# VOLUME 3
# Technical Specifications

## Section 5
## Particular Technical Requirements

## CONTENT

# 1. BREAKDOWN OF CONSTRUCTION

All works regarding ETS Trebešica will be conducted in accordance with the solutions elaborated in the main electrical, architectural – civil, mechanical and other designs, in accordance state-of-the-art technologies. The process of ETS Trebešica construction will be carried out over a limited time period.

Constructions of the new ETS Trebešica will consist of following works:

- surveys - topographical and geotechnical,
- adaptation of the end part of 110 kV feeding line,
- dismantling of the existing equipment in the old substation,
- organized and safe removal of the dismantled equipment,
- demolition works and preparation of the terrain for the works under the Project,
- construction of a new retaining wall with draining ditches,
- construction of a new facility according to main electrical, architectural – civil, mechanical and other designs,
- installation of new equipment,
- testing, commissioning and running in of the system.

The design provided by the Contractor for the new ETS Trebešica should in general comprise the following:

- demolition works and dismantling of old equipment
- preparation of the territory,
- construction of a new retaining wall with draining ditches,
- a new 110 kV substation with two incoming three pole GIS modules with cross connection (air or gas-insulated), two outgoing two pole air-insulated 110 kV feeder bays,
- to save room, the outgoing 110 kV feeder bays will be connected to traction transformers by single-conductor 110 kV cables. The cables will be terminated by cable heads and surge arresters mounted on steel supports,
- two single phase 110 kV/27 kV traction transformers with power 2x 10 MVA will be situated at transformer outpost covered by a roof,
- 25 kV single-phase gas-insulated cabinet-enclosed indoor switchgear,
- digital protections and control system and remote control (SCADA),
- connection to the contact line,
- service consumption for feeding of the control circuitry and process protections of the R110 and R25 switchgears, interior wiring of the R25 switchgear and remote control, outdoor lighting of the traction substation site, communication and transmission systems of the ETS, fire detection and fire alarm systems, electronic security signalling, intrusion detection systems, an outdoor camera,
- alternative power supply (an automatic start-up diesel generator),
- outdoor lighting,
- protective and operating earthing,
- substation building with a cesspool and a rainwater accumulation tank,
- substation fence,
- transmission and telecom systems,
- fire detection and fire alarm systems, physical security and an outdoor camera.

## 2. GEOMORPHOLOGICAL, GEOLOGICAL AND HYDRO-GEOLOGICAL CONDITIONS OF A THE WIDER AREA

The site is located in the northern part of the territorial district of the capital city of Montenegro - Podgorica, near the border with the territorial district of Kolašin. The overall grade is part of the easternmost mountain range territory of Prekornica, defined by the Valley of the Morača River and Prekornica in the West and through the Valley of the River Tara in the East. The main factor forming the current landscape is the erosion activity of both rivers and their tributaries, which has created deeply cut valleys and canyons with steep to vertical slopes. Another phenomenon creating the landscape in the affected territory was the erosion activity of glaciers during the last ice age on the continent, while at present it is also karstic erosion on the surface and underground karst formations of all types (karstic fields, caverns, caves, underground streams, etc.) affecting the rock complexes formed by carbonic rock (lime stone and dolomites), which are typical in this territory.

From the geological point of view the territory belongs to the northern part of what is called the high-karst zone (Sarajevska sigmoida) on the interface of the Prekornica massif (anticlinorium) and the massif of the Valley of the Morača (sinclinorium). The northern part of the Valley of the Morača is bounded by the Durmitor overlying rock.

The Prekornica massif is predominantly created by Triassic and Jurassic carbonates with the remains of Lower Cretaceous carbonates. Rocks are represented mainly by dolomites and lime stones. The Valley of the Morača massif is formed by rocks of Middle Cretaceous formation with clay and silt sandstone, which is transgressively laid on the Jurassic carbonates.

The hydrogeological conditions are defined by geological and tectonic structures of the territory, where in the carbonic rock complex (The Prekornica massif) water-bearing of the rocks is prevailing with typical karst structures (caverns, karst groundwater flows) and with porosity. However the rock massif complex of the Morača Valley is made up of very heterogeneous environment, the most watered areas are those made of lime stones and sandstone formation with the crack-karst porosity, siltstone forming the throughput of impermeable environment. Ground water presence is unique only in the zone of weathering. The territory is drained by the River Morača in the West and by the River Tara in the East. Rivers Morača and Tara form the erosion basis of the two massifs and define the direction of the groundwater flow.

### 2.1 ENGINEERING GEOLOGY RATIOS OF INTEREST SITES AND GEODYNAMIC PHENOMENA

The engineering geology conditions of the territory can be characterized on the basis of information from the site inspections carried out by the study specialists. The current ETS as well as the stretch of railway line is located in the right side of the rocky notch of the eastern slopes, where the rocky notch is protected by gravitational concrete walls. The left side of the railway leads in a low embankment, which - at the proposed site of the substation where the embankment is higher because of a terrain hollow - is protected by concrete walls.

Based on the general data the site is likely to be situated in the Morača Valley massif territory.

According to the rock samples from the uncovered rock wall directly from the premises of the proposed project, the construction of the geological sites involved rocks of Jurassic (lime stones and dolomites) and clay, silt sandstone of Middle Cretaceous (flesh).

Jurassic lime stones are dark grey, dolomites are grey white, rocks are massive, and their nature is obvious from the large rock wall near railway station (RwSt) Trebešica.

The rock wall was probably created as a rock cut for the railway station platform, while in the upper positions in the zone of weathering rocks, or in the place of occurrence of stony debris, the cut is secured by concrete walls (concrete seal) and concrete ribs. According to the documentation of uncovered limestone and dolomites, the rocks in the massif are set in the high weathering zone and in the low weathering zone.

The rocks in the high weathering area are affected in particular by the influence of tectonic factors (cracks) and subsequently by climatic factors (water, frost cycles). The rocks have a character of solid blocks alternating with breaking rock character of broken stones. According to the classification (Euro codes) this is a heavily weathered rock rocks (weathering grade 3-4) with low strength (R4), in the places of intensive breaking up rocks with a very low strength (R5).

The rocks in the zone of low weathering are compact, broken only by irregular cracks, forming a hard block of rock massif. According to the classification (Eurocodes), the lime stones and dolomites in the zone can be characterized as weakly weathered rock (degree of weathering 1) with medium to high strength (R2-R3).

The RwSt Trebešica platform is located in a relatively narrow erosive valley along the creek, which is recessing to the lime stone massif. The creek passes under the railway through a culvert and continues in its natural valley. The valley is parallel with the railway and it is assumed that the valley probably also is a lithological interface.

The massive Jurassic lime stones and dolomites in the right side of rock cut - in direction of the current RwSt - dribbles out and switches to lower Cretaceous rocks which are represented by clay, silt sandstone (flesh), which is likely to continue the railway line up to a short tunnel under the current substation.

The flesh course forms irregular positions of grey clay stone with a slip layer, dark grey slate siltstone with a thickness of layers up to 1 cm and a brown bench fine grain sandstone formation. As with the lime stones and dolomites we assume that in the flesh massif the rocks are in the zone of high weathering (grade 3-5), where they have a character of rocks with very low to extremely low strength (R5-R6), while parts of the earthy debris may be present locally, and low weathering zone (grade 1-2), where the rocks have mostly the nature of the rocks with low strength (R4) with a local occurrence of more solid blocks of rock with medium strength (R3).

As a comprehensive rock wall flesh formation has not been documented on the site and the formation is covered up with slope sediments, or the cut is supported by a concrete wall, the occurrence of flesh massif is assumed on the basis of flesh debris presence in the slope above the concrete walls. According to the nature of the territory (fairly steep slopes above the concrete walls with no signs of instability), we assume a favourable orientation of the flesh formation in the slope.
The quaternary cover of rocks is formed mainly by diluvia sediments made of detritus.

On the limestone base, the detritus is mainly stony with variable-size debris fragments from small-grained up to boulder debris. Their thickness is not significant, as the terrain is relatively steep. By Eurocodes, stony debris can be classified as gravelly soil (GP, G-F).

On the flesh base we assume that presence of mostly stony debris with a significant incidence of earthy-debris can be expected in the area of the shallow rough depression, in which the current substation is situated. By Eurocode, the earthy-stony debris can be classified as fine grain to gravelly soil (CG, GC).

In the valley of a creek, where the flow is of clearly erosive character, we do not see any occurrence of fluvial sediments.

A part of the embankments of the railroad is made up of anthropogenic sediments represented by earthy-stony debris, which is probably a mixture of rocks extracted from the railway cut and from the tunnels.

The current geodynamic phenomenon in the territory is mainly erosion and weathering, karst corrosion, the creep of debris and seismic disturbance.

Erosion is bound to a local surface creek, which ensures mainly deep erosion, as well as lateral erosion of the slopes, which is obvious from the nature of the valley, which is fairly deep cut into the rock massif.

Clay stone, siltstone and sandstones have the tendency to weathering more than lime stones and dolomites, assuming that the zone of flesh formation weathering is thicker than the carbonic one. Weathering is conditional on climate, rainfall ratio and freezing cycles. By lime stones we can also expect significant karst corrosion, with typical karst phenomena.

Any significant slope deformations are not present in the territory, but we do not exclude that the depression in which the current substation is situated, is a relic of fossil landslide slope sediments, while its likely break area is at the top of the slope. Landslides may have been bound to the tectonic zone with more significant broken rocks. Accumulation of landslide materials was taken away probably by the surface creek. The current presence of instability of the territory can be characterized only in the form of a slow creep of debris with a shallow flat shear at the interface with the subsoil, which is primarily seen on vegetation damage (bent and uprooted trees).

## 2.2 HYDRO-GEOLOGICAL CONDITIONS OF INTEREST SITES

Hydrogeological conditions of the site are a reflection of the geological structure of the territory. The part of the territory formed by lime stones and dolomites forms the hydrogeological collector with good conditions for the circulation and accumulation of groundwater. the part of the territory formed by flesh rocks forms the hydrogeological insulator (low permeable to impermeable environment).

Accumulation and circulation of groundwater in lime stone and dolomites is in predominantly cracks-karst regime, while the amount of accumulated water is dependent only on rain and snow. Due to the landscape of the territory and hydro-geological characteristics of the massif the rapid drainage of groundwater into the level erosive base occurs frequently. The erosive base is made up by the

Morača River in the West and the Tara River in the East. Accumulated groundwater stocks at their low replenishment especially in the summer are rapidly losing due to the nature of karst environment.

In an environment of flesh, due to their hydro-geological characteristics, the rainfall infiltration into the massif is not present. The vast majority from precipitation due to landscape conditions run-off into the river network. In the area there is a nameless tributary creek of Sjeverice river. Non-significant part of precipitation, however, infiltrates into the environment, where it is accumulated only in the subsurface zone (in the debris or in the zone of weathering), but also with regard to relief, rather quickly drains into the valley, where it is drained by a surface flow.

### *2.2.1 Description of the current situation*

The existing traction power station and the adjacent section of the railway track, with the nearby

Trebešica railway station, are located in a cutaway from the mountainside, fortified with gravitational retaining walls made of concrete. The retaining walls are lined with a drainage channel, collecting water from the retaining wall drainage as well as precipitation runoff from the mountainside. A concrete chute is used to drain runoff water from the vicinity of the traction power station into the drainage channel. Both the concrete channel and the chute are in the state of disrepair, with considerable amount of deposits in some places. The locally damaged and clogged channel could cause problems during torrential and/or lasting rainfall, while flooding of the traction substation with surface runoff.

The left side of the railway track bed is positioned on a small embankment. The embankments near the traction substation were made higher, due to a depression in the terrain, and supported by a gravitational retaining wall.

The platform of the Trebešica railway station and the traction power station are located in a narrow erosion vale, cut by an unnamed stream (sometimes referred to as the Trebješica Brook). The brook passes underneath the track bed through a culvert near the railway station and continues through its natural bed approximately parallel to the rail track. The brook receives all drainage water from the abovementioned concrete channel running alongside the retaining walls, drains water from a relatively long section along the rail track, including the existing traction substation and a part of the adjacent mountainside.

### 2.3 SEISMOLOGICAL CONDITIONS

According to the regional classification, the territory of the site belongs to an area with abundance seismic shocks of magnitude 5,6° (Richter scale).

## 3. TECHNICAL DESCRIPTION

### 3.1 SURVEYS

#### *3.1.1 Topographical Survey*

A topographical survey of the closest ETS area was performed in December 2013 during works on Conceptual Design and Feasibility Study. Results of the survey were incorporated into drawings.

Nevertheless, the future Contractor shall have an obligation to carry out his own topographical survey, which will be the basis of his detail design.

#### *3.1.2 Geotechnical Survey*

A geotechnical survey has not been carried out during works on Conceptual Design and Feasibility Study.

For optimal design of the project, a detailed geology (geotechnical) survey should be carried out, consisting of drilling, geophysical, geological and laboratory work in the following recommended scope:

Geological works will consists of geological mapping, documentation of drilling places, construction of geological sections, evaluation of the laboratory work and drawing up a final report of the survey.

### 3.2 PREPARATION OF THE TERRITORY

#### *3.2.1 Landscaping*

Removal the current vegetation and perform subsequent improvements including the planting of the species with deep roots in the slope of the walls in the range of about 5 m over the walls.

The Contractor shall submit for approval to the Engineer a detailed proposal for landscaping including the proposed species of trees and shrubs.

#### *3.2.2 Demolition works*

The existing traction substation site is located close to the track, in a slope cutting. The cutting walls are strengthened by reinforced concrete retaining walls; there is a draining ditch in the wall footing to carry away the rainwater from the slope over the walls outside the substation site. The site of the traction substation is enclosed by a fence. The 110 kV substation is outdoor, air-insulated, the 110/27 kV transformers are not under roof but are exposed to atmospheric condensation.

The future reconstruction of the 110/25 kV ETS Trebešica will include dismantling of the all existing electrical apparatus and demolition of civil structures like:

- 2x 110 kV line with feeder ropes AlFe 150/25 mm2, approx. 70 m long,

- 110 kV outdoor substation with two three-phase 110 kV busbars and two two-phase 110 kV feeders (disconnectors, power breakers, current and voltage transformers, surge arresters; control boxes, cables, ropes, insulators; main and auxiliary steel supports, foundations),
- two traction transformer fields with single-phase regulation transformers 110/27,5 kV, 7,5 MVA and associated elements of the fields (cables, auxiliary steel constructions, return line),

- transformer oil may be delivered to an operator possessing a licence for its treatment or for reuse,
- removal of the third faulty traction transformer from the site,
- connection between the 25 kV secondary side of the transformer and the 25 kV distribution building is by an overhead line (ropes, insulators),
- the 25 kV distribution device is of cellular (module) type with inlets, pigtails, service consumption field and cross-couplings (disconnectors, power breakers, current and voltage transformers, surge arresters; control boxes, cables, support insulators, bus-bars, switchgear steel frames),
- control devices and protections, transmission device, batteries, transformer for service consumption, interior wiring, switchboards, etc.,
- existing outgoing feeders of the 25 kV switchgear to overhead contact line with traction disconnectors,
- all other equipment as protective and operating earthing, outdoor and indoor lighting, electrical installation, concrete cable trenches and chambers, etc.,
- existing retaining wall and drainage gutters behind the substation building approx. 28 m long,
- complete the substation building (area of 66 m2),
- substation fence with four double gates for maintenance and two single gates for staff (approx. 137 m long); the fence is made of steel, the gates are manually operated, made of tubular steel frames, the fence poles are of concrete,
- all foundations will be completely demolished.

For an overview of origin, categories and technology of waste material treatment, see Annex 1.

### *3.2.3 Waste and Technical Solutions for Environmental Protection*

For the construction of ETS Trebešica, materials not containing hazardous substances and not generating hazardous waste will be used. The quantities of these materials will be defined in the main architectural and structural, electrical, mechanical and other designs.

The waste generated during construction will mostly be municipal waste and various non-hazardous construction types of waste, both in relatively small quantities. But it is realistic to determine the amount of waste contaminated by dangerous substances. This is primarily related to the presence of PCB oils in the soil, old batteries, electrical waste, fluorescent pipes containing mercury, etc. The Contractor shall be obliged to prepare a waste management plan and provide for its implementation. Sorting and temporary storage of waste materials have to be in accordance with the waste law. All the waste generated during construction works should be sorted and transported to the location provided by a company responsible for temporary waste storage.

Materials resulting from excavation works shall be tested for presence of certain pollutants (PCBs, heavy metals, etc.), submitted to classification compliant with law and to further procedures. The soil under each transformer can be contaminated with transformer oil, so the Contractor shall be obliged to analyse soil samples and, if necessary, store the contaminated soil in a specialized waste deposit.

An accredited laboratory is to certify that the soil is free from contamination and can be used for backfilling of certain locations. All waste characterised as containing hazardous substances should be stored separately until it is delivered to an authorized operator.

Used oil is to be temporarily stored in previously provided locations. Filter cartridges/inserts, dehydration mass and oil-soaked absorbents are to be stored separately. Everything is to be transported to a centralised location for temporary storage of such waste. During transport, the cargo must be secured from leaking, falling or rolling over. Final waste disposal shall be organized after its classification and categorisation by authorized laboratories.

Testing, treatment and/or storage of the contaminated soil/hazardous material will be performed in line with the relevant Montenegro Laws and regulations. No contaminated soil and/or any other hazardous material will remain on the site at the date of issuance of the Taking-Over Certificate. All relevant cost is considered to be included in the Lump-Sum Contract Price. More information can be obtained from the Agency for Environmental Protection of Montenegro at the following web-link: http://www.epa.org.me/

### *3.2.4 Extension of the existing recess (retaining walls)*

A part of the existing recess which is recently less deeply cut into the rock massif will be cut deeper in the rock over approx. 4 m, whereby the entire area will be extended approx. by 20,0 m. In this case, the rock massif can be protected by pre-creting, just as it is done now. Pre-creting will either consist of a plain slightly tilting away from the vertical axis or consist of steps.

This area may as well be secured by shot-creting combined with soil (rock) anchors. The specific solution will be decided on the basis of surveying and the results of exploration.

The proposed solution for the protection of slopes remains unchanged. In the view of the above, the Contractor should to implement the following measures:

- as for the proposed new retaining walls, in order to minimize earthworks and breaking into the slope, it is recommended to opt for a nailing or anchored structure with concrete facing,
- all along the new walls, a drain of sufficient capacity to retain surface water from the slopes is to be built,
- in the new walls, subsurface drainage wells are to be made, 5-10 m deep, to ensure the drainage of the ground of the massif behind the walls,
- at the foot of the wall, reconstruct drainage gutters of sufficient capacity.

### *3.2.5 Drainage Troughs*

#### *3.2.5.1 Hydro Technical Calculations*

A correct design of the drainage system requires the following calculations:

- calculation of rainwater drainage from the drained area to the point of the new traction substation; calculation was made for two values of design rainfall intensity

Design rainfall intensity:

- rainfall intensity: 150 litres per second per ha, 221 litres per second per ha
- rainfall duration: 15 minutes

Rainfall drainage:

- design area: 65,000 square metres
- drainage coefficient: 0,25
- rainfall drainage at 150 litres per second per ha: 243,8 litres per second
- rainfall drainage at 221 litres per second per ha: 359,1 litres per second

Sizing of the proposed drainage troughs along the retaining walls on the site of the new traction station: The evaluation is made for a channel gradient of 2,0 % (the gradient must be checked at later stages of project documentation, in accordance with a detailed geodesic survey

**EVALUATION OF TRAPEZOID PROFILE FOR A LONGITUDINAL GRADIENT OF 2,00** %

**TRAPEZOID TROUGH**

| | | | | |
|---|---|---|---|---|
| b | - | trough bottom width | **0,35** | m |
| B | - | width at water surface level | **0,45** | m |
| h | - | water level height | **0,50** | m |
| 1:m | | trough side slope | **0,10** | |
| n | | coefficient of coarseness | **0,014** | |
| i | - | longitudinal trough slope | **0,020** | |

**CALCULATION ACCORDING TO CHÉZY FORMULA:**

$$Q_{KAP} = C \cdot S \cdot \sqrt{R \cdot i}$$

$$v_{KAP} = \frac{Q_{KAP}}{S}$$

| | | | | | |
|---|---|---|---|---|---|
| S | - | flow cross-section area | **0,20** | $m^2$ | |
| O | - | wetted perimeter | **1,35** | m | |
| R | - | hydraulic radius | **0,15** | m | |
| C | - | coefficient of velocity | **52** | $m^{0,5}.s^{-1}$ | |
| $Q_{KAP}$ | - | capacity flow rate for circular profile | **0,564** | $m^3.s^{-1}$ | **564,26** $l.s^{-1}$ |
| $v_{KAP}$ | - | capacity velocity for circular profile | **2,82** | $m.s^{-1}$ | |

The capacity of the drainage channel shall meet the requirement of draining design level for torrential rains.

#### *3.2.5.2 Description of the Draft Drainage Concept*

The existing power station will be partially extended to the South (toward the Trebešica station).

The underlying principle for the drainage system is to collect all water from the vicinity and drain it into the nearest suitable recipient watercourse. That should result in a reduced risk of flooding of the proposed power station by water originating from torrential or prolonged rainfall.
The proposed concept for the power station drainage is based on the following principles:

- A drainage trough is to be constructed all along the cutaway, above the existing retaining wall, to collect all runoff from the mountainside above the retaining wall. Water from the trough will pass at the end of the trough into the drainage channel at the visible foot of the wall. The trough will be made either of traditional concrete trough profiles, or of stone pavement in concrete.
- Short boreholes of 5 to 10 metres are to be drilled below the surface level in the new retaining wall to remove water from the rock behind the walls.
- Drainage channels are to be reconstructed at the visible foot of the existing retaining walls, with new channels of the same dimensions built along the new retaining walls.

The underlying principle of the proposed drainage is to collect all runoff from the neighbourhood and to direct it to the nearest recipient watercourse. That should minimise the risk of flooding of the proposed traction power station due to torrential or long-lasting precipitation. The existing and the newly proposed drainage channels will meet the requirements of draining the runoff in case that design torrential rains occur.

#### *3.2.5.3 Description of Drainage Channel Reconstruction*

The existing concrete trough is to be reconstructed. Its parameters are the following: 0,35 m wide at the bottom, 0,45 m wide at the maximum water level, 0,5 m deep. The trough is covered with a concrete slab. The trough will be cleared of vegetation, and degraded concrete will be remove until intact material comes to the surface. All surfaces will be blasted with pressurised water up to 800 bar. Exposed reinforcement and other surfaces will be treated with profiling mortar. Where more than 40 mm of material is necessary, concrete with coupled reinforcement will be used. The coupling reinforcement bars will be inserted in predrilled holes. Couplings will be set at specified distances. After installation of the bars, the holes will be filled with cement mortar suitable for concrete structures. Concrete surfaces will be treated with two layers of a consolidating and impregnating coat to prevent moisture from penetrating in the concrete covering layers. Any expansion joints will be maintained and suitably restored.

## 3.3 CONSTRUCTION PART

### *3.3.1 General*

The new building structures will be based on strip foundation, due to heterogeneous foundation soil (variable thickness the different layers extending toward the slope and interface with flysch rocks), it is recommend to homogenise the foundation soil by a compacted gravel layer.

The foundations of transformers and electrical poles (main and auxiliary steel structures) rest over the block foundations which reach as deep as the flysch rocks.

The lines and levels for earthworks shall comply with drawings.

### *3.3.2 Substation Building*

The substation building is a 2-floor masonry building, with no basement.

The groundwork consists of excavations for foundation construction and backfilling plus compacting after the foundation has been built.

The foundation structures consist of wall footings of plain concrete C16/20. The vertical load-bearing structures will be built by traditional technology as a wall structural system.

The circumference wall is of bricks filled with thermally insulating material. The internal non-bearing walls are of bricks.

There is an access path and a gutter pavement all around the building. The load-bearing part of the roof structure will be made by a system of timber components – rafters and beam ties; the roofing is of zinc-coated plate with a double standing seam. The roof bearing structure must be sized to carry the necessary load imposed by snow approx. 1,2 m thickness. The ceiling will be made of a reinforced concrete slab.

Floors shall be designed with a finish depending on the room purpose (concrete slab, anti-static PVC, ceramic tiles, including thermal insulation of floor in control room, sanitary rooms, dressing and day room). The proposed windows are plastic, with double glazing, turn and tilt; all the windows will be provided with grates. Glass-block windows are proposed in the 25 kV switchgear room, in the control room and in the alternative power source room. The interior doors will be of timber, the exterior door of safety timber; the door to the R25 room and to the alternative power source will be of steel, padded warm. The interior plaster is compo, painted with no-dust white; the ceramic wall cladding in the lavatories is as high as 2000 mm above the floor.

The exterior facade plasters shall be provided in a colour which must be approved by the Engineer. Auxiliary structures consist of roof gutters and down-pipes, trimming of window sills, trimming of passages, drain lid, door scraper and air grating. The building will be equipped with sanitary installations, electronic fire alarm, intrusion alarm system, wiring for the socket and light circuits, telephone extension and an incoming service cable for structured wiring. There will be electrical heating by electrical convectors. Split air conditioning unit/units shall be installed for rooms 25 kV substation, own consumption, alternative power source, dressing room / day room and control room (office).

The building will at the same time provide shelter for occasionally arriving labour force of the infrastructure manager. Drink water will be supplied in cans. The rainwater captured and stored in a tank will be used for service purposes.

The substation building shall be constructed to the ETS requirements. The following rooms have to be provided as a minimum requirement. Those rooms are accessed either directly from outside or by a staircase and a corridor. The building is intended for occasional attendance when not more than 1 - 2 persons will be inside. The lavatory has been sized for this number of persons.

| Room Description | HVAC |
|---|---|
| **1st floor rooms** | |
| Substation 25 kV | HVAC |
| Own consumption | HVAC |
| Alternative power source | HVAC |
| Staircase | HV |
| Fuel storage (storage space) | HV |
| **2nd floor rooms** | |
| Hallway | HV |
| Hall | HV |
| Shower | HV |
| Lavatory | HV |
| Dressing room / day room | HVAC |
| Control room (office) | HVAC |
| Reserve (contingency place) | HV |

H = Heating; V = Ventilation; AC = Air Conditioning

**Table 1:** Substation building rooms

| Room Description | Required Furniture / Equipment |
|---|---|
| Control room (office) | 1 computer table, 1 office chair, 2 filing cabinets, shelve |
| Dressing room / day room | 1 bed, 1 table, 1 chair, 1 filing cabinet, 2 steel clothes closets, cupboard, hot water kettle, utensils |
| Hall | A mirror and a shelf, clothes hanger, towel hanger |
| Lavatory | Toilet paper holder |
| Shower | Towel hanger |
| Reserve (contingency place) | Shelves on one of the walls |

**Table 2:** Furniture and mobile equipment

Technical solution of the substation building shall take into account the requirements of energy performance of buildings (Directive 2010/31/EU). The Contractor shall provide for energy certification of the building after its completion.

### *3.3.3 Substation Building - Cesspool*

The cesspool for the traction substation is proposed to be a reinforced concrete accumulation tank. The proposed cesspool is built in an orderly style and easy and fast to build in. The tank has a reinforced concrete floor and ceiling slabs, its lid is of cast iron, it is trafficable by people or vehicles, and there are plastic-coated ladder steps inside it. It is placed over a concrete base.

### *3.3.4 Substation Building - Rainwater Accumulation Tank*

Due to the fact that there is not any water supply system in the location intended for the new ETS, it is proposed to catch and store rainwater for service purposes (cleaning, flushing of toilets or washing, for instance). The water will be accumulated in a subsurface single-chamber tank of a volume of approx. 2000 l, to which rainwater will be carried by downpipes from the roof of the substation building. The water from the draining of paved areas may not be supplied to the tank!

The complete system for using rainwater consists of a tank, a filtration set and a pump with accessories. The system is micro-processor controlled and features a digital level gauge. Automatic flushing intervals for cleaning the filter are provided for. The tank is sunk in a pit, over a layer of 8/16 gravel, approx. 200 mm thick.

### *3.3.5 Substation Fence and Gates*

The site of the traction substation will be enclosed by a galvanized steel fence with gates for maintenance (3) and staff (1).

The permanent fence shall consist of galvanized steel mesh and three rows of barbed wire above the steel mesh. The fence shall be 2,70 m high. The fence poles each 3,00 m shall be of galvanised iron pipe. Furthermore, the steel mesh and posts shall be embedded in concrete foundations.
Three two-part and one one-part wing gates are to be installed at the entrances to the ETS area.

The gates are to be manually operated. The gates shall be 2,70 m high. They are made of galvanized tubular steel frame and galvanised steel mesh is used for the fence. The gate posts are of galvanized tubular steel.

The gates shall be completed with the necessary fittings such as drop bolts; back catches, locking bars, lock plates and locks with three keys. The gates have to be provided with cylinder locks.

### *3.3.6 Traction Transformer Outpost*

The transformer outpost will be able to accommodate two single-phase 110/27 kV, 10 MVA traction transformers. The outpost will be partially roofed – under a shelter. There will be an access platform high on the front side of the yard. The rails for moving the transformers delivered to the site will be fixed to the foundations of the transformer outpost. The gauge will be 1435 mm. The transformers will be pulled to their place by means of a pull-in pulley and isolated from the frame protection rails. In order to prevent leakage of oil into the soil, a concrete watertight tub for receiving of accidental leakage of oil is built under each transformer. In case of accident, oil is led by oil sewage to oil pits. The oil sewage and oil pits shall be watertight, to prevent possible greasing of the surrounding soil by the leaked transformer oil. If it comes to oil leakage, the pit serves as a separator and separates water from the oil.

The concrete sump will be covered with bars over which there is a layer of gravel, grain size 30-50 mm, at least 20 cm thick. Should the leaked oil catch fire, the gravel filter will prevents any further spreading of the fire, the extinguished oil runs into the sump, and then to the oil sewage system and the oil pit.

Potential fire shall be extinguished with sand, foam or dry powder (boxes with dry sand are placed at each transformer and portable fire extinguishers next to equipment). Water must not be used for fire-fighting. Water may not get into the container where oil is under fire: this may cause the fire to spread.

Auxiliary structures will consist of support insulators, roof gutters and down-pipes, steel construction for cables, cable duct, electrical installation for lighting, socket outlets etc.

#### *3.3.7 110 kV Substation - Construction Part*

The construction part for new 110 kV technological equipment will consists of following:

- reinforced concrete foundations for 110 kV technology equipment (auxiliary steel construction for gas insulated modules (GIS), voltage transformers, current transformers, circuit breakers, disconnectors, surge arresters),
- reinforced concrete foundations for 110 kV for main steel constructions (portal structure for anchoring of feeder lines, portal structure cross connection of three phase and two phase parts).

#### *3.3.8 110 kV Substation – Cable Channels*

Cable ducts with will be built to accommodate cable routes in the new ETS.

The main cable route will be a reinforced concrete cable duct leading from the transformer outpost to the substation building. The duct will be sloped for drainage. The walls are made of reinforced concrete; the cover will be made of prefabricated monolithic slabs. The slabs are removable to allow access to the duct for maintenance and repair of cable lines. The main cable pit will be made of reinforced concrete as a part of the substation building construction. All dimensions, auxiliary equipment as ladders and steel constructions will be specified in the detailed design.

Low voltage and control cables will be laid in plastic multi-channel cable duct leading from the main cable draw pit into the site of the 110 kV substation. A plastic multi-channel cable duct will be laid 610 mm deep under the ground level. The number of holes for the multi-channel will be specified in the detailed design. Cable pits shall be designed in plastic.

### 3.4 TECHNOLOGY EQUIPMENT

#### *3.4.1 110 kV Substation*

##### *3.4.1.1 Substation Basic Data*

- voltage system 3 AC, 110 kV / TT, a system with a directly earthed zero point
- maximum service voltage — 123 kV
- nominal current – busbars — 800 A
- substation layout — H with additional cross connection
- traction feeding system — 1 PEN AC, 25 kV / TN-C
- nominal voltage – moderate heating, sockets — 3 PEN AC, 230/400V / TN-C-S
- nominal voltage – auxiliary circuits — 1 PEN AC, 230/400V / TN-C-S
- protections feeding — 2 DC, 110 V /IT
- substation control system — 2 DC, 110 V /IT
- installed power of transformers — 2x 10 MVA

The 110 kV switch plant will be an H-type with additional cross connection. Cross connection between switch plant parts can be also insulated with SF6 gas. The H coupling will make part of the 110 kV overhead lines loop. The outgoing feeders to traction transformers will be two-pole.

It is proposed to locate the traction substation on the site enclosed by a fence, as shown in the layout drawings. The site will accommodate a 110 kV substation, a transformer outpost and a substation building.

In order to save room, the proposed outdoor-type 110 kV switch plant will consist of two SF6-insulated 110 kV enclosed modules.

The substation will be powered by the existing 110 kV line Podgorica – Berane which was built to supply the existing ETS Trebešica. Incoming 110 kV overhead cables are proposed from the existing

110 kV poles above the existing traction substation which will be terminated on the master steel frame of the substation.

The busbars and mutual connections of all HV devices will be provided by an AlFe rope.

Current transformers, combined and double combined disconnectors with earthing switches and power breakers will be encapsulated in modules. Both the outgoing feeders to traction transformers and the transformers themselves will be two-pole.

The two-pole part with circuit breakers and disconnectors for additional cross connection will be at classical outdoor air insulated type. Various devices in the substation (surge arresters, voltage transformers, 110 kV cable heads, etc.) will be mounted on auxiliary steel structures fitted on concrete foundations, as indicated in the layout drawings.

The various devices will be controlled from the section control box, by the station control system. When the control system will have been modified, the H coupling can as well be controlled from the power distribution control centre.

Three pole gas insulated modules will consist of following parts:

- input disconnectors and disconnectors with an earthing knife,
- current transformers,
- circuit breakers,
- output disconnectors and disconnectors with an earthing knife.

Two pole classical air insulated parts will contain:

- circuit breakers,
- single-conductor 110 kV cables between 110 kV feeder bays and traction transformers incl. cable heads,
- protective surge arresters,
- current transformers,
- voltage transformers.

### 3.4.2 Adaptation of the 110 kV Feeding Line

The positions and orientation of the overhead 110 kV feeding line allow feeding the 110 kV substation. The conductors connecting the terminal poles and the dead-end portal structure of the ETS will be replaced by new ones of the same cross section.

While the substation is closed, the 110 kV line will be off and earthed. In the event that a closure is impossible, the terminal poles will have to be temporarily connected, which will mean erection of a temporary pole.

### 3.4.3 Connection of the 110 kV Substation with Traction Transformers

To save room, the outgoing 110 kV feeder bays will be connected to traction transformers by single-conductor 110 kV cables. The cables will be terminated by cable heads and surge arresters mounted on steel supports. The cable heads will be:

- outdoor, for insulated type of conductor, with total creepage distance 2 850 mm.

The surge arresters will be suitable to protect 110 kV cable sheath against tensions in the sheath induced by normal or short-circuit currents. Upon laying the cables and prior to their commissioning, the line will be submitted to model tests. The model tests are performed by an authorised entity. Total earthing resistance and model short circuit of the line will be measured. Depending on the test results, a set of precautions will be defined for safe operation of the cable lines.

### 3.4.4 Traction Transformers 110/27kV

The ETS Trebešica will include two single-phase transformers connected to two phases of the 110 kV system on their primary side. On their secondary side, the transformers will have their common point both earthed and brought out to the track return circuit. To allow a margin for possible changes in the traffic flows, the nominal continuous power of the transformer is proposed to be 10 MVA, the nominal no-load ration 110/27 kV and short-circuit voltage 10 %. The transformer will be equipped with a control on-load tap charger. Type of cooling: ONAN (oil-natural, air-natural) or ONAF (oil-natural, air-forced). For normal service, the transformer will operate in ONAN mode. However, fans shall be mounted at the initial stage, so that when the load increases, such as during emergency feed extensions, the transformer will be ready to feed the demand, if required, in ONAF mode.

The HV side will be connected by an AlFe rope. Support insulators are proposed on the rear wall of the yard. The T1 and T2 transformers will be connected to 0, 4 phases just as in the existing substation.

The secondary 27 kV side will be brought out by cables placed in a cable channel. One outgoing feeder of the transformers will supply the 25 kV switchgear; another outgoing (return) feeder will serve as a rail pole. The outgoing return cables will be terminated in the return cable switchboard which will be located in the middle of the outpost.

The tank which accommodates a core-and-coil assembly and oil filling has to have low dead weight with static security, of high oil impermeability. The tank has to include high-quality corrosion protection to help ensure a long service life.

#### *3.4.5 25 kV Switchgear*

The proposed 25 kV switchgear system is a single-phase SF6-insulated indoor switchgear.

The feeders from T1 and T2 transformers will be brought to the R25 switchgear and separated by disconnectors.

The various R25 parts will be structured into separate sections which will allow eliminating the scope of the gear failure if there is any (gas leak).

The system will contain outgoing-feeder bays to supply the overhead contact line bound to Podgorica, Beograd and Railway Station (RwSt) Trebešica. The outgoing-feeder bays will be separated from the main busbars by power breakers.

A separate outgoing-feeder bay allows supplying the service consumption transformer 25/0,23kV AC. Transformer will be installed in the separate room. Each section of the case with a switch will include a control box superimposed to the switchgear and containing protection, control and signalling devices.

#### *3.4.6 Digital Protections*

Differential protection:

- The differential protection allows a fast and selective transformer cut-off. It includes temperature-dependant overload protection and overcurrent time protection;

Overcurrent protection:

- The two-level overcurrent protection provides a backup and frame protection to the transformer. Its first level will act as overcurrent protection if undervoltage occurs. Its second level will act as fast short-circuit protection. The protection also provides overload functionality;

Overvoltage protection of the 25 kV switchgear:

- The 25 kV switchgear includes overvoltage protection. If actuated, the protection cuts off the circuit breaker on the 110 kV side as well.

The digital protection system will be specified in the detailed design.

#### *3.4.7 Control and Signalling*

The following control will be provided:

- local – from the control box,
- remote (control room or supervisory control station),
- by device controls.

Terminals will be linked to the control and information systems by fibre-optic cables to carry failure or process signalling, readings of electrical quantities and controlling. Local control will be connected to the terminal by a metallic cable. Either local or remote control (from a work table or from a railway supervisory control station, respectively) will be possible.

The signalling of the various devices will be supplied by 110 V DC.

### *3.4.8 Control System and Remote Control (SCADA)*

The substation building of the ETS Trebešica will accommodate an assembly of the station's control system with accessories and a terminal for the remote control of section disconnecting switches. The control system of the new ETS has to be fully compatible with the existing system used in the main dispatcher system in Podgorica.
The station's control system (SCS) is intended to perform the following basic duties:

- to collect logical signals representing the states of the respective process devices, provide for their transmission to the railway control centre,
- to provide for the transmission of command signals from the control centre to the devices which exercise those commands in the process and – depending on the control algorithm – generate its own commands to process devices,
- to read the values of analogue quantities, process them and transmit them to the railway control centre,
- to communicate with the relevant process devices in the transformer substation by means of digital protections linked to the station control system through a fibre-optic system,
- to store the status information of the technology process and its changes and allow viewing of the data stored,
- local control of the technology via operating terminal whose role is to receive information on the state of process devices and other signals including measurements from the station control system and provide for their imaging in a format suitable for the operator, as well as allow the operator enter actuating commands for the technology,
- by means of the remote control terminal (RCT) as a substation of the station control system, to allow remote control of the section disconnecting switches of the contact line

The SCS device and the RCT will be powered by the substation service consumption switchboard and will be backed up by its own alternative power sources.

The data connection between the station control system and the railway supervisory control station will be provided by connecting the transmission circuits of the SCS with the transmission system. The supply and installation of the station control system includes the supply of all software incl. licences used.

### *3.4.9 Connection to the Contact Line*

The outgoing feeders of the 25 kV switchgear will be cable lines terminated on new traction poles along the track in load-breaking traction disconnectors (switch disconnectors).

To simplify the handling in case of traffic closures, three outgoing feeders will be switched through traction disconnectors. All disconnectors will be motor-driven and connected to the remote control system actuated from the control centre or locally, from the traction substation building.

The return line will be made by cables from the return cable switchboard at the traction transformer yard, the connection to the track rails will be provided by a cable line.

There are not any cutting neutral posts (or neutral sections between two feeders) in RwSt Trebešica now. Short neutral sections will be installed in the overhead contact line at the ends of RwSt Trebešica according to EN 50367:2006 Railway applications. Current collection systems. Technical criteria for the interaction between pantograph and overhead line (to achieve free access). Neutral sections will be designed with insulators installed into overhead contact line (OCL).

### *3.4.10 Service Consumption*

As for service consumption, the traction substation supplies energy to:

- control circuitry and process protections of the R110 and R25 switchgears,
- interior wiring of the R25 switchgear and remote control,
- outdoor lighting of the traction substation site,
- communication and transmission systems of the ETS,

- fire detection and fire alarm systems,
- electronic security signalling, intrusion detection systems.

The AC part of service equipment is supplied by:

- a feeder from the R25 switchgear system, the 25/0,23 kV AC transformer – basic supply, 1 PEN AC, 230 V / TN-C-S system,
- a feeder from the switchgear system of the Diesel generator switchboard – alternative power supply, 3 PEN AC, 230/400V / TN-C-S system,
- a low voltage cable feeder from the distribution transformer station, 3 PEN AC, 230/400V / TN-S system. It is recommended to realize reconstruction of existing switchboard in transformer station.

The low voltage lines will be terminated in the R11 switchboard which will be accommodated in the substation building of the R25 switchgear and remote control.

The control circuitry and process protections in the R110 and R25 switchgears will be supplied from the R12 switchboard, for which the supply from R11 switchboard will be proposed:

- secured supply from 2 DC 110V / IT source.

#### *3.4.11 Alternative Power Supply*

Should the primary service supply of the traction substation fail, there will be a new alternative power supply – an automatic start-up Diesel generator. The alternative power supply source will be accommodated in a separate room of the substation building. The motor generator set is a compact unit consisting of a Diesel combustion engine and a generator set attached to it. This complex is cushioned on a solid steel frame by means of anti-vibrating blocks. In the frame, under the motor generator set, there is a fuel tank with a sump. The generator set input has to be specified in detailed design. The proposed alternative power supply is equipped with a sound damping cover making it suitable for the interior of the machinery room.

#### *3.4.12 Outdoor Lighting*

To provide for outdoor lighting of the R110 substation, 110/27 kV transformer outpost and around the substation building, external lighting is proposed, consisting of hinged poles, carrying high-pressure discharge lamps. The poles will be erected along the site circumference, next to its fence. The lighting will be supplied from the R11 switchboard. The night lighting will be actuated automatically, by a switch with a dawning sensor. The working lighting will be locally controlled from the R11 switchboard. The traction transformer outpost will be lit by fluorescent lamps mounted on their walls.

The lighting of transformer outpost will be controlled locally from the respective outposts. The conductors will be laid in cableways or in the ground, over a sand bed, covered by a PVC tape as a warning. In the transformer yards, the cabled distributions will be fixed to the surface.

#### *3.4.13 Protective and Operating Earthing*

The exterior earthing wires must be designed compliant with HD 637S1:1999 so that its short-circuit capability can stand the short-circuit currents in the ETS. The main earthing network will be built compliant with IEC 364.5-54:2011, consisting of two parallel FeZn 30/4 mm strip earth electrodes accompanied – if necessary – by earthing rods to achieve the specified earth resistance value. The down leads from devices in the 110 kV switchgear will be made of FeZn 30/4 mm earthing strips running from the steel supports of the device in question. Each lead will be welded to an independent branch of the main earthing network. The earthing strips will be welded to one another in nodes. The bonds will be corrosion-protected. There will be metering wells with lids in the earthing network.

An earthing system will also be built around the substation building, of FeZn 30/4 mm earthing strips, to which all steel structures of the 110 kV substation, cable and roof structures of the building, technology inside the 25 kV switchgear and the lightning conductor will be connected. The fence around the substation site will be connected to the earthing system, too.

When the earthing system is completed, the step and touch voltage must be checked on their compliance with EN 50122-1:2011.

## 3.5 LIGHT-CURRENT EQUIPMENT

### *3.5.1 The Fibre-Optic Route*

The fibre-optic cable route is situated close to the existing traction substation. Therefore, it is better to make a tapping of 4 fibres off the existing fibre-optic trunk cable near the newly-built ETS and terminate those fibres in the fibre-optic distribution rack. The established physical layer of the transmission route would allow full transmission of all data and system states in the necessary scope and quality. The transmission route would support the transmission and lagging parameters for ONLINE process control from the railway control centre.

### *3.5.2 Transmission System*

At the time being, signals are transmitted from the existing ETS without any transmission system along a metallic line.

The scope of the processes required and the requirements concerning their quality and lagging necessitate building a transmission system in ETS Trebešica. The transmission system depends on the physical layer of the transmission model employed. The transmission equipment consists of a set of hardware and software allowing aggregation and data transmission between two or several distant points. The transmission equipment will include structured wiring distributions in ETS Trebešica.

This means building a transmission system incorporating any and all data flows from ETS Trebešica to Railway Station Podgorica. There, a new hub will be built, which allows separating the individual data flows from the new transmission route. For this option, no additional equipment will have to be installed which would necessitate any additions to the process equipment.

### *3.5.3 Telecom System*

Introduction of the telecom system is necessitated by the introduction of the transmission system to transmit data. The technical solution includes introduction of a telephone link with the central control point in RwSt Podgorica, with RwSt Trebešica and connection to the TICG telephone network.

The strong point of the solution in building a link which allow communication of people present in the ETS, in particular for reasons of maintenance and emergencies, when communication is the primary prerequisite for resolving the situation in place.

### *3.5.4 Fire Detection and Alarm System*

The existing ETS is not equipped with a fire detection and alarm system. The solution concerns fire detection and fire alarm signalling.

The protection of the ETS building and of its inbuilt technology is proposed by building measures as well as by an electric fire detection and alarm system.

The proposal of the fire detection and alarm system will be based and developed on the basis of fire protection concept prepared as a part of the project proposal. The proposal must be based on currently valid legal provisions and technical standards.

As the traction substation will not be a manned building, it is proposed to install electric fire detection and alarm throughout the building. The electric fire detection and alarm system will be one-level, which means that alarm will be signalled immediately after detection, without any need to have the alarm verified by man. In addition to the fire signalling itself, the electric fire detection and alarm system will be provided by an input-output unit to control and monitor other process equipment. Fire alarm will be signalled in several points, namely in the control room, to the power control staff in RwSt Podgorica and to the guard in the railway office in RwSt Trebešica. In the above-listed points, fire will be shown on signal panels but mainly by means of the existing superior system in RwSt Podgorica. Signals will be transmitted by the transmission system.

Advantage of this solution is an early detection of a developing fire which – along with an efficient intervention – may prevent major material, environmental and economic damage and result in considerably restricting the disturbance of smooth railway traffic throughout the track section.

#### *3.5.5 Physical Security, Electronic Security Signalling, Intrusion Detection Systems*

Physical security is represented by a set of technical tools whose role is to prevent illegal intrusion in the premises or later possibly detect unauthorised entry.

Physical security is provided for by a combination of a mechanical layer and intrusion detection with alarm.

The mechanic layer consists of a series of mechanical means (locks, bars, sheets, security frames and panes, etc.) to deter the potential intruder or possibly frustrate attempts to access the facility.

The electric security signalling is a set of technical tools (fire alarm station, triggers and auxiliary tools making a system) whose role is to provide early signals of unauthorised intrusion or attempted intrusion of a facility (the secured area), or of undesirable activities of the intruder. The electronic security signalling also has a preventive function. Certain its components are to be visible to deter from intrusion.

Physical security of the facility will be signalled in several points, namely in the control room, to power control staff in RwSt Podgorica and to the guard in the railway office in RwSt Trebešica. In the above-listed points, the status will be shown on signal panels but mainly through the existing superior system in RwSt Podgorica. Signals will be transmitted by the transmission system.

The electric signalling system will allow identify and authorise authorised persons, to monitor authorisations to enter various areas and to store recorded data.

#### *3.5.6 Visual Monitoring System*

An outdoor HD IP camera will be installed at the entrance (front door) of the substation building. The IP camera will allow recording local data and be supplied by power cabling. Data transfer will be allowed by the newly built transmission system. Data will be displayed in a monitoring station in the dispatcher centre in Podgorica. The monitoring station will consist of a personal computer with peripherals and software, including a license for the management system.

## 4. TESTING, TRIAL OPERATION AND SAFETY PRECAUTIONS

### 4.1 COMPREHENSIVE TESTS AND OTHER TESTING

All process equipment of the transformer substation must be tested during installation to establish any potential failures of its parts/components resulting from their transportation and to check their completeness. After the process equipment has been installed and connected, it must be submitted to comprehensive testing by its manufacturer. Upon passing the tests, the equipment will be submitted to commissioning tests by its future manager and then, it may be put into permanent service.

Requirements for tests are described in Volume 3, Section 4.

### 4.2 TRIAL OPERATION (TESTING AND COMMISSIONING)

Trial operation should cover a period of two month to establish and eliminate potential deficiencies.
Before the equipment is put into operation, it must be submitted to initial inspection.

### 4.3 REQUIREMENTS CONCERNING FUTURE OPERATION AND MAINTENANCE

There are not any special requirements concerning the operation and maintenance of the newly installed equipment. The new substation will be unmanned and remotely controlled. It will be operated by the existing labour that will be acquainted with the new system and provided the necessary training.

### 4.4 SAFETY PRECAUTIONS

Safety plates shall be fixed on the switchgear assembly and on entrances in the substation. The substation may only be entered by skilled persons who have been charged with certain working duties.

### 4.5 LABOUR AND PLANT SAFETY

Before the construction works are started, all underground services on the project site are to be staked out and their locations must be marked in the terrain. When construction works are performed in touch with the track in operation, the working section must be consequently marked.

The construction works may only be performed if all the requirements imposed by the labour safety and health principles are followed.

During construction it is necessary for the various construction parties to follow all the regulations concerning labour safety and health, starting by preparatory works and ending by the site evacuation and removal of the site plant. Labour safety and health need to be given more attention in situations where a higher number of labours are cumulated in a single place during construction.

It is equally necessary to take into account and follow the measures proposed by the labour safety coordinator.

### 4.6 FIRE RESISTANCE AND SECURITY WITH REGARD TO FIRE PROTECTION

The fire safety assessment for the project will be prepared in line with the regulations in effect at the time when more detailed project documents are being prepared. With regard to fire safety, the project – if the above-stated is observed – complies with the requirements.

The Contractor shall obtain a certificate of approval from the fire officer before the building is taken over. This shall cover all aspects of fire protection, including fire separation partition walls and doors, fire escape doors, fire detection and fire-fighting equipment.

## 5. ENVIRONMENTAL IMPACT OF THE PROJECT CONSTRUCTION AND OPERATION

### 5.1 PROPOSALS TO ELIMINATE OR MITIGATE THE PROJECT IMPACTS DURING CONSTRUCTION

The most relevant areas of proposals for the elimination of environmental impacts during the project construction may be considered the following:

- all technologies used in the project construction must be secured by technical precautions to eliminate or minimise the impacts, which result from technical standards, thresholds and regulations,
- during all the works, close attention is to be paid to the prevention of pollutant emissions to the environment, with major stress on the protection of surface water and groundwater,
- develop and follow the proposals for eliminating the impacts of potential accidents,
- develop an emergency plan to minimise the risk of serious environmental impacts in the event of an accident during construction or of other unforeseeable events,

- minimise the temporary occupancy of soil, prevent the contamination from the site plant, etc.,
- Minimise the space occupied and physically disturbed of protected areas and of elements of the environmental stability spatial system as well as other elements stabilising the environment,
- the beginning of the traction substation construction which means logging of wood species and removal of vegetation cover is to be planned out of vegetation and nesting periods,
- provide for a consequent recovery and revitalisation of areas degraded as a result of construction activities; develop adequate proposals of landscape improvements – plant replacement vegetation to contribute to a higher environmental stability of the area.

## 5.2 PROPOSALS TO ELIMINATE OR MITIGATE THE PROJECT IMPACTS DURING OPERATION

Several impacts, which were the most serious during the traction substation construction, do not continue any more or are fading out; the "nature's wounds“ caused by those impacts are gradually healing.

During operation and maintenance, impacts like noise, vibration, threat to water and accidents come to the foreground.

Therefore, the most relevant measures mean obeying strictly all measures imposed by technical standards, thresholds and regulations, along with those measures which are indicated in the EIA document.

The construction site is hardly accessible by road machinery and therefore, all works will be carried out by means of rail transport. The implementation will necessitate a permanent closure of the adjacent track serving the conveyance of materials and machinery.

With regard to the substation siting in a railway station, the contractor's plant and equipment should be situated in the area at the station building. Those areas may partially be used for temporary stocking of building materials. The loading platform may partially be used in the same way, too.

Power and water supply is available for the contractor in this location.

## 5.3 EXPECTED COURSE OF CONSTRUCTION

- Shut off the traction substation and disconnect the incoming 110 kV feeder line (the railway track will be powered by adjacent substations throughout the construction period).
- Dismantle and cart away the technology, deposit the materials in pre-determined locations.
- Prepare the building site for the building of new structures (remove the old foundations, demolish the old building, prepare the slopes).
- Build new structures (foundations and steel structures, retaining walls, transformer outpost, building, earthing network, cable channels, etc.).
- Install new technology (conveyance by rail is intended, the traction transformers will be pulled out of the carriage with the help of an auxiliary steel structure, the SF6 modules and other 110 kV equipment will be set in their places by means of cranes).
- Connect the substation to the feeding 110 kV line, connect the various technology sets by cables (the 110 kV substation with traction transformers, the 25 kV switchgear and the contact line).
- Make changes in the railway control centre Podgorica and other works in the traction substation site (paved areas, fence, etc.).
- Testing and trial operation, commissioning into full operation upon evaluation.
- Maintenance during DNP.

## ANNEXES

### Annex 1: Overview of Origin, Categories and Technology for Waste Material Treatment

| Waste category | Origin | Total amount (t) | Waste treatment |
|---|---|---|---|
| **H** | Waste nickel-cadmium batteries | 0,23 | Landfill for hazardous waste |
| **N** | Concrete generated of foundations demolition cable channels, retaining walls etc. | 274 | Recycling or landfill |
| **N** | Bricks, roof tiles, ceramic tiles | 1,76 | Recycling or landfill |
| **N** | Mixtures of concrete, bricks, stone and gravel containing no hazardous materials | 126 | Landfill for construction waste |
| **N** | Copper, bronze, brass | 0,27 | Recycling |
| **N** | Aluminium | 0,12 | Recycling |
| **N** | Iron and steel (steel plants and structures) | 4,85 | Recycling |
| **N** | Wires and cables of aluminium and iron | 0,22 | Recycling |
| **H** | Metal waste contaminated with dangerous substances | 1,29 | Landfill for hazardous waste |
| **N** | Cables (incl. signalling cables, low voltage…) | 0,94 | Recycling |
| **H** | Earth, rock, gravel, sand, etc. contaminated by dangerous substances | 23 | Landfill for hazardous waste |
| **H** | Other waste types from demolition incl. mixed wastes containing dangerous substances | 0,85 | Landfill for hazardous waste |
| **H** | Fluorescent lamps and other mercury-containing waste | 0,05 | Landfill for hazardous waste |
| **H** | Discarded electrical, electronic equipment containing hazardous components | 1,1 | Landfill for hazardous waste |
| **N** | Discarded electrical, electronic equipment (insulators, disconnectors) | 5,1 | Depot for old equipment |
| **H** | Discarded electrical, electronic equipment (3x traction transformer) | 84 | Landfill for hazardous waste |
| **N** | Wood – trees, branches, roots, etc. | 1 | Recycling or fuel |
| **N** | Mixture of soil and stones, not contaminated | 1344 | Landfill for construction waste |
| **N** | Concrete generated of retaining walls demolition | 120 | Landfill for construction waste |

Note:
H - contaminated (hazardous) waste; N - other non-hazardous waste.

**Table 3:** Estimate of waste material quantities resulting of ETS Trebešica demolition, sorted according to origin, category and treatment

The construction material of the old substation – if demolished – will mostly be non-hazardous waste. However, a certain amount of some materials has in the meantime been in contact with hazardous materials and have become hazardous waste. In addition, certain amount of non-hazardous waste (metals-copper, aluminium etc., then sorted construction waste concrete, iron etc.), can be recycled and reused.

The table shows the estimates of certain quantities of waste material classified by origin, category and treatment. This analysis did not consider some equipment - transformers, disconnectors, etc. which will be dismantled and transformer oil contained in these devices. Considering that they may be classified as hazardous waste as they have come in touch with hazardous materials and that they may be reused in some way, they should be treated separately. That primarily means handling of oil, their transport and possible future storage.

Testing, treatment and/or storage of the contaminated soil/hazardous material will be performed in line with the relevant Montenegro Laws and regulations. No contaminated soil and/or any other hazardous material will remain on the site at the date of issuance of the Taking-Over Certificate. All relevant cost is considered to be included in the Lump-Sum Contract Price. More information can be obtained from the Agency for Environmental Protection of Montenegro at the following web-link: http://www.epa.org.me/