air bubbles, honeycomb, and holes left by rods and bolts; other surface deficiencies that penetrate to the reinforcement; fins and other objectionable projections on the surface, as determined by the Engineer; and stains and discolorations that cannot be removed by cleaning.

2.10.3 Cement Mortars

1. Characteristics of materials

- The specification of materials shall comply with the following:

Cement: [UNI/CNR ref]

Sand: [UNI/CNR ref]

Water: [UNI/CNR ref]

Water shall be clean and uncontaminated with asulphate content less than 1.4g per litre.

Water from sea or tidal rivers shall not be used.

Penetration resistance of the mixes shall comply with UNI 7927-78.

2. Mortar Mixes

Cement mortar for brickwork, rubble masonry and rendering of the face of masonry work shall be mixed in the proportions given in the table below:

Purpose	Cement	Sand
Brickwork	400kg	1 m^3
Rubble masonry	350kg	1 m^3
Rendering	400kg	1 m^3

3. Mixing

Mortar shall be mixed thoroughly either by hand or mechanically until its color and consistency are uniform. The constituent materials shall be accurately gauged, allowance being made for bulking of sand. Mortar shall be made in small quantities only as and when required. Mortar which has begun to set or which has been mixed for more than one hour shall be discarded.

2.10.4 Concrete for Copings, Connecting Angles, Special Pieces, Parapets, etc.

For execution of the works to complete the roadway and structures such as: parapets, copings of retaining walls, wing walls, boundary walls, sills, kerbs, connecting angles, etc. a concrete having an Rck ≥ 30 N/mm2 will be prepared, placed and perfectly compacted with special vibrators.

Subject to the requirements under the sections relative to the aggregates and the mixing and placing of concrete for reinforced concrete works, it shall be borne in mind that the coarse aggregate to be used shall be of 20 mm size.

Special care shall be exercised in the construction of the reinforcements or formworks in order to obtain a perfect execution of the casting and the precise measurements and profiles as directed by the Engineer or shown on the project drawings.

In the works where expansion or contraction joints are required the Contractor is to execute them in perfect workmanship, at due distance and as directed by the Engineer; the relevant cost has been considered in determining the relevant rate in the BOQ.

2.10.5 Steel for Reinforced and Prestressed Concrete

1. General

Reinforcement shall comply with British Standards or AASHTO Standards, in accordance with the requirements shown on the drawings. Reinforcement covers plain and deformed bar reinforcement and steel fabric to be cast into concrete in any part of the Works but does not include prestressing tendons or any other embedded steel.

Where compliance with British Standards is required, reinforcement shall comply with the following:

BS 4449 for hot rolled plain bar and high yield deformed bar

BS 4482 for hard drawn mild steel wire

BS 4461 for cold worked steel bar

BS 4483 for steel mesh fabric.

Where compliance with British Standards is required, prestressing steel shall comply with the following:

BS 5896 for hot rolled high tensile alloy steel bars

BS 4486 for hot rolled high tensile steel wires and strands

Where compliance with AASHTO is required, reinforcement shall comply with the following:

All reinforcing bars shall be of a deformed type in accordance with AASHTO M31, except that plain bars may be used where specifically indicated on the Drawings.

Mild steel reinforcing bars shall conform to AASHTO M31 (ASTM A615) Grade 40 and high tensile steel reinforcing bars shall conform to the requirements of AASHTO M31 (ASTM A615) Grade 60.

Tying wire used for fixing reinforcement shall be SWG No.16 (1.625 mm) annealed soft iron wire, except for exposed surfaces and bridge decks were 1.2 mm diameter stainless steel wire shall be used.

All reinforcement shall be from an approved manufacturer and, if required by the Engineer, the Contractor shall submit a test certificate from the manufacturer.

All reinforcement for uses in the Works shall be tested for compliance with the appropriate British Standard in a laboratory acceptable to the Engineer and two copies of each test certificate shall be supplied to the Engineer. The frequency of testing shall be as set out in the British Standard.

In addition to the testing requirements descried above, the Contractor shall carry out additional tests as instructed by the Engineer.

Any reinforcement which does not comply with the Specification shall be removed from Site.

2. Storage

All reinforcement shall be delivered to Site either in straight lengths or cut and bent. No reinforcement shall be accepted in long lengths which have been transported bent over double.

Any reinforcement which is likely to remain in storage for a long period shall be protected from the weather so as to avoid corrosion and pitting. All reinforcement which has become corroded or pitted to an extent which in the opinion of the Engineer, will affect its properties shall either be removed from Site or may be tested for compliance with the appropriate British Standard in accordance this Specification at the Contractor's expense.

Reinforcement shall be stored on racks clear of the ground and shall be protected to prevent accumulation of dust, windblown salt and sand and other harmful substances.

The separate types and sizes of bar reinforcement shall be stored in separate racks, the type and diameter being clearly marked in each case. Similarly, different sizes and arrangements of mesh shall also be stored separately and clearly marked in each case.

Where large daily variations in ambient temperature and/or humidity occur, storage racks shall be enclosed in a light building.

3. Bending

Unless otherwise shown on the Drawings, bending and cutting shall comply with BS 4466.

The Contractor shall satisfy himself as to the accuracy of any bar bending schedules supplied and shall be responsible for cutting, bending, and fixing the reinforcement in accordance with the Drawings.

Bars shall be bent cold by the application of slow steady pressure. At temperatures below 50 C the rate of bending shall be reduced if necessary, to prevent fracture of the steel.

After bending, bars shall be securely tied together in bundles or groups and legibly labelled as set out in BS 4466.

Reinforcement shall be thoroughly cleaned, and all dirt, scale, loose rust, oil and other contaminants removed before it is placed in the Works.

4. Fixing

Reinforcement shall be clean and free from loose mill scale, loose rust, oil, grease, tar, paint, mud, ice, retarders, concrete droppings and contamination by salts or other deleterious matter and shall be maintained in such condition up to the time of concreting.

Reinforcement shall be securely fixed in position within a dimensional tolerance of 20 mm in any direction parallel to a concrete face and within a tolerance of 5 mm at right angles to a face, provided that the cover is not thereby decreased below the minimum shown on the Drawings, or if not shown shall be not less than 25 mm or the diameter of the bar, whichever is the greater. Cover on distribution steel shall not be less than 15 mm or the diameter of the bar whichever is the greater.

Unless otherwise agreed by the Engineer, all intersecting bars shall either be tied together with 1.6 mm diameter soft annealed iron wire and the ends of the wire turned into the body of the concrete, or shall be secured with a wire clip of a type agreed by the Engineer .

Spacer blocks shall be used for ensuring that the correct cover is maintained on the reinforcement. Blocks shall be as small as practicable and of a shape agreed by the Engineer. They shall be made of mortar mixed in the proportions of one part of cement to two parts of sand. Wires cast into the block for tying into the reinforcement shall be 1.6- mm diameter soft annealed iron.

Any precast spacer blocks approved for use shall be at least equal in strength to the body of the concrete in which they are being placed.

No ferrous metal part of any device used for connecting bars or for maintaining reinforcement in the correct position shall remain within the specified minimum concrete cover to the reinforcement except where expressly instructed or provided for within the Contract.

No permanent spacers to reinforcement shall be allowed to affect the overall uniformity of the surface appearance or surface finishes which shall, in any event, comply with the Specification requirements.

Alternatively, another type of spacer block may be used subject to the Engineer ’s agreement.

Reinforcement shall be rigidly fixed so that no movement can occur during concrete placing. Any fixings made to the formwork shall not be within the space to be occupied by the concrete being currently placed.

No splices shall be made in the reinforcement except where shown on the Drawings or agreed by the Engineer. Splice lengths shall be as shown on the Drawings.

Reinforcement shall not be welded except where required by the Contract or agreed by the Engineer. If welding is employed, the procedures shall be as set out in BS 2640 for gas welding or BS 5135 for metal arc welding. Full strength butt welds shall only be used for steel complying with BC 4449, and if used on high yield deformed bars complying with BS 4449 the permissible stresses in the vicinity of weld shall be reduced to those applicable to plain bars complying with that Specification.

Mechanical splices shall not be used unless the Engineer agrees otherwise.

The Contractor shall ensure that reinforcement left exposed in the Works shall not suffer distortion, displacement or other damage. When it is necessary to bend protruding reinforcement aside temporarily, the radius of the bend shall not be less than four times the bar diameter for mild steel bars or six times the bar diameter for high yield bars. Such bends shall be carefully straightened before concrete placing continues, without leaving residual kinks or damaging the concrete round them. In no circumstances will heating and bending of high yield bars be permitted.

Bars complying with BS 4461 or other high tensile bars shall not be bent after placing in the Works.

Before concrete is placed in any section of the Works which includes reinforcement, the reinforcement shall be completely clean and free from all contamination including concrete which may have been deposited on it from previous operations.

No concreting shall be commenced until the Engineer has inspected and approved the placed reinforcement.

5. Reinforcement drawings and schedules

The Contractor shall prepare reinforcement drawings and bar bending schedules to suit his approved proposed method of construction. The drawings and bending schedules shall be based on the outline design details given on the relevant drawings.

The drawings and bar schedules shall be submitted to the Engineer for approval a minimum of six weeks in advance of the ordering of reinforcement. The Engineer shall then check the Contractor's proposals within 14 days of receipt of the design.

Should the Engineer at any stage be unable to accept the proposals submitted by the Contractor due to non-compliance with the requirements of the Specification, the Contractor shall re-submit his proposals and the above approval/acceptance periods shall re-commence.

Work on the structures shall not commence until the above procedures have been completed.

Upon completion of the fabrication of the structure, the Contractor shall provide electronic copies of the final working and fabrication drawings in AutoCAD DWG format (release 2004 or more recent as approved by the Engineer).

Concrete covering for reinforcement shall be as stated on the drawings.

The distance between every two parallel bars shall be not greater than 30 mm.

Concreting shall not commence until reinforcing is inspected, approved and registered. A notification shall be made to the Engineer 48 hours prior to such inspection.

6. Testing of Materials

The test unit for plain and deformed steel bar is represented by a lot of 25 t; each lot of less than 25 t is to be considered as an independent unit.

The test unit adopted for steel for prestressed concrete is represented by a cargo lot of 30 t. shipped as one consignment and composed of products having homogeneous nominal entities (dimensional, mechanical and of formation).

All the Producer shall mark the steel materials in order to guarantee the identification of the Factory, the class of steel and his Welding capability.

Sampling and testing of steel shall conform to the following standards: BS 4486, BS 5896, BS 5400 Part 6.

The manufacturer shall accompany each consignment with certificates of qualification and verification of manufacture issued by an official laboratory of the country of origin. At the worksite the Engineer in agreement with the Contractor will take samples of each class of steel to be sent to the official laboratory for control of the characteristics declared by the manufacturer.

Certain tests can be carried out directly at the worksite.

A report will be issued of the sampling operations, signed by both parties to be delivered to the Employer upon completion of the works.

All costs and charges for sampling, transport to laboratory and tests shall be borne by the Contractor.

2.10.6 Pre-stressing Steel

This section covers the materials, equipment and work required to prestress (by post or pre-tension) structural concrete members.

The Contractor shall submit to the Engineer full details of the equipment he proposes to use for the installation of prestressing tendons, the materials he proposes to use and the arrangements he proposes to make. He shall also submit evidence of his competence to undertake the installation.

The prestressing steel consists of low relaxation strands having received a European Technical Approval and having the CE marking.

1. Ducting

The ducting shall be conformed according to EN 523. All ducting for post-tensioning shall be sufficiently strong to withstand without damage the stresses to which it may be subjected during handling and after being fixed in position. The ducting shall completely protect the wires or cables from contact with concrete and the Contractor shall ensure that the wires or cables are completely free in the duct before tensioning. Any ducting which has been damaged during transportation to the site or which in the opinion of the Engineer is inadequate for its purpose shall not be used in the works. Ducting shall be free from loose material, oil coatings, or other contaminants which may affect the bond with the concrete.

The stools, saddles or supports for the ducts shall be of rigid construction and of such form that they remain securely in position and maintain the correct profile of the cables until the concrete placed round them has hardened.

Vents shall be incorporated into each duct at high and low points, at each end and at intermediate points not more than five meters apart. Blocking of vents during concreting operations shall be prevented.

2. Ancgorages

All anchorages are active, and cables shall be jacked at both ends.

Anchorages shall be the correct type for the prestressing system used and shall be rigidly fixed true to alignment in the formwork so that they cannot move during concreting operations. The anchorages shall be provided with means for injecting grout into the ducts.

If the anchorage is fixed after the main body of the concrete has been placed, it shall be carefully bedded so that it is bearing evenly and is in intimate contact with the concrete.

Anchorages shall be protected by a reinforced mortar or concrete.

3. Jacks for Prestressing

Jacks for tensioning tendons shall be hydraulically operated and capable of providing a slow uniform increase of load. Each jack shall be equipped with an appropriate pressure gauge capable of indicating the hydraulic fluid pressure at all times during the stressing operation. A certified calibration chart showing the relationship between gauge readings and force on the ram for both ascending and descending ram movements shall be available on the site.

The Contractor shall maintain tensioning jacks in good working order and shall ensure true and accurate readings by regular testing, calibration and servicing.

4. Storing

Tendons shall be stored on site under cover and protected from the weather. The storage area shall have a hard-impermeable floor. Tendons shall be stored either straight or in the coils in which they left the factory.

Tendons shall not be allowed to become affected by excessive rusting or by pitting of’ the surface by corrosion. If pitting is present, the Contractor shall replace the affected tendons by new approved ones.

5. Installation of Prestressing Tedons

Before being installed, prestressing tendons shall be thoroughly cleaned of mill scale, mortar, oil, paint, dust, grease, or any other deleterious matter whatsoever, to the satisfaction of the Engineer.

Prestressing steel shall be cut by rotating disc or blade cutters or by such method as is recommended by the manufacturer.

The prestressing steel (or where the tendons are accommodated in ducts, the sheaths, ducting or formers) shall be accurately placed in the positions shown on the drawings and shall be firmly secured in position. Wooden supports shall not be used nor shall the sheaths, ducting or formers be placed on previous layers of fresh concrete or be adjusted during the placing of concrete.

The prestressing steel, sheaths, ducting or formers shall be so placed and secured that twisting, kinking or excessive deformation during and subsequent to concreting is eliminated and the prestressing tendons when finally stressed shall conform accurately to the profiles shown on the drawings. Ducts and formers shall not be placed with small radius bends which would induce excessive frictional restraint on the wires or strands.

6. Pre-Tensioning

The tendons shall be anchored in such a manner that during concreting they will not suffer any loss of tension whatsoever due to anchorage yield or deficiency or due to yielding of the prestressing beds. No variation in the tension of the wires shall be made subsequent to the commencement of concreting until transfer of prestressing force to the concrete is authorized.

At the appropriate time the prestressing force shall be transferred to the concrete uniformly by means of slow de-tensioning. The wires shall not be de-tensioned individually and the de-tensioning operation shall be applied to all the wires simultaneously. Where a set of wires passes through several units, the units shall be free to move longitudinally during de-tensioning.

The prestressing steel shall be cut off flush with the end of the member and the exposed ends of the prestressing steel and anchorages shall be heavily coated with an approved cement compound or with an epoxy resin to prevent corrosion of the prestressing steel.

The tolerance on the position of the tendons after tensioning, with respect to the theoretical position shown on the drawings is 10 mm.

7. Post-Tensioning

When a post-tensioning system is employed, all cable ducts, excluding extractable formers shall be thoroughly cleaned with oil-free compressed air immediately after concreting and before the concrete has hardened. The use of water is not permitted.

Where anchorage of the pre-stressing tendons is by friction grips or wedges and where no other slipping limitation is specified, the slip of each individual pre-stressing steel element, both during tensioning and after anchoring shall not exceed seven millimeters. Tendons failing to satisfy this limitation shall be re-stressed.

The sequence of stressing shall be as shown on the drawings or in the calculation note and shall be such that lateral eccentricity of stress on any member is reduced to a minimum.

After stressing and anchoring, no tendon shall be cut, bent or in any way deformed until the bonding grout or concrete is at least seven days old.

Where tendons are cut back, the exposed ends of the tendons and anchorages shall be heavily coated with an approved bituminous compound or epoxy resin to prevent corrosion of the pre-stressing steel.

The tolerances for the placing of the ducts or the anchorage elements, with respect to the theoretical position shown on the drawings are as follows: “a” being the dimension of the element in the direction where the tolerance is measured

- For $a \leq 50$ cm, the tolerance is 10 mm.
- For 50 cm $< a \leq$ 200 cm, the tolerance is $a / 50$.
- For $a >$ 200 cm, the tolerance is 40 mm.

8. Tensioning Operations

Prestressing force, whether partial or full, shall not be transferred to the concrete until compressive strength tests have indicated that the concrete has attained the strength specified on the drawings or in the calculation note. Stressing of the tendons shall be carried out with due care by experienced workmen under competent supervision and adequate steps shall be taken to safeguard against injury. Full and accurate records shall be kept of all stressing operations and two copies of the record, which shall include wedging slip measurements during anchoring, loads and extensions, shall be submitted to the Engineer on the day for each stressing operation. The accuracy of the measurement of cable extensions shall be plus or minus two per cent. The Engineer may order the Contractor to cease any or all stressing operations where proper records are not being kept or where the operations are not being properly or safely carried out and the Contractor shall take immediate steps to ensure that the work is carried out to the satisfaction of the Engineer.

Where the required tensions or extensions are not obtained, the tendons shall be re-tensioned as directed by the Engineer. If on re-stressing, the extensions are not achieved, the Engineer may at his discretion reject the tendons involved.

9. Bonding and Grouting

Post-tensioned tendons shall, after stressing and anchoring, be intimately bonded to the adjacent concrete by means of cement grout.

The properties of grout shall conform to EN 447. The grout shall either be part of the certified post-tension kit or shall have the CE marking based on a particular European Technical Approval (ETA). In both cases, the grout shall comply with the requirements of ETAG 013 (Guideline for European Technical Approval of Post-Tensioning Kits for Prestressing of Structures) for special grouts.

The cement shall be CEM I, CEM II/A-L or CEM II/A-D (silica fume limited to 8%). Required properties:

- Chloride ion Cl- content: < 0.05%.
- Sulphur ion S2- content: < 0.01%.

Admixtures, if any, shall conform to EN 934-4.

The grout is subject to acceptance test with control, at the beginning and at the end of the estimated grouting duration, of the fluidity and the grout temperature.

A fluidity test is systematically performed during the grouting of each tendon.

Equipment and the grouting procedure shall be in accordance with EN 446 and the recommendation of ETAG 013. The mixing equipment on site shall be approved by the holder of the ETA. The grouting shall be carried out by a specialized Contractor fulfilling the requirements of CEN Workshop Agreement n°14646.

The grout pressure shall not exceed 1.5 MPa and a constant pressure of 0.5 MPa minimum shall be applied during 1 minute after the end of the grouting.

After grouting, anchorages shall be protected against corrosion by a protective mortar conforming to the recommendations of the post-tensioning system supplier.

2.10.7 Industrial floor

For industrial floor, a curing and sealing compound for concrete floors type SIKAFLOOR PROSEAL-22 or equivalent is used in order to limit surface drying and cracking.

- It is used for optimum curing and sealing of fresh concrete floors and structures.
- It is applied at ambient temperature +10°C min. / +30°C max.

The Contractor shall prepare the concrete surface for industrial floor implementation.

Concrete expands and shrinks with changes in moisture and temperature. The overall tendency is to shrink, and this can cause cracking at an early age. Irregular cracks are unsightly and difficult to maintain but generally do not affect the integrity of concrete. Joints are simply pre-planned cracks.

Joints in concrete slabs can be created by forming, tooling, sawing, and placement of joint formers.

Some forms of joints are:

- Contraction joints – are intended to create weak- ened planes in the concrete and regulate the location where cracks, resulting from dimensional changes, will occur.
- Isolation or expansion joints – separate or isolate slabs from other parts of the structure, such as walls, footings, or columns; and driveways and patios from sidewalks, garage slabs, stairs, lightpoles and other points of restraint. They permit independent vertical and horizontal movement between adjoining parts of the structure and help minimize cracking when such movements are restrained.
- Construction joints – are surfaces where two successive placements of concrete meet. They are typically placed at the end of a day's work but may be required when concrete placement is stopped for longer than the initial setting time of concrete. In slabs they may be designed to permit movement and/or to transfer load. The location of construction joints should be planned. It might be desirable to achieve bond and continue reinforcement through a construction joint.

2.11 Technical Structures: Bridges, Overpasses, Underpasses, Culverts & Retaining Walls

2.11.1 Bridge Works

1. Foundations

During the execution, the Contractor shall consider that the technology proposed in the details of execution and the provision of the present specification, including all the relevant British Standard concerning this section.

Any modification of the execution technology of the foundations proposed by the Contractor shall be carried out only after getting the Engineer's approval.

This documentation shall include:

- position and dimensions of the shore-up site;
- steps for keeping the shape and size of the foundation and measures avoiding the deforming of the site during the execution;
- method of digging;
- composition and parameters of concrete poured in foundations;
- Procedure of concreting.

Before starting the works, the Contractor shall notify the Engineer, in due time, for checking the true position of the foundation, its dimensional accuracy, for ensuring that the dimensional deviations are kept within permissible limits. Close supervision of the all aspects of the process is essential.

Before starting the execution, the Contractor shall check if there are possible underground installations on the location of the foundations. If such installations are found, they shall be removed before the works will start. If during the execution of the works some installations are uncovered, the Engineer shall stop the works and the Contractor shall carry out their identification. The works will continue only when measures for removing and insulating, previously approved by owners, will be undertaken by the Contractor.

After reaching the bottom level of foundations, the Contractor shall notify the Engineer:

- location of foundations;
- slopes;
- stability of the site;

– bottom level of foundations;

- Foundation size.

Only when the Engineer's control on the above-mentioned information will be done, the Contractor shall start the following operation connected with the works.

The foundation depth is established taking in account, beside the structural analysis, the stability of scouring. The foundation level shall be under the frost depth.

After finishing each foundation, the Contractor shall perform a new lay-out, notice any deviation from the initial lay-out to the Engineer and perform any remedial solution ordered by the Engineer. As well as, the Contractor shall check the alignment of the entire foundation works at the end of their execution and transmit to the Engineer the result of the final control to be approved.

2. Bridge substructure. Abutments and piers

The abutments are substructure units for the bearing of the end span and the connection of the bridge to the access ramp.

The bridge piers are also substructure units for the bearing of two adjacent spans of the bridge.

The bridge pier and abutments shall be performed only on the basis of the Detailed Design Documentation supplied or approved by the Engineer. They may have direct or indirect foundations. In both cases the Contractor shall strictly follow the requirement stated in the present Specifications.

The substructure must observe the conditions provided in the Detailed Design Documentation, the relevant British Standard regarding "Road bridges. Substructures of masonry, concrete and reinforced concrete. Specification for the design" and the present Technical specification.

The execution of substructures without adequate Geotechnical Study is forbidden. The Contractor shall check the correspondence between the stratification provided by the study and the data available in the Tender Documentation in order to find out any possible misfit.

As previously said, the Contractor shall mark the axes of the foundation before starting the execution and shall obtain the previous authorization by the Engineer concerning the starting of the works.

Topographical measurements shall be made also after the completion of the elevation, with the purpose to establish the length of the future superstructure.

Possible remedial works will be performed but only with the Engineer's approval.

Shuttering and facing of the substructure works shall have the Engineer's approval concerning also the architectural design, if required by the Engineer.

The joining of the abutment with the earthworks may be achieved by cone-quarter or wing wall. The construction procedure shall be selected and approved by the Engineer following the Detail Design Documentation requirements and the present Specification. In any case cone quarters shall have minimum slope 1:1 and shall be protected by rubble stone or slab pitching. The pitching must have a foundation deeper than the frost depth of the zone. In case of indirect foundations scouring will be avoid.

Where wing walls are be used, the Contractor shall take measures to avoid scouring.

The method of substructures surface forming, and curing shall be approved by the Engineer.

In order to get surfaces with high degree of finishing, the formwork must be coated.

Concerning reinforcement, the top ends of the bars shall be embedded in the cross beam of the substructure.

The length of embedding (or overlapping) of the structural ribbed bars shall be at least 40 Φ (Φ = reinforcement diameter).

The allowed deviation of reinforcements are the following:

- ±3 mm for the distance between the axis of the bars;
- ±3 mm for the nominal cover course;
- ±3Φ for the overlapping length.

If possible, concreting of elevation should be done on the whole height, during one stage, the compaction being carried out by lateral windows.

Pouring the cross beam may be carried out after at least 21 days since the end of the concreting operations, in order to ensure propping of the scaffolding.

Particular attention shall be given to the zone of monolithically connection of substructure elevations with the cross beams.

The permissible deviations shall be the following:

- ±8 mm for the thickness;
- ±25 mm for the height.

3. Bridge superstructure

The bridge superstructure is composed by a slab in reinforced concrete and composite steel beams system. The execution works shall be performed only following the Detail Design Documentation has been submitted and approved by Engineer.

The composite steel beam shall be manufactured by Cor-Ten steel type (weathering steel), as per characteristic shown on drawings.

The Detailed Design Documentation shall contain full method of statement including:

- design of site organisation;
- working drawings of the superstructure;
- Design of all temporary scaffolding necessary for the construction;
- programme schedule of the works;
- quality control programme.

The design of the site organization shall emphasize the conditions of storage and maintenance of the material, steel frame, steel beam, components precast units and devices necessary for the execution of the works.

The working drawings, accompanied by calculation notes, shall contain all the data necessary to be used to carry out the works.

The Working Drawings shall include frameworks drawings as well steel works and concrete steel reinforcement drawings for the entire superstructure and for parts of it, in zones of strain concentration, heavily reinforced, the working drawings must show, at a convenient scale, the compliance between the reinforcement design and the actual conditions of concreting.

The framework drawing must include all the details regarding dimensions, tolerances, performance of the steel frame/ face concrete.

4. Reinforced concrete superstructure

The reinforcement drawings must contain all the data concerning the geometry and position of the reinforcement, diameters, partial and total length. The drawings must include also:

- quality of the bars;
- position tolerances;
- position of joint and joining details;
- position, shape and natures of spacers and other devices;
- position of handling ears of the precast unit.

In addition, the reinforcement drawings must show the sections of concreting restart, the treatment of the surfaces and of the reinforcing bars in these sections.

The sections with dense reinforcement shall be showed at large scale, with details at actual scale of the curvature radii and of the bars diameter.

The diagram of bars shall include:

- item of every mark of the bars;
- steel type;
- diameter;
- sketch of the bar;
- partial and total length;
- nominal weight;
- number of the bars with the same mark.

The diagrams may be on the drawings or in annexes.

5. Pre-cast elements

The precast units shall be manufactured on site or in plant according Engineer decision, and they shall be stored in adequate areas. The precast elements shall be used only if accompanied by the quality certificates requested by the Engineer. The precast elements shall be numbered and the date of fabrication and the type of predalle shall be marked on them with paint.

The assembling of the precast units shall be carried out under the competent supervision of the Contractor's senior engineer specialized in this field. The equipment used for assembling the precast units must ensure safe performing conditions.

Precast units shall be handled only using special parts and devices provided for this purpose.

The transport and storage of the girders shall be carried out using fixing parts, spacers, devices for keeping the correct position of the elements and for avoiding blemishes. The arrangement in the storehouse shall be made at minimum 10 cm from the ground.

The laying on supports shall be carried out checking the correct position in conformity with the detailed design documentation concerning both the assurance of the placement and the supporting and contact length on the bearing surface as well.

The final joins must be performed as soon as possible after the erection process.

The elements shall be removed from the fastening device after the achievement of the appropriate arrangement.

The faces of the elements which will be in contact with the monolith concrete shall be well cleaned by wire brushing and later on, washed with abundant water and air sprayed.

6. Cast in situ plate

The execution of the monolith slab shall be in accordance with the detailed design documentation supplied or approved by the Engineer.

The works shall be carried out using temporary works, such as:

- scaffoldings, propping of the formwork;
- scaffoldings for mounting formwork and reinforcement;
- formwork for exposed surfaces;

The design of temporary works, including working drawings and calculation notes, shall be provided by the Contractor for the Engineer's approval in due time prior the starting up of the works, as stated in the Condition of the Contract.

The technology of concreting shall be proposed by the Contractor and approved by the Engineer. In particular, the Contractor shall fulfill the following indications:

- The deviation limit for the thickness of the plate is ±5 mm;
- The reinforcement cover coating shall be 30 mm and its deviation limit is ±3 mm;

- Compacting fresh concrete poured in the plate shall be carried out by surface vibrating, for 30÷60 minutes. The recommendable workability shall be with a minimal slump of 2 cm. the layer thickness shall be 1.1÷1.25 time greater than the final thickness (after vibrating);
- The continuous pouring of plates on one span is also recommended. Working joints in plate are permitted, placed at a 1/5÷1/3 of span length, from the extremity of the girder;
- Particular attention should be given to the protection of the surfaces of the plate in order to avoid developing of contraction fissures, during minimum 7 days after pouring (by covering with mats or sand layer permanently kept in moist conditions).

7. Materials

Quality, quantity, dimensions and all the other information regarding materials and their technology which the Contractor shall utilize during the execution of bridge works must correspond to the requirements specified in the Detail Design Documentation and shall be in accordance with these Requirements.

8. Construction Tolerances for finished structures

The tolerances at final acceptance shall be as follows:

a. Dimensions

The size tolerances of the reinforced concrete structures are specified in the following table:

Part of Structure	Length	Width/Height	Thickness
Deck slabs	+/- 25 mm	+/- 20 mm	+/- 10 mm
Piers	---	+/- 10 mm	+/- 10 mm
Foundations or bottom slabs	+/- 25 mm	+/- 20 mm	+/- 10 mm
Piles	---	+/- 20 mm	---
Walls	---	+/- 20 mm	+/- 10 mm

b. Verticality

Piers and walls

verticality: ±1.5 mm/m of height, with a maximum of ±15 mm over the full height of any element,

twist around the axis: the twist should be one radian of between more or less 1 cm (±1/100 rad) per five meters.

Piles

Verticality: 1 horizontal in 75 vertical

c. General tolerances on the alignment

The general tolerances at final acceptance shall be as follows:

Parts of the structure	Measurement references	Tolerance
All parts	in relation to the position of the base of the structures	±5 cm
Piers	in relation to any references points taken from another bearing	±2 cm
Abutments, side and	in relation to any reference points taken	±2 cm

wing walls	from another bearing	
Deck or crossbeam cast in place	in relation to the piers and abutments or side walls of the structure	±2 cm
Stone facing superstructure	in relation to the piers of the structure	±2 cm
Foundation footings	in relation to the position of the base of the structure	±5 cm
Axis of the finished structure	in relation to the position of the base of the structure.	±1.5 cm

The Contractor shall repair, at his own expense, any shoddy work where the tolerances have not been respected.

2.11.2 Bridge Work Ancillaries

This section deals with the general requirements for the construction, manufacture and installation of ancillary bridge components including:

- Bridge expansion joints.
- Bearings
- Joint sealing
- Bridge Bearings
- Manufacture of Steel Parapets
- Waterproofing
- Bridge drainage

Quality, quantity, dimensions and all the other information regarding materials and their technology which the Contractor shall utilize during the execution of the above bridge ancillaries works must correspond to the requirements specified here and in the Detail Design Documentation.

2.11.3 Bridge Expansion Joints

1. Embedment in Concrete

The Tenderer shall base his tender on the bridge expansion joints as specified in the drawings for each bridge.

- Gap

The size of the gap will be compatible with the mean bridge temperature at the time of installation. This temperature shall be determined in accordance with arrangements agreed with the Engineer.

- Mixing of Materials

The mixing, application and curing of all proprietary materials shall comply with the manufacturer’s requirements.

- Epoxy mortar nosings

Epoxy mortar nosings shall be formed under the direction of a competent Engineer experienced in the use of the material. The work shall be carried out preferably in warm dry weather. The air temperature around the joint shall be not less than 10 degrees C which shall be achieved artificially if necessary.

- Surfaces

Concrete surfaces to which the nosings are applied shall be dry, sound and free from laitance. Before application of the priming coat, loose material and dust shall be removed by an air jet tested to ensure that no oil is carried over from the compressor.

- Preparation

Unless otherwise described in the Contract or directed by the Engineer, surfacing shall be carried across the joint and then cut back to accommodate the nosing. The cutting shall be done with a diamond saw to give a clean edge throughout the depth of the material to be removed. Masking material provided to prevent surfacing materials adhering to the deck where nosings are to be formed shall be adequately located to prevent displacement by the paving machine.

A paving coat of unfilled epoxy resin in composition shall be well worked in by a brush to all surfaces with which the nosings will be permanently in contact at a uniform rate of not less than 300g/m2. The mortar shall then be applied as quickly as possible while the priming coat is still tacky.

- Installation

The positioning of holding down bolts and anchorage systems shall be checked for accuracy and agreed by the Engineer before casting of concrete commences. Templates or shuttering agreed by the Engineer shall be fixed to box out the concrete for the joint and to locate holding down bolts or anchorage pockets. Threaded parts shall be protected, kept clean and free from rust.

Before installation of the joint, the concrete surfaces shall be free from laitance, sound, clean and comply with the manufacturer’s requirements.

Expansions joints shall be of uniform width and a straight alignment and shall be accurately set and finished and aligned with the finished surface.

The expansion joint and the bridge deck waterproofing shall be formed so that a watertight seal is provided.

During the placing and hardening of the bedding and bonding materials, movement between the joint and the substrate shall be prevented.

- Epoxy Mortar

The epoxy mortar shall be to be approved by the Engineer. Aggregates shall be either silica sand, calcinated bauxite or other approved synthetic or natural aggregate of suitable grading. The particle size distribution shall be that which produces a mortar with adequate workability and minimum void volume. Aggregate shall be clean and completely dry.

Whichever type of aggregate is used, the epoxy mortar components shall be thoroughly mixed in a suitable mechanical mixer. The sequence, duration and temperature of mixing shall be in accordance with the manufacturer’s instructions.

The mortar shall be placed in position within the time recommended by the manufacturer, it shall be well worked against the primed surfaces and troweled flush with the adjacent road surface to form a dense mortar to the profiles described in the contract. Epoxy mortar shall generally be compacted in courses of more than 1 hour old it shall unless otherwise agreed by the Engineer, be primed with an unfilled epoxy resin priming coat before placing the next course.

Traffic shall not be permitted to run on the mortar until the Engineer’s agreement has been obtained.

2. Fillers, sealants and accessories

- General

All materials used in the forming, construction and sealing of permanent joints shall be subject to the approval of the Engineer.

When required by the Engineer the Contractor shall submit test certificates from an approved, independent testing authority to show that the respective materials conform with the specified requirements, or a certificate from patent holder of designer certifying that the manufactured item complies in all the respects with relevant product specifications.

- Joint filler

Joint filler shall consist of sheets or strip of the following materials complying with the requirements of the relevant specifications listed:

- Bitumen impregnated fiberboard and impregnated corkboard - U.S. Federal Specification HH-F-341F or AASHTO Specification M213;
- Resin impregnated corkboard - U.S. Federal Specification HH-F-341F;
- Flexible foams of expanded polyethylene, polyurethane, PVC or polypropylene – AASHTO Specification M153;
- Rigid foams or expanded polyethylene, polyurethane or polystyrene - BS 4840 or BS 3837;
- Other joint filler materials may be used if approved by the Engineer after submission of full specifications and information by the Contractor.

  - Sealants

Thermoplastic hot-poured sealants shall comply with the requirements of U.S. Federal Specification SS-S-1401B, BS 2499 or AASHTO Specification M173. The sealants shall be of the rubberized bituminous type containing a minimum of 20% natural or synthetic rubber:

- Thermoplastic cold applied sealants shall comply with the requirements of U.S. Federal Specification SS-S-156. The sealant shall be of the rubberized bituminous type containing a minimum of 20% natural or synthetic rubber;
- Thermosetting chemically curing sealants shall comply with the requirements of US Federal Specification ANSI A 116.1 (formerly ASA A 116.1 and USASI A 116.1) or BS 4254. The final IRHD hardness of the sealant shall be 20±5.

Other sealants may be used if approved by the Engineer after submission of full specifications and information by the Contractor.

  - Preformed elastomeric compression seals:

Preformed elastomeric compression seals shall comply with the requirements of the Engineer and the Contractor shall submit samples for approval.

  - Primers:

When a primer is to be used in conjunction with the sealant it shall be of the prescribed proprietary material.

  - Adhesives:

Adhesives used in conjunction with preformed seals shall be of a proved and approved type compatible with the material of the seal.

  - Bond breakers:

Polyethylene tape, coated papers, metal foils or similar material may be used where bond breakers are required.

  - Backup material:

Backup material shall consist of a compressible material of correct width and shape, to ensure that after installation it is in approximately 50% compression and the sealant can be formed to the specified depth.

Backup materials shall be compatible with the sealant used. Material containing bitumen or volatiles shall not be used with thermosetting chemically curing sealants.

3. Filling and sealing of joints

  - Filled joints:

Filled joints shall be accurately formed to the dimensions shown and with the filler material selected by the Contractor and approved by the Engineer. The filler shall be secured in position not to displace during concreting, or thereafter if the filler is to remain permanently in the joint.

Wherever polystyrene or similar material susceptible to damage is used to form joints, it shall be lined with a hard surface on the side to be concreted. The hard surface shall be sufficiently resilient to ensure that the joint and surfaces can be formed free from defects.

- Sealing of joints:

Sealed joints shall be made watertight over the full length of the joints unless permitted otherwise by the Engineer.

- Preparation of joints

Care shall be exercised to ensure that primers or adhesives are applied only to surfaces that are absolutely clean and dry. The primer or adhesive shall be applied strictly in accordance with the manufacturer's instructions. Unless specified otherwise the primer shall be applied within the temperature range of 10 degrees C to 40 degrees C and the sealant shall be applied after the curing period of the primer and within the period that the primer remains active.

- Sealants

Sealants shall be applied strictly in accordance with the manufacturer's instructions by a person skilled in the use of the particular type of sealant. Trapping of air and formation of voids in the sealant shall be avoided. The sealant shall be finished to a neat appearance flush with the edges of the concrete or to the specified depth.

Thermoplastic hot-poured sealants shall not be poured into the joints when the temperature of the joint is below 10 degrees C. The safe heating temperature shall not exceed the specified pouring temperature by more than 10 degrees C.

Two-part thermosetting chemically curing sealants shall not be applied after expiry of the specified pot life period which commences once the base and activator of the sealant have been combined.

- Preformed compression seals

The seal shall be inserted and secured with a lubricant adhesive covering both sides of the seal over the full area in contact with the inside faces of the joint. The lubricant adhesive shall be applied immediately ahead of inserting the seal.

The seal shall be installed with the appropriate equipment in a compressed state such that under the most adverse condition the seal will remain in compression. The seal shall at all times be between 5 and 10 mm below the level of the pavement. The seal shall not be stretched during installation; however, unintentional stretching may occur which shall not exceed 5%.

Joints in seals shall be bonded or fused and shall be only at positions agreed to by the Engineer.

2.11.4 Bearings

Proprietary products other than those specified may be used provided they are shown to comply with the specified requirements, provided that the efficacy of the bearing has been verified by tests and successful previous use. Evidence of these as well as information on the bearing's durability and suitability for the specified use shall be submitted to the Engineer for his consideration.

Details of the product guarantee shall be submitted to the Engineer.

1. Filling and sealing of joints

- Storage and handling:

The bearings shall be stored under cover and clear of the ground, away from sunlight, heat, oils and chemicals deleterious to the bearings. The bearings shall not be stacked in a manner or on a surface that will cause distortion of the bearing.

The bearings shall be handled with care to ensure that they are not subjected to impact loads or any other condition that may be harmful.

- Installation:

The bearings shall be installed in accordance with the manufacturer's recommendations.

2. POT Bearings

The POT bearings shall have the following properties:

- design according to the European code EN1337-5 and EN1337-2 for sliding surfaces
- manufactured by laminated steel according to EN 10025
- CE mark according to the European codes on construction products
- corrosion protection of the steel components by a protection treatment approved according to European code EN 1337-9.

The POT bearings will be according the types, as detailed and shown on drawings:

- Fixed Bearing Type; it allows rotations of a spherical hinge and carries the vertical load and the horizontal loads along each direction of the horizontal plane
- Transversal Guided Bearing Type; it allows rotations of a spherical hinge and the horizontal displacement in the transversal direction; it carries the vertical load and the horizontal load along the longitudinal direction;
- Longitudinal Guided Bearings Type; it allows rotations of a spherical hinge and the horizontal displacement in the longitudinal direction; it carries the vertical load and the horizontal load along the transversal direction
- Free Sliding Bearing Type; it allows rotations of a spherical hinge and the horizontal displacement along each direction of the horizontal plane; it carries only the vertical load

3. Epoxy Resin Mortar Bedding for Bearing Pads

The components of the epoxy resin mortar shall be supplied in ready to use packs and no splitting of packs on site will be permitted.

The work on site shall be carried out by a specialist sub-Contractor experienced in the application of this material.

Application shall be carried out in accordance with the manufacturer’s instructions. The manufacturer’s recommendations for safe handling shall be observed.

The concrete to receive the bedding mortar shall have been properly cured for at least fourteen days prior to applying the epoxy mortar.

The surface of the concrete on which the epoxy bedding mortar is to be applied shall be abraded and shall be clean, dry and mechanically sound, any laitance oil or curing compounds being removed. All loose material shall be removed by air blasting with clean oil free compressed air.

Epoxy resin mortar shall preferably be mixed and applied at temperatures above 15oC. For applications at lower the components shall be stored overnight at 15-20oC before use. At site temperatures below 10oC some form of external heating shall be used during the first twelve hours after placing unless a special formulation for lower temperatures is used.

A tack coat comprising thoroughly mixed binder or as otherwise recommended by the manufacturer shall be applied to the substrate by brush, roller, squeegee or spray at a spreading rate of 250-500g per sqm immediately before laying the resin mortar. This bonding layer must still tacky when the resin mortar is applied. If the tack coat has hardened it must be abraded and a further tack coat applied.

The components of the tack must be supplied separately in a convenient small pack size.

When mixing the epoxy resin mortar, it is essential that the resin and hardener components are thoroughly mixed prior to adding the filler.

For small quantities up to a maximum pack size 7.5 kg mixing may be by hand using a trowel in a clean plastic bucket. For larger packs a mixer must be used. The thoroughly mixed mortar shall be applied immediately after mixing.

Loading shall not be applied to the mortar bed until it shall have cured to an adequate compressive strength, to the satisfaction of the Engineer. The air temperature during curing will have a considerable influence on the rate of cure and on the time to achieve a given strength.

4. Mechanical Structural Bearings

The Contractor shall if required supply and fix proprietary Mechanical Structural Bearings to certain bridges.

The bearings shall be supplied and installed in accordance with the manufacturer's requirements and in compliance with the specification clauses of BS5400 : Part 9 : Section 9.2 : 1983.

Mating surfaces of bearings shall be kept free from contamination and, after the deck has been completed, each bearing and the area around it shall be left clean.

All bearings shall be indelibly marked with the appropriate Type numbers and shall be supplied complete with upper bolts and holding down bolts as required.

Corrosion protection to the bearings shall be provided as follows:

– One coat of zinc epoxy primer

– Two coats of coal tar epoxy

– Minimum dry film thickness 275 microns.

– All bolts and washers to be zinc plated.

The Contractor shall inform the Engineer at least 14 days in advance of the date of the manufacture of the bearings and of the date when tests are to be carried out.

Bearings shall not be dispatched to the site until the tests described in the Contract have been satisfactorily completed and the certified results of such tests approved by the Engineer.

Metal bearings shall comply in all aspects with BS 153: Part 1.

2.11.5 Structural Steelwork

This section deals with requirements for site fabrication of structural steelwork. The Tenderer shall base his tender on the structural steel works characteristic as specified on drawings.

1. General Requirements:

- Workmanship, fabrication and erection:

Unless otherwise specified in the Contract, structural steelwork shall comply with the provisions of BS 153.

- Working drawings:

Two copies of all detailed working drawings prepared by or on behalf of the Contractor shall be submitted to the Engineer for his approval, but this approval shall in no way relieve the Contractor of his responsibilities for the work under the Contract.

- Welding and Flame Cutting, procedure trials:

a. When directed by the Engineer and before fabrication is commenced, welding and flame cutting procedure trials shall be carried out using representative samples of materials to be used in the work.
b. The samples of material shall be selected and marked by the Engineer when the materials for the work are inspected at the mills.
c. Trials on materials 20 mm thick shall be taken to include all material up to but not exceeding 20 mm thick. Trials on materials 38 mm thick shall be taken to include material over 20 mm thick and up to but not exceeding 38 mm thick. Material over 38 mm thick shall be tested for every thickness increment of 6 mm.
d. The welding and flame cutting trials shall demonstrate to the satisfaction of the Engineer the procedures to be adopted in the fabrication of the work which shall include:

i) Welding procedure in accordance with BS 1856 and BS 2642

ii) The heat control techniques required to ensure that the flame cut surfaces of steel are free from cracks, local hardness, and any other defects which would be detrimental to the finished work.

e. The trials shall include specimen weld details representative of the actual construction, which shall be welded in a manner simulating the most unfavourable conditions liable to occur in the particular fabrication. Where primers are to be applied to the work prior to fabrication, they shall be applied to the sample material before the procedure trials are made. After welding the specimens shall be held at a temperature not less than 10 degrees C for a period not less than 72 hours and shall than be sectioned and examined for cracks and other defects.
f. The following groups of tests to BS 709 shall be carried out.

i) Butt welds

Transverse tensile test.

Transverse and longitudinal bend tests.

Separate tests shall be performed in each case with the root of the weld in tension and compression respectively.

Charpy V-notch impact tests except for Grades 43A and 50B steels to BS 4360.

Macro examination test.

ii) Fillet welds

Fillet weld fracture test.

Macro examination test.

- Qualification and testing of Welders:

The evidence to be provided in accordance with BS 153: Part 1 shall be extended to include tests MA/S32 to 35 of BS 2645: Part 1 where plates of 12 mm thickness and over are to be butt welded manually.

- Supervision of Welding:

Welding shall be carried out under the direction of an experienced and competent Engineer.

Unless otherwise agreed by the Engineer, a record shall be kept enabling major butt welds to be identified with the welders responsible for the work, but finished work shall not be marked by hard stamping for this purpose.

- Welding Plant:

The welding plant shall be capable of maintaining at the weld the voltage and current specified by the manufacturer of the electrodes. The Contractor shall supply instruments for verifying voltages and current as and when required by the Engineer.

- Welding:

a. Unless otherwise described in the Contract, metal-arc welding shall comply with BS 1856 and BS 2642, as appropriate, except for tack welds and temporary attachments for which the procedures laid down in BS 2642 shall be followed.
b. The temperature of steels welded in accordance with BS 2642 shall be not less than 10 degrees C when welding is commenced.
c. Electrodes and fluxes shall be used in accordance with the manufacturer’s instructions. The use of welding processes other than those covered by BS 1856 and BS 2642 shall be subject to the approval of the Engineer.
d. The general welding programme for shop and site welds, including particulars of the fusion faces the method of preheating where required, the methods of making the welds, and the types of electrodes shall be submitted to the Engineer for his approval before the work is put in hand. No departure from the agreed welding programme or from the details shown on the Drawings shall be made without the agreement of the Engineer. Electrodes and fluxes shall be so chosen that the properties of the deposited metal are not inferior to those of the parent metal.
e. The procedures for welding and flame cutting established in the Specification shall be strictly followed.
f. Unless otherwise described in the Contract, all but welds shall be complete penetration welds made between prepared fusion faces.
g. In the fabrication of built-up assemblies, all butt welds in each component part shall be completed, whenever possible, before the final assembly.
h. The position of welds required for temporary attachments shall be agreed by the

Engineer before the work commences

i. Where automatic or semi-automatic processes are used back gouging of the deposited weld will not be required where the Engineer is satisfied that the root run is free from imperfection.
j. Where butt welds are to be ground flush there shall be no loss of parent metal. The final grinding shall be in the direction described in the Contract.
k. Stud shear connectors shall be welded in accordance with the manufacturer's instructions.
l. In butt joints the rot edges or root faces shall not be out of alignment by more than 0.125 times the thickness of the thinner material for material up to 12 mm thick or by more than 2 mm for thicker material.
m. Requirements for 'run-on' plates and 'run-off' plates shall be as follows:
   i. One pair of run-on plates and one pair of run-off plates all prepared to the same thickness and profile as the parent metal shall be attached by clamps to the start and finish respectively of all butt welds. Unless otherwise required by the Engineer approximately 1 in 5 pairs of run-off plates for butt welds in tension flanges and 1 in 10 pairs for other butt welds shall be production test plates. The combined size of each pair of production test plates shall be either 225 mm, 300 mm or 375 mm wide x 200 mm long as shown in Table 8213/1 the length being measured in the rolling direction of the metal and at right angles to the weld.
   ii. Butt welds shall run the full length of the joint and extend at full weld profile for a minimum distance of 25 mm into the run-off plates, and for minimum distances of 200 mm, 275 mm and 350 mm respectively into the 225 mm x 220 mm, 300 mm x 200 mm and 375 mm x 200 mm run-off production test pates.
   iii. On completion of the welds the run-off production test plates shall not be removed until they have been marked in a manner agreed by the Engineer to identify them with the joints to which they have been attached.
   iv. When removing the run-on and run-off plates by flame cutting the cuts shall not be nearer than 5 mm to the sides of parent metal and the remaining metal shall be removed by grinding or other method agreed by the Engineer.
   v. Specimens for the following tests to be carried out in accordance with Clause 8402 shall be selected from the run-off production test plates by the Engineer.
      - Transverse tensile test(s). (The number of test pieces shall be sufficient to cover the full thickness of plate).
      - Transverse bend test.
      - Three Charpy V-notch tests except for steel of Grades 43A and 50B to BS 4360.

- Materials

a. Structural steel shall comply with the requirements of BS 153: Part 1 and BS 4360. In addition, structural steel hot-rolled sections and structural steel hot-rolled hollow sections shall comply with the requirements of BS 4 and BS 4848.
b. Steel for headed stud type shear connectors shall have a minimum yield stress of 386 N/mm^2 and a minimum tensile strength of 494 N/mm^2. Material for other types of steel shear connectors shall, unless otherwise described in the Contract, comply with the requirements of BS 4360.

- Testing

a. Testing of Steel for Structures:

All tests on structural steel shall comply with BS 4360.

b. Testing of Welding:

The tests detailed in this section shall be carried out by the methods described in BS 709. The following requirements shall also be met.

i. General

The test results of welded joints shall not be inferior, in any respect, to the British Standard test requirements for the parent metal.

ii. Procedure Trials
   - Tensile and Bend Tests

Should any one of the weld joint test pieces selected for transverse tensile and transverse and longitudinal bend tests fail to comply with the test requirements applicable to the parent metal of the joint represented by the test, 2 additional test pieces shall be taken from the joint material represented by the test. Both shall then comply with the test requirements in order to qualify for acceptance.

– Charpy V-notch Test

Should the average impact value obtained from any set of 3 Charpy v-notch specimens fail to comply with the test requirements, 3 additional test pieces from the same sample shall be tested. The average of the 6 test results shall comply with the test requirements in order to qualify for acceptance.

– Revised Procedures

In the event of failure to meet the test requirements, the Contractor shall carry out further trials, using revised procedures, and further tests to the satisfaction of the Engineer.

iii. Production Tests

– Production Test Plates

The run-off production test plate size specified shall be cut on the instructions of the Engineer, to enable up to 2 complete sets of test specimens to be obtained.

– Tensile and Bend Tests

Should any one of the weld joint test pieces selected for transverse tensile and transverse bend tests fail to comply with the test requirements applicable to the parent metal of the joint represented by the test, additional specimens shall be cut from the same production test plates and the tests repeated. Should either of the additional tests fail to comply with the requirements of the joint shall be rejected.

– Charpy V-notch Tests

Should the average impact value obtained from any set of 3 Charpy V-notch specimens selected fail to comply with the test requirements, 3 additional test pieces from the same production test plates shall be tested. Should the average of the 6 test results fail to comply with the test requirements the joint shall be rejected.

– Re-welding and Re-testing

In the event of failure to meet the test requirements the weld joint represented by the tests shall be completely cut out. The joint shall then be rewelded and the tests repeated.

iv. Non-destructive Testing

A method of non-destructive testing agreed by the Engineer shall be used for the examination of butt welds in tension members and where otherwise directed.

Table 2.11.5.1: Sizes of Run-off Production Test Plates

Combined size (per pair) of run-off production test plates			
Material	Combined size (per pair) of run-off production test plates		
	Plates up to 30 mm thick	Plates from 30 mm to 75 mm thick	Plates over 75 mm thick
Steel of Grades 43A and 50B to BS 4360	mm 225 x 200	mm 300 x 200	Size to be agreed with the Engineer
Steel of Grades 40C, D&E, 43C, D&E and 50C to BS 4360	300 x 200	375 x 200	

- Metal Parapets

The Tenderer shall base his tender on the metal parapet characteristic as specified on drawings.

For the metal parapets to be installed on bridge's sides see description in Section 2.4 Road Works and ancillary works.

- Painting of Structural Steelwork

The Tenderer shall base his tender on the painting of structural steel work as specified on drawings.

a. Preparation of Surfaces to receive Paint

– All bare metal surfaces: blast cleaning

Blast cleaning shall be carried out to first quality of surface finish to BS 4232 using chilled iron abrasive. Chilled iron grit shall be graded in accordance with BS 2451, the size shall be G24 for use in automatic impeller type equipment and G12 for manual or compressed air equipment. Where agreed by the Engineer non-metallic abrasives may be used with portable equipment only. The abrasive used for blast cleaning shall be from harmful contamination and every recovered material shall be cleaned to the satisfaction of the Engineer before re-use. The imum amplitude (peak to through) of the blast cleaned surface shall not exceed 100 μm. A sample blast cleaned steel panel measuring not less than 150 mm x 150 mm x 6 mm adequately protected by a sealed transparent wrapping shall be submitted to the Engineer for approval before any work is put in hand. The approved sample shall then be retained by the Engineer's inspectors for comparison with the prepared steelwork.

– General cleaning

Weld spatter shall be cleaned off all surfaces, and paint films shall be free of embedded foreign metallic particles. Deposits of concrete or other adherent matter shall be washed or cleaned off immediately they occur and if necessary, the surface made good to the satisfaction of the Engineer.

Areas contaminated by oil or grease shall be cleaned with white spirit. Unless otherwise instructed by the Engineer, the final works coating on external surfaces shall be cleaned at Site by washing with a solution of an approved liquid detergent, using scrubbing brushes where necessary, following by rinsing with clean fresh water and allowed to dry thoroughly before over-coating. Immediately prior to the application of paint all loose particles, dust and debris shall be removed.

– Cleaning to remove Chemicals, Metallic Dust and Grit Particles:

A protective coating shall not be applied to surfaces bearing atmospheric corrosion products, other chemicals, metallic dust or particles of grit which may be harmful to the coating or succeeding coatings. These contaminants which include any remaining after surface preparation as specified in Clause 10101 and any produced by welding, shall be cleaned off to an extent agreed by the Engineer to be compatible with the specified protective system.

b. Metal Coatings

– Materials:

Sprayed metal coatings shall comply with the requirements of BS 2569: Part 1.

– Application:

The nominal thickness of coating shall be 100□m of sealed sprayed, reference no. SC5Z as given on Table 4C part 2 of BS 5493. The procedure for application shall be in accordance with BS 2549, part 1.

c. Protection of Joints

– Bolted Joints:

Shop Joints: Metal spray plus etch primer, or blast primer alone, shall be applied to parent and joint material. The joint shall be assembled immediately after the first undercoat of the parent system has been applied to the contact surfaces.

Site Joints: Unless otherwise described in the Contract all surfaces, excepting those of fasteners, shall receive in the shop the painting system which is applied to the parent surfaces.

– Welded Joints:

Unless otherwise described in the Contract, welds and surfaces which have been affected by welding shall receive the protective system which is applied to the parent surfaces.

– Treatment adjacent to joints:

Metal spray shall be kept at least 15 mm clear of areas to be welded and these areas shall be masked off during spraying.

Where paints other than blast primers are to be applied to the parent surfaces before the making of a joint they shall be stepped back at 30 mm intervals commencing at 80 mm from welded joints and at 10 mm from the perimeter of all other joints.

- Surface preparation and Painting of Completed Joints;

Within 14 days of the joints having been made and passed by the Engineer, the parent and joint material, exposed parts of bolts, nuts and washers, weld and weld affected areas shall be prepared and painted.

- Other Treatment of Joints:

All bolted joints shall be sealed against the ingress of water. Before painting commences, and subject to the approval of the Engineer, gaps and joints shall be plugged with an approved filler.

The perimeter of all joints shall be sealed with subsequent coats of paint.

d. Storage of Paint
- Paint shall be stored in sealed containers in a lock-up store where it is not exposed to extreme temperature. The temperature of the store shall be kept between 4ºC and 27ºC. Any special storage conditions recommended by the manufacturer shall be observed.
- Paint which has not been used within the ‘shelf life’ period specified on the containers or within 18 months of the date of manufacture, whichever is the lesser, shall be replaced.
- At the end of each working period paints with a limited ‘pot life’ shall be discarded. Other types of paints from painters’ kettles shall be returned to store and kept in sealed containers with not more than 10% ullage.

e. Application of Paint
   i. The Contractor shall furnish the Engineer with duplicate copies of each completed BES/P2 Paint System Sheet, and duplicate copies of Paint Data Sheet, provided by the paint manufacturer, for each of the paints he proposes to use. Following the Engineer’s written instruction, the requirements of BES/P2 paint System Sheets shall be adopted for the Works.
   ii. Where called for by the Engineer the Contractor shall carry out paint application procedure trials either at the fabricator’s works or at Site as appropriate, with the equipment and labour to be used in the Works. The Contractor shall supply suitable blast cleaned steel and sufficient paint for the trials and must demonstrate his ability to apply each coat of paint of a designated paint system in accordance with the specification and the paint manufacturer’s data sheet. No painting of the contract steelwork will be permitted until the procedure trials have been completed to the satisfaction of the Engineer. Any adjustment to the registered paint formulation shown to be required by the trials, other than an increase in the amount of thinners, must be agreed to by the Engineer and made at the paint manufacturer’s works before the final stage of a paint procedure trial and before delivery of the first batch of paint.
   iii. The Contractor shall ensure that the paint manufacturer’s Data Sheets cover the conditions at works or at site, including temperature and humidity, under which the paints are to be applied.
   iv. Paint shall be supplied by the Contractor’s paint store to the painters ready for application, the only adjustment of formulation being as provided for in ii) above. Any addition of thinners must be made in the store under the supervision of the Engineer and only as allowed by the manufacturer’s data sheet.
   v. All painting shall be carried out by skilled and experienced painters under constant supervision by competent qualified staff.
   vi. Paint shall be applied only to surfaces which have been prepared and cleaned in accordance with this section.
   vii. Paint shall not be applied under the following conditions:
      - When the ambient temperature falls below 4ºC or the relative humidity rises above 90 per cent.
      - During rain, snow, fog or mist.
      - Where the amount of moisture on the surface or that likely to be caused by subsequent condensation may have a harmful effect.
   viii. As soon as the first undercoat has dried, an extra stripe coat of paint shall be applied by brush to edges, corners, crevices, exposed parts of bolts, rivet heads and welds, using a similar undercoat but in contrasting shade.

Successive coats shall have different shades for identification.

ix. The Contractor shall ensure that the proposed coverage rates will enable the specified average dry film thickness of each coat to be attained.

x. Wet film thickness gauges shall be used to check the rate of paint application.

xi. All shop painting shall be carried out in a fully enclosed workshop unless otherwise agreed by the Engineer.

xii. Unless otherwise described in the Contract a coat of paint in a system shall be applied by spraying.

xiii. Each coat of paint of a specified paint system shall be generally free from surface defects, particularly cratering, pin holing, revelling, sagging, bittiness, dry spray and cissing. The finished system shall have an even and uniform appearance.

xiv. Each coat of paint of a specified system shall have satisfactory adhesion as demonstrated by one of the currently accepted adhesion tests specified by the Engineer.

f. Storage of steel and fabricated steelwork

- The Contractor shall take precautions to minimize exposure to chemical pollution of steel awaiting fabrication.
- Fabricated steelwork, which is stored, awaiting delivery to site or erection, shall be kept clear of the ground and shall be laid out or stacked so as to prevent water or dirt accumulating on or against any of the surfaces. Suitable packing shall be placed between layers of stacked steelwork. Where cover is provided it shall be ventilated sufficiently to keep condensation to a minimum.
- Unless otherwise described in the Contract, exposure times for blast cleaned or coated surfaces other than at joints shall not be longer than those in Table 2.8.7.2 below. “Outside” refers to any area outside a fully enclosed workshop. The exposure times tabulated in Table 1 refer to any part of the surface being cleaned in accordance with this section. For surface condition ‘c’ where blast primed steelwork is exposed outside, the minimum dry paint film thickness over the peaks of the blast cleaned steel shall not be less than 13μm. Zinc rich coated steelwork may only be exposed outside for the minimum period to allow movement at the fabricator’s works. Such movement shall be under the supervision of the Engineer and unless the weather conditions are favorable the sections shall be covered.
- No steelwork shall be loaded for transport until the paint system has been passed by the Engineer as being sufficiently dry for handling.

Table 2.11.5.2: Exposure times for blast cleaned or coated surfaces

Surface	Enclosed workshop	Outside
a) Blast cleaned	4 Hours	Nil
b) Metal sprayed	4 Hours	Nil
c) Blast primer on ‘a’	imum exposure of 8 weeks with up to 2 weeks of this time outside	
d) Etch primer on ‘b’	24 Hours	Nil

g. Repairs to Damaged Surfaces

- Areas of paint which have been damaged shall be cleaned to bare metal, or to metal coating where this has been applied, and the edges of the undamaged paint beveled with sandpaper.
- Where a metal coating has been damaged the affected area shall be rubbed down to remove excessive roughness, cleaned and made good by the application of coats of an approved zinc-rich primer to a minimum dry film thickness of 100μm.
- The full specified painting system excepting blast or etch primers which may be omitted at the recommendation of the paint manufacturer, shall then be applied in such a manner that the new paint overlaps the existing paint by at least 50 mm all-round the affected part.

h. Etch primers and blast primer

Etch primers and blast primers shall be suitable for continuous spray application. They shall not be used on phosphate steel nor shall they be over-coated with zinc rich primers.

i. Protection of Works during Painting Operations

The Contractor shall protect all parts of the structure against disfigurements by spatters, splashes and smirches of paint or of paint materials. The Contractor shall be responsible for any damage, paint or dirt caused by his operations to vehicles, persons or property, including plant and animal, and he will be required to provide protective measures at his expense to prevent such damage.

Any paint stains which may result in an unsightly appearance shall be removed or obliterated by the Contractor at his expense.

If passing traffic creates sufficient dust to harm or spoil the appearance of painted surfaces, the Contractor shall sprinkle the adjacent roads and shoulders with water at his own expense, for a sufficient distance on each side of the location where painting is being done to keep dust away from freshly painted surfaces. The Contractor shall also furnish and post at his own expense DRIVE SLOWLY signs and take other necessary precautions to prevent dust and dirt from adhering onto freshly painted surfaces.

j. Testing of Paints

- Immediately after selection by the Engineer, samples of each type of paint to be used for the Works shall be despatched by the Contractor to the testing authority in accordance with the Engineer’s instructions. The samples shall be supplied in 5 litre-unopened containers as received from the paint manufacturer.
- The first sample shall always be taken from the first batch of each type of paint to be supplied and painting shall not commence until the Engineer confirms that these first samples are satisfactory. Paint must be supplied in sufficient time to allow for the initial testing.

Immediately after selection by the Engineer of control samples of paints being used for the Works, the Contractor shall fill 500ml containers with the selected materials and hermetically seal and dispatch these to the testing authority. The containers shall be provided by the Contractor and be of such material as not to affect the contents.

2.11.6 Waterproofing

Where the project drawings so require or when the Engineer deems it proper, the extrados of the vaults of artificial tunnels and other structures, including bridges, viaducts, underpasses, etc. shall be waterproofed by means of:

- bituminous coatings, if the structure is to be covered;
- elastic membranes, when the structure is to remain uncovered.

For bridges and similar structures such as viaducts, underpasses, overpasses, etc.; the waterproofing layers, besides being nearly totally waterproof, shall be so designed and executed as to have:

- high mechanical resistance, especially to rip in relation to the site traffic and the works subsequent to the laying of the waterproofing layer;
- deformability, meaning that the material shall follow the deformations of the structure without cracking or breaking away from the support, maintaining practically unaltered all the impermeability and mechanical resistance characteristics;
- chemical resistance to the substances which may be found in solution or suspension in the permeation water.

In particular account shall be taken of the presence in solution of the chlorides employed as antifreeze agent;

- durability, meaning that the waterproofing material shall retain its properties for a duration not inferior to that of the pavement, taking into account the eventual effect of fatigue for the repetition of loads;
- compatibility and adhesiveness in respect to both the underlying materials and the overlying materials (pavement);

- other required characteristics concern easiness of placing under different climatic conditions and the possibility for easy local repair.

The above waterproofing characteristics are to remain unaltered:

- between the operating temperatures which may occur in the area and, however, always between -15°C and +60°C;
- under the action of thermal changes and mechanical stresses which may occur when laying pavements or other upper layers.

Tests and quality controls and possible efficiency tests shall be foreseen.

1. Bituminous webs

The materials to be used and the methods of application will be as follows:

- cleaning of surfaces: a good cleaning with compressed air and removal of the larger irregularities is imperative; differences in level should be not greater than 0,5%; the surfaces shall have at least 28 days curing and be dry;
- primer: this will be formed by the application of about 0.5 kg/m2 of bituminous mass similar to that of the web, to be cold applied (in water emulsion or with solvent 50%);
- type of web: the web will be plants formed, of 3-4 mm overall thickness, of which at least 2 mm is bituminous mass; weight of backing shall be not less than 250 g/m2; the joints between two consecutive webs shall be overlapped at least 10 cm and shall be accurately sealed with flame and metal spatula;
- resistance to punching of the web: not less than 10 kg;
- tensile strength: 60 kg/5 cm minimum.

The greatest care shall be exercised in applying the terminal parts of the webs to prevent infiltration of water beneath; the Engineer may request the use of a greater quantity of bituminous mass to be spread on the primer for a band of at least 1 meter along these points, or other similar measures to ensure water tightness.

2. Elastic membranes

Placing of the elastic membranes will be preceded by the preparation of the concrete surfaces to be designed, consisting in a thorough cleaning with compressed air, while plastering of lesions or unevenness and/or removal of concrete knobs will be decided from time to time by the Engineer. The surfaces shall be perfectly dry.

The preformed membrane sheets shall be applied to the primed surfaces either by hand methods or by mechanical applicators. The membrane sheet shall be placed in such a manner that a shingling effect is achieved in the direction that water will drain.

After positioning of the membranes to determine the exact overlapping at the junction points, the membranes will be removed to proceed with the impregnation of the surfaces with the special adhesives. The surfaces to be sealed will include the whole surface to be covered or part of it (overlapping areas, top of structure, points of possible water infiltration, etc.) and the choice will be from time to time made by the Engineer. After applying the adhesive, the membranes will be unrolled exerting on them the necessary pressure to obtain the adherence to the support.

The joints will be sealed by vulcanization to be obtained through the use of hot air produced by special electric heating torches.

The so welded zones shall then be roller pressed. In certain cases (critical joints in respect to infiltrations) the Engineer may request double welding.

The edges of the membranes shall be so formed that they will prevent infiltrations of water; they will thus end either in channels to be sealed with elastic mastics or will be covered with stainless metal profiles to be nailed to the support. Longitudinal edges shall be treated as shown on the drawings.

The characteristics of the membranes shall be as follows:

- weight: 1-1.5 kg/m2;

– tensile strength (ASTM - D 412) at ambient temperature: 70 kg/cm2;

– resistance to oxidizing agents (ozone): 12 hours in atmosphere of 50 mg/m2 without formation of micro-cracks or other alterations.

1. Bridge deck waterproofing

Bridge deck waterproofing shall be composed of a prime coat coal tar emulsion and two layers of asphalt-coated glass fabric, and three mopping in the following sequence: prime coat, coal tar emulsion, glass fabric, coal tar emulsion, then the asphaltic concrete wearing surface.

All concrete surfaces which are to be waterproofed shall be smooth and shall be free of projections or depressions that might cause puncture of the membrane.

The surface shall be dry and free of dust and loose materials immediately before the application of the waterproofing. Waterproofing shall not be done in wet or freezing weather without written authorization from the Engineer.

Asphalt shall be applied at a temperature between 150oC and 180oC, and tar between 100oC and 120oC.

The prime coat shall be applied by brush or hand roller so as to penetrate the concrete and provide bond between the concrete and the waterproofing. Primer shall be applied at the rate of 0.25 to 0.50 liters per square meter. Primer shall not be applied when the ambient air temperature is less than 10oC and shall be allowed to cure a minimum of 4 hours prior to the application of the waterproofing.

Surfaces shall be dry so as to prevent the formation of steam when the coal tar emulsion is applied. No waterproofing shall be done in wet weather or when temperature is below 10oC.

The bituminized glass fabric shall be shingled so that there will be at least two thicknesses at all points. Edge laps shall be at least 5 cm. One ply of fabric shall not touch another or the primed concrete surface, since there must be three unbroken mopping’s.

The first strip of fabric shall be one-half the width of the roll; the second shall be full width of the roll lapped with full width of the first strip; the third shall be full of the roll lapped one-half the width of the second strip plus 5 cm. Each succeeding strip shall lap one-half the width of the preceding strip so that there will be at least two layers of fabric at all points. No strips less than 30 cm. wide shall be used.

On horizontal surfaces not less than 12 liters and not more than 15 liters of asphalt mop coat shall be used for each mopping for each 10 square meters of finished work; on vertical surfaces not less than 15 liters and not more than 20 liters for each mopping per 10 square meters shall be used.

Each strip of fabric shall be carefully pressed into place to eliminate all air bubbles and to provide a smooth flat surface.

Waterproofing applied to surfaces that change abruptly in direction shall be reinforced at these points by application of an extra layer of fabric of suitable dimensions. The Engineer shall be considered the sole judge to determine an abrupt change.

Care shall be taken to prevent damage to the waterproofing strip and course during the placing of the pavement or by any other construction operation. Planks, plywood, or suitable sheet material shall be laid over the waterproofing when any trucking or tracking is unavoidable. Any damage shall be repaired at no additional expenses to the Employer.

A special waterproofing detail at the juncture of the concrete deck slab and the kerb shall be installed as indicated on the plans and in conjunction with the placement of the bridge deck waterproofing. Approximately 4 cm. of the waterproofing strip nearest the kerbs shall be turned up the face of the kerb or into a specially provided recess directly beneath the face of the kerb. Recess filler shall then be installed between the concrete deck and the underside of the kerb and in front of the turned-up waterproofing.

Waterproofing at the juncture of the deck slab and scuppers, expansion joints, manholes, etc., shall be accomplished by turning up the waterproofing at such junctures, with the waterproofing snug against the face to a point that will be flush with the wearing surface when placed.

3. Bituminous coating to buried concrete

Concrete elements in contact with the soil shall be coated with bituminous coating (coal tar). The coating consists in a de-acidified tar, hot bitumen or an emulsion of de-acidified bitumen. The compound of the bituminous coating is to be submitted for the Engineer's approval. Three layers shall be laid. The total minimum thickness is 1 mm.

2.11.7 Bridge drainage

In-let Gullies shall be heavy-duty cast iron type suitable for road traffic consisting of a strong hinged grating and frame and complying with the requirements of BS 497.

Gullies shall be laid on a 1:3 cement mortar bed to a line level matching the adjacent finished road surface.

Pipes shall be of approved plastic materials approved by the Engineer Un-plasticized polyvinylchloride (uPVC) pipes shall comply with the requirements of BS 4660 or BS 3506, except that class 0 pipes shall not be used.

Pipe brackets shall be proprietary type suitable for the pipes used.

Weep holes, drainage gullies and pipes shall be provided in accordance with the details shown on the Drawings or ordered by the Engineer.

Weep holes shall not be placed within 40 mm. of any reinforcement and shall be cleaned to permit the free flow of water on completion of the work.

Drainage pipes shall be on completion cleared of all foreign matter and the interior surface left smooth.

2.11.8 Foundation Piles

1. General

The present Specification is to be read in conjunction with any specifications prepared by specialist subcontractors, or directed, obtained or otherwise approved by the Engineer.

Provision of the technical data necessary to design piles and/or piling layouts is the responsibility of the Contractor as provided elsewhere in the documents.

Records shall be kept for each pile installed, to include:

- Pile type and dimensions, dates of driving or boring, pile cut-off level;
- Type, weight and drop of hammer, details of packing, and driving records, resistance at 0.25m intervals, pile set in mm per 10 blows or number of blows per 25mm penetration;
- For bored piles, description of ground excavated;
- Details of concrete, reinforcement and cover.

2. Details from Contractor

In all cases where the choice of the type of pile to be used is left to the Contractor, complete particular specifications, calculations and drawings of the piles proposed for use by the Contractor shall be submitted with the tender.

The Contractor shall submit to the Engineer 4 weeks before any piles are driven, or holes formed, the following information:

- How the holes will be formed, and casings driven if any;
- The mass of the hammer, if applicable;
- The set for the last ten blows, if any;
- Size of bulbous base, if any;
- How concrete is to be placed and compacted in the case of cast in-situ piles;
- How reinforcing steel is to be maintained in place during the placing and compaction of the concrete in cast in-situ piles;
- Details of permanent casing, if any.

3. Plant & Equipment

The plant and equipment used for driving, forming of holes or other methods of sinking piles shall be suitable for the purpose and shall be in good working order and to the Engineer's approval.

Installation equipment shall be of such design as to ensure that piles can be installed in their proper position and to their correct alignment and slope.

4. Piling platforms

Piling platforms shall include the prepared in situ material, or artificial islands or any structure, excluding the piling equipment, constructed to gain access to the pile position and for carrying out the piling operations.

The foundation material required to support the piling plant and equipment shall, where necessary, be consolidated to provide first support. The Contractor may use any material he deems suitable for the construction of piling platforms but shall note that obstructions to piling encountered within the artificially constructed platform material shall not be measured and paid for.

Prior to and during the course of installation of piles, the level and alignment of the piling frame shall be constantly checked, and any deviation immediately corrected.

Structural piling platforms shall be rigid while floating barges used for this purpose shall afford sufficient stability to enable piles to be properly installed.

On completion of the piling the Contractor shall remove the artificially constructed platforms and reinstate the site to the satisfaction of the Engineer.

The Contractor shall set out the pile positions and shall stake these positions with a durable marker.

5. Ground surface for piling

Prior to commencement of any piling, the Contractor shall notify the Engineer in good time to ensure that levels of the ground surface be taken in order that an average ground surface from which the piling is to be measured be established and agreed to between the Engineer and the Contractor. Where piling at a site is preceded by excavation of the construction of fill, the surface from which piling is to be undertaken shall be formed as near as possible to the underside of the pile capping slab as directed by the Engineer.

6. Cast in situ concrete piles
   - Reinforcement

Reinforcement shall not be placed in the pile holes until immediately before concreting. Before the reinforcement is placed, the bottom of the hole shall be thoroughly cleaned of mud, water, and any loose or soft material.

Steel reinforcement shall be accurately maintained in position without damage to the sides of the hole or the reinforcing cage. Spacers shall be used to maintain reinforcement at the required distance from the inside face of the casing and wall of the pile hole and shall not cause zones through which aggressive ground water may penetrate towards the reinforcement.

The longitudinal bars shall project above the cut-off point by the distance indicated of the Drawings, or by 40 times the bar diameter if no dimension is indicated.

Splicing of reinforcement will be permitted, and the Contractor shall keep available on the site sufficient steel reinforcement so that an additional length of pile reinforcement can be assembled whenever necessary.

The assembly of this additional reinforcement shall be carried out expeditiously, and before concreting of any specific pile commences. If splices have to be provided, the longitudinal bars shall overlap a distance of 40 bar diameters or as required by the Engineer.

- Concreting of piles

Concreting of the piles shall not take place before the Engineer has given his permission, therefore.

The concrete, while being proportioned to ensure adequate strength, shall be sufficiently workable to enable proper placing and shall be thoroughly compacted by approved means. Extraction of the temporary casing during concreting shall be such that no damage is caused to the pile and the advancing concrete level is at all times kept considerably above the temporary casing's trailing edge. Concrete shall generally be placed in the dry, however, where this is not practicable it shall be placed by means of a tremie.

The requirements of the specifications for the placing of concrete under water shall apply. In addition, the following requirements shall apply when concrete is placed by tremie:

- The cement content shall be not less than 400 kg per m3 and the slump shall be such that concrete of specified strength and desired density can be obtained.
- A temporary or permanent casing shall be installed to the full depth of the hole to prevent fragments of ground dropping from the sides into the concrete. When concreting under drilling mud the temporary casing may not be necessary except near the top.
- The hopper and tremie shall be a closed system through which water cannot penetrate.
- The tremie pipe shall be at least 150 mm diameter for 40 mm aggregates and larger for larger aggregates.
- The concrete shall be placed in such a manner that the mixing of water and concrete is prevented. The tremie pipe shall at all times penetrate into the concrete.
- Concreting of that part of the pile below the water level in the casing shall be completed in one operation and the method of placing the concrete shall be maintained throughout.
- All tremies shall be scrupulously cleaned before and after use.
- Where required bulbous (enlarged) bases shall be formed after the excavation or driven casing has reached the required depth. The base shall be formed through progressive displacement of the surrounding sub-soil by repeated action of a gravity hammer or raising and lowering the casing. The size of the base will depend on the compressibility of the surrounding subsoil but shall in no case have a diameter of less than 1.5 times the diameter of the pile.

Whenever practicable, concrete shall be placed in a manner that will prevent segregation.

7. Augering and boring
    - Auger and bore pile holes.

Augering and boring of pile holes shall be carried out as expeditiously as local conditions permit taking due account of services or other restrictions on the site.

Holes shall be cleaned after augering and boring to obtain a clean and level surface.

Where indicated by the Engineer, suitable casing shall be installed in those portions of the augered where the sides are in danger of caving in before concreting is completed.

During extraction of the casing care shall be exercised to avoid lifting of the concrete and damage to the pile.

The use of water for augering and boring holes or for any other purpose where it may enter the hole shall not be permitted. Surface water shall not be allowed to enter the hole.

- Under-reaming

Where required, the holes shall be enlarged or belled out to form and under-ream. Removal of the earth excavated shall be carried out in a way will not damage the wall of the hole.

The shape of the under-ream shall be a truncated cone with base diameter dependent on the bearing capacity of the founding material but shall not be less than twice the shaft diameter. The base angle of the cone between the inclined face and horizontal plane shall not be less than 60°.

Full safety measures shall be enforced to protect workmen working down a pile hole.

- Bulbous bases

Where required, bulbous (enlarged) bases shall be formed after the driven casing has reached the required depth. The base shall be formed through progressive displacement of the surrounding subsoil by concrete that is placed under repeated action of a gravity hammer. the size of the base will depend on the compressibility of the surrounding subsoil but shall in no case have a diameter of less than 1.5 times the diameter of the pile.

- Inspection of pile holes

Immediately before the reinforcement is to be installed or the concrete to be placed, the Engineer shall be informed to inspect the pile holes. When piles are to be under-reamed the excavation shall be inspected twice, firstly to ascertain that suitable founding material has been obtained before under-reaming commences and, secondly, after under-reaming is complete to give approval for casting the pile.

8. Ground Conditions
   - Classification of Materials

For piling only, the following classification of material shall apply to the identification and description of ground conditions.

1. Matrix

The matrix shall comprise that part of the material that will pass through a sieve with 50x50 mm openings.

2. Coarse gravel

Coarse gravel shall comprise that part of the material (stones, pebbles, cobbles, etc.) that will pass through a 200 x 200 mm opening but will not pass through a 50x50 mm opening.

3. Boulders

Boulders shall mean any rock mass of at least Class R1 rock hardness that would pass through a 350x350 mm opening but not a 200x200 mm opening.

4. Rock Formation

Rock formation shall be any rock mass of at least Class R1 rock hardness and of a size greater than that defined for boulders.

For the identification of rock in terms of this clause, the classification in Table 2.11.8.1 shall apply.

Table 2.11.8.1: Rock Classification

Description of Hardness	Description of Rock	Field Indicator Tests	Unconfined Compression Class Strength (N/mm^2)
R1	Very soft rock	Material crumbles under (moderate) blows with sharp end of geological pick and can be peeled off with a knife: it is too hard to cut a triamial sample by hand.	0.7 to 3.0
R2	Soft rock	Can just be scraped and peeled with a knife: indentations 1 mm to 3 mm show in specimens with firm (moderate) blows of the pick point.	3.0 to 10.0
R3	Hard rock	Cannot be scraped or peeled with a knife: hand-held specimen can be broken with hammer end of a geological pick with a single firm(moderate) blow.	10.0 to 20.0
R4	Very hard	Hand-held specimen breaks with hammer end of pick under more than one blow.	20.0 to 70.0
R5	Extremely hard rock	Specimen requires many blows with geological pick to breaks through intact material.	more than 70.0

9. Stripping of pile heads

Cast in-situ piles shall be concreted to a level of at least 150 mm above the cut-off level. The excess concrete shall be stripped off such that the remaining sound concrete will project 75 mm into the pile capping slab.

The stripping off of the concrete shall be performed in such a manner as to avoid damaging the pile below the cut-off level. In the case of such damaged or defective concrete in the completed pile, the damaged/defective concrete shall be cut away and made good with new concrete well bonded to the old concrete or the pile shall be replaced as directed by the Engineer at the Contractor's cost.

The main reinforcement from the piles shall extend a minimum of 40 bar diameters beyond the cut-off level into the pile capping slab. This reinforcement shall be left straight unless otherwise detailed or directed by the Engineer.

The "cut-off" level for piles shall be deemed to be a level 75 mm above the underside of the pile capping slab.

10. Construction of pile capping slab

The Contractor shall not be permitted to construct the pile capping slab before the Engineer has confirmed in writing that all relevant load testing has been completed and the piles have been accepted.

11. Test loading
    - General

The procedure for test loading shall comply with the requirements specified by the Engineer. During the period of testing, driving of other piles that may influence the testing shall cease.

The Contractor shall provide the necessary plant, equipment, instruments and labor to carry out the test and to determine accurately the settlement of the piles under each increase or decrease of the load. The plant, equipment and instruments used and testing procedure to be followed shall be to the approval of the Engineer.

Within two days of completing the test the Contractor shall supply the Engineer with the test readings and neatly plotted. Load versus Settlement, Load versus Time, and Settlement versus Time graphs.

- Design Load Test (MDLT)

The test load shall be applied in increments of 20% of the specified working load up to a maximum test load equal to 1,5 the Design Load (MDL). Successive load increments shall not be applied until the rate of settlement or rise under the acting load has stabilized at a rate of movement not exceeding 0,10 mm in 20 minutes.

When the loading has been completed, the full test load shall be maintained until the movement is less than 0,2 mm in a 24-hour period. Unloading shall be made in decrements of 20% of the specified working load and at intervals of not less than 20 minutes.

After change of load, the pile movements shall be recorded on all gauges to an accuracy of 0.1 mm at time intervals of 0, 5, 1, 2, 5, 10, 20 minutes, and every 40 minutes thereafter until change of load. The final rebound shall be recorded 24 hours after the entire test load has been removed.

During the test, the pile shall be loaded to 50 per cent of the test load, unloaded, reloaded to the full test load and unloaded.

The allowable settlement shall be as specified or agreed by the Engineer.

- Ultimate Load Test (ULT)

Prior the start of the piling construction activity on bridges, Ultimate Load Tests (ULT) shall be performed by the Contractor, as specified in these Specifications.

The piles ULT locations shall be selected by the Engineer. The ultimate test load in the compression load test shall be the load where settlement suddenly increases disproportionately to the load applied.

The ultimate test load in the tension load test shall be the load where the upward movement suddenly increases disproportionately to the load applied or the load producing a permanent set of 10mm at the top of the pile, whichever is the lesser. The Contractor shall submit to the Engineer for approval a detailed method of statement for execution of piles Ultimate Load Tests.

- Control of Piles

Control of Transparency by “ultra” sonic test shall be conducted by the Contractor on each pile after placing of concrete. The Testing shall be carried out by the Contractor according the instruction of the Engineer. The Contractor shall submit to the Engineer for approval a detailed method of statement for execution of Ultra” sonic tests, as per French Standard LCPC Setra, 1978 or equivalent approved standard.

- Defective piles

The test pile and the piles represented by the test pile shall be classified as defective if a pile has inadequate bearing capacity or excessive settlement. Defective piles shall also include any pile damaged beyond repair, piles with structural defects or piles that do not comply with the tolerance requirements.

Defective piles shall be corrected at the Contractor's expense by one of the following methods approved by the Engineer:

– Extracting the pile and replacing it with a new pile;

– Installing a new pile adjacent to the defective pile;

– Lengthening the pile to the correct length if defective in length only;

– Altering the design to meet the new conditions caused by the defective pile(s).

2.12 Signalling - interlocking

2.12.1 General Requirements

These Technical specifications govern design and construction of a fully operational Signalling - Telecommand system, according to ERTMS/ETCS level1, which shall include electronic interlocking (CBI) as described in the design documents which is part of Tender Documents.

The Contractor is obligated to provide a Detail Implementation Study for Signalling - Telecommand Systems as described in design documents (Book 5) and in compliance with Technical Specifications.

The Contractor shall supply and install an Electronic Interlocking System. The hardware to be used shall ensure high availability and reliability levels. The software shall be modular by design – with a LED indication of the status of the line equipment it controls – thoroughly tested during the implementation phase and capable of monitoring all required interlocks, including the interface to the existing interlocking systems, either conventional (with relays) or electronic.

The electronic interlocking system shall allow the introduction of Level 2 ERTMS/ETCS technologies in the future (FUTURE OPTIONS ARE NOT PART OF THIS TENDER)

The Contractor shall submit documentation describing the architecture of the interlocking system, clearly setting out and allowing quantitative calculations of the reliability, availability and redundancy levels ensured. Computers shall be fed by the two parallel UPS units.

The interface between the Electronic Interlocking System and the outdoor equipment (turnouts, signals, train detection system, etc.) shall be achieved through intermediate interface modules. The above-mentioned modules shall be fail-safe. The Contractor shall include in the design to be submitted information regarding the method used to achieve the required safety level.

The Electronic Interlocking System shall include fully configured cabinets fitted with a sufficient number of interface printed circuit boards with a view to meeting the needs of all outdoor equipment. The entire control and supervision process between mainframe computers, intermediate modules and outdoor equipment, shall be fail safe. The Contractor shall provide information regarding the method used to achieve the required safety level. The Contractor shall, in accordance with the needs of the proposed hardware, ensure the design and installation of air conditioning systems in the rooms made available to him, in the event that no provision is made for implementing the systems as part of the construction and other electromechanical works.

The Contractor shall implement and identify those characteristics that reduce the equipment’s susceptibility to unauthorized interference, theft and vandalism, both at design and installation levels.

Any fault of the power supply system which may cause, for any reason whatsoever, an outage in the electronic interlocking system (e.g. UPS or battery fault), shall be handed by the interlocking system in such a way that will allow for a system reboot without any intervention by the signalling system maintenance personnel.

In order to achieve high safety and operating reliability levels, bidders shall use consistently the approved safety tested equipment. All the equipment to be used, shall ensure high availability and reliability levels. For data transmission purposes between equipment units, supervision techniques shall be used for the detection of possible errors in order to achieve a minimum safety level. The proper functioning of the interlocking system software shall be ensured through testing and verification procedures. The Contractor shall submit the required documentation concerning all the above stipulations.

The supervision - control programs shall monitor the operational status of the equipment controlled by them, in order to ensure proper processing of interlocks. These programs shall be executed in a cyclic fashion and continuously by the interlocking system. Detection of a safety-related error by these programs shall lead to appropriate actions (e.g. discontinuation of regular program execution), and the system shall be switched to fail safe mode. Regular program execution shall be carried out in accordance with perfect fail safety principles. The Contractor shall provide information concerning all the above stipulations.

The Contractor shall provide documented information regarding the proposed system evidencing reliable and absolutely safe operation thereof on an installed main railway system. The above shall be supported by a detailed technical interpretation of the operating principles, including operating capabilities and operation under fault conditions. In case a fault or malfunction is detected in a component of the interlocking system or any part of the outdoor equipment, the interlocking system shall be switched to fail safe mode.

All the equipment – wiring (circuits), installed outside the signalling equipment room shall be designed for perfectly safe operation, shall be protected against mechanical stresses and shall be immune to malfunctions caused by external interference. The Contractor shall explain how the above-mentioned requirements shall be satisfied. Separate cables shall be used for critical circuits, e.g. train detection, turnout position detection, signals etc.

All circuits shall be protected (e.g. by fuses or circuit breakers), so that an error occurring in a circuit does not cause an error in another irrelevant circuit. All connections between the electronic interlocking system and other types of equipment shall be provided with overvoltage and overcurrent protection. All interlocking system inputs/outputs shall be fitted with the required protection equipment for adapting to the modules and outdoor devices. In case of short circuit or overcurrent at a load output, the output shall be displayed by the electronic interlocking system (audio-visual indications). The circuits shall be separated in such a manner that they may be isolated through fuse removal or through connection isolation for testing, fault detection purposes, etc. without affecting other circuits. It shall be possible to isolate all incoming/outgoing circuits of a signalling equipment room or of the cabinets installed in the open line through removable fuses or connections of approved design. All the terminal strips used shall provide for connection of the testing instrumentation.

The Contractor shall explicitly describe how compliance with all such requirements is to be ensured, by using standard drawings and circuit diagrams, where possible, and shall be provide a detailed description of the proposed equipment. The Contractor shall also provide calculations for the response time of each input/output operation.

All operating requirements given in Book 5 Sections shall be fulfilled by the Contractor's Implementation Studies in order to be approved by the Engineer.

2.12.2 Safety – Availability - Standards

1. Standards

Safety constitutes a main characteristic as well as necessity of railway signalling. All safety-related requirements and activities shall be governed by European standardization, mainly documented through standards EN 50126, EN 50128 and EN 50129.

A high safety level has been established for railway signalling installations used by European railway operators, corresponding to Safety Integrity Level 4 (SIL 4), as defined in EN 50129. In accordance with this approved standard, the interlocking system subject to this specification must comply with the Safety Integrity Level 4 (SIL 4).

The Control-Command and Signalling subsystem shall respect the requirements for ERTMS/ETCS equipment and installations stated in TSI CCS par. "4.2.1.1 Safety".

The entire system and its components, including those supplied by sub-suppliers, must be designed and constructed in accordance with the following standards:

EN 50121-4: Railway applications – Electromagnetic compatibility - Part 4: Emission and immunity of the signalling and telecommunications apparatus

EN 50121-5: Railway applications - Electromagnetic compatibility - Part 5: Emission and immunity of fixed power supply installations and apparatus

EN 50122-1: Railway applications - Fixed installations -- Part 1: Protective provisions relating to electrical safety and earthing

EN 50124-1: Railway applications – Insulation coordination - Part 1:

Basic requirements - Clearances and creepage distances for all electrical and electronic equipment

EN 50124-2: Railway applications – Insulation coordination - Part 2:

Overvoltage and related protection

EN 50125-3L: Railway applications – Environmental conditions for equipment - Part 3: Equipment for signalling and telecommunications

EN 50126: Railway applications - The specification and demonstration of reliability, availability, maintainability and safety (RAMS)

EN 50128: Railway applications - Software for railway control and protection systems

EN 50129: Railway applications - Safety related electronic systems for signalling

EN 50159-1: Railway applications - Communication, signalling and processing systems - Part 1: Safety-related communication in closed transmission systems

UIC 738: Processing and transmission of safety information

EN ISO 9000-1: Quality management and quality assurance standards - Part 1: Guidelines for selection and use

EN ISO 9000-3: Quality management and quality assurance standards - Part 3: Guidelines for the application of ISO 9001:1994 to the development, supply, installation and maintenance of computer software

EN ISO 9001: Quality Systems - Model for quality assurance in design, development, production, installation and servicing

EN ISO 9002: Quality Systems - Model for quality assurance in production, installation and servicing

EN ISO 9003: Quality Systems - Requirements for final inspection and testing

EN 30011-1: Guidelines for auditing quality systems - Audit

EN 30011-2: Guidelines for auditing quality systems - Qualification criteria for quality systems auditors

EN 30011-3: Guidelines for auditing quality systems - Management of audit programs

Applicable Albanian Technical Standards

Albanian Signalling Regulation. (All issues concerning the implementation design that are not covered by the Signalling Regulation will be especially listed)

NOTE: The Contractor should use the most recent versions of the above norms and regulations.

Standards of the country of the manufacturer shall be accepted only if they are equal to or higher than the above stated.

The tender documents covers implementation design studies, delivery and installation of signalling-interlocking systems (equipment, facilities and works), and if particular requirements and conditions are not specified, then those set out in relevant documents in order to prove that the proposed technology and equipment are in compliance with Technical Requirements of the Tender.

All facilities should be able to operate on electrified lines 25kV, 50 Hz (future Installation)

Tenderers should offer the equipment in line with the above stated and fully in accordance with the technical specifications set forth hereinafter according to the required technical characteristics, of equal or higher quality.

2. Technical Safety

All designs, materials and equipment (including software) directly related to critical safety functions shall be fail-safe, i.e. a potential fault, loss or disconnection shall result in applying a more restrictive condition or shall otherwise lead to checks preventing train traffic under unsafe conditions.

The Contractor shall provide documented information regarding the proposed system evidencing reliable and absolutely safe operation thereof on an installed main railway system. The above shall be supported by a detailed technical interpretation of the system operating principles, including operating capabilities, operation under fault conditions, as well as evidence that a single fault will not affect operation with regard to more than one local interlocking systems. Explanations shall be provided with respect to the effects of such a fault to the operation of the respective interlock. The system shall ensure that no hazardous operating conditions develop in case of an isolated equipment fault.

3. Reliability and Availability

The key system reliability parameter is MTBF (Mean Time between Failures). The Contractor shall submit a report including models used to calculate the Mean Time between Failures for all components of the interlocking system (equipment of central and peripheral interlocking systems), Traffic Control Centre (TCC), power supply system, line signalling equipment. The following (non-binding) minimum MTBF values shall be achieved:

- Equipment of central and peripheral interlocking systems, TCC: 4*106 hours
- Power supply system: 80,000 hours
- Line signalling equipment: 15,000 hours

Based on the above values and the assumption for a 10-hour Mean Time to Repair (MTTR) (night-time fault), the following availability values are calculated:

- Equipment of central and peripheral interlocking systems, TCC: 99.999 %
- Power supply system: 99.99 %
- Line signalling equipment: 99.93 %

4. Lifecycle

All the equipment shall be designed and installed for a minimum service life of 25 years. The Contractor shall draw up a relevant general maintenance plan. For each item of equipment that is not expected to meet this requirement and is not a consumable spare part, the Contractor shall indicate its estimated service life , as well as any additional support to be provided to ensure that the system will be fully operational for a period of at least 25 years.

The Contractor shall:

- Be at the disposal of the operator when it intends to upgrade the system or change the settings of all or part of the system or to deliver data and information relating to the above to a third party.
- Correct such possible problems or errors as detected.
- Keep the operator informed of possible upgrades of the software and/or hardware he has supplied.
- Keep a complete set of documentation, which has not been delivered to the client, for possible future use.

2.12.3 Notice of Construction site

Contractor should visit the sites before planning and starting of works. If necessary, traffic to the railways will be stopped periodically to allow Contractor to perform works. Periods without traffic vary from two to five hours, depending on the location and period of days. For detailed information, Contractor shall contact the responsible on the railway. Contractor will not be allowed to work in any area other than the agreed work without written permission Albanian Railway.

All costs of construction sites and the use of electricity, water and phone paid by Contractor.

The Contractor shall keep the following documentation on the site:

- Construction permit and/or a principal approval for project construction
- Construction design documentation with changes and amendments
- The documents which can be used to check the compliance of the works performed with the approved regulations, technical codes and standards (rulebooks, standards, test certificates, test results etc.)
- Construction journal

- Construction book
- Technical description of organization of work.
- Site organization chart
- Time schedule (plan of actions)
- Quality control project

2.12.4 Testing – Deliveries

The Contractor shall conduct all necessary tests in order to ensure and confirm proper and safe operation of the signalling system. The tests shall include the following sections:

- Factory Acceptance Tests (FAT)
- Site Acceptance Tests (SAT)
- System integration tests - commissioning
- Provisional acceptance tests
- Final acceptance tests

1. Factory Acceptance Tests

These tests shall be conducted at the manufacturer's factory in the presence of HSH.

The travelling and accommodation costs to be incurred by HSH in connection with these tests shall be borne by the Contractor.

Complete integrated systems shall be subjected to these tests. If this is not possible, individual system parts shall be tested, with simulation of the missing ones. All required in-factory and quality control tests shall have been conducted prior to these tests. Certificates for the said tests shall be provided to HSH prior to factory acceptance tests.

Following is an indicative list of factory acceptance tests:

- Correct wiring test on panels or devices relating to safety information.
- Testing the interlocking system logic with respect to development or correct results, internally and externally.
- Testing recognition of commands issued to the interlocking system and response thereof within an acceptable time frame to commands from the local operating panel and to information from the interface with the telecommand, train detection system, turnout machines.
- Fail safe system operation test in case of fault, outage or disconnection.

Any failure or remark shall be mentioned in the testing record and shall be remedied prior to transportation from the factory. The tests shall be conducted successfully in order to allow equipment installation. The Contractor shall give a fifteen (15) day notice to HSH on the availability of equipment, with a view to performing factory acceptance tests.

2. Site Acceptance Tests

These shall include the following sections:

- Correct installation / connection tests (e.g. insulation, continuity, earthing, mounting).
- Correct operation tests for each integrated material unit.

Following is an indicative (non-exhaustive) list:

- Train detection system activation limits test.
- Correct connections between turnout machines, interlocking system signals.

- Interlocking relations between track circuits, signals, turnout machines, and the local operating panel.
- Fail safe system operation test in case of fault, outage or disconnection.
- The Contractor shall propose a site acceptance testing plan, which shall be in accordance with all equipment manuals and shall be subject to approval by HSH.

3. System Correct Operation Tests

These shall include testing the integrated operation and commissioning of the system.

The Contractor shall propose a correct operation testing plan, which shall be compliant with the system operating and performance requirements and shall be subject to approval by HSH. HSH shall have the right to revise this plan and enhance it by adding tests at discretion. The Contractor shall keep complete information on the type of tests performed and their results, with a view to submitting them to HSH.

4. Provisional Acceptance Tests

These tests are aimed at verifying that the entire installation complies with the operating requirements and specifications set out in the contract. For this purpose the project shall be put to trial operation for at least one month. The instruments, components, mechanical equipment, materials and supplies in general required for conducting the tests shall be provided by the Contractor. The cost of all provisional acceptance tests, except for electricity and employer personnel costs, shall be borne by the Contractor.

The Contractor shall, at least three (3) months prior to conducting the provisional tests, submit to HSH a complete list of tests per section, testing procedure, testing and inspection tables, which shall indicate necessarily the testing method and acceptable results. The above shall be approved by HSH necessarily in order to start the respective testing.

5. Final Acceptance Tests

Final acceptance tests shall be conducted by the Contractor following expiry of the maintenance and fault remedy period and shall include the same inspections and tests as those performed for provisional acceptance, as well as any additional tests deemed appropriate by HSH.

The instruments, components, mechanical equipment, materials and supplies in general required for conduct thereof shall be provided by the Contractor, and electricity costs shall be borne by HSH. The Contractor shall also provide technical guidance and the required specialized personnel.

With respect to final acceptance tests in particular, the wear of mechanical and electrical equipment shall be checked, which should include only normal wear and tear due to operation of the installations in the period concerned.

2.12.5 Safety Plan

The following are required for making an electronic railway signalling system / subsystem / equipment acceptable as safe:

- Quality management assurances
- Safety management assurances
- Functional and technical safety assurances

Evidenced proof that the above-mentioned conditions are met shall be included in a safety documentation file, called Safety Plan, having the following structure:

- Part 1: System (or subsystem / equipment) definition
- Part 2: Quality Management Report
- Part 3: Safety Management Report
- Part 4: Technical Safety Report
- Part 5: Issues Relevant to Safety Functions
- Part 6: Conclusions

In accordance with EN 50126, the main concept behind quality management as a core component of safety assurance is to take into account the entire lifecycle of the system, from the preliminary phase to its dismantling and disposal. RAMS (Reliability, Availability, Maintainability, Safety) issues shall be dealt with in each system lifecycle phase.

The Safety Plan shall be subject to approval by a certified organization before it is submitted to the competent safety authority of the Ministry of Transport for obtaining relevant authorization. The certification organization shall be recommended by the Contractor and approved by HSH.

In the event of partial provisional acceptance of the project, the Safety Plan shall be submitted in different phases in order to ensure that each phase covers the respective section under provisional acceptance.

2.12.6 Operating Requirements

This chapter lays down the operating performance of the interlocking system. The system hardware and software shall be designed in such a way that will ensure the required functions and characteristics.

1. Key Operating Principles

The interlocking system shall be divided into three logical operating levels:

- *Operations, display and fault logging level*: The functions of this level shall allow for operations, display and fault logging. The information compiled at this level shall interface with the safety and control / monitoring levels, through a permanent communications channel, ensuring safe data transfer.

- *Safety level*: The commands originating from the above-mentioned level through the communications channel shall be forwarded to the safety level and, after being processed by the interlocking operating logic, shall be relayed to the control and monitoring level. The resulting situation and any faults occurring shall be forwarded to the above level in the same manner.

- *Outdoor equipment control and monitoring level*: The control and monitoring level shall be responsible for controlling and monitoring outdoor components in a completely safe manner. The actual condition of outdoor equipment (signal indications, location of turnouts, etc.) as well as all faults (e.g. LED failure in any signal, faulty wiring, etc.) shall be monitored and detected. Communication with the safety level shall be carried out through a secure communications channel, provided with redundancy for availability purposes. The Contractor shall provide information on system interfaces with external systems (e.g. external alarms).

2. Interfacing with neighbouring systems

The interlocking system in the Durres – Tirana line shall be fitted with appropriate equipment and shall provide the information required for being compatible with neighbouring conventional (with relays) or electronic interlocking systems.

All the requirements for Interfacing are given in Book 5 Section 4.1.3. Technical characteristics and equipment details will be arranged in Implementation Design Study in accordance with Book 5 and current Specifications.

3. Local Workstations (Operations and Control)

The local workstation shall be installed in the Station Master Room in order to control and monitor its designated control area.

All indications necessary for operating requirements shall be displayed in geographical form and shall include vehicle detection, turnout indications, route setting, requested routes, signal status, direction etc. Other indications shall be displayed either by use of graphics or in an alphanumerical form. The Contractor shall propose together with his offer a detailed description of the system's capabilities.

The hardware used for each local workstation shall include an industrial grade, state-of-the-art, top quality computer made by a well-known manufacturer, provided with a 23'' high resolution colour monitor and a printer. The software installed on the computer shall be suited for handling safety related information. All installed application software in the workstation shall be dedicated to the operating system.

A state-of-the-art, low noise laser printer suitable for use in an office environment shall be provided for the workstation.

In case the workstation is not operational (when operation is transferred to TCC), it shall be updated with indications from the interlocking system / central computer. It shall be possible to switch the workstation off without affecting the operation of the system.

It shall be possible to handle an emergency by causing groups of signals to display a 'stop' indication, as well as to adjust the brightness of signals at night time (day-night).

Access to workstations shall be password protected.

The Contractor shall include in the implementation design operational procedures concerning the use and operation of local workstations, based on the experience gained from the function of the system in railway applications.

4. System Launch (Booting)

The entire hardware shall boot automatically upon commencement or restoration of power supply. Following a short downtime the data relating to manually set blockages during the downtime, in particular, shall be available (e.g. blocked turnouts or lines, non-interlocking routes).

The system boot function shall be the first possible function, prior to any other one, during system start up or restart. This shall aim at making sure that all trains have stopped.

5. Turnout Machines - Derailers

All the requirements for turnouts operation are given in Book 5 Section 4.2.

6. Routes

All the requirements for main and shunting routes are given in Book 5 Section 4.3.

2.12.7 Hardware Requirements

1. Interlocking System Computers

The microprocessor-based interlocking system shall consist of fully configured cabinets fitted with the required number of interface circuit boards, in full correspondence with the outdoor equipment.

The electronic interlocking system shall consist of multiple state-of-the-art design and technology microprocessors. Suitably dimensioned auxiliary power supply units shall be provided for each microprocessor system.

The interface module equipment shall constitute the interface point between the interlocking system and outdoor equipment. The above-mentioned equipment shall be subject to control and monitoring by the interlocking system and shall be fail safe.

The Contractor shall indicate how many units (signals, turnouts, train detection systems, etc.) can be interfaced with and controlled by its system. More-over the Contractor shall provide information about his wider range of systems and the relevant dimensioning, as the number of controlled units increases.

2. Indoor Equipment Areas

All the indoor equipment, except for local workstations (used for operation and visual control) shall be installed in station buildings (the "Technical Room") to be provided by the employer. The areas made available (switchboard area, generator area, battery area), in addition to the construction and other electromechanical works to be carried out within the context of this contract, shall be arranged by the Contractor, without any special remuneration. At any rate, the Contractor shall set the final dimensions and the number of cabinets and relevant devices, so as to ensure optimal utilization of the areas made available in the existing buildings.

The cabinets shall be properly dimensioned in order to be installed in the Technical Room or elsewhere as required. Floor mounting of the cabinets shall take account of the area's seismic zone, and cable entry to the cabinets requires the construction of a raised floor, which shall be done by the Contractor. The clearance between the raised floor and the actual floor shall be not less than 30 cm, allowing orderly and comfortable cable installation. It should be noted that technical rooms shall be available at the locations given in Book 5.

Where, in accordance with the implementation design, it becomes apparent that equipment has to be installed at more locations, (shelter) booths suitable for the intended use shall be installed. The booths shall allow for installing and connecting all signalling equipment, as well as any possible turnout heating devices, hot-box detectors, telecommunication devices and LC equipment and shall be mounted on a concrete base to be constructed for this purpose. Air conditioning units along with a complete electrical infrastructure shall also be installed.

Outdoor area cabinets shall be hot-dip galvanized and properly painted for protection against weather conditions. The final paint coat shall be selected by project owner. Painting may be omitted if the metal surface has been subjected to rust proofing treatment to the satisfaction of the employer. Indoor cabinets shall be subjected to appropriate rust proofing treatment and shall be painted to a colour chosen by the employer. Cabinets manufactured by other materials may also be proposed provided that their suitability is sufficiently documented; nevertheless, acceptance thereof shall be at the discretion of HSH.

Cabinet doors shall be locked with a safety padlock; the same key shall be used for all cabinets.

The different components shall be wired with conductors of appropriate cross sections, shall be neatly arranged, thus ensuring easy technician intervention and shall end up to numbered terminal strips. With regard to cables from outdoor areas in particular, an easily isolated interconnection shall be provided for detecting potential faults (e.g. through jumper-type or sliding connections). Typically, the entry and exit points of the different cables shall be on the underside of the cabinets, in accordance with instructions from the Engineer y authority. Possible fusible links and overcurrent or similar circuit breakers that can also be operated by non-specialized personnel shall all be installed in a special section of the cabinet, which shall be secured by a separate key. Indoor cabinets shall be properly fixed onto the installation area floor at a minimum height of 30 cm above the floor, in accordance with instructions from the Engineer y authority. Outdoor cabinets, where provided, shall be bolted upon a concrete base. The cabinet base shall be constructed so as to prevent the ingress of water into the cabinets and IP54 protection shall be determined in cooperation with the Engineer y authority on a case-by-case basis.

An interface – via the relevant signalling or telecommunications system – with the Station’s Master office of the same station and with the TCC, shall be installed on the technical room doors. This shall detect entry of persons to the technical rooms, with a view to avoiding malicious actions. The method used to satisfy this requirement shall be clarified in the implementation design to be submitted by the Contractor, and the relevant implementation costs shall be included in bid.

Technical rooms will be equipped with fire alarm system, to alert in case of fire in the early stages of its development. The fire alarm system covers all independent rooms.

The system to be delivered and installed shall be addressable fire alarm system for receiving signals from automatic and manual fire alarm devices. The system should give acoustic and light signals indicating the exact location (address) of activation. The system should allow connection of external signalling devices and actuators. The system should have the following technical and functional capabilities:

- fully program in place by built-in keyboard
- monitor conditions /normal, fire, damage/ of address points and displays them on the LCD display
- for each address point can be assigned a text message that is displayed to indicate the exact location for ex. waiting room, electronic board
- communication between the system and the address points
- provide protection against false alarms by repeatedly checking the active detector.
- These conditions and all other general damage should be visualized and recorded by the system
- visualization - liquid crystal display
- should have built-in real time clock
- should operate in “day” and ”night mode depending on the site
- should have built-in back-up battery supply with automatic charge
- should have energy independent storage archive for events indicating the type, date and time of their occurrence
- communication interface with the option to connect to Ethernet network

The fire alarm system should be installed in the control room of the station. Technical possibility should be provided to link a phone dialer that in case of fire automatically selects pre-programmed telephone numbers /e.g. Fire Safety Office, etc. /.

The automated fire detectors should be selected depending on the combustible loading of premises and combustion products - smoke, heat, etc.

Manual fire alarm keys should be mounted on the evacuation way on the wall at a height of 1.40 m from the finished floor.

The automated fire detectors should be installed on the ceiling symmetrically in terms of lighting and at a minimum distance of 0.5 meters from them.

A general light and acoustic signalling is envisaged for evacuation of employees in case of fire.

The connection of automatic and manual fire detectors to the system should be executed by hardly inflammable cable JY / L/Y 4x0.5. In the pulling of lines from detector to detector there should be no interruption, and the places where this is necessary reliable connection should be ensured.

The power supply of the fire alarm system should be executed from the electrical panel in the station technical building. The power supply of the system should be backed by batteries.

3. Operation under Power Supply Failure Conditions

This refers to a loss of power supply to the interlocking system computers. Such a situation should be rare because of the uninterrupted power supply (UPS) system, which replaces almost immediately any power outage in the network.

Following a power supply outage regardless of cause, there shall be a system reboot by switching to safe mode. During a power outage of up to one minute, the data relating to manually set interlocks shall be kept in the system memory. The Contractor shall provide in his design a detailed description of his system’s behavior in such a case.

The Contractor shall also propose the simplest possible operational procedure for retrieving line release information following a power outage.

2.12.8 Software Requirements

1. General Requirements

The software shall be modular in order to facilitate, in the event of extension, the integration of new interlocking functions or new application data. During the implementation phase, the software shall be tested thoroughly and shall be able to control and monitor the entire system.

Normal program execution shall take place in accordance with known safety principles and applicable European standards.

2. Software Structure

The software shall be broken down into two categories: basic or generic software and application software.

- Basic Software

The basic software shall boot the system, allowing for network operation (as required). On system boot, memory modules shall be checked and activated, internal testing programs shall be run and procedures shall be initiated according to the specified sequence. Reliable primary and backup data transmission channels shall be set up and verified. The software structure shall be submitted to HSH together with the Contractor’s design, whereas the entire software documentation shall be submitted along with the implementation design.

- Application Software

The application software shall constitute a safe gateway to the signalling logic. All information to be transmitted by the operating control level to the interlocking system shall be monitored for syntax or format errors. The application software status management system shall be provided with a central processing system.

The memory modules of each element shall be immediately updated for any element status modifications. Thereafter, the operation control level information shall be updated based on this data. The Contractor shall indicate specifically which information can, or cannot, be retained in memory following a power outage.

The application software shall be approved by HSH and shall comply with the following requirements: It shall be properly structured, with detailed documentation and analyzed through flow and status charts. The software structure shall be submitted to HSH together with the Contractor’s design, whereas the entire software documentation shall be submitted along with the implementation design.

The system shall provide a user-friendly man - machine interface (MMI), and the graphical interface shall provide dynamic real time visual displays for all elements. The display method shall provide the user with immediate user-level malfunction source identification and user-level fault diagnostics capabilities.

The application software, including all hardware and software tools required for parametric variable configuration and verification-rechecking of the application software following a parameter modification, shall be delivered to HSH together with the necessary manuals, allowing for extending or modifying the system if necessary.

2.12.9 Data Transmission

The exchange of security-related data in an interlocking system or between central and peripheral interlocking systems shall be implemented through a channel of interlocking communication systems. This is a fixed and perfectly secure serial communication channel.

A secure transmission protocol using code detection and error correction shall be used for all security-related data transmissions. All necessary error detection steps shall be taken in order to achieve maximum security during data transmission.

For availability purposes, the interface channel between the interlocking systems shall have redundancy, which shall be achieved by using two independent physical data channels, i.e. along the open line there will be two distinct cable routings following different geographic routes. Both transmission channels will use fibre optics technology. The two channels shall use fibre optic cables to be installed on either side of the entire line and shall form the backbone of the section. One side will be used for signalling and the other one for telecommunications.

The signalling system Contractor shall, in designing the channels, make optimal use of cable capacity by using suitable multiplexing devices. The design for the construction of the communication channels shall be submitted to HSH for approval along with the implementation design, and the latter shall decide whether the optimal use requirement is satisfied.

2.12.10 Traffic Control Centre - Signalling telecommand

The electronic interlocking system shall be subject to control and telecommand from the Traffic Control Centre (TCC) to be set up in the SHKOZET.

The Contractor shall rearrange the SHKOZET TCC area so as to make it possible to install the DURRES-TIRANA telecommand equipment. Arrangement of the area shall include the following:

All kinds of construction, electrical, ergonomics, etc. works required for the proper rearrangement of the SHKOZET, area in order to install the DURRES-TIRANA telecommand equipment.

All the requirements for Traffic Control Centre (TCC) are given in Book 5 Section 4.7.

1. General Operation

The Traffic Control Centre (TCC) shall be the central man machine interface (MMI) used for the operation of the interlocking system. The Contractor shall include in the design a detailed description of the architecture (e.g. local area network (LAN) topology, computer application platform architecture (e.g. application client server), communication server data), an operating description of the application and a description of the system’s scalability options. The number of monitors and the layout and overall architecture of the system shall be included in the implementation design to be submitted.

The Contractor shall submit for approval, together with the implementation design, the method to be used for ensuring synchronization of the individual interlocking systems and of the TCC system.

Access to the workstation shall be password protected. All operators shall be able to control each section of the line and there shall be no fixed allocation of line sections to specific workstations. However, it shall be possible to ensure that a line section is controlled by one workstation at a time.

The system shall provide a capability of retrieving all traffic and equipment-related data (e.g. signal status and switching, turnout movements, occupation of line sections, set routes) for at least two weeks.

There will be the possibility to replay all the events in a dynamic way with the use of a special software (Play Back), to an independent offline workstation.

2. Man-Machine Interface (MMI) Devices

The following devices shall be used for importing and exporting data:

- Monitors

Each workstation shall be equipped with at least (3) monitors. 23’’ high resolution, LCD monitors shall be provided.

The monitors shall be used to display the following information:

- Overview
- The monitors shall present an overall picture of the entire area controlled by the respective operator.

- Alphanumeric data

A monitor shall be used for displaying alphanumeric data, such as commands, messages, on line help manuals, dispatcher data, etc. The operator shall be use drop-down menus.

- Magnification (Optional)

The Contractor shall clearly indicate in the design whether his system provides a magnification capability, which shall be implemented in the following manner:

The monitors shall display magnified images of parts of the controlled area. The number of these images shall depend on the overall size of the controlled area and the number of elements in a magnified image shall depend on the topography of interlocking system. It shall be possible to switch from one magnified image to another by entering an appropriate command.

- Data Input Devices

Two data input devices shall be provided at each workstation:

- Mouse: A computer mouse shall be used for graphical entry of data relating to the key functions of the interlocking system (e.g. setting or cancelling routes).
- Keyboard: One of the graphics monitors shall have a special graphics key used to enter a specific command for a default function. Alternatively, it shall be possible to do this by a specific command entered on a keyboard.

No data entry technology involving touch screens, graphics panels or other similar devices shall be used.

3. Execution

The status of the entire system shall be displayed in real time without any delay for any operator action. The system shall be able to display all changes and transmit each command within a period of less than 3 seconds, regardless of workload. The Contractor shall provide information on the time required to restore power supply following outage in the TCC or in the interlocking system hardware, with a view to displaying the required indications.

4. Ergonomics

The Contractor shall provide a fully functional workspace, including the necessary furniture such as desks, chairs, etc. The workplace design must follow ergonomics principles.

5. Additional Operations

The system shall support both Albanian and English for all local stations and TCC workstations. Each operator shall use a language of his/her choice, regardless of the choices made by operators at other workstations, thus allowing operators the use both languages.

2.12.11 Track Equipment

1. General Requirements

Part of the equipment, including only key necessary equipment, such as turnout equipment, train detection devices, signals, signs, connection boxes, etc., shall be installed on or close to the track. The rest of the equipment shall be installed in the signalling system technical rooms. Devices shall be provided for protection against overvoltage’s or lightning in cable terminal cabinets, with a view to protecting the equipment. Connecting cables shall be protected against short circuit and shall be continuously monitored by appropriate insulation and earth leakage monitoring equipment.

2. Turnout Machine Controls

Electric, state-of-the-art turnout and derailer machine controls shall be used.

The railway line is designed and constructed for speeds of up to 120 km/h, and turnout safety shall be ensured by dovetail external locking devices.

Certificates shall be provided to evidence that they have been successfully tested under the above conditions in major railway networks at speeds of at least 120 km/h.

Technical brochures for both turnout and derailer machine controls shall also be included in the design to be submitted. The controls, as well as installation thereof, shall be suitable for the type of turnouts used and shall comply with the relevant standards.

The turnouts have dovetail locking devices, which shall be retained, and the installation of the machine controls shall make them non-trailable turnouts. By way or derogation, when the design is submitted, the possibility of some of them remaining trailable shall be considered.

The following paragraphs shall apply to the both turnout and derailer machine controls (except for trailing).

- Turnout machine controls shall ensure the operation and blockage of a turnout at its end position by following the relevant procedure: unlocking the blades, moving them from one position to the other and locking them at the new position with a simultaneous verification of proper contact of the blades and verification of proper position in the intermediate section in the case of very long flexible blades. Similarly, there must not be a clearance of more than 3 mm between the blade and the stock rail.
- Respectively, the machine controls shall be secured in such a way that will ensure secure connection between the blade and stock rail, as well as a minimum clearance of 160 mm between the open blade and the respective stock rail at the closed turnout position. Normal blade contact, within the above set limits, shall be controlled by electric devices and circuits provided for this purpose, and such control shall be included in the signal operating conditions. Turnout machine controls shall be accompanied by a suitable manual control, hand wheel, crank-handle or lever for manual turnout setting, which shall be achieved (for UIC 60 1:12 R500 type turnouts) by approximately 30 rotations. Insertion of the hand wheel or lever shall result in the disconnection of the turnout machine.
- The connecting and control rods of the turnout machine control shall be heavy duty type, shall allow for easy disassembly and shall prevent loss of adjustment in any way whatsoever due to vibration from passing trains, as well as wear at various connection points (hole reaming, etc.). The rods shall have fine adjustment capabilities.
- The internal electric circuits - motor, as well as the control contacts shall be fully protected against water or dust (IP 65) through an appropriate housing, and the contacts controlling the end positions of point travel shall be heavy duty type, ensuring a long service life.
- Electric motors shall be protected mechanically through a dry friction transmission system (clutch) or other similar device.
- A permanent label shall be put up at a conspicuous location on the outside of each turnout control housing designating (in large, clear embossed fonts) the turnout number, as referred to in the local operation panel.
- All electric turnout and derailer controls to be installed shall be provided with turnout indicators fitted with night-time lights.
- Concerning electric locally-operated turnouts, the Contractor shall state the time required by the turnout machine to execute a complete point change operation (from one locking to another). The design of the turnout machine operating circuit shall associate the length of the line section to the point change time, so that under worst-case conditions it shall be ensured that the turnout does not move before an approaching train/vehicle.
- The Contractor shall provide all the necessary equipment (immobilization clamps and spacers) for assured immobilization of all installed turnout machines at any of their two possible positions during testing, or in case securing or control (position detection) through these machines in impossible due to fault. The Contractor shall also submit implementation instructions and shall define potential speed restrictions.

3. Electrical Requirements

The machine control electric motors shall be DC-powered or AC-powered, and a complete documentation set shall be provided along with the design to be submitted, including their detailed technical characteristics (operation, locking and detection). Their main technical characteristics shall also be included in the design. A minimum 6.0 km control distance shall be ensured for the controls from the peripheral interlocking systems.

The power supply and control cables of the machine controls shall terminate in heavy duty and perfectly sealed terminal boxes (IP 65). The machine controls shall be connected thereto through other flexible sealed-connection cables in order to avoid cable damage due to train vibrations. Separate cables shall be provided for connecting each turnout machine to the signalling equipment installation area. These cables shall be protected against short circuits and shall be continuously controlled against earth leakage.

The operation of turnout machine controls shall be supervised over time. In the event that the turnout locking is not confirmed within 7 sec from machine operation commencement, the power supply to the machine shall be disconnected.

Electric motors shall be provided with electric protection by means an automatic device which, in the event of overloading, due to obstacles, etc., shall switch off the motor and prepare it for the following operation without local intervention.

2.12.12 Signals

Signals with 1, 2, 3 or 4 colour aspects in general, in compliance with the Albanian Rail Traffic Code, shall be installed in the line sections referred to herein. The numbering of signals installed at stations and in the open line shall comply with the numbering principles used by HSH.

Regular traffic signals shall always be installed on the right side of or above the track they are used for.

Train traffic on a dual line shall be conducted normally on the right branch of the line in accordance with the direction of movement. Every train movement in a direction opposite to the above shall be designated as “opposite traffic”.

The sequence distance of main Station Area signals (entry and exit signals, and – in large stations – intermediate signals) ranges typically between 1200 and 1500 m (between 700 and 1000 m for line sections with 700 m long braking lengths, respectively).

The main signals may also display warning indications for the indication expected from the next signal, if they are installed successively without any intermediate advanced signals.

Details for Signal types, Indicators and operation usage are given in Book 5 Section 4.4.

1. Shape and Construction Engineering

The various signals shall consist of the carrying post, base, vertical and horizontal shades, indicator sign, post sign, and the required number of lights depending on the signal type, lamps and wiring/cabling etc.

The post shall be permanently fixed on the ground upon a suitable concrete base with four (4) anchors, making the entire signal, including signs, strong enough to withstand mechanical stresses near the track (wind blowing at 150 km/h, vibrations, trains travelling at 120 km/h). Satisfaction of the above requirements shall be evidenced by a relevant design to be submitted by the Contractor together with the implementation design. The post may be removable from its base. The post shall be fitted with a sign dimensioned 30X25 cm on which a black reflective film shall be attached to form the characteristic number of each signal, except for the indication “A” of advanced signals, which shall be red, upon a white reflective surface, in accordance with Standard Technical Specifications - of the Ministry of Public Works. The letter “A” shall appear before that number on the advanced signal. The signs shall be made of aluminium of a thickness of at least 3 mm, or of plastic suitable for the intended use. The signals shall be fitted with the respective identification and post signs.

Aspect colours shall be ensured by Fresnel colour lenses. The required colour indications shall be ensured by more than one monochromatic railway grade lights, excluding different colours combined in one aspect (moving screen lights and the like), and with colour shades in accordance with the standards applicable to the major railway networks in EU Member States. In any event, the Contractor shall state in his design the specific European railway regulations to be complied with in connection with the colour shades of the offered signals.

The lights of signals located on the primary line and overrun lines shall have an approximate diameter of 120-200 mm. All lights of the different signals shall be railway grade, comprising appropriate arrangements that allow for a narrow, clear and potent light beam, visible from an approximate distance of 1000 m under broad daylight and clear atmospheric conditions, preventing any light reflection caused by the trains or other sources, which could result in a false interpretation of the indications by the train driver (PHANTOM LIGHT). The light beam shall be suitable for any case due to curves etc. using the necessary lenses, and the service life of signal lights shall be at least 50000h (over 5 years) by the use of LED lamps. The vertical and horizontal shades shall be suitably dimensioned in order to ensure proper light visibility conditions and shall be made of aluminium of a thickness of at least 3 mm for vertical shades and 1 mm for horizontal shades, plus suitable reinforcements coated with two layers of durable paint. Alternatively, the shades can be made of plastic suitable for the intended use. The post and shades shall be painted with durable paint to be selected by the employer and shall be pre-coated with two layers of primer paint and two layers of rust-resistant paint.

The interface cable between signals and the interlocking system shall be connected via a connection box at which the internal wiring of the signal shall terminate. The box shall be installed on the back of the signal post base or on a separate concrete post close to the signal. The box shall be perfectly waterproof (IP 65).

2. Signal Visibility

Following are provisions concerning signal visibility:

- The visibility distance of entry signals and block signals is 500 m.
- The desired visibility distance of exit signals is 500 m; there is a mandatory minimum distance of 300 m, however.
- Where the above visibility levels cannot be ensured, repeater advanced signals shall be provided.
- The visibility distance of repeater signals is 300 m.

Where these distances cannot be ensured, five warning beacons shall be installed.

In each case the final locations of signals shall be submitted by the Contractor within the context of the final definitive design.

3. Signal Gantries

Typically, all signals shall be installed on posts only. They shall be installed so as to ensure that the part of the signal that is closest to the line shall be at least 2.50 m far from its axis. Where a signal is installed between two main lines, or where there is lack of available space, the above distance may be reduced to 2.20 m. In any event, certain signal components (shades, etc.) may be even closer to the axis of the adjacent line(s), in case they define (without entering) the perimeter of the free cross section of the line in question or of adjacent lines (“traffic gauge”).

Provided that local conditions do not allow this type of construction, the signals shall be mounted on metallic gantries which will be designed, included in the implementation design and constructed by the Contractor.

The gantry and other metal parts shall be made of steel coated with rust-resistant material, in compliance with the specifications laid down in the paragraph entitled “Shape and Construction Engineering of Signals”. They shall also be provided with a ladder for climbing thereupon, a maintenance platform with a protective cage for each signal, as well as a corridor along the gantry for accessing the signal platforms.

Signal gantries shall be mounted on a concrete base. The overall structure shall be capable of withstanding the mechanical stresses occurring next to a railway line (vibrations, wind, trains travelling at 120 km/h, staff climbing on the gantry).

Clearance in tunnel is extremely limited and therefore signals cannot be mounted on trackside frames or posts. In these cases, the signals shall be mounted on the ceiling or the side of the tunnel upon a special structure, using a special fixing method. Signals shall be mounted on the ceiling of the tunnel in such a way as to be easily accessible for maintenance purposes by the use of mobile ladders. This special installation method shall be submitted for approval together with the implementation design.

4. Electrical Requirements

All LED lamps on advanced and main signals shall be continuously monitored for proper operation. A device shall be provided allowing for reducing the brightness of the signals at night-time through operation from each station's local panel and by the Telecommand operator. It shall be possible to adjust the brightness of i.e. tunnel signals individually (depending on their distance from the exit of the tunnel).

Complementary signals used for speed, direction, opposite traffic, etc. indications shall be manufactured using fibre optics technology. A complementary signal shall be capable of displaying at least four different indications (e.g. speeds or directions).

It shall ensure a minimum control distance of 3000 m from any peripheral interlocking unit to the signal via a stranded cable.

2.12.13 Train detection system

For occupied line detection purposes, axle counters will be used.

Axle counters shall be used for detection of line occupation by the train, by counting its axles during entry to and exit from a line section and then comparing the results.

The same axle counter type shall have been used successfully in major European railway networks (speeds of not less than 120 km/h).

The Contractor shall include in the design to be submitted a complete operating description and certificates demonstrating fail safe operation of the proposed axle counter detection system and confirming successful cooperation thereof with the remaining equipment.

The trackside equipment shall consist of:

- A double wheel detector: Two transmitters and two receivers in a box, shall allow detection of the travel direction. The detection cables shall be located within a heavy-duty type, high mechanical strength.
- Terminal box: This box shall include the trackside elements required for interfacing the detector with the electronic interlocking system. The box shall be made of stainless material, or synthetic material suitable for the intended use, which shall be resistant to mechanical stresses and sunlight and compliant with the requirements referred to in other chapters hereof concerning outdoor equipment. The box shall contain a dual channel microprocessor for better safety and reliability, which shall execute cyclic, continuous proper operation monitoring and shall be fitted with a built-in connection device for fault detection. The above-mentioned detection shall be performed by computer.

The following requirements shall be satisfied:

– Ambient temperature: -30 °C to +70 °C (track equipment)

– The equipment selected for the rail track must allow installation to rails of all the types installed in the project.

– A minimum control distance of 20 km is required

– The removal from the rail of the counting heads must immediately be followed by passing of the counting section into “occupied” state.

– The axle counters system must be compatible with all types of rolling stock, allowed to operate in Albania. This compatibility must include, without being limited to, the parameters of the vehicles, required to ensure the correct operation of the detection equipment, including the vehicle wheel bandage, length of the bogie / axle spacing and wheel profile.

2.12.14 Hot Axle Box Detection system (HABD)

In accordance with the interoperability principles, Hot Box and Blocked Brake Detectors (HBDs) shall be installed with a view to preventing derailing, at a turnout or in a tunnel, of trains in which hot box problems have been detected.

HBD systems shall meet the TSI interoperability specifications and shall be accompanied by appropriate certificates issued to that effect by a European certification organization, as well as by information evidencing that they have already been installed and operated in a European network, in order to be approved.

The equipment shall include at least the following items:

- Special sleepers with built-in meters
- Sensors (HBD, BBD) and track contacts (approach SK1, activation SK2, etc.) as per Contractor’s implementation design
- Data processing equipment
- Handling and operating terminal station, event logger, etc.

- Interfacing with the TCC and the respective interlocking system that includes the point of installation, via a telecommunications network
- Uninterrupted power supply
- Booth for indoor equipment installation
- All necessary power and weak current cabling, earthing and lightning protection systems, as well as all major and minor materials

These devices shall be installed at sufficient distance from the entrances to the tunnels in both traffic branches (regular and reverse direction). The electronic interlocking system shall include an interface with the HBD devices and shall ensure the showing of 'stop' signals to prevent entry to the tunnel if hot box problems are detected in a train. Data from the HBD devices shall be processed first by the respective local interlocking system and second by the TCC, in accordance with the implementation design to be prepared and submitted by the Contractor for approval.

The terminal stations used for the operation and function of HBDs shall be installed in the technical signalling rooms, where the interfaces with the respective interlocking systems shall also be established, and they shall be interconnected with the respective HDB processing systems via the telecommunications network to be developed within the context hereof.

2.12.15 Train Numbering system

The train numbering system shall replace the verbal train reference system. The numbering system via a data communication line shall collect all necessary train traffic information from interlocking systems.

The display of train numbers shall be integrated in the monitor displays of the TCC workstations and in the rear projection panel. The corresponding train number shall be displayed in a field which shall prominently indicate the relevant line section that is occupied. The indication shall be forwarded automatically to the corresponding field of the following line section to be occupied as the train travels on. It shall be possible to enter train numbers manually at the marginal station where the line section starts or ends, which has a train numbering capability.

The information on the occupation of successive individual line sections, which comprises the overall route of the train, shall be transmitted via the individual interlocking systems.

The entry or modification of data relating to the train numbering system in a line section shall be done by the dispatcher of the corresponding section through his/her workstation. The train numbering system shall comply with the guidelines of the International Union of Railways (UIC).

2.12.16 Maintenance and Diagnostics Equipment

A properly trained user shall be able to perform effective, in-operation error detection and shall also be able to perform error removal procedures. Errors and faults shall be detected, analysed and classified in groups and at several levels according to the seriousness of each error.

The diagnostics system shall display the status of the controlled equipment, shall continuously log and display any fault indications and shall provide authorized users with quick and straightforward instructions.

In particular the diagnostics system shall, for each fault indication, indicate the faulty element, fault details and troubleshooting procedure. An electronic maintenance manual shall be available through the diagnostics system, which shall provide maintenance personnel with specific information on how to remedy the fault.

Following is part of the information to be displayed by the diagnostics system:

Train Detection System Status	Occupied or free sections of a route, preselected sections in a route or sections locked in an overlap segment or blocked for personnel protection purposes.
Turnout Status	Detection, turnouts locked in a route, preselected turnouts in a route or turnouts locked in an overlap segment or locked for

	lateral protection purposes. Movement log - statistics
Signal Status	Indications and status of signals locked for a route as entry or destination signals, or as signals used to provide lateral protection.
Preselected Routes	Alphanumeric display support shall be provided to show hidden information such as preselected routes and emergency cancellation underway. Route cancellation status.
Status of central processors, I/O cards, memory cards of the interlocking system.	Information relating to the interlocking system computers, error detection, flooding in auxiliary data storage facilities, power supply status and computer standby or operating status.
Train numbers	Concerning line sections and possible double numbers due to the presence of two trains in the same area.
Power supply and status UPS	Information about the UPS and relevant power switchboards. Power supply source (primary/backup), power switch released and insulation error
Battery charging level	Battery charging indications and status. (Faulty battery in each loop)
Trespassing of Technical Areas	Alarm caused by possible malicious trespassing of technical room

The diagnostics and maintenance system shall be installed in the signalling/telecommand technical room. Each fault shall remain displayed on screen until the diagnostics and maintenance system logs the remedy of the fault. The system shall also be used for activating the testing program in all operational units of the interlocking system.

The diagnostics and maintenance equipment shall consist of a branded computer (using state-of-the-art PC technology), equipped with the necessary software, fed by the UPS, plus a log printer. A state-of-the-art, noise-free laser printer shall be provided. The computer shall have a 23’’ high resolution monitor. Access to the maintenance and diagnostics application shall be password protected.

The interlocking system shall provide for event logging in a time-referenced manner. The log shall be created in accordance with a rolling timescale, and the information shall be stored for at least 2 weeks. The Contractor shall state the maximum historic data retention time.

The interlocking system shall be provided with an error and alarm logging function, with time reference and an error - fault category identification code. The fault log shall follow a rolling timescale, and the information shall be stored for at least 1 month. The Contractor shall state the maximum historic data retention time.

The diagnostics and maintenance system shall allow access to the above function and error logs.

The performance and functions of the diagnostics system shall be subject to approval by HSH. The Contractor shall provide in his design a detailed description of the diagnostics and maintenance system’s capabilities.

2.12.17 Cabling

All necessary cables for Signalling - Telecommand and peripheral Systems operation, resulting from the Contractors Implementation Study.

All cables shall be designed in accordance with international railway signalling standards.

The Contractor shall submit a series of complete specifications concerning the proposed cables, as well as a 20 cm long cable sample for each type of cable proposed for installation.

The specifications shall include details pertaining to both their mechanical and electrical characteristics (insulating material between conductors, insulating jackets, cross sections, insulation resistance, mechanical protection - reinforcement, electromagnetic protection - shielding, etc.).

The sleeve sockets to be used, where required, shall be of approved type, acceptable by the national railway operator of the equipment's country of origin, as well as by HSH. Generally, it is prohibited to use underground connections inside the stations. The Contractor shall include in the design to be submitted technical information about the sleeve sockets to be used.

The main cables shall be single-wire or stranded and shielded, while terminal cables shall be stranded and shielded. All cables to be installed in outdoor areas shall be reinforced. The Contractor shall supply the necessary documentation concerning the manufacture and effectiveness of the shielding/reinforcement.

All internal cables and wiring, including those routed through any location in a building, shall be fire retardant, as specified in the IEC 60332-3 standard. Cables in tunnels in particular shall be fire resistant, as specified in the IEC 60331 standard. All this internal cabling shall be low smoke zero halogen according to the IEC 60754-1 and IEC 60754-2 standards.

All cabling shall be resistant to corrosion, rodents and insects. They shall be suitable in all respects for continuous operation under the ambient conditions prevailing in the area.

Furthermore, the cabling shall be so designed and constructed as to prevent any interference with other low voltage (up to 1000 V) and high frequency (up to 2 MHz) cabling installed in parallel configuration.

Multiple conductor cables shall be equipped with an error-free system for identification of the individual conductors, plus an additional 20% or 4 conductors (whichever is greater) for redundancy purposes. Unique identification of conductors shall be sufficiently documented.

All cables shall, following installation, be subjected at least to continuity and insulation testing. HSH shall demand replacement of any cables failing the tests.

2.12.18 Installation of Equipment

The Contractor shall install all the equipment in a comprehensive manner, in a workmanlike fashion and in accordance with the requirements laid down in this specification and in other contractual documents.

Equipment installation works shall be carried out from start to end under the direction of a competent Certified Electrical or Mechanical Engineer, assisted by specialized foreign technicians, as designated by the manufacturers, and other experienced and proven specialized staff. Transportation, accommodation and other expenses shall be included in contractual price. Within the scope of safety requirements, the Contractor’s personnel to be employed in the project shall be properly certified for work to be performed close to an electrified railway track or shall attend a relevant special safety seminar at the Contractor’s care and cost. The Contractor shall notify to HSH, prior to commencement of the seminar, the time and contents thereof and participants thereto.

The expenses to be incurred for transporting the equipment, including necessary ancillary materials, to the project site and installing it thereat, as well as all other expenses or works necessary for rendering the equipment ready for operation shall be deemed to be included in the Contractor’s bid.

The Contractor’s obligations shall include construction of raised floors in the technical rooms and at the TCC, as well as performance of all necessary building works, such as painting, various minor finishing works, etc. The raised floor shall consist of easy-to-move panels with a view to ensuring direct and easy access to cables lying underneath. The upper side shall be made of insulating, antistatic material, and the bottom side shall be covered with a sheet of iron (not aluminium) with a view to ensuring conductivity and connection of all plates to one another, in order to avoid potential electrostatic charges that may influence the operation of electronic devices.

Prior to the installation of each set of equipment (e.g. turnout machines), the Contractor shall provide a set of documents required for installation, i.e. the “Installation File”, including but not limited to the following:

- the installation procedure for each material;
- detailed installation drawings showing all information relevant to location, support, cabling, sealing, protection etc.;
- a list of all technical data and information about the type, resistance to mechanical stresses, sunlight, anti-corrosion protection etc. of all the materials to be used (e.g. terminal strips, cable glands, protective tubes, junction box fastening materials, etc.);
- working instructions (e.g. rail track drilling, cable fastening);
- a list of proper installation inspection mechanical tests;

– a list of proper installation inspection electrical tests.

The junction boxes and all outdoor materials shall be heavy duty type, built to withstand corrosion. All outdoor equipment shall be water and dust proof and its construction shall prevent moisture accumulation due to condensation in accordance with the IEC 60529 (IP 65) standard, or a different equivalent standard; details regarding the standard shall be provided by the Contractor .

The bolts, studs, washers and nuts to be used for mechanical fastening shall be in accordance with an approved standard, in metric dimensions, made of stainless steel. Any of these that are subject to vibration, high temperature or pressure, shall be made of high tensile strength materials.

The bolts, studs, washers and nuts to be used for electrical connections shall be made of a manganese alloy or bronze, according to an approved standard, with a view to ensuring protection against corrosion.

The nuts, bolts, pins and all components to be subjected to vibration shall be secured through special devices, whose details shall be agreed upon between the Contractor and HSH.

In addition, if so required by system technology, cabinets shall also be installed next to the signals or along the line. The cabinets shall be made of resistant material appropriate for the weather conditions prevailing in Albania, with main wall thickness of at least 1.5 mm and a protection class (IP 65) according to the IC 60529, EN 50102 standard. The cabinets shall be durable and appropriate for the respective installation area, thus ensuring long service life both for same and for the components and devices contained therein, under existing weather conditions.

2.12.19 Relays

Safety circuit relays shall be of recent design and high operating strength, and all their contacts shall be suitable for the operating current, fitted with a transparent and dust - proof housing made of such a material that will ensure that it stops burning upon elimination of the cause of inflammation, and they shall general comply with the characteristics set out in UIC leaflet 736. The relays shall be either type N only or type C only. The electrical life of the relays will be at least 1x106 cycles. It is understood that the relays shall be used in combination with circuiting devices appropriate for their type.

2.12.20 Power Supply

1. Ordinary power supply

All locations with signalling equipment shall be provided with independent power supply (distribution board), which shall provide the power required for the signalling installations.

In general, electrical power supply for the buildings will be done in accordance with the standards and normatives of the local electrical distributor of Albania. Electrical installations will be designed according to current technical regulations and standards.

The ordinary power supply of the new signalling and auxiliary installations shall be implemented from the local PPC power network by means of a lead from the existing Main Distribution Board of the reception station building. The Contractor of the project shall calculate the necessary consumed power and shall be responsible (in close collaboration with HSH) for upgrading the connection to the mains in case that the existing connection is not sufficient for supplying the existing plus the newly installed equipment.

In particular, there shall be an independent power supply to the Durres, Shkozet, Sukth, Vore, Kashar, Tirana, Airport railway stations and Shelter.

At locations where the implementation design has provided for the installation of signalling equipment but there is no PPC power supply line (i.e. SHELTER), the Contractor shall ensure uninterrupted power supply to the signalling equipment from a primary source and a secondary source. This shall be realized in the same way as above, but through power supply from a new network connection. The Contractor is free to propose other reliable solution i.e. supply via 1000V power cables from the 2 neighbouring stations. The resulting power requirements shall be taken into account in the dimensioning of both the power installations feeding the remote equipment and the power supply cables.

The construction and installation of the power plant shall include all the necessary connecting, disconnecting, securing, conversion, transformation, metering and other instruments, as well as any other installation, device or instrument required for ensuring full power supply to the installation.

The operating power rating of the signalling system shall be equal to the power required for each station in order for the indoor and outdoor signalling equipment to be in full operation with all its signals switched on and a simultaneous operation of two turnout machines, plus 25% in order to accommodate future needs (i.e. new ETCS equipment).

The Contractor shall include in the implementation design to be submitted a load calculation and dimensioning design for the power supply system, which shall demonstrate that the above requirements are satisfied. The additional power demand due to possible future ETHDs installation shall be considered in the load calculations.

The Contractor shall take all necessary measures to ensure that ambient conditions in the areas where the power plant is installed (UPS, power generator, batteries) are within the operating limits specified by the manufacturers and are those required for maximizing the service life of individual systems.

2. Uninterrupted Power Supply (UPS) System

The signalling system shall be supplied with power from an external reliable source and shall be based on an Uninterrupted Power Supply (UPS) system consisting of two (2) parallel-configured power supply units or of the new technology UPS modular unit, the redundancy of which is 20% of the total UPS power, to which load requirements shall be allocated. The overall performance of the parallel-configured UPS units shall exceed the load requirements by the rated performance of at least one UPS unit, so that it is possible to disconnect one unit and ensure that the other unit is capable of providing uninterrupted supply to the load. Load synchronization and distribution circuits shall also be required. The system shall be equipped with a bypass switch and battery banks. The input side of the UPS system shall be protected against overvoltage. The UPS shall be so configured as to allow operation of the system, in case of fault of a single element (rectifier or inverter), with the remaining elements. The batteries shall be installed in a separate battery room.

The UPS system shall consist of the following units:

- The Uninterrupted Power Supply (UPS) unit, which shall be fully equipped with all automation and control devices.
- The electronic Static Bypass Switch (SBS).
- The manual Maintenance Bypass Switch (MBS).
- The Battery Bank (BB), which shall be of sealed type, along with its cabinet and all materials, and of appropriate size to ensure autonomy under full UPS load conditions.
- The battery switch on a panel.
- Communication with a computer, where all the UPS and battery monitoring and control information shall be transmitted. The data shall be transmitted to the overall diagnostics and maintenance system and shall be accessible from its intended installation locations.
- The operation and maintenance Technical Manual, including the necessary drawings and details.
- The galvanic isolation transformer (GIT) (for total galvanic isolation of network 1 and network 2).

The UPS system shall feed linear and nonlinear loads.

The value of the current crest factor of these loads shall be deemed to be up to 3 (i.e. crest factor - Ipeak / Irms = 3).

All the materials to be used for the construction of the UPS system shall be reliable and brand new.

The electromagnetic phenomena as well as the harmonics generated by the operation of the UPS system shall be limited to a minimum through appropriate filter units and devices to ensure problem-free and interference-free operation of various electronic systems and computers. For this purpose and depending on the size of the UPS system, the manufacturer shall, in manufacturing the UPS system, comply with the interference levels permitted by EU Directive 89/336/EEC on EMC and RFI, European Norms (EN) and the IECs referred to therein.

3. Standards

Compliance with the following standards shall be mandatory, and the relevant certificates and marks shall be provided:

- IEC146-4
- IEC 950/EN 60950
- EN 50091-1, EN 50091-2
- IEC 801-2-3-4-5
- EN 55011 class A group 1
- VDE 0875 level N

4. Certificates

Valid ISO 9001 certificates shall be submitted necessarily.

A compatibility certificate shall also be provided for the UPS system - computer communication program.

5. Marks

The total harmonic distortion of current coefficient at the UPS system input point shall not be higher than 5% (THDI ≤ 5%).

This reduction shall be achieved by active or passive input anti-distortion filters. Preferably the filters shall be able to handle 2nd class to 25th class harmonics individually or collectively.

6. Input

The Uninterrupted Power Supply system shall be supplied with electricity under normal conditions from the national PPC network (three-phase AC) and in case of outage or inappropriateness thereof, from a backup generator. The input AC shall meet the following characteristics and therefore the UPS system shall be so designed as to function normally at least within the following limits:

- Rated AC voltage: 400V AC + 10% - 15%
- Power supply frequency: 50 / 60 Hz ± 5%

Preferably the offered UPS system shall have a wide operating range, which shall be stated in the design.

• UPS input power factor (p.f.) with rated input and output voltages, rated output KW, and batteries under conservative charging:	
	≥ 0.8 inductive
	≥ 0.95 inductive by the use of a filter
• Input harmonic distortion of current:	THDI ≤ 5%

7. Rectifier - Charger Electrical Characteristics
- Inrush currents: To ensure smooth start of the rectifier - charger, the UPS system shall be equipped with an output voltage step increase system, which shall reach imum voltage (DC) in about 10 sec.
- Current limitation: To prolong battery service life, an electronic device shall limit the imum current value of the charger to that recommended by the battery manufacturer. A second device shall control the rectifier - charger's input current so as not overloaded the UPS system input.
- Direct voltage: To prolong battery service life without, however, compromising battery performance, the rectifier - charger shall have the following functions:

i. Conservative charging function:

The charger output shall be set to a voltage equal to that recommended by the battery manufacturer.

ii. Automatic charging function:

In case of PPC outage for more than 30 seconds, the battery recharge cycle shall be switched on upon restoration of PPC power supply. This cycle shall consist of two operating phases, first constant current charging and then constant voltage charging. Constant voltage charging shall be specified by the battery manufacturer. Upon completion of the charging cycle, the rectifier - charger operation shall revert to conservative charging.

iii. Manual charging function:

The UPS system shall be equipped with a manual battery charging function. Upon completion of the manual charging cycle, the operation of the rectifier - charger shall revert to conservative charging.

iv. Initial or equalizing charging function:

This function relates to the initial or equalizing battery charging, which involves considerable voltage differences between battery elements. This function shall only be activated when the inverter is off.

- Input power factor: The rectifier - charger shall have an input power factor higher than 0.8 when input voltage and frequency are normal and the inverter functions at 100% of its capacity.
- Voltage setting: The rectifier - charger output shall not vary by more than 1% of its default output voltage, regardless of input and load changes, provided that these are within default input limits.

8. Output

The UPS system inverter shall be fitted with transistors and shall operate in accordance with the pulse-width modulation technique (Free PWM)

- Rated AC output voltage: (3P + neutral): 400V AC ± 0.5%
- Output frequency

– with PPC input: 50 / 60 Hz ± 0.5 Hz

– from a crystal oscillator: 1 / 2500

There shall be two operating capabilities available:

Under normal operating conditions, the inverter output frequency shall be synchronized with the static switch input frequency, at ± 0.5Hz.

If the Static Switch is fed from a generator, the frequency fluctuation tolerance shall be set approximately to ± 2Hz.

If the Static Switch input frequency is off the above limits, the inverter shall be switched by its internal crystal oscillator to free frequency modulation of the order of ± 1Hz. In the event of switching from free oscillation to synchronization and/or vice versa, the frequency change (dF/dt) shall be limited to 1 Hz/s.

- Apparent output power (KVA), according to the load calculation design (with an inductive output load power factor of 0.8):

- Inverter overload: 1.1PN for ≥ 2 hours

1.15 PN for ≥ 30 min

1.25 PN for ≥ 10 min

1.35 PN for ≥ 3 min

> 1.5 PN for ≥ 1 min

- Momentary Overload: > 2.33 In for 1 second
- Load current crest factor: up to 3
- Output Voltage Harmonic Distortion coefficient

(THDU for a 100% linear load): Ph / Ph ≤ 1.5%

Ph / N ≤ 2%

- Output Voltage Harmonic Distortion coefficient
  (THDU for a 100% nonlinear load): Ph / Ph ≤ 2%

  Ph / N ≤ 3%
- Output voltage change ± 2% for step load change from 0-100% and 100-0%. In all cases, the voltage shall be restored to normal levels in not more than 10 msec.
- Voltage set for an unequally distributed load.

In case of unequal load distribution at the output by 30%, the voltage difference between phases shall be less than 1.1%.

The momentary overload shall reach 163%.

If necessary, the UPS system shall reduce power in order to feed – however, with considerable voltage fluctuations – situations (such as overload, high peak currents, etc.) without switching to the Static Switch.

9. Electronic Static Bypass Switch (SBS)

- Rated operating voltage : 400V AC ± 10%
- Rated operating frequency : 50 / 60Hz ± 10%
- SBS rated power : According to the needs
- SBS overload: : 1.1PN for ≥ 2 hours

  1.15 PN for ≥ 30 min

  1.25 PN for ≥ 10 min

  1.35 PN for ≥ 3 min

  > 1.35 PN for ≥ 1 min
- Momentary Overload : >2.33 In for 1 second
- Short-circuit resistance for 20 ms
- Switching time when:

a. switching conditions T=0 are met

b. switching conditions T=500 to 800 ms are not met (forced transferred).

10. General UPS System Characteristics

There shall be necessarily total galvanic isolation between the input and output points.

The total harmonic distortion of current (THDI ≤ 5%) shall apply necessarily even if the UPS system is on Static By - Pass or Maintenance By - Pass.

BB autonomy at full output load, with cos phi = 0.8, voltages and other technical characteristics	: 4h
Static Bypass Switch (SBS) with two antiparallel thyristors per phase and zero switching time	: KVA capacity at least equal to the power of the respective UPS unit

SBS synchronization range adjustable	
a. to a voltage of	: 400V±10%
b. to a frequency of	: 50/60Hz adjustable from 0.25 Hz to 2 Hz in steps of 0.25 Hz.
Maintenance Bypass Switch	
(MPS) of a capacity at least equal to the power of the UPS system	: Built-in in the UPS system
UPS system performance:	at 25% of the load ≥ 90%
	at 50% of the load ≥ 92.5% at 75% of the load ≥ 93% at 100% of the load ≥ 92% 94%

Please, note that it is mandatory for the UPS system to have a high efficiency level across its operating range from 25% to 100%.

Generated acoustic noise as measured at a distance of 1 meter from the UPS system at half its height according to ISO 3746 : 60 dBA

Interference protection in accordance with the operating principle and size:

EN 50091-2/EN55011

Class A group 1,

VDE 0875 Level N,

IEC 801-2, IEC 801-3,

IEC 801-4, IEC 801-5

The offered UPS system shall feature digital technology.

There shall be no analogue settings (settings through potentiometers).

The UPS printed circuit boards (PCBs) shall be Plub & Play.

Protection: IP205

MTBF: ≈200,000 hours.

MTTR: ≈ with spare parts available, the time needed to repair from the time of arrival of the technician shall be about 3-4 hours.

11. Mechanical Design

The UPS cabinet shall be designed with a strong and rigid frame that can withstand transportation, mounting and installation-related difficulties.

The inside of the UPS shall be accessed from central front doors fitted with locks.

All metal frames, covers shall be corrosion and rust resistant.

12. Dimensions

The UPS unit shall occupy as little space as possible.

13. Connections and Bars

It shall be possible for power supply or data cables to enter from the base, back or bottom (raised floor). The connection points shall be clearly marked for easy installation.

The neutral conductor or bar shall be oversized, so as to allow possible routing of a third harmonic or its multiples: The size of the neutral conductor shall necessarily be 1.5 times higher than that of the phases.

14. Maintenance
    - All UPS subunits shall be accessible from the front.
    - UPS design shall ensure maximum reliability.
    - The UPS system shall also be equipped with an advanced fault diagnostics unit capable of identifying any problem and providing technicians with guidance for repair purposes.

All electronic control units shall be equipped with a microprocessor, and the following shall be permitted:

- self-diagnostics
- automatic board settings in the event of replacement
- Computerized fault diagnostics.

The UPS system shall have a panel displaying the setting parameters, operating status, possible signal malfunctions (alarms) and instructions on how to switch from one status to another.

- Storage of all the UPS operating changes in memory, and repair methods analysis.
- Connecting the UPS system to the Building Management System (BMS) in case there will be such a system in a station building.
- Protective equipment and devices.

15. Operating Conditions

The UPS system shall be suitable for operation under the following conditions:

- Ambient air temperature: 0-35°C, 40°C for eight (8) hours
- Ambient air relative humidity: 0 to 90%
- Altitude above sea level: 0-1000 m

16. Safety

The UPS system shall have an IP 205 protection rating.

The UPS system shall bear a transportation impact protection indicator. The indicator shall change colour if the UPS system has suffered impact during transportation or in any other case, so that the recipient is able to determine whether the transportation of the UPS system has been done under normal conditions or not.

For maintenance engineer safety purposes, the device shall be equipped with a manual bypass switch to enable isolation of rectifier-charger, inverter and Static Switch while ensuring supply to the load from PPC.

Control circuits shall necessarily be galvanically isolated from power circuits. All dangerous parts (components) of the UPS system shall be protected by insulating materials or protective covers for larger surfaces.

17. Protection

The following are mandatory and inviolable.

The UPS system shall provide input overvoltage protection devices (e.g. IEC 146), as well as external or internal transportation impact indicators.

The rectifier-charger shall be so designed as to “open” the battery switch automatically in case of battery fault.

The inverter shall be so designed as to stop functioning if direct voltage drops to its minimum value, as set by the battery manufacturer.

The load shall be protected from inverter faults so that the output voltage value is not off preset limits.

The rectifier-charger shall be so designed as to stop functioning if direct voltage peaks to its maximum value.

The system inverter shall be fitted with a circuit self-protection system in case of output overload, when the by-pass network is off permitted limits.

Moreover, in the event of short circuit on the load side, the inverter shall be switched off without burning any fuses. The results of the mandatory factory short circuit testing shall be provided necessarily.

The total harmonic distortion of the input current of all UPS systems (THDI) shall be ≤ 5%.

18. Checks - Indications - Measurements

There shall be a control panel installed on the front of the UPS system to perform the following functions:

- on / off
- forced inverter disconnection
- device self-diagnostics
- battery charging cycle

The following information shall be displayed through LEDs on the control panel:

- Rectifier-charger on.
- Load on the inverter.
- Load on the static switch.
- General error indication (General alarm).
- There shall be a buzzer to provide an audible alarm in case of error, malfunction or battery operation. There shall be a buzzer mute capability.

Moreover, the following information shall be displayed:

- Remaining battery runtime.
- Fan fault indication.
- Battery low voltage.
- Static Switch supply off limits.

The following measurements shall be provided about the unit:

- output voltage.
- output current.
- output frequency.
- voltage at battery bank ends.
- battery charge or discharge current
- input voltage
- charger-rectifier input current
- peak current.
- actual and apparent power.

- load power factor

19. Testing Procedures

Bidders shall necessarily send their factory acceptance testing procedures and a filled-out procedure sample, preferably for a UPS system of the same power.

One of the control tests to be carried out necessarily, for which results shall be provided, regardless of whether the Engineer y authority has attended the tests or not, is the output short circuit test.

In this test, the UPS system shall interrupt its output supply electronically WITHOUT BURNING ANY FUSES.

Before leaving the factory, the UPS system shall necessarily be subjected to an OVERLOAD TEST.

The UPS system manufacturer shall have a ISO 9001 Quality Certificate. There shall be an inspection procedure for materials that come into the manufacturing plant from other suppliers or cooperating firms.

The supplier shall have been an active manufacturer for the last 10 years and shall provide product support.

20. Other Requirements and Elements.

The following elements and requirements are indicative and relate (concerning the completeness of the specification) to the devices and requirements that each UPS system shall have and satisfy, that is:

Operation and control devices for protection against overloading, overheating, short circuiting, as well as network overvoltage and lightning.

Voltage, current and frequency control devices or meters.

Overloading capabilities within short operating times. Electrical operating characteristics configuration capabilities. Provision of a POWER OFF switch on the front of the UPS system.

Visual and audible relay contact signals (potential free) for remote signalling at an overlying control centre in the following cases:

- Normal operation
- Operation on BB.
- Operation on by-pass.
- Operation on generator.
- fault.
- PPC off limits.

The design shall indicate exactly all the signals provided.

There shall be a UPS-computer communication system used to provide information about the power, voltage, current, batteries, frequency, remaining battery runtime, etc.

There shall be a device to automatically disconnect the BB, for protection against deep discharge and to reconnect it after resetting the network.

It shall be mandatory to provide lists of public organizations, entities, private clients, general customer lists internationally so to demonstrate that the company is internationally known, as well as Installation Certificates from known domestic and foreign customers.

21. Backup supply

The following shall be provided by the bidder for backup power supply purposes:

- a battery bank and
- a diesel generator.

The generator and batteries shall be used for supplying power both to the stations and open line installations.

22. Power generator

The power rating of the generator shall be at least 20% higher than the power required for the operation of the signalling system and other supported loads, and the power rating of the motor shall be at least 5% higher the power required at the generator shaft. The calculation method / study relating to the power required shall be included in the design to be submitted.

The generator shall be accompanied by all required automation and control instrumentation.

The generator shall be switched on automatically in case of PPC power outage and shall be switched off automatically when power supply is restored. The time needed for the generator to be switched on following a PPC power outage and to be switched off following restoration of power shall be configurable. The control panel of the Electrical Generator will be equipped, besides the automatic control, with manual operation control of the Electrical Generator.

23. Batteries

In case of PPC power outage, the UPS batteries shall be so dimensioned as to ensure uninterrupted power supply for 6 hours, with the inverter at full load, as defined in the preceding paragraph.

A protection device shall protect the batteries from deep discharge. A second device shall protect the batteries from discharging through the inverter circuitry when the UPS is off for at least 2 hours.

The UPS batteries shall be constantly controlled with regard to sufficient support time (PPC on), remaining runtime (PPC off), in accordance with to the load, and service life thereof.

The battery compartment temperature shall be monitored through the UPS system.

If the inverter interrupts its output supply due to an error, the battery switch shall be opened NECESSARILY.

Details shall be provided necessarily about the battery monitoring program and parameters.

The required battery technical characteristics are:

- Type: NiCd - (closed type)
- Autonomy under rated
- output load and cosφ. = 0.8 : 6h

Time required for battery recharging (Following full discharge)

- for 90% of battery capacity : 8 hours
- for 100% of battery capacity : 10 hours
- BB service life in years : 10+
- Residual AC ripple : < 1% of DC voltage

24. Electric Turnout heating devices

ETHD are not in the scope of works of the present project. This paragraph is given only for power supply system's capacity calculations in accordance with Book 5 par. 4.2.8. The power demand of ETHD systems, possibly installed in the future, shall be included in the power calculations that will be presented in the implementation design to be submitted by the Contractor). Electric Turnout Heating Devices (ETHD) could be provided in certain turnouts, including a set of heaters, a power supply transformer and power supply and control cabling.

Heaters are installed on the stock rails at each turnout, they have an approximate heating capacity of 250 W per meter and cover the flexible part of the turnout. Also the locking chamber of the turnout (space between sleepers with drive rod and locking bars) are heated.

ETHDs are supplied with power from the Station.

- The required power for each power supply unit is dependent upon the number and type of the turnouts to be heated by the unit in question, as well as upon the unit-turnout distance.
- The ETHDs of neighbouring turnouts shall be supplied by one power supply unit including all
- Required equipment (switching devices, transformers, all protection systems, all

power supply cabling, major and minor materials, etc.).

- The number of ETHDs to be supplied by each power supply unit shall be presented in the calculations and subject to approval by HSH.

2.12.21 Circuits – Operating Safety

The different safety circuits shall be so set up as to guarantee maximum system operating safety both for the systems and train traffic. That is why, when relays are de-excitated, excitation thereof by potential dispersed currents, etc. shall be typically impossible. Generally fail safety principles shall apply to such systems. All designs, materials and equipment pertaining to signalling safety circuits shall be in accordance with fail safe operating standards, so that in case of fault, outage or disconnection, train traffic under unsafe conditions is prevented.

Any malfunctions to the different safety circuits shall activate respective signal safety indications, shall prevent an unsafe indication or untimely release due to fault, etc., also including a case of power or conductor outage or conductor short circuit. Circuits used to ensure rail traffic safety shall operate through encoded currents originating from coders - decoders, preventing any error.

The different circuits shall be protected by appropriate fuses, and automatic circuit breakers shall be used preferably for the signals. Fuses and automatic circuit breakers shall be suitable for circuit disconnection in case of short circuit, even at the farthest location. Turnout machines shall be fitted with automatic reset protection switches.

Circuits used for miscellaneous functions shall be separated in individual cables comprising related functions, without ruling out the single cable technique, if approved by HSH.

Two-pole disconnection shall be used for circuits from and to external equipment.

The Contractor shall ensure and guarantee to HSH that the operation of the signalling installation is safe and shall be the sole person liable therefore regardless of any item being submitted to and approved by HSH.

The implementation design shall be accompanied by a technical description specifying the safety levels which the system switches to in case of fault, as well as its restricted operation capabilities.

2.12.22 Earthing – Lightning protection

All equipment provided shall withstand power supply overvoltage and interference or impulse voltages created by lightning on the power networks.

It is mandatory that all system equipment, as well as the system itself across its geographical area, shall be shielded against interference and overvoltage resulting in any way whatsoever (contact, magnetic or capacitive induction, etc.) and against normal operation and faults (e.g. short circuits),

The Contractor shall deliver design and drawings for the shielding / earthing / lightning protection system to be implemented for the entire equipment. The design shall indicate the following:

- Earthing principles. Equipotential connections shall be included as well.
- The national standard they comply with.
- Detailed drawings complete with distances, etc. in order to prevent sparkovers between individual networks under any circumstances, as well as to demonstrate the adequacy of shielding.
- The method of protection against lightning and all kinds of impulse voltages.

For protection of the interlocking system against impulse voltages, surge arrestors shall be installed at the locations where cables enter the equipment room.

Additional requirements:

- If the manufacturer of newly constructed devices has more stringent regulations, the regulations of the manufacturer shall apply.
- All earthing wires should have yellow-green markings.
- The connection between the earthing bus and the equipment cabinets should be made with insulated stranded copper wire with the required section.

2.12.23 Electromagnetic Interference – Compatibility

It is anticipated that train equipment shall utilize a wide range of frequencies (power frequencies to radio frequencies). In addition, the station area may accommodate various devices generating further electromagnetic radiation. The Contractor shall ensure that frequencies and modulations of other AC signals (including all potential variations) do not cause interference or fault to the equipment. All systems, materials and equipment shall function properly and safely in the presence of electromagnetic fields created by other types or third-party equipment. The Contractor shall be responsible for identifying such sources and providing for appropriate shielding or other protection measures.

Similarly, the Contractor shall see to it that the equipment provided within the context hereof does not be generated electromagnetic radiation exceeding acceptable limits during operation.

The Contractor shall prepare and submit to HSH a plan for ensuring electromagnetic compatibility (EMC) (object matter and assurance),. Equipment EMC shall conform to and comply with the requirements of the relevant standards of the international standards, including specification UIC / EEIG 97s066 on electromagnetic compatibility and specification EN 50121.

2.12.24 Cable routing

Both in-station and out-of-station cabling, as defined, shall include cabling located inside buildings as well as outdoor cabling (outside buildings).

In-building cabling shall be generally installed by the Contractor within underground cable routes (channels or halogen free tubes according to DIN 49016 or DIN 49018). In-floor channels as well as any other special construction for in-building cable protection up to the external side of the exterior building wall shall also be constructed by the Contractor, based on the detailed design to be prepared by the latter. Where cabling cannot be installed in underground routes, the Contractor shall submit to HSH for approval an alternative proposal (installation on roof-hung trays, in raised floors, etc.) and shall procure the materials required for that and shall execute the relevant works at his own expense. Building floor plans, etc. shall be supplied by HSH.

The external cabling will be installed by the contractor, as a regular procedure, along the line with heavy duty protective HDPE (High Density Polyethylene) tubes of 50mm diameter. Tubes diameter is indicative, and Contractor is free to propose other diameters suitable for the cables used. Their installation should include the construction of the necessary shafts (protective containers). The shafts (containers) should be constructed so that they may be covered with at least 30-40 cm earth fill to the ground level.

A yellow warning tape marked “Attention optical and power cables” should be placed over the HDPE pipes at a depth equal to the half of the distance between the ground surface and the cable.

Along the open line there will be two cable routings. One side will be for signalling and the other one for telecommunications, where, at the signalling side 2 plastic tubes of 50mm will run inside a trench, and on the other side 2 tubes of 50mm diameter. The second one should remain free for the future development of the telecommunications.

Where cables are routed under railway lines, roads, sidewalks, platforms, etc., heavy duty flexible HDPE tubes of a diameter of 160 mm and a thickness of 4.9 shall be used, which shall be embedded in concrete. The power cable shall be installed in a separate tube at all times. Where cables are routed under railway lines, the installation depth shall be 0.80 m from sleeper bottom, or it may be reduced to 0.60 m for rocky ground, subject to approval by the Engineer y authority. Where cables are routed under roads and in platform sidewalks, the installation depth shall be 0.80 m from road or sidewalk surface. The Contractor shall be responsible for taking the actions necessary to obtain authorization for road cutting operations from competent authorities.

The Contractor shall be responsible for identifying the need to build underground cable routes under railway lines early enough with a view to allowing for construction thereof by open excavation prior to laying the superstructure.

Where the cable route is not evident, route markers shall be installed at 100 m intervals along the route. Similarly, markers shall be installed at cable route direction change points. The route markers shall be made of concrete, dimensioned 20×20 cm, and their length shall be in accordance with ground conditions.

In-building cable routes shall terminate at a shaft located right after the external side of the building wall.

The entry into the station buildings shall be executed via non-combustible station optic fibre protected by a metal pipe.

A spare cable should be placed at the input points in the building.

The Contractor shall make provision for a fire protection diaphragm at the openings created for cable routing purposes through walls, floors and shafts. The openings of protective tubes and all tubes used for cable entry to buildings shall be sealed with fire resistant material for fire protection purposes and to prevent the entrance of rodents or insects. Generally, the installation shall ensure protection against the spreading of fire and smoke between rooms. The Contractor shall include in his design a description of the method and materials to be used.

Two cables carriers, the "signalling" carrier and the "telecommunications" carrier, shall be constructed along the line. The former, shall contain the signalling cables, electromechanical cables, as well as two HDPE tubes for telecommunications purposes. The latter shall be constructed on the other side of the line for telecommunications purposes.

The possible existing concrete carriers shall be checked and if acceptable shall be used in tunnels and on bridges.

1. Trench

The cable installation trenches shall be constructed by the Contractor and its width shall be typically 0.50 m (signalling trench) and 0.30 m (telecommunications trench) to a depth from 0.50m to 0.80m. The work shall be carried by hand or through mechanical means, on all type of terrain, including rocky ground, along a straight or curved or zigzag line, at any location, i.e. on the open line, inside and outside station areas, close to any other cable carrier, etc.

Following is a detailed list of the works included:

- Excavation of a trench dimensioned as per the above and at suitable locations for the construction of the route, which shall be carried out by hand or through mechanical means.
- Removal of all types of deck, regardless of thickness, (blocks, sidewalk tiles, etc.) where necessary, including demolition of part of the concrete. All necessary preparatory work, such as uprooting and clearance of scrub, removal of water from the trench, removal of falling materials, removal of sleepers, rails, etc.
- Retaining of the trench sidewalls where necessary.
- Loading, unloading, transportation and disposal of excavated material at locations permitted by competent authorities, regardless of transportation distance.
- Formation of the bottom of the trench so that it is smooth and free from aggregates (if the depth of the trench cannot reach at 0.80 m due to special circumstances, special protection measures shall be taken, at the same unit price and in accordance with the requirements set by the Engineer y authority).

2. Requirements for the HDPE protective tube

The HDPE tubes have been issued “Permission for installation in the urban telephone networks”.

The HDPE tubes have a special ribbed inner surface to reduce the coefficient of friction between the cable and tube and to facilitate the installation.

The HDPE tubes should be manufactured only by primary material brand 273-79 and should have a size of ø50x3.5, 5 - at the discretion of the Contractor. At each meter of the tube indelibly imprinted should be the trade mark, the size, the material, the standard, the current length and direction of growth of the footage.

The hermetic connection of the tubes should be carried out by compression fittings (couplings).

All HDPE tubes should have indelible marking of different colour clearly visible for easy identification (or the tubes themselves should be of different colour), with an inscription and the current footage.

3. Shafts

In order to facilitate installation of the various cables, shafts shall be provided where required. Shafts shall be provided generally in the following cases:

- at the ends of crossings with embedded tubes, at 40 m intervals along the crossings, as well as at sudden direction changes;
- at the ends of road and railway line crossings;
- at locations where the installation method changes, e.g. from routing in a plastic tube to direct installation in the ground;
- at locations where cables enter buildings.

As telecommunications and electromechanical installations cables shall be installed in cable carriers, in addition to signalling cables, the Contractor shall construct shafts at such locations as required with a view to addressing the needs of the above systems. The Contractor shall submit an implementation design for the installation of the cable carrier and shafts to HSH for approval.

The top view dimensions of the shafts shall be 100×100 cm, their depth shall be different on a case-by-case basis and sufficient for ensuring a distance of 25-30 cm between the bottom of the deepest crossing and the bottom of the shaft. Possible adjustments to the shape or dimensions of the shafts in order to facilitate cable routing, depending on local conditions, shall be made by the Contractor.

The shafts shall be constructed from concrete with smooth inner surfaces, but no special cement dust sealing shall be applied. Their bottom shall not be sealed but shall be covered by a 5-10 cm thick layer of sand in order to facilitate drainage of storm water potentially entering the shaft.

The shaft lid shall be heavy duty type, made of cast iron and fitted with a safety lock. The lid basis shall be made of a properly dimensioned steel angle profile fixed upon concrete using appropriate fasteners.

Following cable installation, the tube openings shall be sealed with glass wool or polyurethane foam in order to avoid entry of rodents as far as practical.

2.12.25 Interfaces

The internal interfaces are technical or organizational connections between various parts or elements of the system, which are specified in different specifications.

The contractor shall be responsible for provision of fully operating signalling equipment. His responsibility covers all interfaces and is not limited to the internal interfaces, specified in this technical specification. The internal interfaces shall be specified in detail by the Contractor.

Each of the signalling equipment systems apart from its own and mutually connected interfaces requires also interfaces to the telecommunication system, the Power supply system, etc.

2.13 Signaling - ETCS level 1 line system requirements

2.13.1 List of abbreviations

Abbreviation	Description
RL	Level 1 ETCS Line System
ERTMS	European Rail Traffic Management System
ETCS	European Train Control System
TCC	Traffic Control Centre
EOA	End Of Authority
LC	Level crossing
LEU	Lineside electronic unit
MA	Movement Authority
OS	On Sight
PATHEP	Greek main railway axis Patras-Athens-Thessaloniki-Idomeni-Promachonas
PT	Post Trip mode
SH	Shunting mode
SIL	System Integrity Safety Level
SR	Staff Responsible mode
SRS	System Requirements Specifications
SSP	Static Speed Profile
STM	Specific Transmission Module
SL	Supervised Location
TENs	Railway Lines of the Trans-European High-Speed Rail Network defined by the relevant Community Directives
TSI	Technical Specifications for Interoperability
TSR	Temporary Speed Restriction
UN	Unfitted Mode
IS	Isolation
IB	Infill balise
SBD	Service Brake Distance
UNISIG	Union industry of European signalling systems suppliers
LCAS	Level Crossing Automatic System

2.13.2 Glossary of terms

Term	Description
ERTMS / ETCS system	The European Traffic Management System means European Railways Traffic Management System / European Train Control System (ERTMS/ETCS).
ETCS system Level 1	The 1st out of 3 operation levels of the ETCS
Train System	The ETCS subsystem installed on the trains
Line System or simply System	The ETCS subsystem installed on the railway lines that interfaces with the existing signalling system and constitutes a single integrated and functional system with all the necessary equipment to be supplied by the Contractor and which after installation and commissioning shall meet all the technical specifications and functional requirements stipulated in the Contract.
Course indication/open signal	Main light signal indicating the ability to pursue the course (e.g. green, yellow signal etc.)
Danger point	Position beyond the end of authority (EOA) which the front of the train may reach without being in a dangerous situation
Slide way	The slide way (when provided in the interlocking system) is the part beyond the EOA (e.g. a mark with a "parking" sign). The slide way extends beyond the danger point to a point where the front of the train can reach without being in a dangerous situation. The extra distance applies only for a limited time (overlap release time).
Secure front section	The front part of the train, i.e. the front of the train or railcar engine
Train tail	The rear of the train, i.e. the rear part of the last vehicle or the railcar
Section	The Durres – Tirana section for which the Level 1 ETCS Line System is designed and is to be implemented and commissioned
Parking indication/closed signal	Main light signal requiring parking (red signal)

2.13.3 References

2.13.3.1 International References:

A. European Community Issues

[1] Directive 2008/57/EC of the European Parliament and of the Council of 17 June 2008 on the interoperability of the rail system within the Community.
[2] Regulation EU 2016/919 and Implementing Regulation EU 2017/6.

B. UNISIG and EEIG Issues

S/N	Reference	Title	Version
[1]	ERA/ERTMS/003204	ERTMS/ETCS Functional Requirements Specification	5.0
[2]	UNISIG SUBSET-023	Glossary of Terms and Abbreviations	2.0.0
[3]	UNISIG SUBSET-026	System Requirement Specification	2.3.0
[4]	UNISIG SUBSET-027	FFFIS Juridical Recorder-Downloading Tool	2.3.0

[5]	UNISIG SUBSET-033	FIS for Man-Machine Interface	2.0.0
[6]	UNISIG SUBSET-034	FIS for the Train Interface	2.0.0
[7]	UNISIG SUBSET-035	Specific Transmission Module FFFIS	2.1.1
[8]	UNISIG SUBSET-036	FFFIS for Eurobalise	2.4.1
[9]	UNISIG SUBSET-037	Euroradio FIS	2.3.0
[10]	UNISIG SUBSET-040	Dimensioning and Engineering rules	2.3.0
[11]	UNISIG SUBSET-041	Performance Requirements for Interoperability	2.1.0
[12]	ERA SUBSET-108	Interoperability-related consolidation on TSI annex A documents	1.2.0
[13]	UNISIG SUBSET-044	FFFIS for Euroloop sub-system	2.3.0
[14]	UNISIG SUBSET-054	Assignment of Values to ETCS variables	2.1.0
[15]	UNISIG SUBSET-056	STM FFFIS Safe Time Layer	2.2.0
[16]	UNISIG SUBSET-057	STM FFFIS Safe Link Layer	2.2.0
[17]	UNISIG SUBSET-091	Safety requirements for the Technical Interoperability of ETCS in Levels 1 & 2	2.5.0
[18]	UNISIG SUBSET-102	Test specification for interface "k"	1.0.0
[19]	UNISIG SUBSET-094	UNISIG Functional Requirements for an On-Board reference Test Facilitiy	2.0.2
[20]	UNISIG SUBSET-074-2	FFFIS STM Test cases document	1.0.0
[21]	UNISIG SUBSET-076-5-2	Test cases related to features	2.3.1
[22]	UNISIG SUBSET 076-6-3	Test sequences	2.3.1
[23]	UNISIG SUBSET-076-7	Scope of the test specifications	1.0.2
[24]	06E068	ETCS Marker boards definition	2.0
[25]	UNISIG SUBSET-085	Test Specification for Eurobalise FFFIS	2.2.2
[26]	UNISIG SUBSET-101	Interface "K" Specification	1.0.0
[27]	UNISIG SUBSET-100	Interface "G" Specification	1.0.1
[28]	UNISIG SUBSET-059	Performance requirements for STM	2.1.1
[29]	UNISIG SUBSET-103	Test specification for EUROLOOP	1.0.0
[30]	UNISIG SUBSET-058	FFFIS STM Application Layer	2.1.1
[31]	EEIG 97S066	Environmental Conditions	5.0
[32]	EEIG 02S126	RAM requirements (chapter 2 only)	6.0

C. EN Standards

[33] EN 50125-1 Railway applications – Environmental conditions for equipment – Part 1: equipment on board rolling stock 1999

[34] EN 50125-3 Railway applications – Environmental conditions for equipment – Part 3: equipment for signalling and telecommunications 2003

[35] EN 50121-3-2 Railway applications – Electromagnetic compatibility - Part 3-2: Rolling stock – Apparatus 2000

[36] EN 50238 Railway applications – Compatibility between rolling stock and train detection

systems 2003

[37] EN 50121-4 “Railway Applications - Electromagnetic compatibility. Part 4. Emission and immunity of the signalling and telecommunications apparatus”

[38] EN 50126 “Railway Applications - Specifications and Demonstration of Reliability, Availability, Maintainability and Safety (RAMS)”, CENELEC, 2000

[39] EN 50128 “Railway Applications - Software for Railway Control and Protection Systems”, CENELEC, 2001

[40] EN 50129 Railway Applications: Safety related electronic systems for signalling, CENELEC, 2003

2.13.4 Scope of the technical specifications

This document sets out the Functional Requirements and the Technical Specifications for the Durres – Tirana railway line including the new line including the new line from the Domje railway intersection to the Tirana International Airport (referred to as Durres – Tirana in the following) to be equipped with a Line System under the terms hereof.

It presents the main principles of the design, which will be considered in the detailed design of the implementation of the system to be developed by the Contractor.

For the project services (such as training, maintenance, spare parts, etc.), as well as for deadlines and procedures not mentioned in this issue, the relevant principles described in the issue of the Technical Specifications for Signalling of the Durres – Tirana section and the remaining tender documents shall apply.

2.13.5 General requirements

2.13.5.1 Standards

The Line System as well as its equipment must represent the latest technology in train control and protection. Specifically, for the project, the standards and specifications to be implemented shall be a version that will be in force on the date of approval of the project notice and at least version 2.3.0 d of the System Requirements Specifications (SRS), baseline 3 (X = 1).

The relevant standards and specifications to be applied for each component and for the ETCS integrated system are presented below:

[1] ISO: International Organisation for Standardisation
[2] IEC: International Electrotechnical Commission
[3] CENELEC : Comité Européen de Normalisation Electrotechnique

The following European standards shall also be applied:

[1] Directive 2008/57/EC of the European Parliament and of the Council of 17 June 2008 on the interoperability of the rail system within the Community

[2] Directive 2007/58/EC of the European Parliament and of the Council of 23 October 2007

[3] Directive 2004/49/EC of the European Parliament and of the Council of 29 April 2004 on safety on the Community’s railways and amending Council Directive 95/18/EC on the licensing of railway undertakings and Directive 2001/14/EC on the allocation of railway infrastructure capacity and the levying of charges for the use of railway infrastructure and safety certification (Railway Safety Directive).

[4] Technical Specifications for Interoperability (TSI), Control Command Signalling (CCS) in accordance with Decision 2012/88/EU, replacing Decisions 2006/679/EC and 2006/860/EC on conventional and high-speed rail systems respectively.

[5] UNISIG: ERTMS/ETCS-Class 1 System Requirements Specifications

[6] Major CENELEC standards to be applied:

[7] Series EN 50121: Railway applications - Electromagnetic compatibility

[8] Series EN 50124: Railway applications - Insulation system

[9] Series EN 50125: Railway applications - Environmental requirements for equipment

[10] EN 50126: Railway applications - Specification and demonstration for Reliability, Availability,

Sustainability and Safety (RAMS)

[11] EN 50128: Railway applications - Communication, signalling and processing systems - Software for railway control and protection systems

[12] Series EN 50159: Railway applications - Communication, signaling and processing systems

[13] EN 60529: Specification for degrees of protection provided by enclosures (IP Code)

If the standards mentioned are less restrictive than these specifications, the specifications shall prevail.

With regard to the Level 1 ETCS specifications, it is noted that they will have baseline 3 (x=1), in accordance with Implementing Regulation (EU) 2017/6 and in full compliance with the technical specification for interoperability for control-command and signalling subsystems (Regulation (EU) 2016/919), applicable on the approval of the project notice.

2.13.5.2 Safety

Safety is a fundamental feature of the systems with vital operations such as railway systems. The ETCS, as a System of Automatic Train Protection, belongs to the category of the railway equipment. It shall meet the safety requirements of a fail-safe system (failsafe). The ETCS safety requirements and operations follow the European Standardization presented in the standards.

For railway signalling and control facilities applicable to European Railways, a high level of safety has been established corresponding to System Integrity Safety Level 4 as presented in the reference [40]. All safety-related operations (i.e. vital functions) for the Line System shall have to comply with the SIL 4 safety level.

All designs, materials and equipment (including software) that are directly related to critical safety functions shall be fail-safe, i.e. an error, loss or disconnection shall result in the application of a more restrictive state.

The Contractor shall ensure that all equipment is resistant to vandalism. In the context of the development of the project, the Contractor's proposals for specific protection against vandalism shall be submitted to the Employer for approval.

2.13.5.3 Reliability, Availability

The ETCS Track System shall meet at least the requirements of the following standards: “Railway Applications - Specifications and Demonstration of Reliability, Availability, Maintainability and Safety (RAMS)” by CENELEC (ref. [38]) and “RAMS Requirement Specifications of ERTMS/ETCS Chapter 2 - RAM” of applicable specifications UNISIG ERTMS/ETCS-Class 1 [32].

The minimum service life of the Level 1 ETCS Line System must be at least 20 years.

2.13.5.4 Interoperability

The Line System shall be interoperable in accordance with European Directives [1] and [2] and in accordance with the relevant Technical Specifications (“TSI Control-Command”). For all parts of the ETCS system, the Contractor is required to provide a Declaration of Conformity, which will be validated and certified by a competent body (interoperability conformity).

In addition, the operation of the installed ETCS Line System along with the ETCS Train System installed in the vehicles by other suppliers should be demonstrated. Positive results of tests performed in other projects may also be presented.

2.13.5.5 System Validation

The Line System proposed by the Tenderer shall be designed, developed and approved on the basis of the CENELEC standards and the specific ETCS requirements in accordance with UNISIG specifications.

The Contractor has full responsibility for the entire Line System validation process. The Contractor has full responsibility for the successful validation of the Line System within the timeframe specified in the Contract.

The Contractor must be able to substantiate the successful operation of the system by producing a validation certificate from a competent body. The Contractor shall provide a list of all sites where the same systems (Table of Reference) have been applied including countries/reports from clients.

For all ETCS data, a document titled Safety Plan shall be provided to confirm the fulfilment of the security requirements. The document shall include a risk analysis for this equipment.

However, the approval process under this project can be simplified by applying a cross-acceptance procedure. In this case, the Contractor shall execute, without limitation, the following actions:

1. Providing the Safety Plan by an authorised body and/or other railway organisation suitable for international recognition
2. Preparation of the risk and operation design taking into account the particular conditions prevailing on the Durres - Tirana line
3. Preparation of the Compliance Report excluding the risks and ensuring that all the functional and safety requirements of the particular project are met.

All the documents shall be audited by a certified independent auditor, who shall be responsible for ensuring that:

1. The quality control methods and compliance management of the Contractor are fairly reliable
2. Risks are minimised as much as possible

The Line System to be proposed must be certified by a Notified Body, which shall certify that the proposed system is interoperable according to the current version of the TSI (c.f. [1] and [2]).

2.13.6 General functional requirements

2.13.6.1 Train Operation

Under the supervision of the Level 1 ETCS system, smooth and safe traffic shall be ensured in the Durres – Tirana section to be equipped with a Line System under the terms hereof.

With the installation of the Level 1 ETCS system, the section shall allow traffic of all types of trains. Particular attention shall be paid to the traffic of passenger trains wherever possible at a speed of 120 km/h.

The ETCS Line System in the – Durres – Tirana section shall be interconnected with the adjacent line system of the Albanian railway. The Contractor shall make all the necessary adjustments - complements of the above existing system in order to ensure their full physical and functional interconnection with the system manufactured under the terms hereof.

2.13.6.2 ETCS Book of Rules

The Contractor shall draw up an ETCS Book of Rules describing and documenting in detail the principles that it will apply for the line ETCS of the Durres – Tirana section. The ETCS Book of Rules shall be submitted to Albanian railway for approval before the system detailed design.

2.13.6.3 Operating Mode - Transitions

Under the supervision of the Level 1 ETCS system, smooth traffic shall be ensured for all types of trains equipped with the Train System. The transition to another operating mode shall be announced in time and shall be carried out without interruption of the system supervision. Normal operation shall take place in the following ways:

I. Full Surveillance (FS): Train runs under full ETCS surveillance
II. On Sight (OS)
III. Substitution signal (SF1) in the entrance light signals: Train runs with On Sight until the station building or next main light signal.
IV. Open line (sequential) blocking light signals: Train runs following authorisation, based on visibility to the next sequential light signal, if a failure occurs in the previous sequential light signal.
V. Intermediate Light Signals (Intermediate Block Post Light Signals): Train runs following authorisation, on the basis of visibility up to the next light signal
VI. Unpowered Traffic (UN): Train runs on lines without ETCS equipment
VII. Shunting (SH): Shunting within the shunting limit specified by the station configuration and/or the existing signalling system.
VIII. Train operation under STM conditions: No European STM [SE] or national STM [SN] is required since there was no ATP in Albania .

2.13.6.4 Braking Lengths

The following braking lengths apply to existing lines of the network, and signalling systems are designed accordingly:

I. Track speed ≤120 km/h: 700 m
II. 120 km/h <Track speed ≤ 160 km/h: 1,200 m.

2.13.6.5 Shunting and shunting areas

In general, shunting shall be conducted in accordance with the Albanian Railway. All shunting shall be supervised via the ETCS. All shunting light signals shall be equipped with an ETCS.

The entrance light signals shall provide for the transmission of packet 132 for the drive units passing through the balise group towards the open line.

Generally, at stations or points on the line with shunting light signals, which allow shunting units to pass through them to the main line or main station lines by tracing routes, the shunting light signals shall be equipped with ETCS.

2.13.6.5.1 Shunting areas:

Shunting areas are defined between the shunting limits of each station. The shunting limits of a station extend 100m. after the entrance light signals on each side of the Station.

2.13.6.5.2 Entrance into a Shunting Area:

When a train comes from the open line in order to enter a station for shunting, entrance to the station can be done as follows:

I. As the shunting unit enters on a signalled track without shunting signals, the stationmaster traces an entrance route (up to the exit light signal). The train enters under full FS supervision and then changes mode and moves to SH for shunting. Shunting limits have been set for each station separately.
II. In the event that it does not enter a signalled track, the stationmaster appropriately arranges all track switches and with appropriate level change overrides the closed entrance light signal and enters the shunting track.

The driver of a train equipped with a train system should be able to select the Shunting Mode (SH) before the entrance light signal and before passing the light signal on the closed position and moving to the shunting area. The train enters the shunting area on Shunting (SH) Mode.

2.13.6.5.3 Procedure to exit from the shunting area:

In some stations there are line group exit light signals to protect the end of a line group to the traffic line. If the shunting area is covered by such (line group) exit light signals, then the trains starting from the shunting area will receive the normal movement authority with FS Full Supervision Mode at the line group exit light signal.

Consequently, exit light signals defining shunting areas must be equipped with an ETCS.

If the shunting area is not covered by line group exit light signals, then:

I. any train ready for departure regresses from the shunting area to a signalled main line section or a reversing line on shunting mode. After the regression to a signalled section, the train departs for the open line under Full Supervision (FS) mode.
II. departs from the shunting line where it is located and under the SH mode it continues its course until the first balise group, from which it will receive a new movement authority if this is feasible.

2.13.6.6 Line performance

In its basic layout, the Level 1 ETCS (i.e. without infill balises and without data exchange between LEUs) could not meet the performance requirements of sections, especially those parts with a track speed of more than 120 km/h. In order to improve the performance of the line, at least the following measures shall be taken:

I. Application of a suitable layout of infill balises.
II. Application of a fixed single release speed as defined in the national parameter values.
III. Accurate determination of train path where applicable. Use of all light signal and light indications (e.g. speed or direction indicators). In the event that an indication is used for more than one route, priority shall be given to the solution of receiving route information directly from the interlocking system. Exceptionally, and subject to specific approval, redefinition balises (i.e., extension of the target distance, correction of slopes etc.) shall be applied by, for example, the group of opposing light balises, if any. For example, for train routes that start with entrance light signals, the balises of the opposite exit light signals can be used.

In long open line sections, the redefinition balises (single balises) shall be positioned at a distance of 2,000 m in order to avoid a reduction in the performance (i.e., early braking) resulting from the cumulative error in the odometer measurements.

2.13.6.7 Line safety

Since the Level 1 ETCS is a point-to-point train control system, any unexpected change of light signal indications to a safer state (e.g. from the “course” to the “parking” position) cannot be transmitted to the train immediately. Any potential risks resulting from manual cancellation of routes shall be minimised as much as possible.

The dangers arising from manual train route cancellation when the train approaches or runs on a route shall be minimised by the use of infill balises approach commitment.

Infill balises performing a safety function (e.g. to restrict movement authority beyond the point of engagement of the approach commitment) shall be interconnected in such a way that, in the event of a failure or absence of an infill balise, the system shall immediately react safely (emergency braking)

2.13.6.8 Danger Points and Slide Ways

On the Albanian rail network, uniform distances from the light signals to the first point of danger are applied, with a few exceptions.

I. After the entrance light signals until the first encountered switch: 300 m
II. After the exit light signals on lines with a motion speed of more than 120 km/h: 100 m
III. After the exit light signals on lines with a motion speed of less than or equal to 120 km/h: 60 m

When the interlocking system uses a slide way that involves switches, then in a specified area beyond the danger point (slide way) the switches are blocked and checked that they are not occupied. In general, the 2-minute release time starts counting from the moment the train occupies the last part of the way, but in some cases this time may vary. The Contractor shall confirm the release time on the route tables.

The Line System shall take into account any danger points that may exist. Movement authorities (MA) shall include distances up to danger points even beyond the end of movement authority (the next signal marked “parking”). Therefore, the emergency braking curve shall be calculated up to the danger point, if any, and in accordance with the UNISIG ERTMS/ETCS-Class 1 System Specification Requirements.

Also, the Line System shall take into account the slide ways beyond the danger point, if any. The overlap release time and the position from which its calculation starts correspond to the starting position applied by the interlocking system.

The supervised location (SL) where the train stops compulsorily at zero speed on the Emergency Braking Curve) shall be the danger point or, if any, the end of the overlap, as defined in the UNISIG ERTMS/ETCS-Class 1 System Specification Requirements.

2.13.6.9 Substitution Signal (SF1)

In general, the entrance light signals are equipped with substitution signals, which allow the train to enter the station on sight if the entrance signal for any reason cannot be set to the “course” position.

If the substitution signal is triggered, the train equipped with a train system is instructed to proceed on sight at the maximum speed permitted by the national parameters. Correspondingly, the train shall be commanded to change the operating status through the balise set of the entrance light signal.

In addition to the OS mode movement authority, the train equipped with a Train System shall receive a text message. With this message, the driver is informed of the cause of the restriction (e.g. touching the substitution signal, and the signal number shall be indicated). The content and language of the message shall be determined when the detailed design is being prepared and shall be approved by the Employer.

The speed restriction shall be valid until the end of the movement authority, which is usually on the exit signal. Even if the train receives intermediate information (passing through an infill balise) about a new movement authority from the exit signal, the speed limitation required by the OS mode shall apply until the next main signal, as specified in the UNISIG ERTMS/ETCS-Class 1 System Specification Requirements.

2.13.6.10 Static Speed and Slope Profile

2.13.6.10.1Static Speed Profile (SSP):

The Line System shall provide a SSP. The system shall take into account the maximum line speed per area and all permanent line idleness.

In particular, at least the following permanent speed restrictions shall be taken into account:

I. Speed restriction due to closed curves
II. Speed restrictions due to very steep falls (e.g. on 200 km/h lines where the required braking distance of 2,000 meters is not possible before the entrance or exit light signals.

In the preparation of the detailed design, the Contractor shall collect or calculate all permanent speed restrictions of the line.

2.13.6.10.2Temporary Speed Restrictions (TSR):

With the ETCS it is possible to observe all Temporary Speed Restrictions (TSR). The Contractor shall demonstrate the implementation of temporary speed restrictions in the Line System using special tools, diagnostic devices, etc.

The Contractor shall provide two (2) line equipment sets that are required for the programming and implementation of the TSR balises in the line, such as stationary balises, programming tools, etc.

2.13.6.10.3Line Slopes:

In the preparation of the detailed design, the Contractor shall ensure the guarantee and confirmation of the line slopes in the Durres - Tirana section.

At the start of the detailed design, the Contractor shall propose to the Employer the appropriate slope analysis to achieve the best combination of performance and ease of design, implementation and maintenance.

2.13.6.11 Entrance and exit on lines equipped with a Level 1 ETCS Line System.

2.13.6.11.1Entrance procedure:

Trains equipped with a train system and approaching an ETCS area shall move from UN mode ("Level 0") to fully supervised ("FS") mode ("Level 1") in time so that their approach to the entrance signal of the first ETCS-equipped station to be fully supervised by the ETCS. If the entrance of the first ETCS-equipped station is in the closed (parking) position, then each ETCS-equipped train shall be forced to park before the entrance light signal.

Consequently, the transition from one level to another shall be performed at least at a distance equal to the service braking distance before the entrance light signal. The entrance light signals shall be equipped with an ETCS system. Prior to the entrance light signal (at least at a distance equal to the service braking distance), a balise group shall be placed in which the following functions shall be implemented:

I. Transition from Level 0 to Level 1
II. Movement Authority (MA) to the entrance signal or to a position beyond the entrance signal, if the entrance signal indicates "course" (open).

However, in front of the set of balises that provide the transition from one level to the other and the first movement authority (MA), another balise group (entrance balise group) shall be placed for the timely announcement of the transition.

2.13.6.11.2Exit Procedure

Train equipped with a Train System that leave areas with a Line System and are routed to non-equipped areas with the UN mode shall receive early notice of the change of level (from Level 1 to UN mode). The level transition shall take place outside the area with Installed Line System, i.e. after the train enters a non-equiped line.

2.13.6.12 Albanian National Parameter Values

Albanian National Parameter Values shall be transmitted to the train equipped with a Train System at least at each entrance Point in a Line System area, providing the driver with a Level 1 ETCS Parameter System as homogeneous as possible.

Data Data	Parameter Value National value	SRS name
Modification of adhesion factor by driver	Not allowed	Q_NVDRIVER_ADHES
SH mode permitted speed limit	25 km/h	V_NVSHUNT
SR mode permitted speed limit	40 km/h	V_NVSTFF
OS mode permitted speed limit	30 km/h	V_NVONSIGHT
UN mode permitted speed limit	100km/h	V_VNUNFIT
Release Speed value	40 km/h	V_NREL

Distance to be used in Roll Away protection, Reverse movement protection and Standstill supervision	2 m	D_NVROLL
Use service brake when braking to a target	Yes	Q_NVSRBKTRG
Permission to release trip Permission to release emergency brake	No No	Q_NVEMRRLS
Max. speed limit for triggering the override EOA function	0 km/h	V_NVALLOWOVTRP
Permitted speed limit to be supervised when the “override EOA” function is active	30 km/h	V_NVSUPOVTRP
Distance for train trip suppression when “override EOA” function is triggered	200 m	D_NVOVTRP
Max. time for train trip suppression when override end of authority function is triggered	60 s	T_NVOVTRP
Change of driver ID permitted while running	YES	M_NVDERUN
System reaction if radio channel monitoring time limit (T_NVCONTACT) expires	No reaction	M_NVCONTACT
Maximum time since creation in the RBC of last received telegram	∞	T_NVCONTACT
Distance to be allowed for reversing in PT mode	100 m	D_NVPOTRP
Max. permitted distance to run in SR mode	∞	D_NVSTFF
Display language	Albanian	

Table 2.13-1: Determination of national values

2.13.6.13 Fault handling and Emergency Procedures

The driver shall monitor the correct operation of the Line System through the Train System. It shall be able to recognise the occurrence of a fault in the LEU unit and the system’s response due to the failure or absence of a balise.

In the case of a LEU unit error, the train driver receives a ‘LEU fault’ error message in the MMI.

If the Line System is damaged, the signalling system shall act as a backup solution. In order to achieve this, the train driver must isolate the on-board ETCS equipment (IS mode). In this case, the maximum speed should not exceed 120 km/h.

2.13.7 Granting movement authorities (MA)

2.13.7.1 General requirements

In the section of the Durres – Tirana line, the signalling system has been designed and built to operate at a maximum speed of 100 – 120 km/h.

If the line is not occupied, all routes have been drawn and the main light signals are in the “course” position, the MA shall be given in time to ensure the smooth movement of the train at the maximum permitted speed. The movement authority shall be renewed before the train reaches the service braking distance (SBD) beginning as calculated by the Train System.

In addition, in order to facilitate the driver, the movement authority shall be renewed in time for the driver to gain knowledge well before that the line is unoccupied and all the routes have been drawn. If the movement authority is renewed shortly before the train approaches the calculated braking distance using a service break, the train driver will not be able to know if he/she will receive a renewal of the movement authority or a “parking” signal. Therefore, the driver must always be prepared to start braking and follow the service braking curve.

2.13.7.2 Solutions applied

To satisfy the requirements set out in paragraph 2.13.7.1, the following solution shall be applied:

1. Infill balise installation at a sufficient distance ahead of the service braking curve
2. The Contractor shall propose the technical solution for the granting of the movement authority as early as the entrance light pre-signal to exit the station if the corresponding route has been drawn. Possible solutions could be for example:
3. Interconnection of LEUs via the telecommunication wiring network and exchange of data on the light signals.
4. Detecting the “course” indications (e.g. “green”) in a signal and transmitting information not only to the LEU unit of the particular light signal but also to the LEU units of the previous light signals.

Please note that this contract includes all the necessary equipment/work to ensure the above LEU/data transmission interface both in the station area and on the open line.

2.13.7.3 Approach Commitment Management

Approach commitment is a vital function that applies to all interlocking systems by reducing the risks of manual route cancellation. If the traffic controller manually cancels the route, the start signal of the route (entrance or exit signal) is immediately set to “parking”. The following procedures depend on the current position of the train:

I. 1st case: If a train does not approach or if the approaching train does not reach the approach commitment engagement point, the train route may be cancelled without recording.
II. 2nd case: If the train has activated the approach commitment (by occupying a specific line circuit or a specific axle counter), the cancellation of the route can only be performed by a two-step controlled release procedure, which bypasses after recording the safe operation interlocking.
III. 3rd case: If the train has passed the entire drawn route or if the train occupies the last section of route track (e.g. platform track), the route can be released without recording.

In the first case, the driver of the upcoming train may start the braking process and stop in front of the starting signal of the route, which now indicates “parking”. The approach commitment engagement point is at such a distance in front of the light pre-signal that the driver can recognise the transition of the light indication in time.

2.13.7.4 Proposed Infill Balise Layouts

To improve the performance and safe operation of Level 1 ETCS lines, the appropriate infill balise solution should be implemented in the following applications:

I. Infill for timely renewal of the movement authority (performance improvement) and management of approach before exit light signals (performance improvement)
II. Infill on platform tracks (improvement of performance and safety)

The following chapters define the functional requirements for the respective applications. The final definition of the Parameters (number and position of infill balises, range of movement authority etc.) shall be made during the preparation of the detailed design and shall be submitted for approval to the Employer.

When passing by an infill balise, the system shall have the following reactions:

I. The LEU does not send a telegram: Restriction of the movement authority to the end of authority granted with the previous movement authority
II. Sending intermediate information via the LEU: Renew movement authority to improve performance
III. Failure or absence of a balise: Safe system Reaction (immediate activation of the trip)

2.13.8 General principles of infill

2.13.8.1 Infill for the timely renewal of the Movement Authority

For the continuation of the course at the maximum permitted speed of the train if the corresponding routes have been drawn, the renewal of the movement authority must be given before the train reaches the distance where it shall be required to activate the service brake for parking at the end of the authority granted by the previous movement authority.

The minimum distances for this purpose can be calculated by dividing the emergency braking distances by 0.7 and adding a distance for a reaction time of 1.5 sec.

The emergency braking distances are given below. Divider 0.7 is based on the best practice of other railway organisations. The 1.5 sec corresponds to the maximum response time foreseen for the ETCS train from the passage through a balise transmitting information to update the movement authority.

I. Track speed up to 120 km/h -> 700 m
II. Track speed up to 160 km/h -> 1200 m

The resulting minimum distances are:

III. Track speed up to 120 km/h -> 1050 m
IV. Track speed up to 160 km/h -> 1781 m

These braking distances are the minimum allowable and in the design shall allow them in some cases and at the request of Albanian Railway to be longer for the optimal performance of the system. (for example, for slopes)

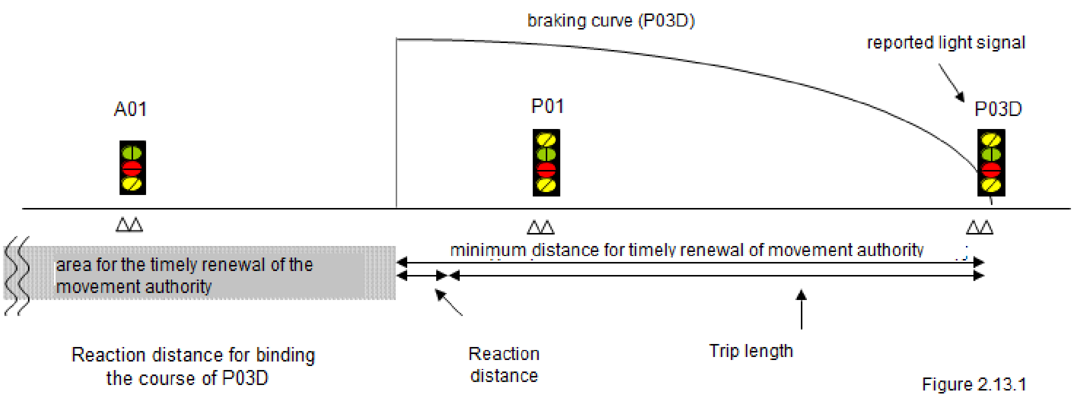


Figure 2.13.1

Figure 2.13.1 illustrates the allowed area for renewal of the movement authority. Transmission of information close to the light signal it concerns, within the permissible range, shall reduce the performance of trains with a weak brake while transmitting the information away from the light signal but always within the permissible range shall reduce the performance of the trains with good braking.

Timely renewal of the movement authority shall be transmitted using three basic methods:

I. The balise group of the previous signal shall be able to transmit this information
II. An additional infill balise shall transmit the information
III. The information shall be transmitted by linking to the next light signal.

2.13.9 Infill to manage the Approach Commitment (AC)

Entrance and exit routes, (protected by entrance and exit light signals respectively) are equipped with the approach commitment function. The transmission point that takes into account the approach commitment must be at a sufficient distance before the reported signal so that the emergency brake can be applied and must also be within a sufficient distance after the approach commitment has begun so that the balise can transmit validated updated information.

The minimum braking distance can be calculated using the braking distances listed below and adding a distance for a reaction time of 1 sec. 1 sec corresponds to the maximum reaction time provided for the ETCS train from the passage through a balise transmitting information to restrict the movement authority.

I. Track speed up to 120 km/h -> 700 m
II. Track speed up to 160 km/h -> 1200 m

The calculated minimum distances are

I. Track speed up to 120 km/h -> 734 m
II. Track speed up to 160 km/h -> 1245 m

These braking distances are the minimum allowed and in the design shall allow them in some cases and at the request of Albanian Railway to be longer for the optimal performance of the system.

The minimum distance after the train's entrance into the approach commitment area can be calculated by taking a 1 sec response time for the interlocking system and adding a distance corresponding to a reaction time of 4.5 sec for the LEU. Reaction time for the interlocking system is the time after which the route is committed. The response time of the LEU is the time the LEU needs to detect the light signal, select the appropriate telegram and send it to the balise.

I. Track speed up to 120 km/h -> 150 m
II. Track speed up to 160 km/h -> 200 m

A presentation of the above is ginven in Figure 2.13.2.

If there is no place to install the infill balise to manage the approach commitment that meets both of these conditions, the Contractor shall suggest a way to deal with this.

In any case, the design of the signalling system shall take account of the above conditions to exclude as far as possible the above possibility. Thus, in the detailed design, the Contractor shall propose approach commitment distances that shall meet the need for a smooth ETCS course. These distances shall require the agreement of the Supervision Albanian Railway.

The above general infill principles are clarified in the application models set forth below.

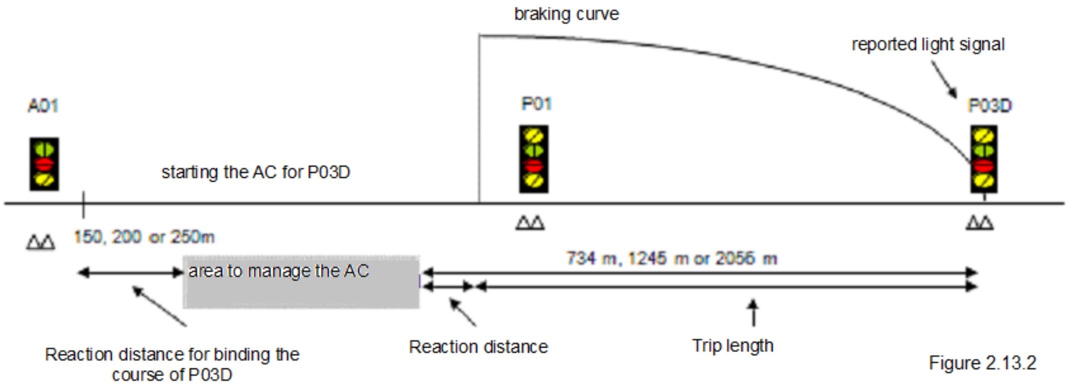


Figure 2.13.2

2.13.9.1 Infill application

2.13.9.1.1 Regular Traffic Direction - Railway Stations

The regular traffic direction is the right one in the direction of movement of the train.

The light pre-signal is placed at a braking distance before the entrance light signal and has no active parking indication. The light signal before the light pre-signal is the exit light signal of the previous station and does not announce the next entrance light signal.

Therefore, for smooth and comfortable driving even at the maximum speed (200 km/h), if the entrance route and/or the corresponding exit route has been established, timely renewal of the movement authority should be ensured taking into account the commitment to approach these routes.

As mentioned before, the renewal should be done before the train reaches the distance where it shall be required to activate the service brake for parking at the end of the authority granted with the previous movement authority.

Irrespective of track speed, the timely renewal of the movement authority for entrance and exit light signals shall be realised by using the link between the LEU of the entrance light signal and of the light pre-signal to transfer to the latter the exit light signal indication. This in any case ensures the granting of a movement authority of a sufficient distance.

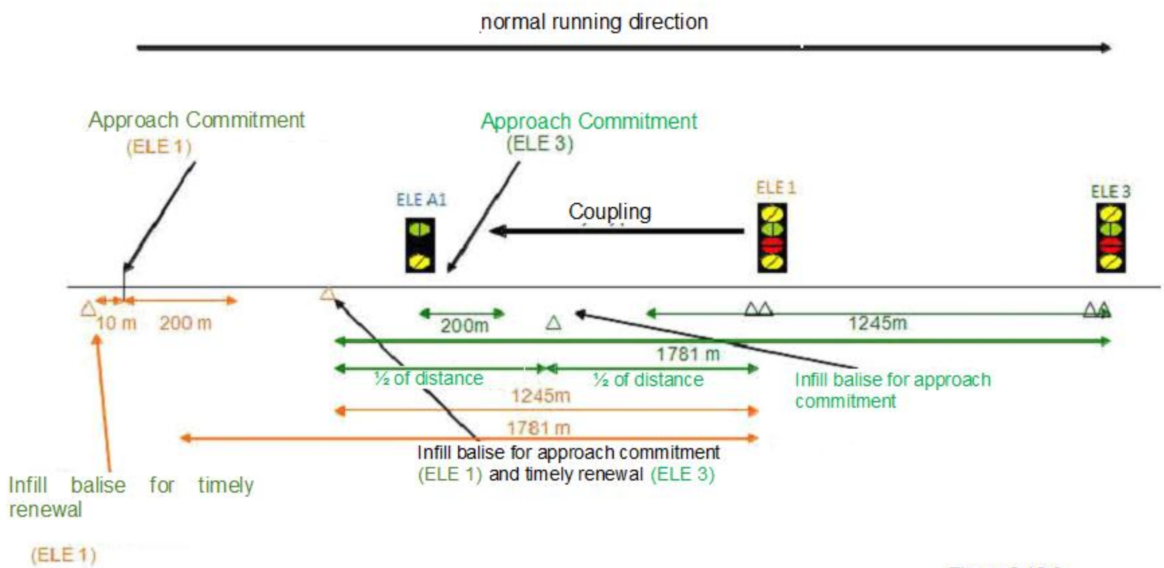
The timely renewal of the movement authority for the route from the entrance light signal shall be achieved by a balise (B1) to be connected to the light pre-signal. This balise shall be installed at least 10 m before the entrance light signal approach commitment point is reached.

Moreover, the light pre-signal shall be equipped with a second balise (B2) which shall cover the approach commitment of the entrance light signal and shall be placed close to the light pre-signal within the allowed area.

Another infill balise (B3) shall be connected to the entrance light signal to cover the approach commitment for the route from the exit light signal to the open line.

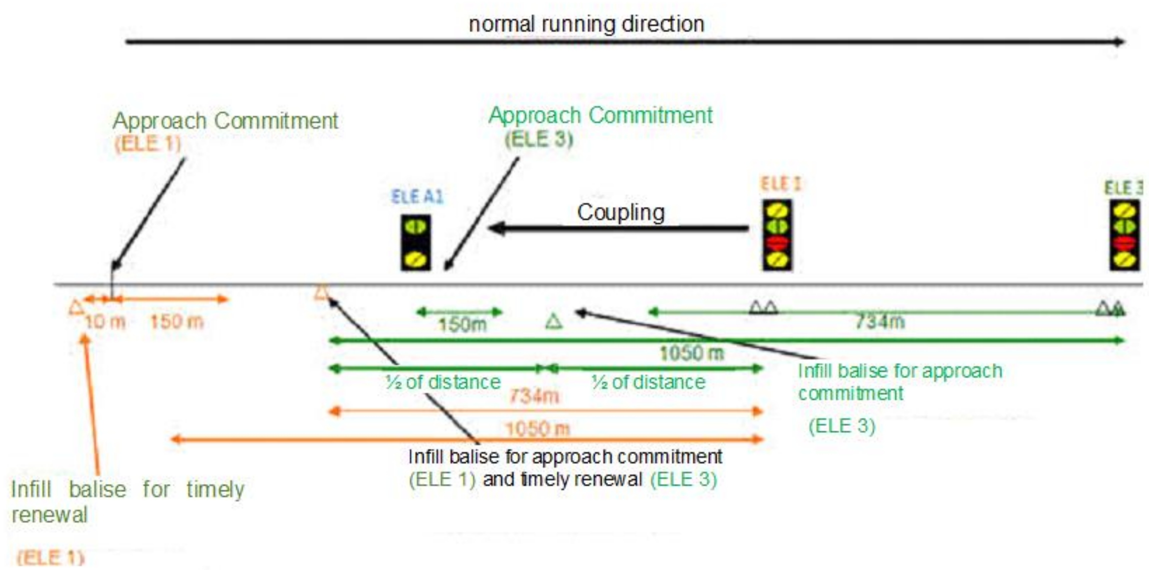
Within the permissible management area of the approach commitment, the infill balise (B3) should be placed in the middle between the balise connected to the light pre-signal (B2) and the balise for the entrance light signal (B4). If this is not possible, the balise (B3) shall be placed within the permissible range but as close as possible to the mid-space between the balise (B2) and the balise (B4).

The following figures 2.13.3 and 2.13.4 show two typical equipment configurations, depending on the maximum speed:



for speed > 120km/h and <= 160km/h

Figure 2.13.3



for speed <= 120km/h

Figure 2.13.4

2.13.9.1.2 Regular movement direction - Block Posts - Tunnels

A block post or entrance into a tunnel are not equipped with exit light signals. Therefore, the timely renewal of the movement authority for the main light signal shall be ensured by a single infill balise connected to the light pre-signal, which shall not have a parking indication.

A balise group shall be installed in the main light signal.

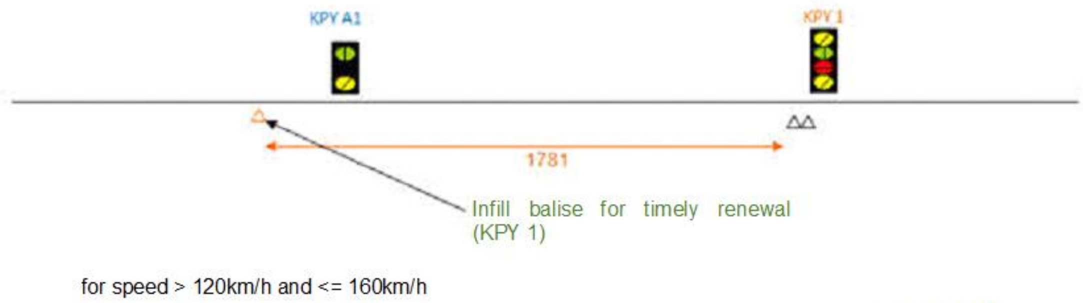


Figure 2.13.5

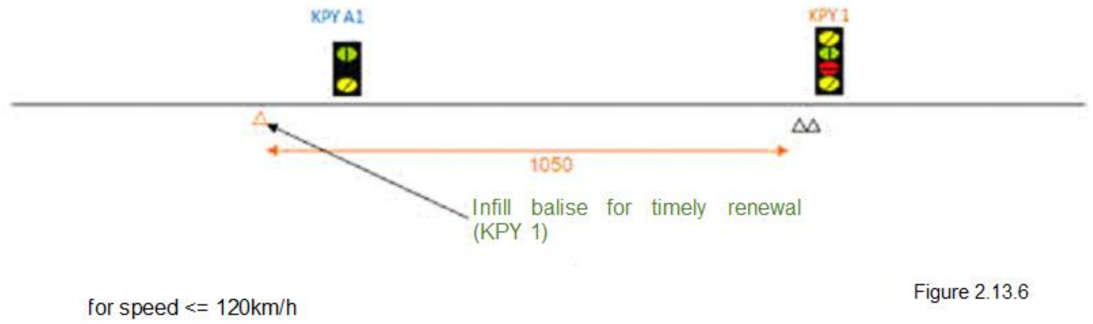


Figure 2.13.6

2.13.9.1.3 Infill before exit light signals

Before the main line exit light signals, performance shall be significantly improved with an infill balise. However, instead of installing separate infill balises, a more cost-effective solution can be applied according to the following principle:

Infill via balise for the main line exit light signals shall be implemented through the set of balises on the opposite exit light signal of the same track of the station.

For this purpose, the LEUs of the two-way exit light signals on the same track shall be connected to each other for data exchange, or the variable balises of said exit light signals shall be controlled by a LEU (see Figure).

This solution shall only be applied to the exit light signals of the main lines and shall concern both directions of movement (normal and opposite)

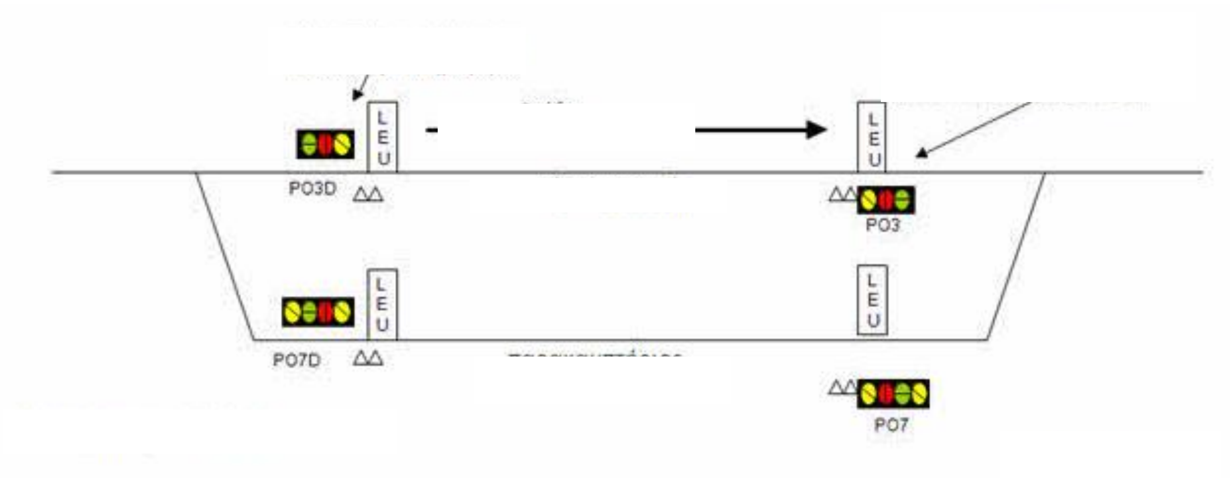


Figure 2.13.7: Infill before exit light signals

2.13.9.1.4 Infill on platform tracks

The performance and safety of trains that stop at the platforms shall be improved by installing infill balises between the platform and the exit signal. These infill balises must perform the following functions:

I. Improving performance: Timely renewal of the movement authority so that the trains can accelerate from the stopping position to the level of the route speed without delay.
II. Improving security: Restriction of the movement authority to the exit signal if the train enters a station while the exit signal has a “course” indication and then the train route is cancelled while the train is parked.

An infill balise shall be installed on platform tracks only if the following two conditions are met:

I. The distance between the normal parking point of the train (i.e. at the end of the platform) and the exit light signal is ≥ 100 meters and if
II. The exit route of the train allows a maximum speed of at least 60 km/h

On the platform tracks where both conditions are met, the infill balise shall be installed at a distance of ≥ 10 meters after the normal parking area of the front part of the train, which is usually the end of the platform.

Balises shall be installed on platforms for both the regular and opposite movement.

2.13.9.2 Reflective Signs

In the contractor's detailed design, the installation of reflective signs shall also be provided to offer information on the Line System. The contractor shall provide information on the installation locations and the indications of reflective signs in its detailed design. Indicatively, the information Reflective Signs can provide includes:

I. Entrance to or Exit from a Line System area. Entrance and exit shall also be indicated by approach warning signs in the entrance/exit .
II. Parking point on platforms: The extreme point where the front of the train can reach without a new telegram (movement authority, end of movement authority, permanent or temporary speed restriction, etc.) shall be marked.
III. Entrance or Exit to a shunting area. This sign shall alert the driver of a shunting unit entering or exiting from a shunting area to enter to or exit from it.

In addition to the above indicative information, the contractor shall indicate, taking into account current European and Albanian Specifications - Requirements, which other points will require installation of reflective signs and what information should they provide.

The appearance and schematic representation of the signs shall be given by Albanian Railway if available. In the absence of a sign, the contractor shall propose a reflective sign for this indication. The proposed reflective sign should be accompanied by a reference to another European Main Network and its regulatory interpretation. The proposed reflective sign shall be submitted for approval to Albanian Railway prior to its installation.

After approval, the contractor shall supply and install the signs, undertaking their maintenance under the terms hereof. All related costs (provision, installation, maintenance etc.) shall be included in the offer.

2.13.9.2.1 Sign Installation

The installation of the signs of the fixed signals on either side of the railroad line shall be made out of the gauge, at a distance of at least 2.20 meters from the track line axis, so that the “Perimeter of the Clearance Gauge” is always maintained.

Signs are placed on 3.5 m tall masts (galvanised piles). The masts are embedded in the ground at a depth of 50 cm. Within the railway Stations and within tunnels, signs are installed in a special way, which shall be proposed by the contractor and shall be approved by Albanian Railway. If sign installation is required, it shall be on both traffic lines (normal & opposite).

Prior to the installation of the signs, the contractor shall submit the exact installation locations for approval. The locations submitted should be such that they do not interfere with the full visibility of vital signs such as light signals or level crossing warning signals. In addition, the installation of signs on lines with particularities due to their geometrical characteristics (uphill, downhills, curves), will take place at points where their position will not interfere with the visibility of light signals or warning signals at a distance of at least 50m.

2.13.9.2.2 Materials for the Construction of Fixed Signal Signs

Due to the safety requirements, reflective films (white, red, blue, fluorescent orange), with microprismatic structure and ultra-high reflectivity (Type III) should be used according to the STD (standard technical Descriptions) for signalling.

In addition, these membranes should have a long shelf life (at least 10 years) and be coated with a special protective film (reflective compatible) which will protect signals from weather, dust, exhaust and possible vandalism with paint spray.

2.13.10 Protection of level crossing automatic systems (LCAS)

2.13.10.1 General

In subsection there are Level Crossing Automatic Systems (LCAS). These Level Crossings are protected by surveillance light signals located close to the Level Crossing and, in some cases, by redundant light signals at an appropriate distance (≥500m) from it. These light signals (main and redundant) indicate to the driver the status of the crossing (on/off).

If the Level Crossing has been successfully activated by the train, then the surveillance light signal emits “a white flashing light”. This signal is visible to the driver at least at a distance equal to the braking distance where fixed warning signs are fitted. In the case where the main surveillance light signal is not visible at a distance from the Level Crossing equal to the braking distance, a redundant light signal is installed and visible at this distance, so that in any case it is ensured that the train is alerted in advance of the activation status of the Level Crossing that it is approaching.

In order to increase safety on Automatic Level Crossings, all shall be protected by an ETCS Line System. The general principle of level crossing protection with ETCS is presented in Figure 2.13.8 for one approach direction. The other approach direction shall be covered in a similar way.

If a LCAS is damaged and its activation by the upcoming train has not been achieved, the ETCS Line System shall oblige the ETCS train to brake before the Level Crossing. The train shall reduce its speed to at least the release speed. However, it shall also be possible to stop the train before the level crossing in case an obstacle occupies the crossing.

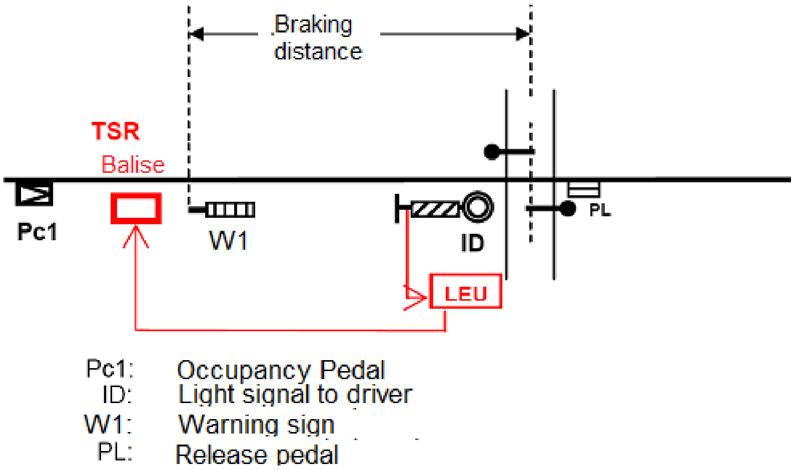


Figure 2.13.8: Principle of protection of level crossings with ETCS (showing coverage of the L.C. only for one traffic direction)

2.13.10.2 ETCS Line System Installations on LCAS

Each Automatic Level Crossing System shall be equipped with one or more Lineside Electronic Units (LEUs) according to the solution proposed by the contractor. The power supply of the LEU(s) shall be provided made by the Power Supply system that shall be available in the cabinet of the Automatic Level Crossing System (LCAS) protection system.

On the open line, one (1) variable balise (TSR balise) shall be installed per line and direction. If there are more lines in the Level Crossing approach (for example, if a Level Crossing is close to a station or a branching), then more than one speed restriction balise is required. The final number of balises required shall be determined in the detailed design and subject to the employer's approval. The total cost of integrating the LCAS into the Line System shall in any case remain fixed.

Individual cables ("C" interface cables) shall be installed from the LEU to each LCAS balise.

TSR balises shall be installed taking into account the following distances:

- The minimum distance between Level Crossings and TSR balises
- The minimum distance between the TSR balise and the level crossing occupation point

A standard layout for single lines at a speed of 160 km/h and a permitted speed of 150 km/h at the level crossing is shown in Figure 2.13.9.

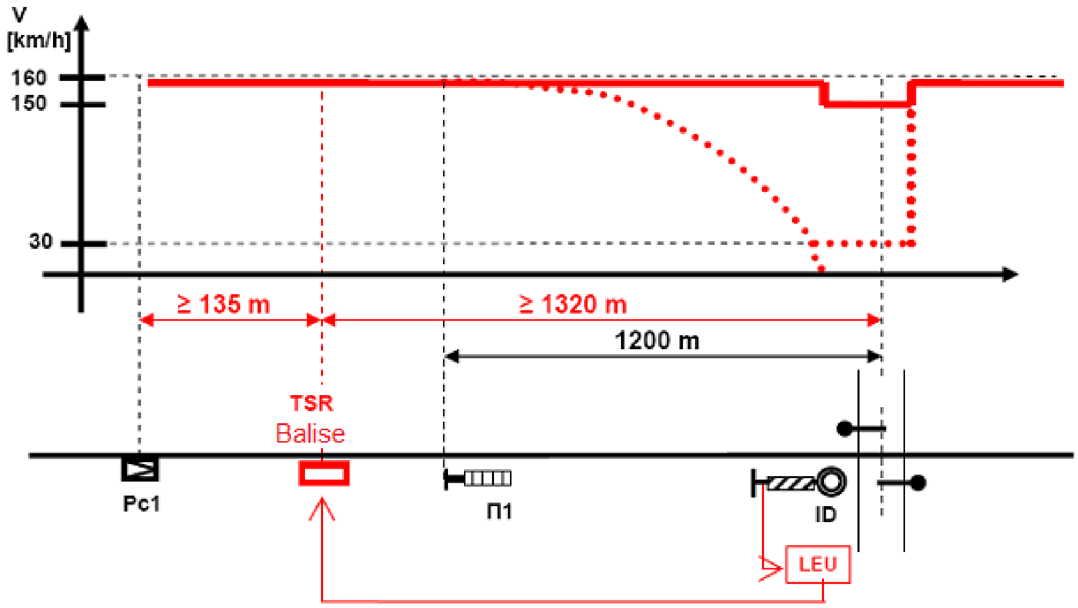


Figure 2.139: Typical ETCS level crossing protection on signalled lines at 160 km/h

2.13.10.3 Information to be transmitted to trains equipped with ETCS

The LEU shall continuously monitor the status of the LCAS. The status can be deduced either from surveillance (main or warning) light signals or from the control cabinet of the LCAS according to the Contractor's offer. The following system responses shall take place:

The surveillance light signal is not lit: TSR balises transmit the preset temporary speed restriction command packet.

The surveillance light signal begins to flash: Obstruction of the preset speed restriction command.

The surveillance light signal stops flashing: TSR balises transmit the preset speed restriction packet again.

The telegram including a speed restriction packet shall be accompanied by a text message packet. The text message shall explain to the driver the unexpected speed restriction, indicating the KM of the level crossing and its status.

Increasing the speed beyond the temporary speed restriction section shall not wait for the entire length of the train to pass. If the front section of the train has reached and passed the level crossing, the train shall now be able to increase its speed up to the permissible speed.

2.13.10.4 Minimum distance between the Level Crossing and ←→ the TSR balise

The minimum distances between the level crossing middle and the TSR balises have been calculated in Table 2.13.1, taking into account the following values:

2 seconds as the response time of the ETCS System

The braking distance

The additional safety margin of 30 metres (including half the width of the road)

Track speed [km/h]:	40	60	80	100	120	140	160
Distance Travelled at 2 seconds of the ETCS reaction time [m]:	23	34	45	56	67	78	89
Braking distance [m]:	700	700	700	700	700	1200	1200
Safety margin [m]:	30	30	30	30	30	30	30
Total:	753	764	775	786	797	1308	1319
Minimum distance required [m]:	755	765	775	790	800	1310	1320

Table 2.13.1: Minimum distance between the Level Crossing and ←→ the TSR balise

2.13.10.5 Minimum TSR balise ←→ crossing point occupation distance

For the minimum distance between the level crossing occupation point and the variable balise transmitting the temporary speed restriction information, the values calculated in Table 2.13.2 must be complied with, taking into account the following values:

- 1 sec as activation time for the level crossing (time from the start of the level crossing activation process to the surveillance signal beginning to flash)
- sec as the response time for the ETCS Line System (including touch tracking of the white surveillance light signal, processing of information in the LEU, transmission of information to the TSR balises).

Track speed [km/h]:	40	60	80	100	120	140	160
Distance Travelled at 1 second of the LCAS reaction time [m]:	12	17	23	28	34	39	45
Distance Travelled at 2 seconds of the ETCS reaction time [m]:	23	34	45	56	67	78	89
Total:	35	51	68	84	101	117	134
Minimum distance required [m]:	35	55	70	85	105	120	135

Table 2.13.2: Minimum TSR balise ←→ crossing point occupation distance

2.13.10.6 Use of variable balises for grouped level crossings or main light signals

If a Level Crossing is near a main light signal or another level crossing, the variable balises of this level crossing or main signal can be used to transmit temporary speed restriction information to save balises and wires. An example is given in Figure 2.13.10.

This solution requires a connection between two LEUs. The Level Crossing LEU shall transmit the temporary speed restriction information to the LEU that controls the neighbouring variable balise. The connection shall be made in a way that shall be indicated by the contractor (modem, LAN, radio link etc.) and shall be included in the offered price.

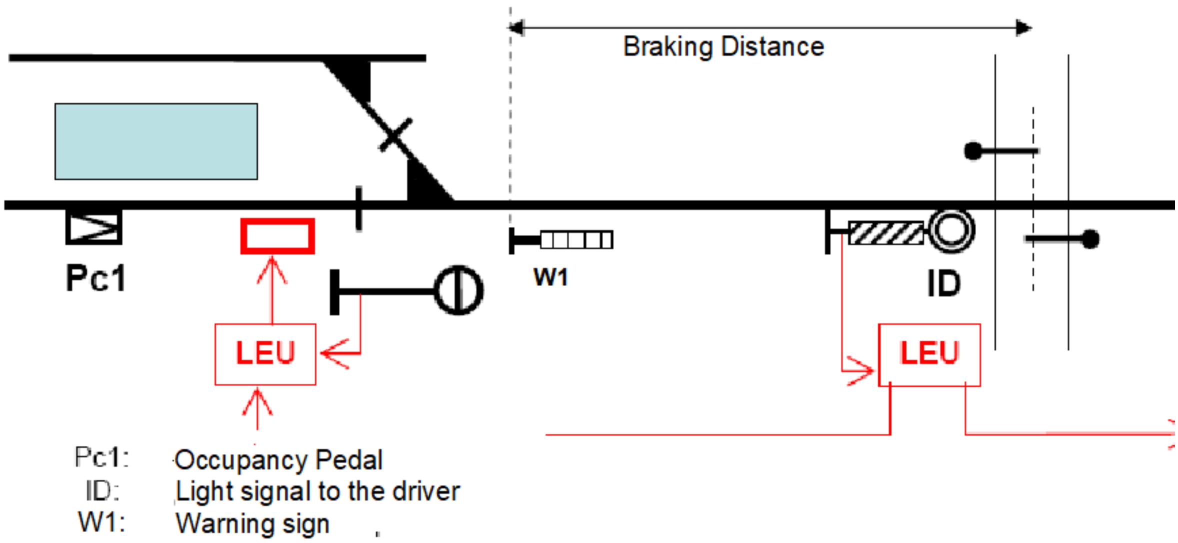


Figure 2.1310: An example for the use of variable balises relating to a neighbouring main light signal

This solution can only be applied if the required distances can be kept. For the minimum distance between the level crossing middle and the variable balise transmitting the TSR information, the values calculated in paragraph 2.13.10.4 shall be met.

Complementary to the distance to be observed between the variable balise and the occupation point of the level crossing according to the calculation in paragraph 2.13.10.5, one (1) additional sec must be added. This sec includes the time required for the transmission between two LEUs and the reaction time of the neighbouring LEU.

The minimum distances to be observed between the occupancy treadles of the Level Crossing and the variable balise associated with a neighbouring LEU or main light signal are shown in Table 2.13.3.

Track speed [km/h]:	40	60	80	100	120	140	160
Distance Travelled at 1 second of the LCAS reaction time [m]:	12	17	23	28	34	39	45
Distance Travelled at 2 seconds of the ETCS reaction time [m]:	23	34	45	56	67	78	89
Distance Travelled at 1 second of the processing time [m]:	12	17	23	28	34	39	45
Total:	47	68	91	112	135	156	179
Minimum distance required [m]:	50	70	95	115	135	160	180

Table 2.13.3: Minimum distance: Level Crossing occupation point ←→neighbouring variable balise

2.13.10.7 Principles of Design

In general, Traffic Regulations define different types of LCAS. These types indicate the relevant position of the level crossing to neighbouring level crossings as well as to stations-branchings and therefore its technical layout.

In any case, the information about the release of the Level Crossing shall be obtained from the LCAS control cabinet or light signals.

Tenderers shall include in their bids all functional requirements of each LCAS.

2.13.11 Power supply

The line system shall be powered by the signalling system power supply. All related costs for securing the power supply of the Line System shall be reduced to the offered price.

The signalling system power supply system (main and backup) shall be designed to meet the line system's power supply needs.

ETCS power supply shall ensure uninterrupted ETCS operation through UPS and accumulators. In the event of power failure, both main and backup, the battery array shall be sufficient to continue ETCS operation for at least 4 hours.

2.13.12 Installation of line system equipment

2.13.12.1 Balise sets

In front of each ETCS main light signal, a balise group shall be installed with the following distances (see also Figure 2.13.11):

I. 1 variable balise: 7 metres before the main light signal
II. 1 fixed balise: 3.5 meters before the variable balise

If required: More fixed balises: Each at a distance ≥ 3 meters

Distances may vary depending on local conditions but at least the minimum required distances as mentioned in <UNISIG: Subset-040, “Dimensioning and Engineering rules”> shall be respected. In any case, the exact location of the balises shall be determined by the detailed design submitted for approval.

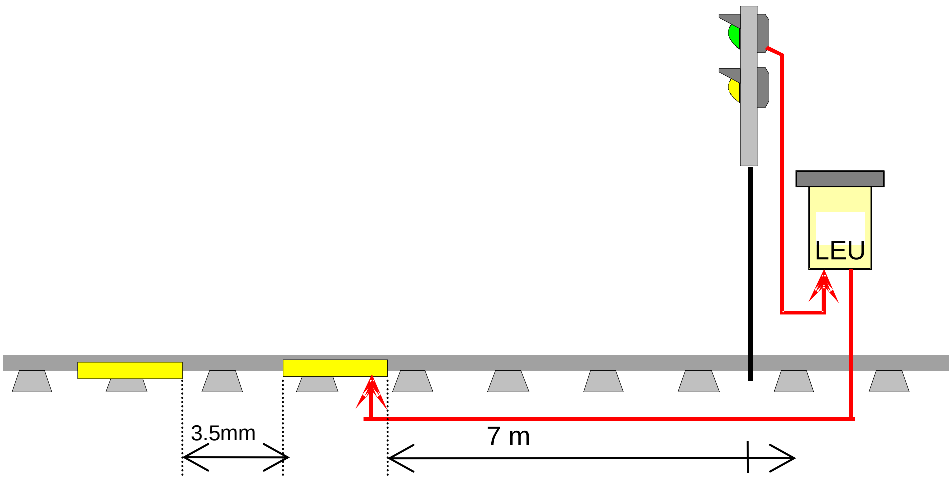


Figure 2.13.11: Placing balise set before main light signals

Through the variable balise, variable data such as movement authorities (MA) shall be transmitted to the train. Fixed balises shall transmit permanent information. Through a balise set, the train shall be able to determine the direction of traffic (normal, opposite) through the ETCS. Telegrams shall be transmitted on trains running in the normal and/or in the opposite direction.

2.13.12.2 Lineside Electronic Units (LEU)

The lineside electronic units shall collect and evaluate all the information required by the existing signalling system in order to provide the required data to the trains equipped with a Train System, such as movement authorities (MAs).

The lineside electronic units can be installed:

I. Either close to interlocking systems to receive information directly from them

II. Or close to the light signals to detect their indications

In the second case, the LEUs shall be installed at an appropriate safe point next to the line to allow safe and easy access to maintenance personnel. These positions shall be submitted for approval by the Employer.

2.13.12.3 Wiring

The wiring for the line system shall be independent of the wiring of other systems (Signalling, Telecommunications). For possible remote interconnection of LEUs, separate cables shall be used.

For the installation of the line system wiring, the infrastructure (cable conduit, transverse passageways, wells, cable distribution boards, incoming wiring in the station interlocking area, cable termination, etc.) shall be included in the Contractor's design, together with the design of the signalling system infrastructure. The cost of the routing shall be covered by the corresponding items in the invoice.

The wiring installation shall be governed by the same specifications as other signalling wiring.

2.13.13 Environmental requirements

The provided Line System equipment and its installation shall meet the requirements of the local Organisation for Standardisation and the international standards regarding the environmental effects such as electromagnetic interference (e.g. ELM radiation, lighting, corrosion and parasitic currents, etc.) and climatic conditions (e.g. ambient temperature, humidity, pollution and contamination, etc.). Particular account shall be taken of the UIC/EEIG 97s066 “ERTMS/ETCS Environmental Requirements [31]”. No deduction to the requirements of these specifications is permitted.

2.13.13.1 Climate Requirements

All Line System circuits and elements shall operate reliably and safely in the environmental conditions prevailing along the railway axis including industrial or any other environmental pollution.

The shells of the Line System equipment shall provide adequate protection against dust, sand, water, rain, snow, ice, hail and moisture accumulation due to condensation.

The equipment provided under the terms hereof shall be capable of operating seamlessly under running conditions at a low speed of 5 km/h on a line covered by water up to 100 mm from the railhead.

The system shall meet the conditions under the worst climate conditions and be fully functional

- Ambient temperature: -25 °C – + 50 °C
- Highest average daily temperature in 24 hours: + 40 °C
- Maximum relevant ambient humidity: 95 %
- Maximum altitude: 600 m

The Contractor shall be responsible for adapting the equipment provided to the operating conditions prevailing in its places of installation within and outside buildings

For other environmental effects such as solar radiation, altitude, hydraulic or mechanical stress, UNISIG 97s066 [31] regulations shall apply.

2.13.13.2 Electromagnetic Compatibility (EMC) Requirements

The provided Line ETCS equipment and its installation shall meet the requirements of the relevant standards of the Hellenic Organisation for Standardisation (ELOT) and international standards including the UIC/EEIG 97s066 specifications on electromagnetic compatibility.

All materials and equipment shall operate correctly and safely under the influence of electromagnetic interference (EMI) caused by other equipment, whether it belongs to the rail system or not. The Contractor is responsible for identifying such sources of electromagnetic interference and for providing adequate protection, shielding or other corrective measures to ensure electromagnetic compatibility (EMC).

The Line System elements shall be fully immune to the effects of the traction current (25 kV, 50 Hz) or other interference sources.

In addition, the Contractor shall ensure, in accordance with validated standards (i.e. UIC EEIG standard 97s066 [31] as well as Cenelec standards and especially EN 50121-4: 2000 [37]), that in the parts of the equipment provided, unwanted interference from a variety of sources, such as domestic or industrial devices operating in the vicinity of the Train System, shall be excluded or shall not affect their operation.

Similarly, it shall be ensured that the equipment provided under the terms hereof shall not produce electromagnetic radiation when operating beyond the acceptable limits.

The Contractor shall submit to the Employer for approval a design demonstrating that the electromagnetic compatibility of the equipment, materials and design that it intends to use for the ETCS Line System is assured.

2.13.13.3 Earthing - lightning protection

The Line ETCS equipment provided and its installation shall meet the requirements of the relevant Standards of the local Organisation for Standardisation and the international standards regarding earthing, protection against corrosion, parasitic currents and lightning.

The entire installed equipment shall be able to resist overvoltage as well as interference and impulse voltage caused by lightning to traction and power circuits.

It is particularly stressed that the entire ETCS Line System and other equipment, installed along the track and power lines, shall be shielded against interference and overvoltage from any source (e.g. contact, magnetic or spatial induction, “random parasitic currents”) associated with the 25KV 50Hz electrification network.

The Contractor shall submit to Albanian Railway a final design of the Line System, which shall also outline all shielding, earthing and lightning protection measures. Among other things, this design shall also include the following:

I. Description of applicable earthing principles.
II. A description of the applied method of protection against lightning and any type of impulse voltage, including demonstration of the adequacy of the shielding.

The Contractor shall propose the earthing and insulation method of shielding and reinforcement to ensure that the Line System cables cannot become traction current return conductors

2.13.14 Detailed design

Following the award and signing of the Contract, and after collecting any required data, the Contractor shall prepare the Detailed Design as well as any supporting designs required. The Contractor should also cooperate with Albanian Railway (HSH) to jointly define the national parameters of the system.

All the data necessary for the preparation of the relevant designs shall be sought by the Contractor with its responsibility and care.

A detailed design for the Line System (e.g. special firmware for the line and system software) shall be prepared. The system software (including the preparation of data) should be tailored to the interoperability requirements, the Technical Specifications, and to HSH functional needs.

The design should also comply with the relevant Albanian and international specifications and standards, with HSH Traffic Regulation, with the EN railway standards and with the EEIG/UNISIG specifications for the ETCS system. The offered system shall follow the latest developments in technology.

Upon request, the Contractor shall propose to HSH the necessary additions/modifications to General Traffic Regulations in order to incorporate into it the new functions resulting from the use of the ETCS system.

2.13.15 Factory tests-quality tests

2.13.15.1 General

The Contractor guarantees that the Equipment to be delivered under this contract shall be loaded and shipped to its place of installation only if it has successfully passed the Factory Acceptance Tests (FAT), inspections and the quality control approved by the Employer.

No equipment with problems that have not been resolved or that are pending shall be sent to the Employer without its prior approval.

These tests shall be carried out at the manufacturer of the respective units and materials or another suitable laboratory approved by the Employer.

The costs of all factory tests shall be borne by the Contractor and shall be included in its offer price, even if not explicitly mentioned in the financial offer.

2.13.15.2 Employer's Presence

The Employer has the right to attend and inspect all Factory Tests of the individual materials and equipment of the system to be delivered by the Contractor.

Twenty (20) days prior to the scheduled start, the Contractor is required to invite the Employer in writing for the participation of its representatives in the Factory Tests.

The Employer's transport and accommodation costs at the place of the factory tests are borne by the Contractor.

2.13.15.3 Conduct of Factory Tests

In the Factory Test Program, the Contractor shall include the equipment and functions to be tested, the test methods and procedures, the sequence of the test steps and the expected results. This program shall be delivered to the Employer's personnel that is to participate at least forty (40) days prior to the start of the tests.

During the Factory Tests, the Contractor is required to thoroughly check the functionality of all the components, units and individual equipment of the system in order to fully meet the specifications resulting from the contract documents (Technical Specifications - Functional Requirements - Standards (UNISIG etc.)). Factory tests shall include controls at all system assembly levels, i.e. at the module, subsystem, and system level, including System Integration Tests.

FAT shall at least verify the following:

I. Factory Testing - through samples - that the correct wires are used in the boards and that the frames manage the information in a fail-safe way
II. Testing that ETCS logic produces proper results internally and externally for its interface with other systems
III. Testing that the system recognises the commands it receives and that the correct response is given
IV. Testing that the system reacts within the acceptable time interval to inputs from the interlocking system.

Any other tests not included above but necessary shall be carried out.

When carrying out any test or check, the Contractor should provide all necessary facilitations and assistance and all the necessary components, facilities, machinery, transport equipment, personnel, instruments and measuring and control devices, which will be required for their absolutely smooth and proper execution. The instruments should provide the required measurement accuracy and must be in excellent condition. The Contractor shall ensure proper calibration of the instruments.

2.13.16 System tests - demonstration of good operation - provisional acceptance-certification-commissioning

2.13.16.1 System Tests

The Contractor is responsible for carrying out the System Tests and shall do so after the installation of the system has been completed.

It is stressed that the system test traction units shall be subject to the availability of Albanian Railway staff and ETCS-equipped traction units.

Due to the particular nature of the required tests (the potential need to book traction units for exclusive use), the Contractor has to adapt to the limitations that to Albanian Railway to shall define, such as indicatively night work, holiday work, allocating the tests to different times depending on the availability of staff, traction units, etc. The Contractor shall not be entitled to any additional compensation or extension for the above reasons. In carrying out these tasks, it shall comply with all applicable provisions.

2.13.16.2 Compatibility Requirements

The Contractor shall comply with the Employer's instructions in order to verify that the above condition is complied with by the installed system.

The Employer shall also have the right to confirm the proper operation of the Line System to be installed under this Contract, using ETCS-equipped traction units, of both the to Albanian Railway and Foreign networks. The Contractor is required to perform the tests that shall be indicated to it without additional compensation.

2.13.16.3 Carrying out System Tests

System Tests shall include functionality checks on all components, units and individual system equipments, and shall certify compliance with all TSIs and the Functional Requirement Technical Specifications of the project contract.

In order to carry out the System Tests, the Contractor shall deliver to the Employer a test file which shall include all the tests to be carried out and the expected results thereof.

System Tests shall at least verify the following:

I. the correct installation and programming of the equipment
II. the connections between the subsystems
III. the use of the right versions of the software

System Tests consist of:

A. Static Tests

B. Dynamic Tests

A. Installation Tests

Include the sections:

I. Testing of correct installation / connections (e.g., insulation, continuity, earthing, support)
II. Testing of correct programming and operation of each individual equipment (e.g. LEU, Balises, interface with Interlocking)
III. Testing of various subsystem/system interfaces
IV. Using the correct version of the installed software
V. Quality Controls

B. Operating Tests

Operating Tests shall include tests of its complete operation and shall consist of at least:

I. System Reliability Tests
II. System Test Run
III. System Functional Requirement Checks
IV. Tests of system behaviour in the event of failure

The Employer has the right to change the location or details of the intended controls or to instruct the Contractor to carry out additional controls. In the event that these differentiated or additional controls show that the equipment, materials or features are not in compliance with the Contract, the cost of making such a change shall be borne by the Contractor, regardless of what other terms of the Contract may provide.

The Contractor is required to have all the necessary instruments and tools to perform the tests as well as the appropriate staff to perform and supervise the tests. The Contractor is solely responsible for the system testing process, which shall be performed at its own expense and for which the Employer assumes no responsibility. The Contractor shall ensure proper calibration by the competent body at its expense.

The Contractor is obliged to collect all the results of all System Tests and submit them to the competent Authorities of the Employer after the tests have been completed and in any case before the provisional acceptance, as specified in the schedule of the project.

2.13.16.4 Commissioning – ETCS Line System Certifications

Upon completion of the ETCS tests of the –Durres Tirana section, the corresponding Line System shall be decommissioned or test ran as instructed by the employer.

The Contractor bears responsibility for the proper and safe operation of the equipment it has installed.

If during the operation of the line ETCS until the termination of the contract there is a need to readjust, adapt or modify any installed item (equipment or software) to improve the operation of the system or to change Albanian Railway regulations or decisions, the relevant work shall be undertaken without charge by the Contractor following a written mandate of the employer.

The Contractor is obliged within 8 months from the Provisional Acceptance of the Line ETCS to secure and submit to the Albanian Railway. under its own responsibility and expense (the cost is reduced to the corresponding invoice items), the following certifications approved by the authority for the Line ETCS supplied and installed under the terms hereof:

I. Certification of the safety of the integrated system. This certification shall be Safety Integrity Level 4 according to CENELEC's EN 50129 standard and shall be issued by an independent certification body competent to issue the above certificate. This body shall be proposed by the Contractor and approved by Albanian Railway.
II. Certification of compliance with the Technical Specifications for Interoperability-TSI and of suitability for use of the integrated system resulting from the inclusion of ETCS equipment in the Albanian Railway line sections. This certification shall be given by an independent certification body responsible for issuing the certificate. This body shall be proposed by the Contractor and approved by Albanian Railway. During the procedure, the certification body shall take also into account the requirements of Albanian Railway

It is clarified that during the time between the Provisional Acceptance and the submission of the above certificates by the Contractor, the responsibility of the installed equipment (maintenance, protection against theft, sabotage etc.) lies with the Contractor.

After the provisional acceptance of the Line ETCS and provided that the certificates for the respective equipment as mentioned above have been presented and approved and that the system is licensed for the line in accordance with the applicable provisions, the corresponding Line System shall be set commissioned.

2.13.17 Literature - technical documentation

2.13.17.1 General

The Contractor is obliged to provide the Employer with complete technical references- technical documentation of the System, as well as maintenance and training references in printed and electronic form (hereinafter references and documentation).

The content of all references - documentation to be provided shall be organised and developed in such a way, using international technical terminology, so that maintenance staff can easily operate, control, maintain and repair the System.

All drawings shall be produced in a specific dimension to be agreed with Albania Railway and all symbols, nomenclature and abbreviations shall be explained fully in the designs, and shall meet recognised specifications or standards referring to the symbols for railway signalling, wiring diagrams and nomenclature (e.g., IEC 60050-821).

The electronic data files to be delivered to the Employer by the Contractor in cd-rom format together with the printed technical documentation shall be in such form that they can be read and processed with the usual applications of the Windows operating system, ε.g. Microsoft Office applications, Microsoft Project, or AutoCAD). The use of any software other than the above shall be subject to the approval of the Employer.

The Contractor shall submit all literature - documentation for review and approval by the Employer in English or Albanian.

The literature-documentation to be delivered to the Employer should include at least the following:

2.13.17.2 Technical documentation of the detailed design

The design may be divided into a general part online equipment (e.g. technical design documentation of the system) and in a specific part (e.g. technical design documentation of the line).

The general part of the technical design documentation shall present functional solutions that refer to the functional specifications and described elements, such as modes of operation, functions, packets etc.

The specific part of the technical documentation shall consist of at least electrical designs and diagrams of mechanical constructions and electrical connections for the –Durres -Tirana section.

The description of the detailed design shall report the sources of data and information used to develop the equipment.

The entire documentation of the design shall be prepared and delivered in Albanian and English. All plans shall be bilingual, with titles and legends in Albanian and English.

The detailed design shall include at least the following:

I. Detailed description of the project
II. ETCS Book of Rules for the ETCS line system of the Durres -Tirana section
III. Description and Specification of the system:

The Contractor shall prepare and submit for approval by the Employer a detailed description of the proposed systems and system specifications.

The System Specification shall describe the types and specifications of the individual components of the equipment, the functionality of all equipment and of the overall system. It shall also describe in detail the structure and mode of the software used to implement the system as a whole, including databases, communication protocols, etc.

2.13.17.2.1Station Schematic Diagram:

For each Station, the relevant Schematic Diagram shall be submitted.

The Station’s Schematic Diagram shall show at least the following information on the signalling to be developed in the context hereof: Positions and identification of all line items (light signals, switches, axle counters, line circuits, etc.), station platforms, bridges and tunnels, level crossings and relevant coverage warning signs, exact equipment locations.

The new ETCS equipment and the measures for adapting the signalling systems, if required, shall be presented clearly, i.e. using different colours.

2.13.17.2.2Open Line Schematic Diagram:

For each Open Line segment, the relevant Schematic Diagram shall be submitted.

The Open Line Schematic Diagram shall show at least the following information on the signalling to be developed in the context hereof: Positions and identification of all line items (sequential light signals, any switches, axle counters, line circuits, etc.), platforms, bridges and tunnels, level crossings and relevant coverage warning signs, exact equipment locations.

The new ETCS equipment and the measures for adapting the signalling systems, if required, shall be presented clearly, i.e. using different colours.

2.13.17.2.3Station Wiring Diagram:

For each station, a Station Wiring Diagram shall be developed. This shall describe all the additional cables to be installed and include details of the cross section, the number of strands, the type of cable and its operation.

2.13.17.2.4Open Line Wiring Diagram:

This shall describe all the cables to be placed on the routing and shall include details of the cross section, number of strands, type of cable and its operation.

2.13.17.2.5Cable Layout Topography:

Cable Layout Topographic Diagrams shall be developed for the entire line. These diagrams shall illustrate the location of all cable routing, including the number and operation of all cables, wells, routing under the line, depth and method of construction.

2.13.17.2.6Layout of Technical Rooms

Layout plans for line ETCS equipment facilities shall be drawn up.

The layout shall include details of all equipment in the area, power supply, cable routing and any environmental control systems, etc., as well as the new ETCS equipment.

The layout shall be drawn on a 1:50 scale.

I. Power supply plans and calculations
II. Circuits/installation plans containing the connections to all outdoor components.
III. Circuit drawings with full features of all components according to the tenderer's technology (electromechanical or programmable components)
IV. Assembly and installation plans with all the necessary explanations and descriptions, including necessary interventions, rearrangements, modifications or additions to existing equipment.
V. Documentation for the option of remote monitoring of the systems from a central position and what kind of equipment is required for its implementation,
VI. Technical characteristics of all the mechanism components and materials used,
VII. Descriptive documentation of equipment and software,
VIII. Supervisory, functional, training, logical flow diagrams etc,
IX. Handling forms for all reported material and programs in Albanian and English.

It is noted that the exact location of the infill balises shall be determined in the detailed design and shall be optimal for the integrity and behaviour of the system to be achieved. The Contractor is required to thoroughly substantiate the above. Also, the design that shall identify the transmitted data of the balises (data preparation) shall be perfectly specialised for each case, taking into account the characteristics of the line, the trackwork, etc. If, even after testing and commissioning, it emerges that in the detailed design, there have been erroneous estimates of the system operating parameters (e.g. the acceleration-braking rate), the Contractor is obliged to adapt the design and consequently the system making all the necessary adjustments and arrangements that shall lead to smooth operation without additional compensation.

Documentation on the design shall include the preparation of the revised “as built” documents, based on the detailed designs and data recorded during the acceptance tests. These documents shall present the current state of implementation of the Line System.

2.13.17.3 Operating and maintenance technical documentation

Documentation related to operation and maintenance shall include the preparation of a set of manuals in an approved format. The manuals shall be delivered before the relevant equipment is put into operation.

The Contractor shall review the manuals in part or in whole, to add the necessary hardware and software modifications that will emerge during the system commissioning process. Copies of the revised manuals shall be submitted to the Employer, to replace the original manuals.

The manuals shall include, without limitation, the following:

I. System manuals - a comprehensive description of all system rules, with block diagrams.
II. Operating manuals - divided into the necessary sub-chapters and containing sufficient information for the non-qualified personnel that will use the corresponding system, following some kind of training.
III. Workshop manuals - including the necessary figures, circuits, wiring diagrams, engineering drawings and spare parts lists for the system's maintenance, repair and smooth operation.
IV. Software manuals - available for each part of the equipment or system that includes software-programmable devices. These manuals should include all software rules, source codes with sufficient comments, communication protocols, databases, flow charts, and operating instructions. The source codes and development tools shall also be made available in electronic form.
V. Maintenance manuals - providing adequate information on diagnostics rules and equipment maintenance practices, allowing the technical staff to proceed with immediate diagnosis and repair of faults. The diagnostics and maintenance system shall also be supported by an online (electronic) maintenance manual.
VI. Definitive Drawings Manual - containing all "as-built" diagrams of circuits and related works, in an easily reproduced electronic format.
VII. Spare parts list - list of all installed components and spare parts with corresponding names, location, quantity, status/date and order number.

2.13.17.4 Additional Literature - Technical Documentation.

If the Employer wishes to use additional literature - technical documentation, the Contractor is obliged to check the accuracy and completeness of the additional literature - technical documentation within a reasonable time from the Employer's relevant written notification. The Contractor, in particular, shall specify the points in respect of which this additional literature - technical documentation is incorrect or incomplete and the measures to be taken to make it correct and complete.

2.13.17.5 Guarantee of the right of use, reproduction, etc.

The Contractor guarantees that the Employer shall have the right to freely use, reproduce for its own use and modify any element of the literature - technical documentation it has supplied to it, without thereby infringing any right of the Contractor or Third Parties and without being obliged to pay for this reason any fees or compensation to the Contractor or Third Parties. The above right of use, reproduction and modification is granted to the Employer only in relation to the provision of railway services and is subject to the restrictions set forth in the software license.

2.13.17.6 Final documents

The Contractor must prepare and keep up to date a complete "final" (printed and electronic) record on the execution of the Contract, which shall accurately state the final placements, sizes and other details of the works, as actually executed. This record shall be kept on the project site and shall be used exclusively for the purposes of this paragraph. Three (3) copies thereof, as well as their electronic form, must be submitted to the Employer before the start of the Integration Checks.

In addition, the Contractor must provide the Employer with the final Project drawings (as built), showing all the works as executed, submitting them to the Employer for approval. The Contractor must obtain the Employer's approval as to their dimensions, the calculation system and other relevant details.

Before the issuance of the Provisional Acceptance Certificate, the Contractor must provide the Employer with the specific number and type of copies of the relevant final plans, in accordance with the Employer's requirements. The Project shall be considered non-complete until the Employer has received these documents.

2.13.17.7 *Errors*

If errors, omissions, ambiguities, inconsistencies or other mistakes are identified in the Contractor's Documents, these must be corrected at the Contractor's expense.

2.13.18 Training

The Contractor is obliged to train the required number of Employer and/or Albanian Railway staff members and provide them with a complete theoretical and practical training programme for Level 1 ETCS, which shall cover all the installation and operation phases, as well as the System and service certification controls. The training courses shall be subdivided into Administration Training, Training for Signalling Engineers, Training for Signalling Technicians and Operations Training.

The training shall take place during the project term both in Albania and abroad, if required. The detailed training program, stating the participants, the place and the time of training shall be submitted for approval to the Employer, in consultation therewith. The Employer may modify this in any way, in particular depending on the availability of the personnel to take part, without this giving rise to the Contractor's right to additional compensation.

In particular:

2.13.18.1 *Training in Administrative issues:*

The Employer's senior management shall take part in training programs in Administrative issues. The purpose of these programs is to familiarise the Employer's managers-department heads with establishing and supporting an efficient organisation for the management of the installed systems, as well as for anticipating the necessary changes, rules and procedures.

The training programs in Administrative issues shall take place well in advance of the start of training in operation and maintenance issues, so that the trained managers-department heads can be able to promptly define the required internal rules, procedures and structures.

A detailed training program for a total of two (2) weeks, with a minimum of 8 participants, shall be submitted.

2.13.18.2 *Training for Signalling Engineers:*

The purpose of training for Engineers is to familiarise them with the general implementation principles of all installed systems, including the supply system and other equipment to be used, and with all installation issues. During the training period, it is necessary to use a combination of theoretical training, training on project management and practical training in similar facilities.

Training includes, without limitation, the following:

I. Methods of management from a technical point of view
II. Equipment programming (e.g. fixed balises)
III. Installation
IV. Measuring systems (at a theoretical and practical level)
V. Software
VI. Power supply
VII. Maintenance, including preventive maintenance, management of diagnostics systems, fault detection and repair.

This training shall also aim at providing the necessary knowledge and skills to identify part or all of the participants as future trainers to enable Albanian Railway to develop an internal training mechanism for their staff

A detailed training program for a total of three (3) weeks, with a minimum of 10 participants, shall be submitted.

2.13.18.3 *Training for Signalling Technicians:*

Signalling technicians shall be trained in locating and repairing faults, unit replacements and regular maintenance. During the training, a description of the use of all testing and maintenance equipment to be delivered under the Contract, as well as practical training, shall be provided.

The training shall take place during the installation process. Upon their successful training, the technicians shall take part in the installation of the system under the supervision of the Contractor's supervisor.

A detailed training program for a total of four (4) weeks, with a minimum of 30 participants, shall be submitted.

2.13.18.4 *Training in Operation issues:*

Operations training shall involve traffic staff working on the line sections concerned. The purpose of this training is to gain an overview of the entire Level 1 ETCS system (train and line) and to become familiar with the operating principles.

The training courses on operations shall include, but are not limited to, the following:

Brief introduction to the Level 1 ETCS, including its operating principles:

I. The capabilities of the installed Level 1 ETCS and their impacts on its operation
II. Procedures in the event of faults and in emergencies

A detailed training program for a total of one (1) week, with a minimum of 20 participants, shall be submitted.

The comprehensive training program should:

I. to allow the Employer and/or Albanian Railway staff to operate and programme the Line System, and to perform the necessary supervision of the equipment, measurements, controls and arrangements and adjustments in operation to ensure the operation of the System, under the specified operating conditions; and
II. allow the personnel of the Employer and/or Albanian Railway to ensure the proper operation of the System at the prescribed operating conditions, through a maintenance program.

It should be taken into account that it will not be possible for all personnel to be trained to be relieved of their duties at the same time in order to participate in the training. This means that the training modules will be repeated for each individual group. Therefore, good and efficient organisation is required.

The Contractor must provide a suitably designed training program for all parts of the System to be installed. The structure of the training program shall be such as to follow the functional structure of the System and facilitate learning.

This programme shall include the title of the training course, the minimum number of presence for each lesson, the subject, the duration, the proposed place, the content, the training material, the minimum level of qualification of the trainees, and the target skills of the course after completing the training.

During training, Employer and/or Albanian Railway staff must be guided in the easy identification and correct use of all System documentation, manuals and drawings so that they can quickly detect errors and immediately remedy failures. Upon the end of the training program, trainees should be able to undertake the functional management of the System.

The training programs for Managers-Department heads and Engineers may be in English or in Albania. The training programs for Maintenance and Operation personnel shall be in Albania. The overall training shall be based and take place on the installed equipment and shall cover all elements and parts of the System (components, mechanisms, programs, etc.). By way of exception, any training abroad shall be done in English.

The necessary material and documentation (printed and electronic) shall be submitted to the Employer for approval at least 60 days prior to the commencement of the training and then shall be available in a sufficient number of copies in Greek and in English and shall be presented to the trainees in time and in any case before starting the training.

The cost of training shall be included in the Contract Price. Thus, all training, whether in Albania or abroad, shall be at the expense of the Contractor.

Additional Training and Printed Material: With regard to changes to HARDWARE or SOFTWARE made by the Contractor prior to Final Acceptance, it shall be required to provide the Employee's staff with the required additional training and also deliver corresponding corrections of the DOCUMENTATION in sufficient number of copies.

2.13.19 Technical support and maintenance-spare parts

2.13.19.1 Technical Support & Maintenance

2.13.19.1.1Introduction

This service should:

I. provide the Employer with technical support for the operation of the System
II. transfer the necessary know-how to the Client’s personnel
III. provide Maintenance services for all equipment covered by this contract.

The Contractor shall provide the Technical Support and Maintenance Services taking the following paragraphs into account. The cost of the above services shall be included reduced in the Contractor’s offer. The works shall be certified based on the corresponding articles on ETCS works.

In its offer, the Contractor shall include a price list of the required special instruments-tools, programming devices, setup accessories and controlgear necessary for preventive maintenance and for the repair of basic failures of all equipment (balises, LEUs, etc.). The type and quantity of the special tools and test equipment shall be sufficient so as to ensure the flexible and efficient operation of the ETCS Line System in the Durres -Tirana section.

2.13.19.1.2Contractor’s Obligations

The Technical Support and Maintenance Service shall support the entire ETCS Line System, which has been installed, tested and commissioned.

The Technical Support and Maintenance Service includes:

I. Technical Support Services for Programming and Operating the System.
II. Preventive maintenance services, including hardware and software, which will be reported on a time basis (weekly, monthly, annual activities).
III. Corrective maintenance services. Corrective maintenance of the equipment shall include all the necessary actions needed to restore the normal functioning of the equipment or part thereof in the event of malfunction.

As far as Technical Support is concerned, the Contractor shall provide appropriately trained staff capable of supporting all installed Line Systems during the maintenance period.

With regard to Maintenance services (preventive and corrective), the Contractor shall provide all the necessary materials - as well as appropriately trained staff - to ensure the uninterrupted maintenance of the installed Line Systems. For each element of equipment, the Contractor’s responsibility starts from its installation and ends upon the final acceptance.

The Contractor’s compliance with the contractual obligations for all of the above services shall be detailed in the Technical Support and Maintenance Program. A draft of the Technical Support and Maintenance Program shall be submitted by the Contractor and approved by the competent Services of the Employer.

The maintenance plan shall specify the quantities of maintenance works required to maintain the efficient operation of all ETCS components.

The necessary maintenance works to be indicated shall be sufficient for the system’s problem-free operation for a minimum useful life of 15 years.

The services shall be available round the clock (24-hour basis) every day, three hundred and sixty-five (365) days a year.

2.13.19.1.3Technical Support and Maintenance Program

In order to achieve maximum system availability, the Contractor is obliged to provide a Technical

Support and Maintenance Program, which shall include operating support and reprogramming services, periodic maintenance services and fault repair services.

The Contractor is obliged to provide technical support services for the entire lifetime of the equipment it has delivered and installed. This technical support shall include the provision of spare parts and the exclusive responsibility for managing and implementing any technical change due to a fault or updates to equipment or the system's functionality.

The Contractor is obliged to classify the fault levels, in a priority list, based on the criterion of their criticality and complying with the contractual response times, to avoid setting the system "Out of Order". The system's availability shall meet the requirements specified in the EEIG standard "ERTMS/ETCS RAMS Requirements Specification, Chapter 2 – RAM"; Reference EEIG 96S126, Chapter Ref: 02s126, [32].

The Employer or HSH shall be obliged as soon as possible to notify the Contractor in writing in as much detail as possible of the occurrence of any anomalies during maintenance. In the event of any fault in the Line System, the Contractor shall take the necessary corrective actions to restore it immediately after written notice and at the latest within four (4) hours. The contractor is required to complete the fault restoration and deliver the system in full and normal operation within 24 hours of the written notification of the fault by the employer or HSH. Faults can be recorded either through the LEU network or by the Contractor's responsible personnel or by authorised personnel of HSH.

In the event that the Contractor fails to fulfil or does not comply with any deadline or other obligation arising from the above provisions, the Employer shall have the right to remedy any damages and deficiencies by any means, not excluding the assignment of the restoration to third parties, in whole and including any related costs, with any expense charged to the Contractor. In order for the Employer to proceed with the above, it is obliged to announce its decision to the Contractor, clearly indicating any breach of terms by the Contractor.

The Contractor shall propose how to collect the data related to the functional status of the installed Line System in order to ensure that it is informed as soon as possible of possible malfunctions of the installed systems.

The Contractor's Technical Support and Maintenance Programme shall include the obligation to have a Technical Support and Maintenance office, which shall be staffed by qualified personnel to provide the required technical support to the Employer. The Technical Support office shall act as the Contractor's representative and shall provide both technical support and On Line Remote Support.

The Contractor shall be solely responsible for installing and certifying any upgrades or technical changes to hardware, software and firmware that may result due to a fault or the restoration of a fault.

The Contractor's obligation is to assist the Employer's operating staff (including the staff of the organisation to which the Employer may entrust the operation and maintenance of the Line System) in identifying, assessing and remedying any failures.

For any failure it restores, the Contractor is obliged to send to the competent Services of the Employer a detailed report (Failure and Corrective Action Report), which shall contain at least the following: cause analysis, failure removal procedure, hardware replacement process (repair or replacement), preventative measures, etc.

The Contractor is required to maintain a record (electronic and printed) at least for all preventive and corrective maintenance, tampering or malfunctions, Failure Reports, replacement of materials and equipment, etc.

Any installed software upgrades shall be easy to implement and at no extra cost for the entire duration of the contractual warranty. If any software upgrades have been issued during the contractual warranty and can be applied to the Line System, the Employer shall decide on their implementation.

2.13.19.1.4 On-line help

The Contractor is required to provide On Line Remote Support to the Employer, for direct technical support.

Specifically, the Contractor is obliged to provide the Employer with a direct technical support hotline, which shall operate round the clock (24 hour basis) every day, three hundred and sixty-five (365) days a year. In order to achieve this, the Contractor must have appropriately trained personnel, which can directly support the Employer.

2.13.19.1.5 Operation and Maintenance Manuals

Before the start of the Tests, the Contractor must provide the Employer with detailed manuals on the operation, programming, maintenance, disassembly, adjustment and repair of the Equipment.

The Project shall be considered non-complete until the Employer has received these operation and maintenance manuals, as well as any other manual defined by the Employer's Requirements to this end.

2.13.19.2 Spare parts

2.13.19.2.1 General

The design and installation of the entire ETCS subsystem on the line shall be carried out for a planned period of at least 25 years. With regard to system components that are not expected to last for 25 years and which are not consumable parts, the Contractor shall determine the expected lifetime for each of them and in addition provide the additional support needed to ensure that the line ETCS subsystem shall be fully functional for a minimum of 25 years.

The contractor shall compile a list of the spare parts necessary for the system. This list shall include a documented selection of the most critical spare parts required for the operation, maintenance and repair of the system. This spare parts list shall be based on a mathematical model taking into account the quantity of each type of spare part provided for the system, and the MTBF and MTTR for each such type.

Two time periods are set, for the use of the spare parts list:

I. Contractor Liability Period
II. Period after expiry of Maintenance

2.13.19.2.2 Contractor Liability Period

In its offer, the Contractor shall submit the spare parts table (Table 1), which shall include all consumable or replaceable spare parts, their code numbers, unit prices, technical specifications and manufacturers. The unit price shall include the procurement, supply and delivery of spare parts to the warehouses of Albanian Railway or wherever else indicated by the employer. The Contractor should be in a position to supply, for a period of twenty-five (25) years after final acceptance and for any quantity requested, any of the spare parts referred to in Table 1.

S/N	Material Name	Unit Price	Code Number	Manufacturer	Specifications

Table 1. Spare parts

The supply of the spare parts, which includes transport, customs clearance, insurance, management, storage in warehouses approved by the Employer, etc., is the sole responsibility of the Contractor and the costs for all above are borne by the Contractor.

The contractor is responsible for the full management of the spare parts required for system maintenance. All spare parts used should be replaced under the Contractor's responsibility.

In order to facilitate the Contractor and to avoid the long-term shut-down of the system, the Contractor may in exceptional cases use spare parts from the stock, under the following conditions:

The borrowed spare parts to be used by the Contractor shall be replaced within one month at the Contractor's expense.

By using borrowed parts, there shall be no delay in the scheduled maintenance of line subsections, otherwise the provisions for extending the warranty period and the imposition of penalties shall apply and concern one or more line subsections still in the warranty period. In the event that the absence of such spare parts leads to downtime of line subsections that have been excluded from the warranty, the penalty clauses shall again be imposed, as well as an equivalent extension of the warranty period for these line subsections still under warranty and for which the parts were borrowed.

2.13.19.2.3Period after expiry of Maintenance

The Contractor shall submit to the Employer an offer detailing the cost for the spare parts management and replacement services, if requested to do so. However, the Contractor is responsible for providing sufficient spare parts to support the maintenance and repair of the systems for a period of two (2) years after the expiry of the maintenance period. The delivery of all spare parts should be completed at least four (4) months before the end of the Contract term. The cost of the spare parts shall be included in the Contractor's offer. Unit prices to calculate the total cost of these spare parts included in the Price hereof shall include the supply, transportation and delivery of the spare part in Albanian Railway warehouses or elsewhere indicated by the Employer. Upon expiry of the Maintenance, the Contractor is required to deliver all tools-instruments. In the offer, the Contractor must include a commitment certificate for the supply of spare parts or appropriate equivalents thereof for at least a period of twenty-five (25) years after the Commissioning of each section. The Contractor must inform the Employer in writing with at least one year's notice if the production of any spare part is to be interrupted and to propose alternatives and any associated costs.

2.14 Telecommunication

2.14.1 General information about the telecommunication system

This chapter determines the type of telecommunication equipment that will be installed in Duress - Tirana railway line, as well as the new rail link to Rinas airport, following the requirements for EU interoperability.

The telecommunication system shall be built as a single automated network of communication points connected by means of digital transmission devices and synchronous digital hierarchy (SDH), Ethernet/IP switching and multiplexing devices.

The telecommunication system should provide the at least the following connections:

- Inter-station connections
- Train traffic control connection
- Telephone connections for general use (automatic phones)
- Intra-station connections
- Transmission of data
- Binding of interlocking station facilities and safety equipment
- Interlocking communication connections

The telecommunication system shall be capable to support future additional types of services:

- Station clocks;
- Loudspeaker passenger announcement system;
- Electronic information boards;
- Video surveillance;
- Ticketing machines.

The realization of this system requires the Contractor to prepare technical and detailed designs and after their approval by the Contracting Authority to install and put into operation the following telecommunication systems and subsystems:

- installation and commissioning of two fibre optic cables containing 48 single-mode fibre optics in accordance with ITU/T G652D;

- installation and commissioning of a digital system for transmission of data of the type SDH, with capacity STM 16 – 2.5 Gb/s and access devices;
- construction and commissioning of a high-speed Gigabit Ethernet data network;
- power-supply equipment 230V/48V and construction of ground wires for the communications at the stations;
- Implementation of structural cabling at the railway stations' technical rooms and main offices.

2.14.2 Technical standards and interoperability

In order to ensure interoperability the standards shall apply set by the European Community legislation, the agreements of the Economic Commission for Europe of the United Nations relating to transport infrastructure or standards established by the European Committee for Standardization (CEN), the European Committee for electrotechnical standardization (CENELEC) and the European telecommunications Standards Institute (ETSI), and the international norms and standards of: the International organization for Standardization (ISO), the International Electrotechnical Commission (IEC) and the International Telecommunication Union (ITU).

The following standards, specifications and regulations must be followed for the development of the telecommunication system and its components.

Recommendation of the European Committee for Electrotechnical Standardization

No	Description
1	CENELEC - EN 60825-1:2007 – Safety of laser products - Part 1: Equipment classification and requirements; IEC 60825-1:2007 - 1994 EN 60825-1:1994 and its amendments - Note 2.1 / 1.9.2010 Article 3 (1) (a) (and Article 2, 2006/95/EO)
2	CENELEC - EN 60825-2:2004 – Safety of laser products - Part 2: Safety of optical fibre communication systems (OFCS) - IEC 60825- 2:2004); EN 60825-2:2000 EN 60825-2:2000; remark 2.1/1.9.2007; Article 3 (1) (a) (and Article 2, 2006/95/EO)
3	Amendment A1: 2007 of EN 60825-2:2004 - IEC 60825-2:2004 / A1: 2006/1.2.2010;
4	CENELEC - EN 60825-4:2006 – Safety of laser products - Part 4: Laser guards - IEC 60825-4:2006;
5	Amendment A1: 2008 of EN 60825-4:2006 - IEC 60825-4:2006 / A1 2008
6	CENELEC - EN 60825-12:2004 - Safety of laser products – Part 12: Safety of laser products - Part 12: Safety of free space optical communication systems used for transmission of information- IEC 6082512:2004); Article 3 (1) (a) (and Article 2, 2006/95/EO)
7	CENELEC - EN 61000-6-3:2007 - Electromagnetic compatibility (EMC) - Part 6-3: Generic standards - Emission standard for residential, commercial and light-industrial environments- IEC 61000-63:2006
8	CENELEC - EN 61000-6-1:2007 - Electromagnetic compatibility (EMC) - Part 6-1: Generic standards - Immunity for residential, commercial and light-industrial environments- IEC 61000-6-1:2005

9	ETSI EN 300019-2-3 (v2.1.2) 1999-09 - European standards and requirements for telecommunication equipment and the areas where they are placed

European Union standards (European Norms)

Standard	Description
EN 300019-2	Equipment engineering (EE) – Environmental conditions and environmental tests for telecommunications equipment - Part 2-2: Specification of environmental tests – Transportation
EN 41003	Particular safety requirements for equipment to be connected to telecommunications networks and/or a cable distribution system
EN 61000-6-4	Electromagnetic compatibility (EMC) - Part 6-4: Generic standards - Emission standard for industrial environments
EN 50121-1	Railway applications – Electromagnetic compatibility – Part 1: General
EN 50121-2	Railway applications – Electromagnetic compatibility – Part 2: Emission of the whole railway system to the outside world
EN 50121-4	Railway applications – Electromagnetic compatibility – Part 4: Emission and immunity of the signalling and telecommunications apparatus
EN 50121-5	Railway applications – Electromagnetic compatibility – Part 5: Emission and immunity of fixed power supply installations and apparatus
EN 50122-1:2011/AC:2012	Railway applications – Fixed installations – Electrical safety, earthing and the return circuit – Part 1: Protective provisions against electric shock
EN 50123-1	Railway applications – Fixed installations – D.C. switchgear – Part 1: General
EN 50124-1/A2	Railway applications – Insulation coordination – Part 1: Basic requirements, Clearances and creepage distances for all electrical and electronic equipment
EN 50126	Railway Applications – The specification and demonstration of reliability, availability, maintainability and safety (RAMS) Part 1: Basic requirements and generic process Part 2: Systems approach to safety
EN 50129	Railway applications – Communication, signalling and processing systems – Safety related electronic systems for signalling
EN 50159-1	Railway applications – Communication, signalling and processing systems. Part 1: Safety-related communication in closed transmission systems
EN 50159-2	Railway applications – Communication, signalling and processing systems. Part 2: Safety-related communication in open transmission systems
EN 55022	Information technology equipment – Radio disturbance characteristics – Limits and methods of measurement
EN 55024	Information technology equipment – Immunity characteristics - Limits and methods of measurement
EN 60849	Sound systems for emergency purposes
EN 60950-1	Information technology equipment – Safety – Part 1: General requirements

EN 61000-3-2	Electromagnetic compatibility (EMC) – Part 3-2: Limits – Limits for harmonic current emissions (equipment input current up to and including 16 A per phase) – (IEC 610003-2:2005 + A1:2008 + A2:2009)
EN 50173-1	Information technology – Generic cabling systems – Part 1: General requirements
EN 61000-6-1	Electromagnetic compatibility (EMC) – Part 6-1: Generic standards – Immunity for residential, commercial and light-industrial environments
EN 61000-3-11	Electromagnetic compatibility (EMC) – Part 3-11: Limits – Limitation of voltage changes, voltage fluctuations and flicker in public low-voltage supply systems – Equipment with rated current <= 75 A and subject to conditional connection
EN 61000-4-2	Electromagnetic compatibility (EMC) – Part 4-2: Testing and measurement techniques – Electrostatic discharge immunity test
ENV 50204	Radiated electromagnetic field from digital radio telephones. Immunity test
EN 300253 V2.1.1	Environmental Engineering (EE) – Earthing and bonding configuration inside telecommunications centres
EN 50310	Application of equipotential bonding and earthing in buildings with information technology equipment

Standards of the International Union of Railways (UIC)

Standard	Description
UIC 750	Railway telecommunications links - Improvements to be expected from the use of telecommunications for operating purposes
UIC 753-1	technical regulations concerning international railway telephone circuits
UIC 753-2	General technical regulations governing establishment and development of communication capacity over the railway telecommunications network of UIC building components
UIC 754	Omnibus telephone circuits - Regulations for construction and equipment
UIC 755-1	Laying of telecommunications and signalling cables and their protection against mechanical damage
UIC 755-2	Protection of telecommunications staff and plant against a large earth potential due to a neighbouring electric traction line
UIC 756	Fixed and portable line-side telephones
UIC 780	Remote control of signalling installations
UIC 781	Transmission systems and methods of remote control for signalling installations
UIC 917-1	Technical provisions for the international interconnected Railway data transmission networks
UIC 917-2	Maintenance of the international railway data transmission network for use by the railways
UIC 917-4	Information and instructions for the maintenance of the telecommunication lines used by the railways for the interconnection of data transmission

	networks

Standards of the International Electrotechnical Commission (IEC)

Standard	Description
IEC 1508	Functional Safety: Safety related systems
IEC 529/ EN60529	Specification for degrees of protection provided by exposures (IP code)
IEC 571	Electronic equipment used on rail vehicles
IEC 60 794-1-2	Optical fibre cables - Part 1-2: Generic specification – Basic optical cable test procedures
IEC 61 643-1:2000-09	Low-voltage surge protective devices - Part 1: Surge protective devices connected to low-voltage power distribution systems - Requirements and tests
IEC 68	Environmental testing
IEC 721	Classification of environmental conditions
ISO/IEC-11801	Information technology – Generic cabling for customer premises
ISO/IEC 8877	Information technology -- Telecommunications and information exchange between systems -- Interface connector and contact assignments for ISDN Basic Access Interface located at reference points S and T

Standards of the Institute of Electrical and Electronics Engineers (IEEE)

Standard	Description
IEEE 802.1q	Virtual LANs
IEEE 802.3x	Full Duplex Operation
IEEE 802.3z	Gigabit Task Force

Standards of the International Telecommunication Union (ITU)

Standard	Description
E.164	The international public telecommunication numbering plan
G.652	Characteristics of single-mode optical fibre and cable
G.703	Physical/electrical characteristics of hierarchical digital interfaces
G.811	Timing characteristics of primary reference clocks
K.12	Characteristics of gas discharge tubes for the protection of telecommunications installations
K.20	Resistibility of telecommunication equipment installed in a telecommunications centre to overvoltages and overcurrents.

M.1020	Characteristics of special quality international leased circuits with special bandwidth conditioning
M.20	Maintenance philosophy for telecommunications networks
M.3000 series	Overview of TMN Recommendations
Q.921	ISDN user-network interface layer 3 specification for basic call control. This Recommendation is also included but not published in I series under alias number I.451
Q.931	ISDN user-network interface - Data link layer specification. This Recommendation is published with the double number Q.921 and I.441
X.21	Interface between Data Terminal Equipment and Data Circuit-terminating Equipment for synchronous operation on public data networks.

Other standards and regulations

Standard	Description
ISO 9001	Quality systems - Model for quality assurance in design, development, production, installation and servicing"
1999/569/EC	European Commission Decision 1999/569/EC „Commission Decision of 28 July 1999 on the basic parameters for the command and control and Signalling subsystem relating to the trans-European high-speed rail system"
CEPT 25-09	CEPT Recommendation T/R E (Chester 1990, revised at Budapest 1995), „Designation of frequencies in the 900 MHZ band for railway purposes"
ERTMS COMMS	Summary of ERTMA communication requirements, EEIG document number 97E7377
VDE 08888-3	Optical fibre cables for communication systems - Part 3: Outdoor cables
VDE 0816-1	External cables for telecommunication and data processing systems - Cables insulated and sheathed with polyethylene, unit stranded - List of type designation for telecommunication cables
VDE 0815/A1	Wiring cables for telecommunication and data processing systems; amendment 1
ANSI/TIA/EIA-568-A-5	Commercial Building Telecommunications Cabling Standard.
EIA/TIA 568, 568A &; TSB-40A	Standards for connecting hardware performance to 100MHz

NOTE: The Contractor should use the most recent versions of the mentioned norms and regulations.

2.14.3 Electromagnetic compatibility

All electrical equipment and installations affect each other when the devices are interconnected or located in close proximity.

Directive 2004/108/EC determines the limits of electromagnetic radiation of the equipment so as to ensure that the intended use of the device will not disrupt the functioning of telecommunication and other equipment and harmonizes the provisions of national legislation ensuring the protection of equipment against electromagnetic interference. The Directive requires that the design and manufacture of equipment correspond to the essential requirements of electromagnetic compatibility.

The Directive applies to the entire telecommunication equipment - electrical and electronic apparatus and fixed installations.

The essential requirements for electromagnetic protection provide that the telecommunication equipment is designed and manufactured in such a way that:

- the electromagnetic interference generated by it does not exceed the level above which radio and telecommunication equipment or other equipment cannot operate as intended;
- the level of protection of the device against electromagnetic interference is such that it enables it to operate without unacceptable degradation of its parameters when working as intended.

2.14.4 Fibre optic cable transmission medium – technical requirements

1. General requirements for the fibre optic cable

The fibre optic cable should be installed along the railway line, the installation will be executed via laying in the ground. The entering in the buildings of the railway stations and telecommunication facilities will be implemented through a fireproof station fibre optic cable, which is protected by a metal pipe.

Each of the fibre optic cable should include 48 single-mode (single-mode 9/125 according to ITU/T G.652 D) fibres, grouped in tubes of different colours. All fibres in a tube should also have a different colour. Both types of cables –underground installation and station cables – should have exactly the same optical characteristics of fibres.

The ODF should be placed in 19’’ standard cabinet with a lock located in the specially designated areas for the telecommunication equipment at the railway stations.

The type of cable for underground installation should be single-mode - ADSS (All-Dielectric Self Supporting Aerial), 9/125 according to ITU/T G.652 D of the type A-DQ(or F)(ZN)2Y4Y AxB E 9/125, with

A … for outdoor installation

D … tubes with fibres

Q … filling of swellable fibres (bar) for moisture protection

F … hydrophobic filling (petroleum jelly or other)

ZN … kevlar fibre yarn

2Y4Y … entirely metal-free elements and rodent protection

AxB … number of the tubes by the number of the fibres

E … single mode with stepped profile of the refractive index, with a core / jacket 9/125 µm, or its equivalent, completely dielectric, waterproof and rodent protected. The cable should be in full compliance with the standards IEC 60794-1-2, VDE 088/part 3.

2. Requirements for the Fibre optics and the Cable

The fibre optics should be single mode. The optical parameters of the fibres should comply with Recommendation G.652D of ITU-T.

The fibres should be grouped in tubes. Each tube should contain no more than 12 fibres.

The fibres located in each tube should have different colours. The colour coating should not hinder the work of the optical identifiers and the LID devices.

The cable for underground installation should have optical characteristics of the fibres and identical colour of the tubes and fibres, according to standard IEC 60794-1-2, VDE 088, item 3.1.3.2.2 – “Requirements for specification for optical fibre cables”.

In accordance with G.652.D recommendation for single-mode optic fibre ITU-T regulates the definition of the following parameters:

- Attenuation at 1310 nm = - 0.40 dB/km

- Attenuation at 1550 nm = - 0.35 dB/km
- Attenuation at 1625 nm = - 0.40 dB/km
- The imum fluctuation of attenuation for each specified wavelength (breakpoint) must not exceed 0.1 dB.
- Breaking the wavelength of the cable fibre should be less than 1260 nm.
- Zero dispersion in wavelength should be between 1300 nm and 1324 nm.
- The zero-dispersion gradient should not exceed 0.093 ps/(km.nm2). Cable PMD = 0.2 s/km0,5.
- The dispersion of 100 turns of mandrel with diameter of 75 mm should not exceed 0.5 dB at 1625 nm.
- Zero water peak.

3. Requirements for the construction of the optic fibre

The fibre optic should be entirely dielectric.

The cable must provide static load of not less than 5800 N, without changing the optical and mechanical characteristics of the fibres.

The cable should contain “ripcord” elements for easy handling.

The cable should maintain its electrical/elastic properties for a long period of time.

The outer polyethylene coating should have good tensile strength and tear resistance.

The outer polyethylene coating should be resistant to the influence of solar radiation, the effects of atmospheric conditions and chemical contaminants, providing life of the fibre of not less than 30 years.

The outer polyethylene coating should have a thickness of at least 1.6 mm.

The outer coating should be marked at a distance of 1m as follows:

- Current measurement length;
- Cable type and number of the fibres (designation of the cable);
- Manufacturer’s name and the month / year of manufacture;
- Cable name - Fiber optic CABLE;
- Warning sign: CAUTION - LASER RADIATION;
- Inscription of the owner - PE MR Infrastructure.

The fibre optic should not contain metal elements.

Suitable dielectric couplers for fibre optic cables should be used to connect the cable lengths.

The material of the coating should not affect in any way the other components of the cable.

The fibre optic should conform to the standards IEC 60794-1-2 and VDE 088/part 3. The tests, parameters and test results should be in accordance with:

- Tensile strength – in accordance with IEC 60794-1-2-E1;
- Crash – in accordance with IEC 60794-1-2-E3;
- Impact – in accordance with IEC 60794-1-2-E4;
- Torsion – in accordance with IEC 60794-1-2-E7;
- Bend – in accordance with IEC 60794-1-2-E11A;
- Bend under pressure – in accordance with IEC 60794-1-2-E18;
- Repeated bending – in accordance with IEC 60794-1-2-E6;

- Temperature cycling – in accordance with IEC 60794-1-2-F1;
- Water penetration – in accordance with IEC 60794-1-2-F5B; - Drip - in accordance with IEC 60794-1-2-E14.

4. Requirements for the Underground fibre optic cable installation

At the underground cable laying the fibre optic cables should be installed in a trench along the railway line in the easement area at the outer side of the drainage ditch at a distance of at least 1 meter away from them and not more than 0.5 m from the end of the easement area in a protective HDPE (High Density Polyethylene) pipe.

The fibre optic cable route, the location of the shafts (containers) and the cable boxes should be marked by permanent benchmarks of concrete blocks and passive tags.

Two HDPE pipes with where the optical cable should be laid should be placed in the trench for the underground fibre optic cable laying, as the second one should remain free for the future development of the telecommunications.

The required shafts should be constructed at the discretion of the Contractor – at a typical distance of every aprox. 1.5 – 2.5 kilometres and according to the fibre optic cable laying standards. The shafts (containers) should be constructed so that they may be covered with at least 30-40 cm earth fill to the ground level.

A yellow warning tape marked “Attention optical cable” should be placed over the HDPE pipes at a depth equal to the half of the distance between the ground surface and the cable”.

The cable should be installed in the protective HDPE (High Density Polyethylene) pipe placed in the trench.

The cable boxes should be installed in the shafts, as technological reserve should be provided for at each side of the cable box.

The entry into the station buildings shall be executed via non-combustible station optic fibre protected by a metal pipe.

A spare cable should be placed at the input points in the building.

5. Requirements for termination and splicing
    - Optical couplers

Suitable dielectric couplers should be used to connect the cable lengths and for deviations from the cable. The optical coupler should be made of weather-resistant hard plastic.

The couplers contain splice – tray with holder.

- In the splice – trays on a special splice – strage) are located the welds of the pig-tails, protected by thermo-fit/ thermo-contracting muff/ tubes. The inclusion of the loss of each weld (joint) should not exceed 0.1 dB.
- The splice-holder, which is placed in the splice-tray, is used to fasten the connected optic fibres and protect the bare optic fibres against mechanical damage.

The input of the coupler should be encapsulated.

Requirements for the encapsulation of the coupler should be checked by applying pressure of 40 kPa for a period of 15 min with coupler immersed in water at room temperature. The coupler should be considered encapsulated, if no constant stream of air bubbles is coming out of it.

For underground cables the couplers are installed in underground pits /containers/, a spare cable should be provided on both sides.

Cable materials and materials used for coupling, installation and commissioning should not be toxic and harmful to the skin.

The structure of the couplers should provide good mechanical protection. The coupling should include:

- reinforced casing

- minimum three cable inputs (hot or cold) with reduction / shrinking couplers
- the necessary number of splice-trays

The casing of the coupler should withstand without damage static load of 1000 N per 5 cm2 of contact area in the center for 15 minutes.

- Optical repartitor

In the endpoints the fibre optic should end on termination and distribution systems - ODF.

The optical repartitor or the optic distribution patch-panel is intended to build and distribute optical communication links between the end fibre optic and the end optical devices of telecommunication facilities.

The optical repartitor should have a removable front panel according to the different types of adapters (FC, SC, ST, E2000, etc.). The optical fibers are ranged thereon.

The optical coupling should be of the type SC/APC.

The inclusion of the loss of each weld (joint) should not exceed 0.2 dB and the increasing loss for connectors should be less than 0.1 dB after 500 turnings of the connector (connection and disconnection).

ODF should be placed in 19'' standard cabinet with a lock located in the specially designated areas for the telecommunication equipment at the railway stations. The dimensions of the cabinets shall be approved by HSH.

All elements of active and passive equipment such as optical splitters, pig tails, fibre optic connectors, fibre optic cords /Patch-cords/, fibre optic adapters, and materials used in the installation of fibre optic cables must comply with the latest editions of the recommendations of the ITU-T (International Telecommunications Union - Telecommunications sector), the European standards and laws, as well as the specific requirements of the International Organization of Railways UIC (sheets 750, 754, 755-1, 755-2, 756, 757-2, 758, 780, 781, 917-2, 917-4).

- Environmental conditions for operation of the fibre optic cable

The installed fibre optic cable should work without interference, under both normal and the most adverse environmental conditions.

- Requirements for the measuring devices

The Contractor shall provide for delivery:

- Fibre optic cable meter (reflectometer);
- Device for connection /welding (splicing) of optical fibres; -
- locator to determine the locations of radiofrequency passive tags;
- Two complete sets of tools for fibre optic cables processing.

Requirements for the reflectometer:

- Display – colour;
- Measuring units – metric;
- Wave length measurement - 1310 ± 20 nm and 1550 ± 20 nm;
- Transmission power no less than 41 dBm and measurement of real distances no less than 150 km;
- Distance of measurement accuracy - ±1 m ± 1.10-5 of the distance;

- “Dead zone” insensitivity area – imum 1 m;
- “Dead zone” /sound fade of attenuation – imum 15 m;
- Measuring device memory – minimum 100 curves;
- Data of port RS 232 or Ethernet; - Software (compatible with Windows, etc.);
- Weight including battery – less than 5 kg.

Requirements for the light source:

- Type of source – laser;
- Emitted waves length range – 1310 ± 20 nm and 1550 ± 20 nm;
- Wave sector – imum 5 nm;
- Power/ ratio transmission performance – 9/125;
- Radiation capacity – min. -7 dBm
- Possibility of modulation;
- Weight including battery – less than 0.5 kg

Requirements for the light metering device:

- Emitted waves length range: from 800 nm to 1550 nm
- Range of measured power: from -60 to + 6 dBm
- Power measurement range: (1310 nm and 1550 nm) – 0.25 dB
- Measurement accuracy – 0.01 dB
- Weight including battery – less than 0.6 kg

Requirements for the measurement protocols:

- Control measurements recorded in the measurement protocols should be made before commissioning of the fibre optical cable.

The protocols shall contain:

- Type of cable;
- Reflecto gram of each fibre in directions A-B and B-A at 1310 nm and 1550 nm;
- A table of specific items with descriptions, distance from the beginning, railway mileage, and imported attenuation;
- Length of the installed cable (footage marking), length of each fibre;
- Attenuation of each fibre in the direction A-B and B-A at 1310 nm and 1550 nm, as measured by source of optical power and meter.

2.14.5 High speed digital transmission system – (SDH/STM16)

SDH systems are the basis for the construction of the highway transportation telecommunication connections network. The telecommunication network serving the rehabilitated line should be constructed as a single automated network of communication points connected by means of digital transmission devices over synchronous digital hierarchy SDH, type STM16 (OC-12/48).

It can carry 30,000 communications, respectively, data channels, possibly to transfer information to 2.4 Gbit/s G10-Ethernet network protocol.

The transmission of voice messages, video images and data will be made through a fibre optic cable connection. Copper cables will only be used for connections to the equipment terminal (phones etc.).

The suggested SDH - high-speed digital transmission network has:

- the best economic indicators
- high reliability of both network and services
- opportunities for protection and management of resources
- predictable behaviour in critical situations involving removal of nodes and transmission lines from the telecommunication network

SDH high-speed digital transmission network and transport modules STM16, STM4 and STM1 should comply with the recommendations of ITUT:

- ITUT G.707 for SDH frame, multiplex structure
- ITUT G.957 /958 for optical interface
- ITUT G.825 Recommendation for jitter and variable tolerance
- ITUT G.821/826 for transmission quality
- ITUT G-811 for synchronization
- ITUT G.813 for synchronization
- ITUT G.783 for SDH equipment specification
- ITUT G.841 for protecting network architecture – detailed review of the methods and devices for reservation of transmission lines at the system level in the SDH hierarchy

- General requirements

The project provides for the supply and installation by the Contractor of transmission equipment for the synchronous digital hierarchy system (SDH/STM16), working on fibre optics.

The transmission system in Shkozet unit should be of synchronous digital hierarchy SDH, STM-16 type and comply with the recommendations G.707, G.783, G.774 of ITU-T.

- SDH transmission system network is a transport plane and is paired with the following modules:
- SDH physical transport level
- channel switching level
- synchronization subsystem
- information system security
- modules for service integration - integration of the processes of sealing (multiplex), transmission of switching and equipment for (SDH)
- interfaces for connections with other transmission systems and communication networks
- automatic network for connection with moving objects
- points of access to the transmission system
- unit for group and individual coding of the information from subscriber to subscriber (digital encryption tracts)
- automated management system

The SDH system should have centralized management. The Control Centre should manage all nodes of all SDH equipment and will be placed in station of Shkozet.

STM 1 transport interface will be extracted from STM 4 transport interface on each station for business and other connections.

The transmission system must provide connections to the following stations, and operating points:

- Durres (terminal station),

- Shkozet,
- Sukth,
- Vore,
- Kashar,
- Tirana Public Transport Terminal
- Rinas Airport

SDH system should consist of a real ring using 4 fibres from the fibre optic cable.

In one direction a beam of SDH ring must come at each station and substation to implement the necessary operational, specialized, administrative and other telecommunication networks.

- Functional requirements

SDH/STM system equipment for digital transmission, access and multiplexing should meet all the standards specified in ETSI EN 30019-2-3V2.1.2. (1999-09) Class 3.1E.

SDH/STM system should be a set of a new generation of switching nodes realized with a small number of modules.

SDH/STM system should meet the following requirements:

- reduced energy consumption to be able to command the growing subscriber traffic
- to be implemented with single stage, unblockable switching matrix
- to allow commutation of connections at successive time intervals
- to allow 100% monitoring of conversations channels through the field;
- to have a Signalling system of the latest generation - a common channel Signalling with its user and application areas
- to serve the exported subscriber steps
- to have high speed subscriber access
- to create switching opportunities for service of narrowband and broadband traffic
- to provide an opportunity for Internet telephony (IPT, VoIP)
- synchronization exported from the information structure
- the standard for synchronous hierarchy to include synchronous coding
- to allow efficient and economical management of the transmission network
- high reliability with mechanisms for automatic backup
- standard interfaces for connections between networks of different providers
- network components should provide an opportunity to upgrade and expand the system
- the devices for simultaneous transmission of voice and data must be integrated solutions with high quality compression, dynamic allocation of the spectrum - VoIP, IP routing
- to enable the use of additional methods for sealing of fibre optical cables by multiplexing along the wavelength

- Connections made by the digital transmission system – SDH

The capacity of digital transmission system (SDH) should ensure the transfer of all operational railway connections.

The SDH equipment should ensure STM-16 - transport interface and total probability of error in the transmission of digital information not higher than 1*10-9.

The proposed SDH hierarchy includes information volume, capacity and transmission speed of the transport module, as follows: 2.5 Gbit/s /2488.32 Mbit/s / - STM16 / 30720 channels/.

The transmission system should provide:

- E1 connections with interface G703/704 symmetrical 120 Ohm
- 1 pc of STM 4 and extracted STM 1 interface at all stations on the line
- one E1 connection between any two adjacent points designated for station telephone connections
- At each point should ensure a minimum number of four Fast Ethernet interfaces.

The remaining free capacity of the SDH system should be used for future expansion.

- Protection of the transmission system

In each of SDH system multiplexers should be provided circuit protection of E1 interface boards and power boards. This means that the failure of one E1 board or one power board should not lead to disruption of the functioning of the connections for more than 1 s.

SDH system should provide:

- Linear protection of type 1+1, where traffic is transmitted simultaneously along the working ring and the guard ring, or 1:1, in which the traffic is transmitted along the working ring, with the ability of all traffic to be transmitted along the backup ring.
- Ring protection of type UPSR (Unidirectional path-switched ring) or ULSR (Unidirectional lineswitched ring) or BLSR (Bidirectional line-switched ring). The ring protection should provide preservation of all links in a single interruption of SDH ring and the functioning of the remaining “islands” upon the termination of the SDH ring in two places.
- SDH ring should provide path protection switching of digital streams at each node:
- upon node exclusion (e.g. interruption of power supply) – the connection should be preserved with all other nodes
- upon termination of fibre optic cable to maintain the functioning of connections in the formed islands

- Management of telecommunication equipment and transmission system

Management and control of telecommunication equipment and transmission system should be performed by centre for control and management of all devices and systems (Network Management system) located in Shkozet station.

The SDH system should have centralized management, which should control all SDH nodes (see also chapter 2.6).

For this purpose, the following requirements for different devices should be fulfilled:

- Each device should have a local control port, which connects to the laptop for diagnostics, configuration and control of space and the possibility of remote monitoring and management.
- Telecommunication node – Shkozet should have 1 pc. of laptop and 1 pc. of desktop PC for functional and administrative control and systems monitoring. The PC must have the capacity to store all types of configurations, data exchange, alarms and messages related to the maintenance for minimum period of six months. disk recorders should be mounted (CD-RW) and/or (DVD+RW) for transmission, data backup and system administration.
- All computers must be equipped with licensed software.
- The supplied control systems for transmission and transport systems STM/SDH, access devices and the network as a whole, should include hardware and software that allows the operator from Shkozet to operate on a daily basis the systems, to monitor the status of connections and their administration, including, where appropriate, to exercise remote control from the centre in the telecommunication node – Shkozet Station.
- The control systems should include the necessary software for graphical display of network

status.

- The systems for control of errors and configuration, for reporting and monitoring of performance should provide opportunities for:
    - alarm control and information
    - full control of faults
    - configuration and reconfiguration
    - accounting and administrative control \ performance control
    - security control

The Automated Management System should include:

- technical support - set of technical tools for management automation
- information support
- linguistic support
- software and mathematical security for solving in real-time information, account, and information-account tasks on planning and management of connections

The architecture and technical basis of the automatic management system should be unified to conform to the modern communication information technologies, to be flexible and open to expansion and improvement.

The system should allow remote and local execution of the following commands:

- management of faults
- configuration and reconfiguration of devices
- administrative and user settings (tariff)
- characteristics monitoring
- performance control
- access control

The management centre should be provided the necessary software for graphic display of the system status.

- Power supply and management

Power supply of all nodes of the STM/SDH digital transmission system, access equipment, Gigabit Ethernet backbone data network, station hubs and traffic control connections, etc. should be 48 V DC from the rectifier and built-in sealed gel battery.

Power supply should be calculated so as to ensure the performance of all devices connected to it and guarantee at least 5 hours in case of 220 V.

For the purpose rectifiers should be mounted of 220 V AC / 48V DC in accordance with the required capacity of the installed equipment and systems.

In calculating the capacity of the rectifier and the battery it should be kept in mind that the same will supply not only the SDH transmission system equipment, but also the multiplex equipment, the station hubs of the connections, the backbone data network, etc.

- Climatic requirements for the equipment

The entire equipment procured for digital transport transmission of the type STM/SDH, and the access and data transmission equipment - Ethernet, should meet all the standards specified in ETSI EN 300019-2-3 class 3.1 E – equipment installed in rooms without air conditioning.

The equipment must work reliably under the following minimum environmental conditions:

- temperature – from -5°C to +45°C
- relative humidity – from 5% to 90%

2.14.6 Access systems (Multiplex equipment)

1. Scope of the system

The project provides delivery and installation by the Contractor of the access system (multiplex equipment for LF connections) and equipment necessary for the realization of low-speed digital interface (n x 64), LF (low-frequency) interface, etc. according to the specification.

The access systems are designed for:

- Connection (cross-connection) of 64 kbit/s channel from one port E1 to 64 kbit/s channel from another port E1 for transit of level 64 kbit/s;
- Connection (cross-connection) of 64 kbit/s channel from one port E1 to local analogue or digital port, including analogue to digital conversion and conference mixing, where and if necessary.

Access devices in the telecommunications node - Shkozet should be envisaged as well as in all stations and traction substations along the line Duress – Tirana – Rinas airport.

2. General requirements

- Power supply - from the station voltage 48 V DC
- The speech signals must be compressed under A Law according to ITU/T
- power module of the devices need to be reserved and can be replaced without the need to shutdown
- termination devices (repartitor), cabinet 19', connecting cables, patch – cords
- Multiplex equipment should be able to configure and control both locally and from the management centre, located in Shkozet.

3. Ports of access equipment
    - E1 Ports

E1 ports should have interface under G.703/704 - 120 Ohm, symmetrical.

E1 interface ports are connected to the appropriate ports of the SDH equipment. For each equipment of the access systems there should be the required number of E1 ports to connect through SDH to the access device to the previous station, and the other - to the access device to the next station.

The number of E1 ports should be consistent with the number of exported automatic telephone posts.

- Ports with local battery (LB) interface

Ports must ensure proper operation when connected to a corresponding interface of station hubs.

The impedance should be 600 ohms.

The call-up voltage of transmission - 80 V with a capacity of 1μF plus resistance 4.7 kΩ, frequency 25 Hz.

The call-up voltage of acceptance– from 120 V to 12 V, frequency from 16 Hz to 60 Hz.

The number of ports and interfaces with local battery (LB) for stations of the line should be at least two pcs. for connection with neighbouring stations in both directions.

The ports serve to implement the inter-station connections.

- Ports with active central battery interface (FXS)

The port should ensure the normal operation of the “central battery” telephone with tone and pulse dialling.

The impedance should be 600 ohms.

The call-up voltage of transmission - 80 V with a capacity of 1μF plus resistance 4.7 kΩ, frequency 25 Hz.

When calling to the switched-on telephone, the port should enable the transmission of signals to identify the caller (CLIP) under the FSK and DTMF systems between the first and second call and DTMF before the first call.

The ports serve to include an analogue telephone subscriber connected to the telephone exchange.

- Ports with passive central battery interface (FXO)

The port should ensure the normal operation upon switching of a remote telephone with tone and pulse dialling.

The impedance should be 600 ohms.

When calling to the switched-on telephone, the port should enable the transmission of signals to identify the caller (CLIP) under the FSK and DTMF systems between the first and second call and DTMF before the first call.

These ports serve to equip only access devices located in the RATE stations. They serve to connect the line of RATE analog telephone number.

The number of FXO ports should comply with the external analog telephone posts.

- E&M Ports

E & M ports consist of two signal wires (E, M wires) and speaking wires in two versions – two-wire call (option 2WE&M) and four-wire call (option 4WE&M).

Switching of the port from 2WE&M to 4WE&M mode should be carried out either by software or hardware by moving the jumpers or switches.

The ports in 2WE&M mode should work with a transmission level of 0 dB and reception level of -7 dB.

The ports in 4WE&M should work with levels of transmission and reception, which can be set by software within -14 dBr to +4 dBr, in steps of 1 dB or less.

In 4WE&M operation mode the security between transmission and reception should be better than 60 dB.

Impedance of conversation pairs should be 600 ohms.

Ports serve for creating telephone channels with different functions and construction of specialized railway connections.

2.14.7 Specialized communications

1. Purpose

Specialized telecommunication systems must provide at least the following types of connections:

- Inter-station direct telephone connection
- train traffic control connection
- Telephone connection for general usage (automatic telephones)

2. Requirements for the connection types
    - Inter-station connection

The inter-station connection is direct analogue link between adjacent stations. The number of interstation connections to be built within the section is equal to the number of interstation sections.

The terminal equipment is located at the train traffic manager at the station and is a port of the station hub.

- Station’s internal telephone connection

The internal phone connection is an operative connection of the station traffic manager with the telephones located in the station’s area.

The internal telephone connection is connected to the station hub ports and is effected via copper cables.

- Automated service telephone connection

The automated telephone connection in the area is provided by the network of railway automated telephone exchanges.

The line of automated telephone of the traffic manager should be connected to the station port hub.

- General functional requirements for traffic control connections

Each traffic control connection is closed non-switching link consisting of traffic control and regulated subscribers.

The linking of traffic control connection to other lines and subscribers shall not be allowed except for the cases provided by regulations of Albanian Railways.

Traffic control telephone connections should operate separately from the switching equipment of the automated telephone connections.

The quality of conversations should be equivalent to the telephone channel with parameters corresponding to Recommendation M.1020 of ITU-T.

- Train traffic control connection

The train traffic control connection is closed non-switching link consisting of a train traffic control and traffic movements in stations within the section in his command.

The train traffic control has speakerphone uninterrupted connection to the train traffic control connection.

The train traffic control has the ability to send calls to the stations - individually or in groups.

The stations are connected to the line by opening of the telephone device and can listen to the ongoing conversation or talk.

The conversations within the train traffic control connection are obvious.

The conversations are generally held at a conference-type manner – the speaking subscriber is heard by everyone else.

The subscribers should be able to engage in the connection at any time, regardless of whether they have received a call or not.

Microphone chains of all devices should be included by force by the speaker in accordance with the “push to talk” principle. To switch on the microphone chains, the traffic control units should have a pedal, panel button and tangent to the handset, the specialized telephones of subscribers can only have tangent of the receiver.

The equipment of subscribers, with which they carry out the connection to the traffic control, is of two types:

- connection hub of the traffic manager at the station
- separate specific telephones

3. Technical requirements for the station hubs
   - General requirements

The station hubs should be installed in the station Shkozet and Tirana. All active general service connections providing the work of the duty manager should be connected there.

The station hubs serve the traffic managers in the station to make phone calls with subscribers of different operational links:

- Inter-station connection
- Intrastation telephone connection

- Train traffic control connection

The equipment of the station hubs should consist of:

- Main unit
- Additional unit
- Switching device
- Terminal device

The main unit is installed in the workplace of the traffic manager and is used for making telephone calls by him only.

The additional unit is installed in the room of the traffic manager and is used for making calls by other persons connected with the train traffic. It can only make calls transferred from the main unit.

The switching device controls the hub operation and performs the switching of the lines.

The terminal device is designed for terminating the telephone wires leading to the hub.

Main unit should feature touchscreen, it shall present individual status indicators of each of the lines (repose, call, conversation, etc.), and individual buttons for switching to each port of the hub.

The main and auxiliary units should be shockproof.

The main and auxiliary units should be in coatings, enclosed with a seal. There should be a seal on the switching device body, if it is installed in the room of the traffic manager.

The couplers of the cables and the regulators of the calling devices (bells, buzzers) should be accessible only with unsealed apparatus.

The station hub should be supplied by the station steady voltage of 48V.

The station hub should make 365-day / 24-hour voice recording of all calls made from the main and additional units.

The station hub should restore its normal operation without any staff intervention after an interruption of the supply voltage.

The station hub ports are protected with five-point protection against overvoltage under the recommendation of the K-12 of ITU-T.

- Calling of the hub

When a call is received on a given port, the call should be displayed on the main unit and should stay until the connection of the main unit to this port.

Upon receipt of each call of a given port, acoustic device (bell, buzzer) should be activated nevertheless the main unit is connected to any port or is at rest. After a certain time expires – form 30 to 60 seconds, the acoustic call may be terminated and only the missed call visualization of the port shall remain.

Each individual port should be able to program in one of two call modes when there is an incoming call:

- single for 1 – 3 seconds
- without interruption until the connection of the main unit to this port

The main unit should be able to stop the ringing for a given call without starting conversation and without stopping the visual indicator of the call and the call status. This action should stop the ringing for next calls on the same or another line.

The hub calling device should be able to include additional external ringing with a separate power supply.

Each individual port should be able to program in one of two call modes of sending the signal “call control” when there is an incoming call:

- single for 0.5 to 1 s (369Hz,-20dB)
- without interruption (369Hz,-20dB with cadence 1s/4s, which is interrupted by a call from the main unit or after 30s)

- Acoustic characteristics

The main unit should be able to work as speakerphone and with a headset. The additional unit should work with headset only.

The design of the main unit, microphone, and other accessories should ensure a strong immunity to background noise that may be present in the room.

The subscriber should not send any other signals in the conversation tract besides the conversation and the signal “call control”

- Interfaces of the hub ports

Local battery interface (LB): The interface should ensure normal operation at connection both to “local battery” telephone and the respective interface of the access devices.

- The impedance should be 600 Ω.
- Call voltage at transmission– 110V at 1μF + 4,7kΩ, 25Hz];
- Call voltage at acceptance– from 12V to 120V, from 16Hz to 60Hz;
- An incoming call is performed by submitting call voltage to the port.
- An outgoing call is performed from the main unit by pressing (repeatedly, for example for submission of Morse code signals) call button on the main unit; the call voltage is supplied while the button is held pressed down.
- No signals are given for reply of the caller or disruption.

Active central battery interface (FXS):

- Used to establish direct telephone connections with phones installed at entry and exit telephones.
- The interface should ensure normal operation when connected to a “central battery” telephone.
- The impedance should be 600 Ω.
- Call voltage at transmission – 80V at 1μF + 4,7kΩ, 25Hz]
- An incoming call to the station hub (switch is implemented by closing the loop current / lifting the handset of the counter unit).

Passive central battery interface (FXO):

- Used to create links to FXS interfaces of other hubs or analogue telephones posts of the ATE.
- The impedance should be 600 Ω.
- Dialling – tone and pulse type.
- When calling in the direction of the ATE to the hub, the interface should allow you to obtain and indicate at the main unit the caller ID signals (CLIP) with DTMF systems before the first call, and DTMF or FSK between the first and second call.

Interface to traffic control connection

- The interface should allow connection in the four-wire traffic control connection, for example 4WE&M interface of station multiplexer.
- The impedance should be 600 Ω.
- The protection between transmission and acceptance should be better than 40dB (in the entire conversation range from 0.3 kHz to 3.4 kHz).

Switching requirements

- The incoming calls should be directed to the main unit.
- The main unit can create link between the additional unit and any port.
- The main unit can create a link between two specific ports, if the software allows for the combination of ports.

– The main unit can break the created connection, and connect to it, creating a three-sided conference.

– Each connection created through the main unit is indicated on the main unit, during the existence of the connection.

- Management system

The hubs should be able to manage both locally and remotely from the control centre.

The Control Centre should be equipped with computers, software, communications devices, printers and office equipment suitable for its proper functioning.

The management system should provide capabilities for:

– management of the malfunctions

– configuration

– accounting and administrative control /implementation control

– security /access/ control

The management system should provide remote access to recorded conversations in the station hubs / switches to perform after the incident analysis.

The control system should include the necessary software for graphical display of network status.

2.14.8 Backbone network for data transmission

The project provides delivery and installation by the Contractor of the high-speed network for transmission of voice, video, and data at a rate not less than 1 GB/s and connection of the LANs thereto.

1. General requirements

The data transmission network of the line is based on Internet Protocol and backbone Ethernet network (Gigabit Ethernet) between the operating points.

The stations will be connected to the data backbone network via the connection Fast Ethernet on SDH transport system.

The data transmission network can be used for various applications, some of which are:

– remote control of electronic information boards

– video surveillance

– SCADA (Engineer y for Control and Data Acquisition)

– remote information loudspeakers

– e-mail, access to Internet

– Future applications – information systems, reservation systems for passengers, security and alarm systems, multimedia applications, etc.

2. Data transmission network
    - Structure of the data transmission network

– Equipment should be installed at all stations to access the DTN along SDH Fast Ethernet connection with a speed of 100 Mbit/s and Ethernet user interfaces 10/100 BASE Tx or faster.

– Equipment should be installed at all stations to provide at least 16 number of user Ethernet ports.

– The physical interfaces at the stations should be RJ-45.

– The data transmission network (the backbone Gigabit Ethernet) should work on independent individual fibre optic cables.

- The traffic capacity of the backbone optical Ethernet network along the fibre optic cable should be 1000 Mbits/s according to IEEE 802.3ae.
- The management of all data transmission network should be provided by a control centre located in Telecommunication node - Shkozet.
- Power supply of new devices of the data transmission network should be from the station 48 V DC.
- The power module of the devices need to be reserved and can be replaced without shutdown (Hot-Swap).
- The backbone Ethernet network devices should be of one product line and should maintain the latest specifications of protocols for level 2 and level 3 of RFC recommendations for dynamic routing protocols, quality of service (QoS), traffic protection level 2 and level 3, Security and DoS protection, remote management and configuration (SNMP, RMON, HTTP, Telnet) and autonomous from the serial port.

    - Hardware requirements

- The network will be executed with routers of one product line.
- The use of a series of routers with different hardware configuration is allowed.
- Power modules on the routers need to be reserved and can be replaced without shutdown (HotSwap).
- GBIC transceivers should be of type LX-GBIC and should maintain the opportunity to work with single-mode optic fibre up to 90 km at least.
- The mechanical dimensions of the routers should be adapted for installation in a standard 19" cabinet.

    - Software requirements

- Requirements for Layer 2 protocols
- Support of IEEE 802.1q – VLAN Tagging.
- Support of IEEE 802.1p – Packet Priority.
- Support of IEEE 802.1ad – Link Aggregation.
- Support of IEEE 802.1D – Spanning Tree.
- Support of IEEE 802.3z (1000 BASE-X).
- Support of IEEE 802. 3x (Gigabit Port Flow Control).
- Support of Port-based VLANs.
- Support of MAC address - based VLANs.
- Support of Protocol-based VLANs.
- Support of IEEE GVRP (Generic VLAN Registration Protocol).
- Support of Jumbo Frames.

    - Requirements for Layer 3 protocols

- Basic routing protocols:
- IPv4 router requirements – RFC 1812
- CIDR – RFC 1519
- IRDP router discovery – RFC 1256
- TFTP – RFC 783
- BootP – RFC 1542
- BootP/DHCP helper – RFC 2131

- DNS (client operation) – RFC 1591
- Host requirements – RFC 1122
- UDP – RFC 768
- Internet Protocol – RFC 791
- ICMP – RFC 792
- TCP – RFC 793
- ARP – RFC 82
  - Dynamic routing protocols:
- RIPv1 – RFC 1058
- RIPv2 - RFC 2453
- OSPFv2 – RFC 2328
- OSPF NSSA Option – RFC 1587
- OSPF with Digital Signatures (password, MD-5) – RFC 2154
- Border Gateway Protocol 4 – RFC 1771
- Autonomous System Confederations for BGP – RFC 1965
- BGP Route Reflection – RFC 1966
- BGP Communities Attribute – RFC 1997
- BGP/OSPF interaction – RFC 1745
  - IP Multicasting:
- PIM-SM – RFC 2362
- PIM-DM – Draft IETF PIM Dense Mode v2-dm-03
- DVMRP Host req. – RFC 1122
- DVMRP v3 – Draft IETF DVMRP v3-07
- IGMP v2 – RFC 2236
- IGMP Snooping
  - Quality of Service (QoS):
- DiffServ Precedence – RFC 2474
- DiffServ Expedited Forwarding – RFC 2598
- DiffServ Assured Forwarding – RFC 2597
- DiffServ Core and Edge router functions – RFC 2475
- Ability to create QoS profiles by defining bandwidth and priority
- Ability of classification and clustering traffic on the following attributes:
- Application (TCP/UDP port)
- Protocol
- IP network/address
- VLAN
- MAC address
- Physical port
- Support of Policy-based QoS
- Support for bidirectional bandwidth control and speed

- Traffic security:

– Layer2 – Support of EAPS (Ethernet Automatic Protection Switching)

– Layer3 – Support of VRRP (Virtual Redundant Router Protocol) – RFC 2338

– Layer3 – Support of Standby Routing Protocol

– Security and DoS protection

– RADIUS – RFC 2138

– RADIUS Accounting – RFC 2139

– RADIUS per command Authentication

– TACACS+

– Access Control Lists on all routing protocols

– Access Control Lists on all management methods

– Network Login

– Support of Secure Shell 2 (SSH2) – FIPS-186

– 3DES-CBC cipher RFC 1851

– Network Ingress Filtering – RFC 2276

– RPF – Reverse Path Forwarding Control

– Rate Limiting by Access Control List

– CERT and ROOTSHELL immunity testing

- Management:

– SNMPv1/v2c – RFC 1157

– SNMPv2 RFC – 1907

– RMON 4 groups: Stats, History, Alarms & Events – RFC 1757

– RMON2 (probe config) – RFC 2021

– IEEE 802.3 MAU MIB – RFC 2668

– Bridge MIB – RFC 1493

– MIB-II – RFC 1213

– Entity MIB – RFC 2037

– Interface MIB – RFC 2233

– IP Forwarding table MIB – RFC 2096

– RIPv2 MIB – RFC 1724;

– Private MIB (to include ACL, QoS policy and VLAN config)

– HTTP – RFC 2068

– Telnet – RFC 854

– Console

– Simple Network Time Protocol Ver 3 – RFC 1769

– Configuration logging

– Multiple images, multiple configs

- Performance for switches of type 48 x 100 Base Tx / 2 x 1000 Base-X GBIC

– unblockable switching field capacity of min 16 Gbps

– Forwarding rate: min. 10 Mil pps

- “Wirespeed” L3 switching of all ports
- “Wirespeed” Access Control List
- Support of 4096 VLANs
- Support of 128 000 MAC address
- Support of hardware QoS tails at each port

3. LAN – Local Area Network

Local networks should be built within each post, which in turn will be connected to a common LAN network with the telecommunications centre - Shkozet.

Building a LAN network will contribute to:

- Effective management and control of operation at the station;
- Easy reorganization of processes, when necessary;
- Use of all internal reserves of personnel and equipment at the station;
- easy and accessible information security;
- efficient use of resources, optimization of the ratio between the input and the result obtained;
- Easy and smooth reorganization of the equipment in case of change in the number of end users.

LANs should be built in accordance with International Standards - IEEE, ISO and IEC, national standards.

4. Structural cabling – technical requirements

The Contractor shall install all necessary indoor distribution cables in the premises of the operating points, i.e. to the workstations and technical facilities for local telephone, specialized and traffic control connections and connecting cables for connections to equipment. Furthermore, to each workstation shall be built an installation for internal LAN network. If the workstations are not properly marked, a socket shall be installed for network of the type RJ-45 at each 4 m2 of work area.

In the technical equipment rooms, the termination of the internal cables shall be on connection modules Krone type or on appropriate patch panels.

All internal wiring should be numbered with unique numbers and appropriately marked.

The cables are designed for installation in buildings, non-flammable and hard burning, with halogen free material (LSZH), mounted in protective PVC channels of adequate size. The indoor distribution cables in buildings can be of the type J-Y (St)Y. Lg; A-2Y(L)2Y; UTP, FTP, S-FTP and other completely equivalent, designed for installation in buildings and structural cabling.

Cables for transmission of analogue and low speed telephone signals must comply with VDE 0816-1 and VDE 0815/A1.

Cables and jacks for the LAN (UTP, FTP, S-FTP) must meet the requirements of ISO/IEC 11801 and ANSI/TIA/EIA-568-A-5.

The structural cable telecommunication system should be based on the following principles:

- The network topology shall be of “star” type.
- The used cables for the construction of the network from the cable distribution to the endpoint shall be copper cables with twisted pairs of cables type FTP Cat 6 or Cat 7, all connecting elements, components and jacks must also meet the requirements of Cat 6 or Cat 7;
- The cable environment for LAN allows data transmission with speeds of at least 100 Mbit/s to each workstation and endpoint;
- Enabling each of the main services (General and special Telephony, Internet, Intranet, etc.) that use the cable system to be efficiently, easily and quickly provided to any premises in the building and to each workstation;

- Communication terminals in the premises in the station building to allow switching of computers, servers, terminals, network printers, telephones, faxes, modems, etc. Therefore, the outlets have been selected on RJ-45– Cat 6 and RJ-11 jacks for analogue telephony. This will allow easy removal or replacement of equipment related thereto;
- The outlets of the cables in the telecommunication room shall be positioned on patch panels located in 19” EIA cabinets with ventilation and locking. They will be terminating all cabling systems of appropriate cable distributors and will house the active network equipment.

When preparing the detailed design all the necessary conditions should be taken into account for the protection against unauthorized access, light, humidity, temperature, protection from electromagnetic radiation, external damage, electrostatic, fire protection, etc.

All cables from the cable structural system should be incontinuous along their entire length by the distributor to the premises without fitting extensions. All cables shall be marked at each end with a unique sign. Used cables should have permanent printed markings on the outer cover indicating the manufacturer, type, impedance, category, number of twisted pairs and cores. The cables that make up the system will be installed mainly on suitable grids in suspended ceiling (where available) and in the working premises in corrugated pipes embedded in the wall or in the appropriate in size cable channels.

In the preparation of the detailed design and its implementation should be kept the requirement that the distance from bundles of telecommunication cables UTP, FTP, S-FTP and TSVV to the electrical installation be not less than 20 cm

The minimum permissible length of routes from each cable distribution cabinet to each of the receptacles shall not exceed 94 meters.

The distribution panel in the communication cabinet is intended to be with sufficient number of ports to include all subscribers. It is necessary to meet the specifications of ISO/IEC 11801, EN 50173-1, Cat 6 or Cat 7. The face of the distribution panel is equipped with connectors RJ-45 (ISO/IEC 8877) for the inclusion of computer systems. For analog phone systems, cables are unwired on a panel with RJ-11 connectors (ISO/IEC 8877). Structural implementation of panels should be designed for installation in 19’’ EIA rack. Connection of cables to the connectors on the distribution panel with communication boxes (sockets) should be executed under 4-pair diagram of crimping according to ISO/IEC 11801. In the communication cabinet should be installed at least one piece of arrange panel for arranging the building installation cables and the active network equipment.

In each communication cabinet should be provided and installed the necessary number of dividing modules “Krone”, designed for installation of cross-bar for the 19 "rack. The same are designed to unwire the connection cable TSVV serving as a link between the premises of TC with the premises of stations.

To the telephone connection modules can be installed attachments with five-point protection - lightning arrestors to protect equipment from overvoltage and power surges.

Communication terminals (outlets) for computer workstations and endpoints of the premises must comply with TIA/EIA TSB 40-A, TIA/EIA 568-A, ISO/IEC 11801, EN 50173-1 for Category minimum Cat 6. The diagram for crimping of cables to the RJ-45 connectors of the communication boxes (outlets) should be executed under the configuration of T 568A. Each of the communication boxes (outlets) for computer workstations should be of the type RJ-45. The diagram for crimping of cables to the RJ-11 connectors of the communication boxes (outlets) should also be executed in four wires to two terminals (two outlets per workplace) to include phone or fax. Each panel with communication terminals should be numbered with a unique number.

2.14.9 Network Management System (NMS)

The centre for control and management of all devices and systems (Network Management System) should be located in the telecommunication unit - Shkozet.

Each device must have local control port to allow connection to a laptop for diagnostics, configuration and control on site and port for remote control and management centre in Shkozet.

The telecommunications system should be equipped with workstations and/or PCs for functional and administrative control and monitoring of the systems. The workstation (PC) should have the required capacity to store all types of configurations, data sharing, alarms and communications related to the systems maintenance for a minimum period of 6 months. Disc recorders (DVD) should be installed for data transmission and backup and system administration.

All workstations (PCs) must be equipped with licensed software.

The supplied control systems for the transmitting and transmission systems STM/SDH, of the access equipment, the supporting network for data transmission Gigabit Ethernet should include hardware and software that enables the operator to operate and control the systems on a daily basis, to monitor the state of relations and their administration, including, where appropriate, via remote control from the operational centre in Shkozet.

The systems for control of errors and configuration, for reporting and monitoring of performance should provide opportunities for:

- alarm control and information
- full control of faults
- configuring and reconfiguring
- accountability and administrative control / monitoring of performance
- security (access) control
- The Automated Management System should include:
- technical support - set of technical tools for management automation
- information support
- linguistic support
- software and mathematical security for solving in real-time information, account, and information-account tasks on planning and management of connections

The system should allow remote and local execution of the following commands:

- management of faults
- configuration and reconfiguration of devices
- administrative and user settings (tariff)
- characteristics monitoring
- performance control
- access control

The management centre should provide the necessary software for graphic display of the system status.

The Contractor shall supply the necessary hardware and software to implement the management systems and Network Management System in sufficient volume and as required. Implemented in one control centre – Shkozet

The Contractor should deliver two portable PCs (laptops) for local configuration and testing of the service personnel of the Contracting Authority.

1. Requirements for the software

All software products for the operation of equipment and systems which will be supplied must have a license period with duration for the entire lifetime of the systems and should work without any additional requirements for payment during this period of work.

The Contractor and equipment suppliers should submit the necessary certificates for software licenses. The version of the software should be the latest effective version not older than one year from the date of implementation of systems and should be installed in the latest possible final OS to the year of commissioning.

2. System architecture

- Centralized management systems should have:
- Client – Server architecture;
- PC work stations;
- Graphical interface;
- Physical and logical topology;
- Fault & Alarm management;
- Configuration Management;
- Status Monitoring;
- Real Time Performance & Statistics;
- Inventory;
- Reports generator;
- End to end VLAN Management;
- Centralized security administration;
- Maintenance of network elements from other suppliers;
- Ability to integrate other functional modules aimed at the management of services at a higher level (Layer 4-7), QoS and Policing and other.

3. Technical premises – technical requirements

Construction of technical buildings with special technical premises for the equipment set of the electronic centralizations is planned in all railway stations and in between stations according to the Contractor's implementation study.

2.14.10 Staff training

The Contractor shall provide training consisting of different training courses for such engineers and technicians from among HSH staff as designated, so that said staff can in turn train other HSH staff whenever this is required for scheduled system equipment maintenance and remedy of faults and malfunctions. The training shall be both theoretical and practical and shall be regularly conducted in Albania, in Albanian language and using appropriate training material, which shall also be in Albanian.

2.14.11 Cable routing

- Trench

The cable installation trenches shall be constructed by the Contractor and its width shall be typically 0.50 m (signalling trench) and 0.30 m (telecommunications trench) to a depth from 0.50m to 0.80m. The work shall be carried by hand or through mechanical means, on all type of terrain, including rocky ground, along a straight or curved or zigzag line, at any location, i.e. on the open line, inside and outside station areas, close to any other cable carrier, etc.

Following is a detailed list of the works included:

– Excavation of a trench dimensioned as per the above and at suitable locations for the construction of the route, which shall be carried out by hand or through mechanical means.

– Removal of all types of deck, regardless of thickness, (blocks, sidewalk tiles, etc.) where necessary, including demolition of part of the concrete. All necessary preparatory work, such as uprooting and clearance of scrub, removal of water from the trench, removal of falling materials, removal of sleepers, rails, etc.

– Retaining of the trench sidewalls where necessary.

– Loading, unloading, transportation and disposal of excavated material at locations permitted by competent authorities, regardless of transportation distance.

– Formation of the bottom of the trench so that it is smooth and free from aggregates (if the depth of the trench cannot reach at 0.80 m due to special circumstances, special protection measures shall be taken, at the same unit price and in accordance with the requirements set by the Engineer y authority).

- Requirements for the HDPE protective tube

The HDPE tubes have been issued “Permission for installation in the urban telephone networks”.

The HDPE tubes have a special ribbed inner surface to reduce the coefficient of friction between the cable and tube and to facilitate the installation.

The HDPE tubes should be manufactured only by primary material brand 273-79 and should have a size of ø50x3.5, 5 - at the discretion of the Contractor. At each meter of the tube indelibly imprinted should be the trademark, the size, the material, the standard, the current length and direction of growth of the footage.

The hermetic connection of the tubes should be carried out by compression fittings (couplings).

All HDPE tubes should have indelible marking of different colour clearly visible for easy identification (or the tubes themselves should be of different colour), with an inscription and the current footage.

2.14.12 Interfaces

The internal interfaces are technical or organizational connections between various parts or elements of the system, which are specified in different specifications.

The contractor shall be responsible for provision of fully operating signalling equipment. His responsibility covers all internal interfaces and is not limited to the internal interfaces, specified in this technical specification. The internal interfaces shall be specified in detail by the Contractor.

Each of the telecommunication equipment systems apart from its own and mutually connected interfaces requires also interfaces to the signalling system, the Power supply system, etc.

2.14.13 Testing - deliveries

The Contractor shall conduct all necessary tests in order to ensure and confirm proper and safe operation of the signalling system. The tests shall include the following sections:

- Factory Acceptance Tests (FAT)
- Site Acceptance Tests (SAT)
- System integration tests - commissioning
- Provisional acceptance tests
- Final acceptance tests

2.15 Electrification Works

2.15.1 Table of Standards

No	Standard	Description
(1)	DIN 10218-1	Steel wire and wire products - General - Part 1: test methods
(2)	DIN 10218-2	Steel wire and wire products - General - Part 2: Wire dimensions and tolerances
(3)	DIN 1025-1	Hot rolled I-beams - Part 1: Narrow flange I-beams, I-series - Dimensions, masses, sectional properties
(4)	DIN 1025-2	Hot rolled I-beams - Part 2: Wide flange I-beams, IPB-series; dimensions, masses, sectional properties
(5)	DIN 12020-1	Aluminium and aluminium alloys - Extruded precision profiles in alloys EN AW-6060 and EN AW-6063 - Part 1: Technical conditions for inspection and delivery
(6)	DIN 12020-2	Aluminium and aluminium alloys - Extruded precision profiles in alloys EN AW-6060 and EN AW-6063 - Part 2: Tolerances on dimensions and form
(7)	DIN 18800	Structural steelwork; design and construction
(8)	DIN VDE 0115-1	Railways applications - General construction and safety requirements - Part 1: Additional requirements
(9)	EN 10021	General technical delivery requirements for steel and iron products
(10)	EN 10024	Hot rolled taper flange I sections - Tolerances on shape and dimensions
(11)	EN 10034	H and I section steel poles - sections, shape and size tolerances
(12)	EN 10160	Ultrasonic testing of steel flat product of thickness equal or greater than 6 mm (reflection method)
(13)	EN 10163-3	Delivery requirements for surface condition of hot-rolled steel plates, wide flats and sections - Part 1: General requirements
(14)	EN 10168	Steel products - Inspection documents - List of information and description
(15)	EN 10204	Metallic products - Types of inspection documents
(16)	EN 10218-1	Steel wire and wire products - General - Part 1: Test methods
(17)	EN 10218-2	Steel wire and wire products - General - Part 2: Wire dimensions and tolerances
(18)	EN 10246-1 to 18	Non-destructive testing of steel tubes - series
(19)	EN 10283	Corrosion resistant steel castings
(20)	EN 10306	Iron and steel - Ultrasonic testing of H beams with parallel flanges and IPE beams
(21)	EN 12020-1	Aluminium and aluminium alloys - Extruded precision profiles in alloys EN AW-6060 and EN AW-6063 - Part 1: Technical conditions for inspection and delivery
(22)	EN 12020-2	Aluminium and aluminium alloys - Extruded precision profiles in alloys EN AW-6060 and EN AW-6063 - Part 2: Tolerances on dimensions and form
(23)	EN 12166	Copper and copper alloys – Wire for general purposes

(24)	EN 1655	Copper and copper alloys – Declarations of conformity
(25)	EN 1706	Aluminium and aluminium alloys - Castings. Chemical compositium and mechanical properties
(26)	EN 50086	Conduit systems for cable management
(27)	EN 50119	Railway applications – Fixed installations-Electric traction overhead contact line
(28)	EN 50121	Railway applications - Electromagnetic compatibility
(29)	EN 50122-1	Railway applications - Fixed installations - Part 1: Protective provisions relating to electrical safety and earthing
(30)	EN 50124-1	Railway applications - Insulation coordination - Part 1: Basic requirements - Clearances and creepage distances for all electrical and electronic equipment
(31)	EN 60652	Loading tests on overhead line structures
(32)	EN 61773	Overhead lines - Testing of foundations for structures
(33)	ISO 11442-3	Technical product documentation - Handling of computer-based technical information - Part 3: Phases in the product design process
(34)	ISO 7083	Technical drawings - Symbols for geometrical tolerancing. Proportions and dimensions
(35)	ISO 9000	Quality management systems - Fundamentals and vocabulary
(36)	ISO 9000-3	Quality management and quality assurance standards - Part 3: Guidelines for the application of ISO 9001: 1994 to the development, supply, installation and maintenance of computer software
(37)	ISO 9001	Quality management systems -- Requirements
(38)	ISO 9001-1	Quality management and quality assurance standards - Part 1: Guidelines for selection and use
(39)	ISO 9004	Quality management systems - Guidelines for performance improvements
(40)	ISO/IEC 90003	Software engineering -- Guidelines for the application of ISO 9001:2000 to computer software
(41)	OSE	Regulations for the installation and maintenance of open air electric power lines
(42)	UIC 600 OR	Electric traction with aerial contact line
(43)	UIC 606-1 OR	Consequences of the application of the kinematic gauges defined by UIC Leaflets in the 505 series on the design of the contact lines.
(44)	UIC 606-2 OR	Installation of 25 kV and 50 or 60 Hz overhead contact lines
(45)	UIC 791 R	Quality assurance of overhead line equipment

2.15.2 General Description

For the Durres – Tirana railway line, including the new line from the Domje railway intersection to the Tirana International Airport, provisions shall be made for the future 25kV/50Hz electrification of the line.

The future electrification works refer to the electrification of the open line track and the station tracks of the line.

Parallel to the railway line and at a distance of 3,30m from the axis there will be the axis of the catenary poles at positions that will be defined by the electrification design to be elaborated by the Contractor.

Other appropriare technical solutions may need to be employed along Rashbull tunnel as well as at locations featuring spatial or environmental constraints, subject to direction and approval by the Client.

This chapter contains the technical documentation concerning the under design and construction part of electrification works, including mast foundations, provisions for earthing and bonding, as well as provisions for future cable routing.

The technical specification is based on IEC, EN, UIC, IEEE, DIN, National Standards etc. for system design, dimensions, distances component use and performance tests, as well as for the construction tests of the parts of the future electrification system.

2.15.3 System Design

The principal requirements of the Design Phase are the production of the Contractor's Documents by the Contractor, which shall fully describe the Works and include the Preliminary Design, the Final Design and the Reference Drawings. The volume and contents of the projects shall be in accordance with the applicable legislation in Albania and existing international norms such as European standards, IEEE standards, UIC leaflets and other EC documents, as well as with the specific HSH regulations where appropriate.

If there are discrepancies between documents referring to the same subject, the more stringent criteria / specifications will be followed where considered necessary by the Client.

The Contractor shall obtain all necessary approvals and agreements for his designs at his account in accordance with the applicable legislation.

The Preliminary Design shall sufficiently define the OCLS as part of the electrification system. In addition, general construction, testing methods and documentation, needed to develop the Final Design, shall be submitted.

The Final Design shall be in accordance with the specifications and shall incorporate the approved Contractor's Proposals developed to the stage at which all required elements of the electrification system (poles' foundation, earthing provisions, cable routing provisions) are fully defined and specified in detail.

In particular the Final Design shall be complete when:

a) All calculations and analyses are complete;

b) All main and all other significant elements are defined;

c) The effects on the Permanent Works of the proposed methods of construction, installation, testing and commissioning and of the Temporary Works are assessed.

During the preparation of the Final Design, all surveys, investigations and testing necessary to complete the design of the Permanent Works shall be undertaken.

All technical solutions, schemes, structures, materials should be fully compatible with the Regulations used by the Employer and should not be in conflict with the applicable legislation in Albania and the Contractor shall obtain all necessary approvals and agreements for his designs.

1. <u>Environmental Conditions</u>

The OCS must correspond to the appropriate climatic, meteorological and technical conditions.

Mechanical calculation must depend on the following temperature range:

Lowest temperature: -20^{O} C

Highest temperature: +70^{O} C

Average temperature: +25^{O} C

The following loads are to be considered to occur simultaneously:

a) Internal pressure of apparatus

b) Static terminal load

c) Wind force of 10 m/s

d) Seismic forces

The design and performance of the electrification has to consider certain intensity of earthquakes and propose respective protection measures.

Aesthetic appearance shall be considered in the design and layout of the electrification system and its constituent equipment, and appropriate measures taken to minimize visual impact, according to location and the local environment.

2. Technical conditions imposed by system and track layout

The following technical conditions are basis of the design:

Rail gauge	1435 mm
The line speed profile of the route	See Requirements
Minimum distance between live parts of the OCL and earthed structures	0,270 m
Variations in curves or according to local peculiarities	See Topographic plan

A clearance of minimum 2,5 m shall be maintained under any conditions between the overhead contact line system and branches of trees or bushes.

3. Signalling and telecommunication layout

The signalization is based on axel-counter system; therefore no special additional requirements for further rail connections are necessary.

4. Additional features

The Contractor shall be responsible for obtaining additional soil information necessary to properly complete the design.

All soil investigation and test data developed by the Contractor shall be included in the final design calculations.

The results of soil borings shall be shown on the construction drawings.

2.15.4 Scope of works

The Scope of the Works comprises the design, construction, testing, and maintenance during the Defects Notification Period, of the parts of Overhead Contact Line System (poles' foundation, earthing provisions, cable routing provisions) for the Durres – Tirana railway line, including the new line from the Domje railway intersection to the Tirana International Airport.

This shall include, but not be limited to, the following:

a) The design of the OCL electrified at 25 kV, A.C.-50Hz.

b) Preparation, presentation and control of all relevant documents.

c) Safety relating to all items designed for the construction, construction process.

d) Quality management, quality assurance accreditation, quality control methodology identified within a quality manual.

2.15.5 Description of works

This specification applies to the railway line to be electrified in the future with an overhead contact line system at 25kV-50Hz. The objective of this specification is to specify the design and performance requirements of the system, at the design and construction stage by a prospective or nominated and experienced Contractor.

This specification shall be used as a guide for the bidder to design and offer an OCLS capable of operating at the required speeds and conditions defined by the project.

1. <u>Overhead Contact Line</u>

The Overhead Contact Line System's elements on this technical document consist out of:

a) Metallic poles with their foundations
b) Other metallic supporting structures (gantry, special steel/supports in the technical work etc.)
c) Supra-elevated and normal anchors
d) Cantilevers (including registration and steady arms as well as their assembling elements)
e) Insulators
f) Wires (contact wire, messenger wire, droppers, electrical connections, wind stay, return wire etc.)
g) Anchoring devices (full-tensioning, half-tensioning or rigid devices) with their entire components as anchor, tensioning devices, counterweights etc.
h) Different other materials for catenary assembling, supports or fixings
i) Special constructions of the contact line as overlaps, crossings, catenary's midpoint anchors etc.
j) Sectioning insulators
k) Bonds, earth electrodes and generally all parts and materials on earthing and bonding system
l) Insulated joints (excluding IJ of signalization track circuit), electrical connection, electrodes etc. parts of the traction return circuits or protective area
m) Disconnector remote control
n) Sub-sectioning point
o) Protective means against electric shock in electrification installations etc.

The overhead contact line is of a catenary suspension type, regulated (full compensated) for main lines and first siding line, and half-compensated catenary for other siding lines, insulated termination, composed of messenger cable of Bz 70 (65.34 mm2) and contact wire of 107 mm2 on main lines, and messenger cable of Bz 50 (48.35 mm2) and contact wire of 80 mm2 on secondary lines, without stitch wire at the supports.

The Contractor shall agree with the Employer on the selection of a suitable method and equipment, which determines compliance with the current collection standard within the range of operating conditions. The system dynamic performance shall comply with the requirements of EN 50119, EN 50317, EN 50318, UIC 608 and UIC 799.

2. <u>Earthing and Bonding System</u>

The earthing and bonding system comprises out of connections to rail, connections to the earth and connections to the return.

All connections have to be executed as steel galvanized crossbars of 78-mm2 minimum, or Aluminium/Steel cable of equivalent electrical cross section.

The conductor or cable ends have to be equipped with adequate press cable shoes for screwing or welding.

The Contractor has to submit separately the design of the earthing and bonding equipment and the type of fixing the bonds to the rails to the Employer or his representative for approval.

For safety reasons, earthing measures must be taken at all metal structure parts in the range of influence of the OCLS and the line feeders (Protective Earthing Area).

Protective earth connections along the railway line are made to the return wire, the adjacent catenary pole or the nearest rail.

The bonding system comprises different types of bonds, such as:

- Connections of metallic structures to the rail,
- Equipotential tracks connections,
- Earth connections to rail,
- Return wire connections to rail,
- Over-voltage protectors (where applicable)

3. Provisions for future cable routing

The Contractor shall be responsible for identifying the needs and proposing limited locations where underground or embedded in concrete empty HDPE conduits shall be installed.

The conduits will serve for cables and conductors routing, during erection of electrification system in the future, aiming to avoid as possible extended excavations close to the embankment or under railway lines, roads, sidewalks, platforms, etc

The final locations shall be agreed with the Client prior to the construction and shall be clearly depicted on as-built drawings as “empty conduits for future use”.

2.15.6 Technical Requirements of the Electrification system

All equipment and components to be supplied and installed, which form the electrification system, shall meet the following requirements:

- Except where standards are specifically identified, they shall comply with the latest versions of relevant standards, in the following order of precedence: European Norms (EN or HD), IEC Standards, UIC leaflets, other standards which are recognized for international use (for example ANSI/IEEE, BS, NF);
- The type of constructions shall have a record of proven experience in commercial service, preferably in a 25kV railway electrification system, under similar conditions to those prevailing in Albania;
- The equipment installed shall be of an appropriate and sufficient quality, commensurate to meet the specified requirements for the electrification system and its constituent equipment;
- The equipment installed shall be suitably rated, designed and constructed, to operate satisfactorily for the specified climatic and operating conditions;
- For each generic type of installation (e.g. OCLS), they shall be of a common form throughout, and of standardized rating where possible;

1. Requirements of the Overhead Contact Line System

OCLS comprises, according to the present technical specification:

1. Components of overhead contact line

2. Components of earthing and bonding system

The most important mechanical requirements are:

- Static quality criteria regarding size and evenness of the catenary elasticity.
- Dynamic quality criteria regarding power transmission at the envisioned speeds.
- Keeping to generally recognized criteria for the contact forces between pantographs and overhead line depending on the operational speed of trains.
- Even wear on the loco contact strips; particular attention has to be paid to the design of the lateral displacement of the contact wire.
- Keeping to security-related intervals between earthed and current-carrying parts.
- Keeping to a planned contact wire position within stipulated tolerances, principally with regard to the routing of the contact wire height and, if necessary, under observance of a pre-sag.
- Fulfilment of the demands on the strength, both in the catenary system as well as on the supports, which could be influenced by warping.

OCLS components and component assemblies shall be developed from the system performance requirements defined in the documents as well as any other requirement included in this technical document and international recognized standards.

a. Basic requirements

The basic requirements are to be agreed with the Employer during design phase.

Indicative requirements are specified in the table

Basic requirements of Overhead Contact line

Contact line type	Full compensated *
The uplift of the contact wire at the support without climatic influence	100 mm
Free uplift at suspension points	200 mm
The space for free and unrestricted uplift at the support, for the maximum span length under normal operating conditions	Minimum of twice the calculated or simulated uplift value (not lower than 1,5 shall be used)
The number of conductors of the contact lines	1 CW +1MW
Nominal tension applied to conductors CW AC107 and AC 80 MW Bz 70 and Bz 50	 ≥105 N/mm2 ≥ 170 N/mm2
Tension values variation limit for CW	+/- 5 %
Maximum span (distance between supports)	63 m (+0/- 1m***)
Maximum difference in length of the neighborhood spans	18 m
Stitch wires	No
Wave propagation velocity	More than 142 % of the operational speed of the line (to be calculated)
Pole clearance (gauge): Nominal Minimum in railway stations Minimum in open line	 3,30 m (-50/+20 mm) 2,20 m 2,50 m

Height of contact wire related to the highest level of rails Nominal Minimum (at special points) Maximum (at special points) At the level crossings	 5500 mm (–0/+60 mm) 4940 mm 6200 mm 6000 mm
Maximum difference in CW height measured between two successive support with constant standard contact wire - height on construction	30 mm
System height maximum / minimum	1400/800 mm****(+/- 30 mm)
Maximum deviation of contact wire related to track axis In front of the support In curve In the middle of the span (with cross wind)	 200 mm (+/- 10%) 250 mm 400 mm
Maximum length of anchorage zone	1600 m
Deflection of contact wire in the middle of the span	10/00 of the span length
Maximum admitted slope of joint	20/00
Maximum admitted slope of contact wire	40/00
Minimum dropper length	200 mm
Maximum spacing between two consecutive droppers on contact wire	9 m
Nominal insulation distance (according to UIC 606)	320 mm
Minimum electrical clearance (according to EN 50119) Static Dynamic	 270 mm 150 mm

* The anchorage zone has to be fully compensated (CW and MW) on main lines.

** The contact forces or loss of contact and wire displacement.

*** The construction tolerances.

**** At technical works, the system height can be reduced to 300 mm, with employer's approval.

The contact wire height of a line is measured at the support, at each dropper and at the lowest point of the contact wire.

The deviation of the pole (support) erection, related to the mark centre of the rails, will be ± 0,5 m, along the track, so that the deviation of the span length between 2 poles (supports) must not exceed 1 m.

The deviation at erection of passing and anchorage poles will not exceed ± 0,2 m.

b. Poles' Foundations, Poles and Gantry Beams

The following construction tolerances shall apply to installation of OCL foundations relative to the designed location co-ordinates, benchmarking and level:

Along track tolerance	±500 mm
Across track tolerance	±50 mm

Foundation finished level ±50 mm

The foundations and poles will erect along the tracks according with the calculation, approved by Employer. The Contractor shall consider for approval any deviations from allowable tolerances listed above.

The poles will be designed as lattice steel poles and/or pipe poles and/or H-shaped steel poles and will be divided into the categories:

- Single pole: as far as possible poles with two-track cantilevers where single pole cannot be erected
- Pole with two (or more) - track cantilever
- Pole for portal structure, where single poles and poles with two-track cantilevers cannot be erected

According to the above functionality, the poles can be also classified as:

- Poles for single suspension within the span (intermediate poles)
- Poles for suspension inside of overlaps (transition poles)
- Poles for anchoring (anchorage poles)
- Poles for special applications (collective support)
- With two or more cantilevers for one line
- With two or more cantilevers for two lines
- Poles for beams supporting
- Poles used to support contact line equipment (disconnectors, transformers etc)

There is a degree of freedom in the choice of the form of the poles and their quantity, in order to enable the Constructor to choose, in accordance with the technology what will be applied, the best and most cost-effective solution.

Generally, the contact line poles will be used to support the contact line equipment, where necessary. Therefore, supplementary poles will not be used for equipment erection. Any exception will be justified and submitted to the employer for approval.

The contractor will propose, the optimal number of poles type's, which will be used in contact line erection.

Following this design, the foundations of the poles resulting from the calculation shall be installed.

Unbalanced loads derived from a single component failure shall not cause the permanent failure of the pole and/or structure.

All foundations have to be designed, to allow the installation of catenary poles with standard pole bases. The erection of those poles with bolted bases requires the installation of anchor bolts.

The anchor bolts shall be installed and adjusted by using a respective template.

The Contractor shall adapt and co-ordinate the design of special foundations to become necessary for the installation of catenary poles.

The Contractor has to establish approved technical advises for the execution of concrete foundations on site on the basis of the Albanian regulations. These advises have to be submitted to the Employer or his representative for acceptance and be available on site, during foundation works.

The preliminary layout of structure locations and wires shall be checked by site survey to establish their relationships and the practical ability to install the equipment at the prescribed locations and alignments.

The pole's foundations can have square, rectangle, cylindrical or other form, according to the technology that will be used.

The contractor has to take into account that the structure will carry fault current within the return circuit current of the electrical system.

Also the nature of ground of each region, local restrictions and the particularities that certainly exist because the adjacency of foundations with the railway line, mountains, up to the existence of installations of telecommunications, signalizations, cables, pipes etc. can impose foundations with cavities for the passage of cables or other solutions of coexistence of foundations with such installations or special construction.

Drawings of poles will incorporate required technical data for manufacturing. Cross (without wind) moments shall also be added to the list.

The Contractor has to establish approved technical advises for the execution of concrete foundations on site based on the Albanian regulations.

These advices have to be submitted to the Employer or his representative for acceptance and be available on site, during foundation work.

The design of the several types of catenary poles has to consider the local peculiarities and critical cross sections the standardization of the pole bases the static strength to take over the total mechanical load requested by the catenary design and its constructional components.

Masts and gantries have to be classified by dimensions and load moments and have to be seen from a “Classification List” to be submitted by the Contractor.

The Contractor has to submit the foundation and pole calculation program to the Employer or his representative for approval before starting the calculation work.

c. Calculation of poles and Gantries

The steel poles and steel beams, to be erected in the future, have to be calculated according to EN, DIN and associated norms or equivalent internationally proved standards or equivalent regulations.

The load calculation of the poles and the pole foundations has to comply to

- Local Regulations in force and to local anti-seismic standards of Albania for measures against earthquakes for the calculation of the load carrying members of the OCLS (masts, cantilevers, wires, clamps, etc.) as well as for suitable tests of the performance against earthquakes.
- Adequate IEC, EN, VDE, DIN Standards for the performance tests as well as for the construction tests of the OCL
- Relevant Albanian Standards for materials - Concretes Technology Regulation for concrete’s quality tests

The following loads have to be considered:

- The specific loads of the wires, cables, poles, cantilevers, insulators, section insulators, fittings, dropping pillars, etc.
- The maximum tension forces of wires and cables;
- The wind loads
- The additional loads
- The extraordinary loads

For catenaries with fixed messenger wire, the forces at the lowest temperature of –300 C have to be considered.

The calculation of single poles and of their foundations has to consider the maximum pulling forces of collector conductor and switch cross connections. For the calculation and dimensioning of the pole foundations, the soil conditions have to be investigated. Normally, they have to be determined by use of simple ram probes or geological probes. Soil investigations by drilling will be the exceptional case.

The manufacturer shall calculate strengths and prepare designs, including manufacturing drawings of the poles and gantries in accordance with the classification list and submitted to the employer for approval.

Calculations of the pole moments shall consider that pole bases, pole joints, screw bolts and anchor bolts will keep the total moment, which will be specified for the different pole types. The same rules should be valid for steel gantries (beams).

d. Composition of the poles and Gantries

The poles consist of a bolted-type welded pole base - to fix the poles at the top of the foundations via anchor bolts - and the pole body.

To achieve various pole lengths parts shall be available for pole extension, which will be joined together with the main pole body via screw bolts.

These pole-extensions have to be designed also for a later assembly on existing poles without any technical problems. The construction tolerance of the pole ‘s length shall be +100/-0 mm. Beams showing after galvanizing a sag (F) within 0.15% to 0.6% of length shall be straightened up to obtain a sag lower than 0.15% of the length.

The steel poles will be fastened on their foundations with an initial opposite deflection.

The Contractor has to calculate this deflection in relation with the operation load. The opposite deflection must guarantee the vertical position of the poles after the assembly of the catenaries.

As material, in general - according to EN corresponding standards- or equivalent norms has to be used.

For welded parts, the used steel types have to be selected according to EN or equivalent norms and certified by the manufacturer.

Welding has to be performed according to EN or equivalent norm.

All bolts, nuts and washers will have been manufactured in metric system according to Greek or European Standards, as EN 28839, EN ISO 3506 etc.

e. Other requirements for poles and gantries

The contractor makes the design of the pole-foundations in such a way, that the foundation bolts, nuts and metallic plate-base are protected and visible for control purposes.

The space between upper level of the foundation and pole’s plate-base shall be filled with suitable material for bolts and nuts protection.

f. Mast / Pole Anchors

The anchors are used to fasten the contact line anchorage poles. They are classified as:

- Normal level anchorage
- Elevated level anchorage

The a) type is used in the open line, where people passage is not frequent. The anchoring stays are fastened to a reinforced concrete foundation via a steel base plate. The stays are at 450 relative to the horizontal and the foundation is located about 7 m from the anchorage pole.

The b) type is used in station and in area of heavy traffic. The anchorage stays are fastened 2,00 m from the ground level and the foundation is located about 5 m from the anchorage pole.

The vertical loads applied to foundations are the most unfavourable loads calculated at the embedding, due to permanent loads with or without imposed load (wind, ice, etc).

The mid-point’s anchors or other anchors shall be calculated and dimensioned accordingly with the correspondent loads.

In any case, the applied technology shall be followed.

2. Protective provisions relating to return circuit, earthing and bonding

The earthing and bonding system shall be designed.

The Contractor will propose the provisions that have to be made and the parts of the system that have to be constructed in order to facilitate the future completion of the earthing and bonding system that will be installed throughout the entire system to insure proper rail return path for the catenary system, proper operation of the signal system, and provide safety to employees and the public. The earthing and bonding system shall allow testing, revisions and many times disassembling and assembling.

The means by which the traction current returns from the traction units to the traction substations and the means of earthing for the electrified railway track, comprises the running rails, aerial return wire, the supports/structures of the Overhead Contact Line System in contact via their foundations or mounting points with earth, together with all return current bonding and earthing interconnections.

The overriding requirement is to prevent harm from electric shock, by ensuring that under all normal and foreseeable fault conditions the touch and step potential between conductive structures does not exceed the safe and recommended maximum touch voltages and that all protective devices operate effectively. All exposed conductive structures, which could become energized under fault conditions should be earthed and if necessary, cross-bonded. The need to bond exposed conductive structures to the appropriate electric traction return system should be considered.

The signalling system allows that both rails of all tracks on the open lines and in the stations are available for the return current flow without any electrical subdivision.

3. Protective provisions relating to electrical safety

This Chapter specifies the main requirements for the protective provisions relating to electrical safety of the fixed installations associated with 27,5 kV A.C. traction systems and to any other installations that may be endangered by the traction power supply system. These requirements to be considered are described in the technical norms EN 50122-1, EN 50122-2, EN 50124-1, EN 50153, EN 50163, EN 50179 and ISO 3864

The conductors for earthing will be made of galvanised stranded steel cable, aluminium-steel cable or iron conductor. The fixing may be done by welding, screwing or clamping by use of adequate proved fittings. The cable ends have to be prepared accordingly, preferably by pressed cable shoes.

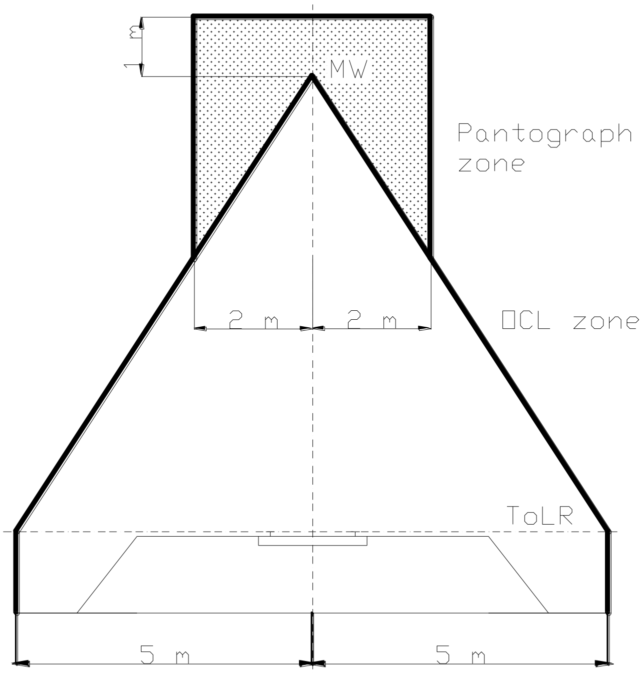
a. Overhead contact line zone and pantograph zone

Taking into account EN 50122-1 provisions, within the project the following should observed:

The contact line zone which has a limit of 5 (five) meters from the track centre line (X=5m), and

Pantograph zone which has a limit of 2 m from the track centre line (Y=2m), respectively 1 m upper part from the highest point of the overhead contact line (Z=1m).

The “protective earthing area” approved for railway administration is shown in Figure below.



b. Safety by earthing

For safety reasons earthing, measures must be taken at all metal structure parts in the range of influence of the OCLS (Protective Earthing Area).

Reinforced concrete structures and other electrically conductive equipment, which may come accidentally in contact with a live broken catenary or derailed pantograph, as well as all non-live metallic parts of the catenary equipment have to be connected with the “railway earth” e.g. the running rails or other parts of the return current system.

Conductive parts of an extension (fencing, etc.) of more than 50 m in parallel to the track, which may not be subdivided into several electrically interrupted sections, have to be earthed directly to the track or pole foot, but only once.

Metallic parts of minor dimension, smaller than 2 m as well as temporary stored rails and other metallic parts are not to be earthed.

On platforms, at loading tracks and other places of public access two earthing bonds will be installed. The second connection should be attached as far as possible to another track.

Protective earth connections along the project line are made to the return wire, the adjacent catenary pole or the nearest rail (in the railway stations) or/and to the earth.

The protective provisions relating to electrical safety in the 27,5 kV A.C. traction systems to any installations that may be endangered by the traction power supply system.

These requirements to be considered are fixed in the technical norms of EN 50122 - Part 1 and 2, EN 50124 - Part 1, EN 50153, EN 50163, EN 50179. ISO 3864.

The Contractor has to prepare Earthing and Bonding Layout Plans for the stations as well as for the open line sections of suitable design, scale and size.

The earthing gauge describes the zone limits, which may not be exceeded by a broken catenary or a derailed pantograph or their fragments, according to EN 50122-1.

The connection via cross span wire of a cross headspan suspension may be treated as the second connection.

c. Safety by clearance

For standing surfaces, accessible to persons, the minimum clearance for touching in a straight line is according to EN 50122-1 and shall be protected against direct contact with live parts of an OCL, as well as any live parts of a vehicle.

The standard assumes that the standing surface does not need protection against contact wire live parts situated below or to the side thereof. Depending on its construction the surface may in practice meet the requirement respecting provision of obstacles.

The minimum clearances to be observed for persons working nearby energised OCLS shall also be according to EN 50122-1.

If clearances as described before cannot be maintained, obstacles shall be provided against direct contact with live parts.

The dimensions of the obstacles shall be such that persons cannot touch live parts in a straight line on a standing surface.

Typical design and dimensions of obstacles for standing surfaces in public areas for protection against direct contact with adjacent live parts of the OCLS for nominal voltages of 25 kV A.C. to earth are according to above mentioned standard.

Obstacles for standing surfaces above live parts of the OCLS shall be of a solid-wall design. The length of the solid-wall standing surface shall correspond to the pantograph zone and extend beyond the live parts of a catenary by at least 0,50 m on each side.

The presence of the OCLS above railway lines requires the installation of various signs and signals for the information of passengers, railway staff and other people working in the vicinity of OCS.

Bridges that cross over the overhead line equipment should have measures designed to avoid access to live equipment. Decks, stairways and parapets should be solid and without gaps through which a wire could be passed.

2.15.7 Technical documents to be supplied by the contractor

The Contractor shall execute the electrification (poles' foundation, earthing provisions, cable routing provisions) works in three phases:

Phase 1, the Design Phase,

Phase 2, the Manufacture & Supply Phase and

Phase 3, the Installation-Testing-Commissioning Phase.

The Design Phase shall begin upon the Commencement Date of the Contract.

This phase shall include the preparation, completion and submission of:

- The Preliminary Design
- The Final Design;
- The Reference Drawings.

The Design Phase will be completed upon the issue of a Notice in respect of the comprehensive and complete Reference Drawings Submission for the whole of the Permanent Works.

The Manufacture and Supply Phase (comprising procurement, manufacture of Plant, production of materials, testing, supply and delivery) for the whole or a part of the Permanent Works shall commence immediately upon the issue by the Employer of a Notice in respect of the relevant Reference Drawings Submission. The Employer in respect of a Reference Drawing Submission covering a major and distinctive part of the Permanent Works may issue such Notice. However, manufacture shall not be commenced until the original copies of the appropriate Working Drawings relating to manufacture have been endorsed:

- by the Contractor as "Good for Manufacture";
- by the Employer that he has no objections to the drawing.

The Manufacture and Supply Phase will be complete upon the issue of a Notice in respect of the comprehensive and complete Manufacture & Supply Verification Submission for the whole of the Permanent Works.

The Installation-Testing-Commissioning Phase for the whole or a part of the Permanent Works shall commence immediately upon the issue by the Employer of a Notice in respect of completion of the relevant Manufacture & Supply Verification Submission. Such Notice may be issued by the Employer in respect of completion of manufacturing and supply of a major and distinctive element comprising part of the Permanent Works. However, installation shall not be commenced until the original copies of the appropriate Working drawings relating to installation at (6) above have been endorsed:

- by the Contractor as "Good for Installation";
- by the Employer that he has no objections to the drawing.

The Installation-Testing-Commissioning Phase shall include the completion and submission of the Final Design and the preparation and submission of the As-Built Drawings and other records as specified.

Before commencing the works, the Contractor has to prepare several technical documents, drawings, plans, descriptions, etc. which have to be submitted to the Employer or his representative for reviewing, commenting and/or approval.

3. Deliverables of the Existing Study (Contract No. C25990/WBES-2013-03-02)

1. BOOK_1_CIVIL_WORKS

1.0 796 01 10 FD TE RWD 01 0 - TECHNICAL REPORT

1.1 PLAN_VIEWS_&_PROFILES

796 01 10 FD SG RWD 01 0 - GENERAL PLAN VIEW

796 01 10 FD OM RWD 01 0 - COMPONENT A. PLAN VIEW - PROFILE SECTION KP 0-639 – KP 0+840

796 01 10 FD OM RWD 02 0 - COMPONENT A. PLAN VIEW - PROFILE SECTION KP 0+800 – KP 2+300

796 01 10 FD OM RWD 03 0 - COMPONENT A. PLAN VIEW - PROFILE SECTION KP 2+260 – KP 3+720

796 01 10 FD OM RWD 04 0 - COMPONENT A. PLAN VIEW - PROFILE SECTION KP 3+680 – KP 5+020

796 01 10 FD OM RWD 05 0 - COMPONENT A. PLAN VIEW - PROFILE SECTION KP 4+980 – KP 6+460

796 01 10 FD OM RWD 06 0 - COMPONENT A. PLAN VIEW - PROFILE SECTION KP 6+420 – KP 7+900

796 01 10 FD OM RWD 07 0 - COMPONENT A. PLAN VIEW - PROFILE SECTION KP 7+860 – KP 9+360

796 01 10 FD OM RWD 08 0 - COMPONENT A. PLAN VIEW - PROFILE SECTION KP 9+320 – KP 10+780

796 01 10 FD OM RWD 09 0 - COMPONENT A. PLAN VIEW - PROFILE SECTION KP 10+740 – KP 12+220

796 01 10 FD OM RWD 10 0 - COMPONENT A. PLAN VIEW - PROFILE SECTION KP 12+180 – KP 13+660

796 01 10 FD OM RWD 11 0 - COMPONENT A. PLAN VIEW - PROFILE SECTION KP 13+620 – KP 15+120

796 01 10 FD OM RWD 12 0 - COMPONENT A. PLAN VIEW - PROFILE SECTION KP 15+080 –

KP 16+580

796 01 10 FD OM RWD 13 0 - COMPONENT A. PLAN VIEW - PROFILE SECTION KP 16+540 – KP 18+040

796 01 10 FD OM RWD 14 0 - COMPONENT A. PLAN VIEW - PROFILE SECTION KP 18+000 – KP 19+500

796 01 10 FD OM RWD 15 0 - COMPONENT A. PLAN VIEW - PROFILE SECTION KP 19+460 – KP 20+520

796 01 10 FD OM RWD 16 0 - COMPONENT A. PLAN VIEW - PROFILE SECTION KP 20+480 – KP 21+980

796 01 10 FD OM RWD 17 0 - COMPONENT A. PLAN VIEW - PROFILE SECTION KP 21+940 – KP 23+440

796 01 10 FD OM RWD 18 0 - COMPONENT A. PLAN VIEW - PROFILE SECTION KP 23+400 – KP 24+860

796 01 10 FD OM RWD 19 0 - COMPONENT A. PLAN VIEW - PROFILE SECTION KP 24+820 – KP 26+320

796 01 10 FD OM RWD 20 0 - COMPONENT A. PLAN VIEW - PROFILE SECTION KP 26+280 – KP 27+300

796 01 10 FD OM RWD 21 0 - COMPONENT A. PLAN VIEW - PROFILE SECTION KP 27+260 – KP 28+740

796 01 10 FD OM RWD 22 0 - COMPONENT A. PLAN VIEW - PROFILE SECTION KP 28+700 – KP 30+180

796 01 10 FD OM RWD 23 0 - COMPONENT A. PLAN VIEW - PROFILE SECTION KP 30+140 – KP 31+620

796 01 10 FD OM RWD 24 0 - COMPONENT A. PLAN VIEW - PROFILE SECTION KP 31+580 – KP 32+660

796 01 10 FD OM RWD 25 0 - COMPONENT A. PLAN VIEW - PROFILE SECTION KP 32+620 – KP 33+740

796 01 10 FD OM RWD 26 0 - COMPONENT C. PLAN VIEW - PROFILE SECTION KP 0+000 – KP 0+720

796 01 10 FD OM RWD 27 0 - COMPONENT C. PLAN VIEW - PROFILE SECTION KP 0+680 – KP 2+160

796 01 10 FD OM RWD 28 0 - COMPONENT C. PLAN VIEW - PROFILE SECTION KP 2+120 – KP 3+620

796 01 10 FD OM RWD 29 0 - COMPONENT C. PLAN VIEW - PROFILE SECTION KP 3+580 – KP 4+700

796 01 10 FD OM RWD 30 0 - COMPONENT C. PLAN VIEW - PROFILE SECTION KP 4+660 – KP 5+697

796 01 10 FD OM RWD 31 0 - COMPONENT C. PLAN VIEW - PROFILE SECTION KP 0+000 – KP 0+815.57

796 01 10 FD OM RWD 32 0 - COMPONENT A. PLAN VIEW - PROFILE PORT- DURRES

1.2 STATION_DETAILS_&_DRAINAGE_PATTERN

PLAN_VIEWS_&_DRAINAGE_PATTERN

796 01 10 FD SP RWD 01 0 - DURRES STATION LAYOUT DETAILS & DRAINAGE PATTERN

796 01 10 FD SP RWD 02 0 - SHKOZET STATION LAYOUT DETAILS & DRAINAGE PATTERN

796 01 10 FD SP RWD 03 0 - SUKTHI STATION LAYOUT DETAILS & DRAINAGE PATTERN

796 01 10 FD SP RWD 04 0 - VORE STATION LAYOUT DETAILS & DRAINAGE PATTERN

796 01 10 FD SP RWD 05 0 - KASHAR STATION LAYOUT DETAILS & DRAINAGE PATTERN

796 01 10 FD SP RWD 06 0 - TIRANA PTT STATION LAYOUT DETAILS & DRAINAGE PATTERN

796 01 10 FD SP RWD 07 0 - TIA STATION LAYOUT DETAILS & DRAINAGE PATTERN

PLATFORMS_TYPICAL_DETAILS

796-04-08-FD-TS-PTF-01_0 - TYPICAL AND SPECIAL ELEMENTS GEOMETRY – PLAN AND SECTIONS

796-04-08-FD-TS-PTF-02_0 - TYPICAL AND SPECIAL ELEMENTS - REINFORCEMENT

1.3 PROFILES_OTHER_THAN_MAIN_AXIS

796 01 10 FD SM RWD 01 0 - COMPONENT A. DURRES STATION PROFILES

AXES DUR-ST_1, DUR-ST_2, DUR-ST_3, DUR-ST_4, DUR-ST_51, DUR-ST_6

796 01 10 FD SM RWD 02 0 - COMPONENT A. SHKOZET STATION PROFILES

AXES SHK-ST_1, SHK-ST_2, SHK-ST_3

796 01 10 FD SM RWD 03 0 - COMPONENT A. SUKTHI STATION PROFILES

AXES SUK-ST_1, SUK-ST_21, SUK_ST_3, SUK-ST_41, SUK-ST-5

796 01 10 FD SM RWD 04 0 - COMPONENT A. VORE STATION PROFILES

AXES VOR-ST_1, VOR-ST_2, VOR-ST_31, VOR-ST_4

796 01 10 FD SM RWD 05 0 - COMPONENT A. KASHAR STATION PROFILES

AXES KAS-ST_1, KAS-ST_2, KAS-ST_3

796 01 10 FD SM RWD 06 0 - COMPONENT A. TIRANA PTT STATION PROFILES

AXES TIR-ST_1, TIR-ST_2, TIR-ST_3, TIR-ST_4, TIR-ST_5

796 01 10 FD SM RWD 07 0 - COMPONENT A & C R/W PROFILES

AXES SYND_3, AIR_PASS_LOOP, AIR-PAR_3

796 01 10 FD SM RWD 08 0 - COMPONENT A. LEFT SERVICE ROADS PROFILES

AXES SRL-3, SRL-4, SRL-5_3, SRL-6, SRL-7

796 01 10 FD SM RWD 09 0 - COMPONENT A. LEFT SERVICE ROADS PROFILES

AXES SRL-8, SRL-9, SRL-10, SRL-11, SRL-14, SRL-15, SRL-16, SRL-17, SRL-18

796 01 10 FD SM RWD 10 0 - COMPONENT A. RIGHT SERVICE ROADS PROFILES

AXES SRR-1, SRR-2, SRR-3, SRR-4

796 01 10 FD SM RWD 11 0 - COMPONENT A. ROAD INTERSECTIONS PROFILES
AXES CROSSING_5, CROSSING_6, CROSSING_7, CROSSING_8, CROSSING_9, CROSSING_10

796 01 10 FD SM RWD 12 0 - COMPONENT A. ROAD INTERSECTIONS PROFILES
AXES CROSSING_11, CROSSING_12, CROSSING_13, CROSSING_14, CROSSING_15, CROSSING_16

796 01 10 FD SM RWD 13 0 - COMPONENT A. LOCAL NETWORK PROFILES
AXES RA, RAMP-1, RAMP-2, TO1

796 01 10 FD SM RWD 14 0 - COMPONENT C. LEFT SERVICE ROADS PROFILES
AXES SRL-1, SRL-2

796 01 10 FD SM RWD 15 0 - COMPONENT C. SERVICE ROADS PROFILES
AXES SRL-12_1, SRL-13, SRR-5_1

796 01 10 FD SM RWD 16 0 - COMPONENT C. ROAD INTERSECTIONS PROFILES
AXES CROSSING_1-3, CROSSING_2-2, CROSSSING_3-3, CROSSING_4-5

1.4 SUPERELEVATION_DIAGRAMS

796 01 10 FD SD CLC 01 0 - COMPONENTS A & C. SUPERELEVATIONS
796 01 10 FD SD RWD 01 0 - COMPONENT A. RAILWAY LINE SUPERELEVATION DIAGRAM
796 01 10 FD SD RWD 02 0 - COMPONENT C. RAILWAY LINE SUPERELEVATION DIAGRAM

1.5 CROSS_SECTIONS

COMPONENT_A_STATIONS

796 01 10 FD CS RWD 01 0 - COMPONENT A. CROSS SECTIONS STATIONS

COMPONENT_A_OPEN_LINE

796 01 10 FD CS RWD 02 0 - COMPONENT A. CROSS SECTIONS KP 2+000 – KP 10+960
796 01 10 FD CS RWD 03 0 - COMPONENT A. CROSS SECTIONS KP 11+820 – KP 19+540
796 01 10 FD CS RWD 04 0 - COMPONENT A. CROSS SECTIONS KP 20+700 – KP 29+480
796 01 10 FD CS RWD 05 0 - COMPONENT A. CROSS SECTIONS KP 30+120 – KP 32+840

COMPONENT_C_LINE_&_STATION

796 01 10 FD CS RWD 06 0 - COMPONENT C. CROSS SECTIONS

COMPONENT_A_ROADS

796 01 10 FD CS RWD 07 0 - COMPONENT A. ROAD INTERSECTION CROSS SECTIONS
AXIS CROSSING_5

796 01 10 FD CS RWD 08 0 - COMPONENT A. ROAD INTERSECTION CROSS SECTIONS
AXIS CROSSING_6

796 01 10 FD CS RWD 09 0 - COMPONENT A. ROAD INTERSECTION CROSS SECTIONS
AXIS CROSSING_7

796 01 10 FD CS RWD 10 0 - COMPONENT A. ROAD INTERSECTION CROSS SECTIONS
AXIS CROSSING_8

796 01 10 FD CS RWD 11 0 - COMPONENT A. ROAD INTERSECTION CROSS SECTIONS
AXIS CROSSING_9

796 01 10 FD CS RWD 12 0 - COMPONENT A. ROAD INTERSECTION CROSS SECTIONS
AXIS CROSSING_10

796 01 10 FD CS RWD 13 0 - COMPONENT A. ROAD INTERSECTION CROSS SECTIONS
AXIS CROSSING_11

796 01 10 FD CS RWD 14 0 - COMPONENT A. ROAD INTERSECTION CROSS SECTIONS
AXIS CROSSING_12

796 01 10 FD CS RWD 15 0 - COMPONENT A. ROAD INTERSECTION CROSS SECTIONS
AXIS CROSSING_13

796 01 10 FD CS RWD 16 0 - COMPONENT A. ROAD INTERSECTION CROSS SECTIONS
AXIS CROSSING_14_2

796 01 10 FD CS RWD 17 0 - COMPONENT A. ROAD INTERSECTION CROSS SECTIONS
AXIS CROSSING_15

796 01 10 FD CS RWD 18 0 - COMPONENT A. ROAD INTERSECTION CROSS SECTIONS
AXIS CROSSING_16_1

796 01 10 FD CS RWD 19 0 - COMPONENT A. LEFT SERVICE ROAD CROSS SECTIONS
AXIS SRL-14

796 01 10 FD CS RWD 20 0 - COMPONENT A. LEFT SERVICE ROAD CROSS SECTIONS
AXIS SRL-15

COMPONENT_C_ROADS

796 01 10 FD CS RWD 21 0 - COMPONENT C. ROAD INTERSECTION CROSS SECTIONS
AXIS CROSSING_1-3

796 01 10 FD CS RWD 22 0 - COMPONENT C. ROAD INTERSECTION CROSS SECTIONS
AXIS CROSSING_2-2

796 01 10 FD CS RWD 23 0 - COMPONENT C. ROAD INTERSECTION CROSS SECTIONS
AXIS CROSSING_3-3

1.6 TYPICAL_CROSS_SECTIONS

796 01 10 FD ST RWD 01 0 - TYPICAL CROSS SECTIONS GENERAL

796 01 10 FD ST RWD 02 0 - TYPICAL CROSS SECTIONS SIGNALLING AND TELECOMMUNICATION INFRASTUCTURE

796 01 10 FD ST RWD 03 0 - COMPONENT A. TYPICAL CROSS SECTIONS SPECIAL SECTIONS

796 01 10 FD ST RWD 04 0 - COMPONENT C. TYPICAL CROSS SECTIONS GENERAL AND SPECIAL SECTIONS

796 01 10 FD ST RWD 05 0 - AT GRADE PEDESTRIAN CROSSING LAYOUT

796 01 10 FD ST RWD 06 0 - FENCES AND PEDESTRIAN CROSSING TYPICAL ELEMENTS

796 01 10 FD ST RWD 07 0 - TYPICAL CROSS SECTIONS ROADS

1.7 HYDRAULIC_DETAILS

796 01 13 FD ST RWD 01 0 - DRAINAGE PIPE DETAILS

796 01 13 FD ST RWD 02 0 - CONCRETE PIPE INSPECTION CHAMBER DETAILS

796 01 13 FD ST RWD 03 0 - HDPE PIPE INSPECTION CHAMBER DETAILS

796 01 13 FD ST RWD 04 0 - CONCRETE RECTANGULAR CHAMBER DETAILS

796 01 13 FD ST RWD 05 0 - CURB INLET WITH LATERAL RECESS AND GRID TYPICAL CROSS SECTIONS

796 01 13 FD ST RWD 06 0 - TRANSITION BETWEEN RECTANGULAR / CIRCULAR AMD TRAPEZOIDAL CHANNEL SECTIONS

796 01 13 FD ST RWD 07 0 - STEP GUTTER DETAILS

796 01 13 FD ST RWD 08 0 - EVACUATION – AIR RELEASE INSPECTION CHAMBER (SIPHON, COMP_C, KP 3+367.15)

796 01 13 FD ST RWD 09 0 - PERFORATED DRAINAGE PIPE DETAIL

796 01 13 FD ST RWD 10 0 - CHANNEL DETAILS COMPONENT A LEFT

796 01 13 FD ST RWD 11 0 - CHANNEL DETAILS COMPONENT A RIGHT

796 01 13 FD ST RWD 12 0 - CHANNEL DETAILS COMPONENT A STATONS

796 01 13 FD ST RWD 13 0 - CHANNEL DETAILS COMPONENT C

1.8 HYDRAULIC_REPORTS

796 01 13 FD HS RWD 01 0 - COMPONENT A. HYDRAULIC STUDY

796 01 13 FD HS RWD 02 0 - COMPONENT C. HYDRAULIC STUDY

796 01 13 FD HS RWD 03 0 - DRAINAGE BASINS

2. BOOK_2_MAJOR_STRUCTURES

2.1 URA KM. 3+560

796 04 08 FD TE RAS 01 0 - TECHNICAL REPORT - STRUCTURAL ANALYSIS - QUANTITY OF WORKS

796 04 08 FD PV RAS 01 0 - GENERAL DESIGN

796 04 08 FD RF RAS 02 0 - REINFORCEMENT OF SLAB AND CABLE CHANNEL

2.2 KM. 5+130

796 04 08 FD TE MAL 01 0 - TECHICAL REPORT - STRUCTURAL ANALYSIS - QUANTITY OF WORKS

01-796 04 08 FD PV MAL 01 0 - GENERAL DESIGN

02-796 04 08 FD RF MAL 02 0 - REINFORCEMENT OF DECK

03-796 04 08 FD RF MAL 03 0 - REINFORCEMENT NEW CAP OF PIER

04-796 04 08 FD RF MAL 04 0 - REINFORCEMENT NEW CAP OF ABUTMENT

05-796 04 08 FD RF MAL 05 0 - REINFORCEMENT OF NEW HEAD OF ABUTMENT AND E/M BOX

2.3 ERZENI BRIDGE

796 04 08 FD TE ERZ 01 0 - TECHNICAL REPORT - STRUCTURAL ANALYSIS - QUANTITY OF WORKS

01-796 04 08 FD PV ERZ 01 0 - LONGITUDINAL SECTION – PLAN VIEW

02-796 04 08 FD TS ERZ 02 0 - NEW AND EXISTING ARRANGEMENT OF ABUTMENTS AND PIERS

03-796 04 08 FD TS ERZ 03 0 - TYPICAL CROSS SECTIONS

04-796 04 08 FD ST ERZ 04 0 - STUCTURAL STEEL ARRANGEMENT

05-796 04 08 FD RF ERZ 05 0 - DECK SLAB REINFORCEMENT

06-796 04 08 FD RF ERZ 06 0 - CROSS BEAMS REIFORCEMENT

07-796 04 08 FD RF ERZ 07 0 - GEOMETRY AND REIFORCEMENT OF PIER CAP

08-796 04 08 FD RF ERZ 08 0 - GEOMETRY AND REIFORCEMENT OF NEW PIER AND HEAD OF ABUTMENT

09-796 04 08 FD RF ERZ 09 0 - GEOMETRY AND REIFORCEMENT NEW CAP OF ABUTMENT

10-796 04 08 FD DE ERZ 10 0 - DETAILS

11-796 04 08 FD SG ERZ 11 0 - SUPERSTRUCTURE CONSTRUCTION STAGES

2.4 TANA BRIDGE

796 04 08 FD TE TAN 01 0 - TECHNICAL REPORT - QUANTITY OF WORKS

796 04 08 FD CA TAN 02 0 - STRUCTURAL ANALYSIS

796 04 08 FD PV TAN 01 0 - PLAN VIEW

796 04 08 FD FD TAN 02 0 - FOUNDATION

796 04 08 FD LS TAN 03 0 - LONGITUDIANAL SECTION

796 04 08 FD EL TAN 04 0 - ELEVATION

796 04 08 FD TS TAN 05 0 - TYPICAL CROSS SECTIONS

796 04 08 FD CS TAN 06 0 - CHARACTERISTIC CROSS SECTIONS

796 04 08 FD RF TAN 07 0 - PILES REINFORCEMENT

796 04 08 FD RF TAN 08 0 - BRIDGE REINFORCEMENT SHEET 1 FROM 3

796 04 08 FD RF TAN 09 0 - BRIDGE REINFORCEMENT SHEET 2 FROM 3

796 04 08 FD RF TAN 10 0 - BRIDGE REINFORCEMENT SHEET 3 FROM 3

796 04 08 FD DE TAN 11 0 - DETAILS

796 04 08 FD BA TAN 12 0 - BED ARRANGEMENT AT BRIDGE CROSSING AREA

2.5 KM 19+526

796 04 08 FD TE BRV 01 0 - TECHNICAL REPORT - STRUCTURAL ANALYSIS - QUANTITY OF WORKS

796 04 08 FD SD BRV 01 0 - BRIDGE KP 19+526

2.6 KM 25+130

796 04 08 FD TE UPL 01 0 - TECHNICAL REPORT - STRUCTURAL ANALYSIS - QUANTITY OF WORKS

796 04 08 FD SD UPL 01 0 - BRIDGE KP 25+130

2.7 LIMUTHI BRIDGE KM 25+400

796 04 08 FD TE LIM 01 0 - TECHNICAL REPORT - STRUCTURAL ANALYSIS - QUANTITY OF WORKS

796 04 08 FD PV LIM 01 0 - GENERAL DESIGN

796 04 08 FD RF LIM 02 0 - REINFORCEMENT OF SLAB AND CABLE CHANNEL

2.8 KM 30+193.70

796 04 08 FD TE LNA 01 0 - TECHNICAL REPORT - STUCTURAL ANALYSIS - QUANTITY OF WORKS

01-796 04 08 FD PV LNA 01 0 - GENERAL DESIGN

02-796 04 08 FD RF LNA 02 0 - REINFORCEMENT OF SLAB, NEW HEAD OF ABUTMENT AND H/M BOX

03-796 04 08 FD RF LNA 03 0 - REINFORCEMENT NEW CAP OF PIER

04-796 04 08 FD RF LNA 04 0 - REINFORCEMENT NEW CAP OF ABUTMENT

2.9 LANA BRIDGE

796 04 08 FD TE LNC 01 0 - TECHNICAL REPORT - QUANTITY OF WORKS

796 04 08 FD CA LNC 02 0 - STRUCTURAL ANALYSIS

796 04 08 FD PV LNC 01 0 - PLAN VIEW

796 04 08 FD FD LNC 02 0 - FOUNDATION

796 04 08 FD LS LNC 03 0 - LONGITUDINAL SECTION

796 04 08 FD EL LNC 04 0 - ELEVATION

796 04 08 FD TS LNC 05 0 - TYPICAL CROSSS SECTIONS, BEAMS ARRANGEMENT, DRAINAGE ARRANGEMENT, BEARINGS ARRANGEMENT

796 04 08 FD GA LNC 06 0 - ABUTMENTS A0 & A3 GEOMETRY

796 04 08 FD GP LNC 07 0 - PIERS P1 & P2 GEOMETRY

796 04 08 FD GB LNC 08 0 - PRECAST BEAMS GEOMETRY

796 04 08 FD PR LNC 09 0 - PRECAST BEAMS PRESTRESSING

796 04 08 FD RF LNC 10 0 - PILES REINFORCEMENT

796 04 08 FD RF LNC 11 0 - ABUTMENTS A0 & A3 REINFORCEMENT SHEET 1 FROM 2

796 04 08 FD RF LNC 12 0 - ABUTMENTS A0 & A3 REINFORCEMENT SHEET 2 FROM 2

796 04 08 FD RF LNC 13 0 - PIERS P1 -P2 REINFORCEMENT

796 04 08 FD RF LNC 14 0 - PRECAST BEAMS REINFORCEMENT (L=15.30m)

796 04 08 FD RF LNC 15 0 - PRECAST BEAMS REINFORCEMENT (L=26.60m)

796 04 08 FD RF LNC 16 0 - DECK SLAB REINFORCEMENT

796 04 08 FD DE LNC 17 0 - DETAILS SHEET 1 FROM 2

796 04 08 FD DE LNC 18 0 - DETAILS SHEET 2 FROM 2

2.10 TIRANA BRIDGE

796 04 08 FD TE TIR 01 0 - TECHNICAL REPORT - QUANTITY OF WORKS

796 04 08 FD CA TIR 02 0 - STRUCTURAL ANALYSIS

796 04 08 FD PV TIR 01 0 - PLAN VIEW

796 04 08 FD FD TIR 02 0 - FOUNDATION

796 04 08 FD LS TIR 03 0 - LONGITUDINAL SECTION

796 04 08 FD EL TIR 04 0 - ELEVATION

796 04 08 FD TS TIR 05 0 - TYPICAL CROSSS SECTIONS, BEAMS ARRANGEMENT, DRAINAGE ARRANGEMENT, BEARINGS ARRANGEMENT

796 04 08 FD GP TIR 06 0 - PIER P1 GEOMETRY

796 04 08 FD GP TIR 07 0 - PIER P2 GEOMETRY

796 04 08 FD GA TIR 08 0 - ABUTMENTS A0 & A3 GEOMETRY

796 04 08 FD GB TIR 09 0 - PRECAST BEAMS GEOMETRY

796 04 08 FD PR TIR 10 0 - PRECAST BEAMS PRESTRESSING

796 04 08 FD RF TIR 11 0 - ABUTMENTS A0 - A3 PILES REINFORCEMENT

796 04 08 FD RF TIR 12 0 - PIERS P1 - P2 - PILES REINFORCEMENT

796 04 08 FD RF TIR 13 0 - ABUTMENTS A0 & A3 REINFORCEMENT SHEET 1 FROM 2

796 04 08 FD RF TIR 14 0 - ABUTMENTS A0 & A3 REINFORCEMENT SHEET 2 FROM 2

796 04 08 FD RF TIR 15 0 - PIER P1 REINFORCEMENT

796 04 08 FD RF TIR 16 0 - PIER P2 REINFORCEMENT

796 04 08 FD RF TIR 17 0 - PRECAST BEAMS REINFORCEMENT

796 04 08 FD RF TIR 18 0 - DECK SLAB REINFORCEMENT

796 04 08 FD DE TIR 19 0 - DETAILS SHEET 1 FROM 2

796 04 08 FD DE TIR 20 0 - DETAILS SHEET 2 FROM 2

2.11 RASBUL TUNNEL CH 3+900

796-04-08-FD-TE-RRA-01-0 - TECHNICAL REPORT - QUANTITY OF WORKS

796-04-08-FD-PV-RRA-01_0 - PLAN VIEW

796-04-08-FD-GE-RRA-02_0 - PLAN VIEW, LONGITUDINAL SECTION, TYPICAL CROSS SECTIONS

796-04-08-FD-CS-RRA-03_0 - CHARACTERISTIC CROSS SECTIONS

2.12 PARKING SHED

796-04-08-FD-CA-STR-01-0 - STRUCTURAL ANALYSIS

796-04-08-FD-TS-SHD-01_0 - TYPICAL AND SPECIAL ELEMENTS GEOMETRY - PLAN AND SECTIONS

796-04-08-FD-TS-SHD-02_0 - TYPICAL SHED TYPES GEOMETRY - PLAN AND SECTIONS 1-2

796-04-08-FD-LS-SHD-03_0 - TYPICAL SHED TYPES GEOMETRY - PLAN AND SECTIONS 2-2

796-04-08-FD-RF-SHD-04-0 - TYPICAL AND SPECIAL ELEMENTS - REINFORCEMENT 1-2

796-04-08-FD-RF-SHD-05-0 - TYPICAL AND SPECIAL ELEMENTS - REINFORCEMENT 2-2

3. BOOK_3_CULVERTS

796 04 08 FD TE CLV 01 0 - COMPONENTS A & C. TECHNICAL REPORT - STRUCTURAL ANALYSIS QUANTITY OF WORKS

796 04 08 FD CA CLV 01 0 - COMPONENT A. CULVERTS PART 1 OF 2

796 04 08 FD CA CLV 02 0 - COMPONENT A. CULVERTS PART 2 OF 2

796 04 08 FD CC CLV 03 0 - COMPONENT C. CULVERTS

796 04 08 FD CP CLV 01 0 - COMPONENTS A & C. CONSTRUCTION PHASING & TRAFFIC DIVERSIONS

4. BOOK_4_SMALL_STRUCTURES

796 04 08 FD TE RTW 01 0 - STRUCTURAL ANALYSIS - QUANTITY OF WORKS

796 04 08 FD PC RWD 01 0 - DETAILS OF PEDESTRIAN CROSSINGS

796 04 08 FD RW RTW 02 0 - RETAINING WALLS

5. BOOK_5_SIGNALLING

796_06_09_FD_GL_STT_01_0 - SIGNALLING AND TELECOMMAND SYSTEM - GENERAL LAYOUT

796_06_09_FD_TR_STT_01_0 - SIGNALLING AND TELECOMMAND SYSTEM - TECHNICAL SPECIFICATIONS - TECHNICAL CONDITIONS SIGNALLING - TELECOMMAND OPERATING REQUIREMENTS AND PERFORMANCE SPECIFICATIONS

6. BOOK_6_TELECOMMUNICATIONS

796_06_09_FD_TR_STT_02_0 - TELECOMMUNICATION SYSTEM - TECHNICAL SPECIFICATIONS OPERATING REQUIREMENTS AND PERFORMANCE SPECIFICATIONS

7. BOOK_7_GEOTECHNICAL STUDY

COMPONENT A

796 03 21 FD DR GTA 01 0 - GEOTECHNICAL DESIGN REPORT OF COMPONENT A

COMPONENT C

796 03 21 FD DR GTC 01 0 - GEOTECHNICAL DESIGN REPORT OF COMPONENT C

796 03 21 FD PL GLG 01 0 - GEOLOGICAL PLAN VIEW - GEOLOGICAL LONGITUDINAL SECTION 0+000-0+700

796 03 21 FD PL GLG 02 0 - GEOLOGICAL PLAN VIEW - GEOLOGICAL LONGITUDINAL SECTION 0+700-2+150

796 03 21 FD PL GLG 03 0 - GEOLOGICAL PLAN VIEW - GEOLOGICAL LONGITUDINAL SECTION 2+150-3+600

796 03 21 FD PL GLG 04 0 - GEOLOGICAL PLAN VIEW - GEOLOGICAL LONGITUDINAL SECTION 3+600-4+700

796 03 21 FD PL GLG 05 0 - GEOLOGICAL PLAN VIEW - GEOLOGICAL LONGITUDINAL SECTION 4+700-5+696.58

796 03 21 FD PL GLG 06 0 - GEOLOGICAL PLAN VIEW - GEOLOGICAL LONGITUDINAL SECTION 0+000-0+815.57

WEST CONNECTION

796 03 21 FD CS GLG 07 0 - GEOLOGICAL CROSS SECTIONS

8. BOOK_8_ENVIRONMENTAL_STUDY

796 05 27 ER ER ENV 01 0 - REPORT

796-05-27-DR-OM-ENV-01-0 - ORIENTATION MAP

796-05-27-DR-AM-ENV-02-0 - STUDY AREA MAP

796-05-27-DR-SM-ENV-03-0 - ALTERNATIVE SOLUTIONS MAP

796-05-27-DR-GM-ENV-04-0 -GEOLOGICAL MAP

796-05-27-DR-LM-ENV-05-0 - LAND USES MAP

796 05 27 DR TR ETR 01 0 - TECHNICAL REPORT

796 05 27 DR TR NTS 01 0 - NON TECHNICAL SUMMARY

4. Supplementary Information (Annex 1)

All necessary documents available such as:

i. SEP
ii. LAF
iii. Environmental licensing of the project
iv. Expropriation documents
v. Concept design of Domje triangular intersection
vi. Environmental Study of the Domje triangular intersection
vii. Building Permit
viii. Decision of the Archaeological Service Agency including Conceptual Survey Report
ix. Technical Opposing from National Construction Institute

NOTE: If further information is needed, please refer to the Project Implementation Unit in Albanian Railways.