

VOLUME 3
Technical Specifications

Section 2
Civil Works, Structural Steel Works and Iron Works

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1. GENERAL

1.1 STANDARDS AND GENERAL REQUIREMENTS

Unless specifically noted in the Drawings, or in the Specifications, all specified works shall be performed by the Contractor under this Contract.

The civil works comprise all works in connection with the construction work such as soil investigations, site installations, temporary works, civil structures below or above ground, reinforced concrete structures and masonry, structural steel and iron works in connection with civil and concrete structures, interior and finishing works, building equipment for installations, etc., infrastructural and environmental works, etc., and as indicated in the Drawings or described in the Schedule of Prices.

The Contractor shall provide all the installation, temporary buildings, temporary site infrastructure and services etc., which make his site operation feasible and enable him to start, to execute and to complete the works in due time and to the satisfaction of the Employer.

The Contractor shall be entirely responsible for the design, safety, stability and sufficiency of the work in accordance with local regulations.

The costs incurred in connection with the foregoing and all any expenses shall be deemed to be covered by the Contract Price.

1.2 SUBMITTALS

In addition to the submittals defined in other Volumes / Sections of this Volume, the Contractor shall submit the following documents and samples.

1.2.1 *For Block Work Material and Work*

Specifications of the brick and/or concrete block manufacturers and technical data sheets with data about the materials and products.

Three samples should be submitted from each type of brick or block. Samples will be taken from the first load of each type of brick or block delivered at the Site and submitted for approval before work is started.

The Contractor shall prepare samples of brick and block work which will show the colour of the mortar, the arrangement of the bricks and blocks and in general the quality of work. The samples shall be used as a standard for purposes of comparison with the brick and block work.

1.2.2 *For Paints*

A list of all surfaces to be painted, the type of the proposed painting, and manufacturer's technical data sheets including instructions for the preparation of surfaces, usage of products and recommended thickness of dry coats.

Three sets of colour scales should be submitted with all types of colours. After approval of the colours selected, the Contractor shall submit three samples of each colour with dimensions 300 x 300 mm. Each sample shall be designated with the type of finish, number and name of the colour, type of lustre, units of lustre and batch number.

In addition to the requirements for the submission of samples of colour paints, the Contractor, before starting painting, shall prepare on site painting samples of all types of surfaces to be painted. The purpose of this is to demonstrate the method of work, the texture of the finish, the colour and the quality of work.

1.2.3 *For Insulation Material*

The Contractor shall submit in his Detailed Design the following items for approval:

- ▶ three pieces with dimensions 300 x 300 mm from each type and thickness of the material he proposes to use,
- ▶ manufacturer's technical data sheets with requirements regarding the application of the materials and recommendations about means for protection against fire hazards,
- ▶ manufacturer's certificates.

1.3 FOUNDATIONS

The Contractor shall carry out his own detailed foundation investigation to make himself fully aware of all the subsoil conditions affecting the construction and maintenance of the substation as well as the safe bearing capacity of the foundation soil adopted in the design. The Contractor shall investigate the amount of sulphate and chlorides contained in the subsoil in order to check the necessity for providing corrosion protection for underground structures.

Suitability of materials on site for filling shall be checked and the Contractor shall carry out tests, investigations to determine the best method for utilisation of excavated materials as fill.

1.4 DESIGN AND CONSTRUCTION CRITERIA

All design and construction work shall be done according to relevant norms and standards.

All structural elements containing or conveying water shall be constructed in reinforced or pre-stressed concrete, including channels.

Substation building intended to house technology equipment and maintenance staff will be made of plain concrete foundations, vertical load-bearing structures will be built by traditional technology as a wall structural system.

The traction transformer outpost will be partially roofed – under a shelter, with reinforced side walls, access platform and a sump under the transformers, sized for no less than 100 % of the transformer oil volume, to serve as an emergency collector tank.

1.5 DESIGN LOADS, STRUCTURAL DESIGN AND ANALYSIS

All structures and parts thereof shall be designed to withstand the loads from within the substation and its components, including dynamic effects where they occur. Such loads shall be clearly indicated in the design calculations.

Loads shall be taken as stated in Eurocode No. 2 Design of Concrete Structures, EN 1990, EN 1991, or any other equivalent EN or national standard.

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

In his quality assurance / quality control (QA/QC) Programme, the Contractor shall define the procedures for the preparation and approval of the structural designs.

During the Design, detailed design calculations for each individual structure, together with general arrangement drawings, reinforcement drawings and bar schedules, are subject to the checking and approval procedures as laid down in the QA/QC Programme.

A statement explaining the principles of the design shall preface the detailed calculations and the type of analysis adopted and any design references on which the design is based.

For the concrete structure, the class into which the structure has been categorized for design purposes shall be stated.

For the superstructure framework, a separate statement shall be included explaining how overall stability has been achieved and whether reliance has been made on infilled walls, whether of brick, concrete or other material to provide stability.

All loads and structural wall sizes, including the positions and sizes of any significant chases and openings shall be clearly indicated in the design calculations.

The design shall allow for the effects of ambient temperatures as well as the effect of direct sunlight.

1.6 SPECIAL LOADS

The Contractor has to specify special loads as roof load, wind load, floor load, etc. in beginning of his design works. The proposed loads have to be approved by Engineer.

1.7 ARCHITECTURAL DESIGN

The architecture of the traction transformer outpost and substation building for technological equipment and generally all visible surface structures shall be combined with good weathering and low maintenance properties.

Materials shall be selected for a long life, taking into account the climate conditions of the site.

The architectural design for buildings and structures exposed above the ground level shall be submitted to the applicable local body with the Preliminary Design for approval before commencing the detailed design. Rainwater disposal shall be provided so that no roof or overhang water runs down the face of the building. Effective drains shall be incorporated in all overhanging elements.

The substation building containing equipment requiring removal by mechanical means shall be provided with equipment access doors sufficient to permit access by a trolley for equipment removal. The door shall be not less than 2,7 m high. Separate personnel access doors shall be provided in addition to equipment doors.

1.7.1 Rooms for Electrical Equipment

Generally, water and sewage, which are not related to the room, shall not enter areas for switchgear and alternative power supply. The floor shall be levelled, dust-free and not slippery.

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. Walls and ceilings shall have surfaces, which do not cause peeling or falling particles.

Walls, ceilings and floors shall be painted with dust-binding paint. All rooms with electrical equipment shall be fire-retardant and resist fire over at least 60 minutes.

Exits out of the rooms with electrical equipment shall be provided with doors, which open outward. The exit doors shall emerge to platforms or other rooms with an area of at least 1,5 m² and be located at the same level as the floor of the switchgear room. From the platform or the escape areas evacuation shall be possible.

1.7.2 Thermal Performance

Heated and air conditioned rooms shall be designed to utilise energy at minimum consumption. Windows shall be designed in such a way that in the summer months, there will be little or no direct sunlight into the rooms. Wall and roof construction shall be designed to prevent condensation within the building elements (interstitial condensation).

1.7.3 Access and Working Space

The design of stairways, ladders, landings, ramps, handrails, etc., and the provision of adequate working space shall be in accordance with the recommendations of the Engineering Equipment Users' Association Handbook (U.K.), or other approved EU national references. Spiral and curved stairways will not normally be permitted.

2. CIVIL WORKS

2.1 EARTHWORKS

2.1.1 *Design Loading standards and norms*

The design shall be in accordance with the specifications included in this Volume and shall comply with all relevant EU standards (Eurocodes, EN standards), and other relevant documentation forming part of the Tender and of the subsequent Contract. A list of the most relevant standards is provided in Volume 3, Section 1 - General Technical Requirements, Annex 1.

2.1.2 *Excavation and Filling*

The Contractor shall submit to the Engineer an Excavation Method Statement Proposal for approval. All excavations shall be barricaded and posted with warning signs for the safety of persons. Warning lights shall be provided during hours of darkness.

Excavations shall be performed in a manner to prevent surface water and subsurface or ground water from flowing into the excavations and to prevent water from flooding the project site and the surrounding area. Water may not accumulate in the excavations. Pumping for excavation drainage shall be considered, when required and as instructed by the Engineer, as subsidiary work.

Following to an order of the Engineer, the entire site, or a part of the site shall be cleared of topsoil to the depth of 25 cm, or any other depth indicated in the drawings.

The removed top soil for reuse shall be disposed in an allocated place within the site. Surplus soil shall be transported to a designated location.

The lines and levels for earthworks shall comply with drawings, unless otherwise ordered by the Engineer. The area excavated to levels lower than designed, or approved by the Engineer shall be filled with plain concrete to the correct levelling at the Contractor's expense.

In case of presence of rock within the excavation area, the Contractor shall notify the Engineer to receive instructions how to proceed. This applies to stones bigger than 0,5 m³ which cannot be removed otherwise hydraulic hammers.

Vegetation, debris, unsatisfactory soil materials, obstructions, and harmful materials shall be removed from ground surface prior to the placement of fills. Sloped surfaces steeper than one vertical to four horizontal shall be ploughed, stripped, or broken-up in such manner that the fill material will bond with the existing material.

Filling, backfilling and casting of concrete over the excavated surfaces can be performed after the sub-soil has been inspected, or any specific tests carried out to the satisfaction of the Engineer and upon his permission to proceed with the works.

Soil lumps larger than 0,1 m in size shall be broken before compaction. The moisture content of the soil shall be carefully controlled either by natural drying or wetting with a fine spray before filling.

Compaction shall be carried out by mechanical rollers, power rammers, vibro-tampers vibrating plate compactors or other approved plant so as to produce the specified density determined in accordance with standards or such other minimum dry density as may be otherwise specified or ordered by the Engineer.

The finished surface shall comply with the required level and profile after consolidation. The filling and backfill shall be carried out with due allowance for compaction, shrinkage and settlement.

Filling and backfilling of the material, as indicated in the drawings, or instructed by the Engineer, shall provide dry density of backfill not less than 95% of the maximum required by ASHO test for fill under foundation, floors and inside and outside of buildings.

Any tests ordered by the Engineer on bearing characteristics of the soil for the major foundations shall be executed prior to installation of concrete.

Unless specified otherwise the excavation for pipes or cables shall receive a minimum layer of approved bedding material below the pipe or cable of depth in the trench according to EN 1610 but

as a minimum within the following range: 0,15 m (internal diameter of pipe up to and including 1,0 m or for cables).

Lateral bedding shall be formed by spreading and compacting the bedding material over the full width of the trench. Sufficient bedding material shall be provided to allow the pipes or cables to be worked into the bedding material and firmly supported to true line and level.

Sufficient space shall be left to enable the pipe joints to be made, tested and inspected and the Contractor shall ensure that at least three quarters of each pipe length is fully supported. Before any further filling, the pipeline has to be tested and approved by the Engineer. Pipe trenches shall be carefully filled with bedding material. Unless specified otherwise for specific pipe types, all pipes shall be covered by bedding material to a level of 0,3 m above their tops.

Unless specified otherwise for specific cable types, all cables shall be covered by bedding material to a level of 0,2 m above their tops.

The bedding material for plastic pipes (GRP / HDPE / PVC) shall be according to the manufacturers requirements.

The bedding material for cable conduits and cables shall consist of sand, graded 0/2 mm.

The difference in the level of backfill on either side of pipes shall not exceed a maximum of 0,2 m. Backfilling to structures shall generally be carried out as soon as practicable.

Embedding of pipes and cables includes the supply of bedding material, preparation of the bed, placing of embedding layers (not more than 0,1 m of compacted thickness) and compaction either by hand or with appropriate machines to the specified density below and around the pipes. The embedding works shall be carried out in compliance with EN 1610.

2.2 CONCRETE WORKS

This section includes all concrete works presented in the design drawings and described in the technical specifications.

At the beginning of the Contract term, the Contractor shall submit for the approval of the Engineer a Method Statement detailing his proposals for the organisation of concreting activities at the site.

The Method Statement shall include the following items:

- ▶ the plant proposed and layout of the concrete production facility,
- ▶ the proposed method of organisation of the concrete delivery or production facility,
- ▶ quality control procedures for concrete and concrete materials,
- ▶ placing of concrete,
- ▶ details of formwork including striking times and procedure for temporary support of beams and slabs,
- ▶ protection and curing.

2.2.1 Standards and Norms

The loading assumptions for the concrete shall be in accordance with applicable standards. Classes of concrete shall be confirmed according to EN 206 on test cylinders of a 15 cm diameter, 30 cm long, or a cube of 15 cm; 28 days after mixing, and ranked as:

- | | |
|----------|-------------|
| ▶ C8/10 | 8 / 10 MPa |
| ▶ C12/15 | 12 / 15 MPa |
| ▶ C20/25 | 20 / 25 MPa |
| ▶ C30/37 | 30 / 37 MPa |
| ▶ C35/45 | 35 / 45 MPa |
| ▶ C45/55 | 45 / 55 MPa |

The design shall be in accordance with the specifications included in this Volume and shall comply with all relevant EU standards (Eurocode, EN standards), and other relevant documentation forming part of the Tender and of the subsequent Contract. A list of the most relevant standards is provided in Volume 3, Section 1 - General Technical Requirements, Annex 1.

2.2.2 Concrete Classes

Adequate use of concrete classes shall be according to following:

- ▶ C8/10 for plain concrete only for filling trenches, for blinding and for screed,
- ▶ C12/15 for plain and reinforced concrete for screed and encasements,
- ▶ C20/25 for reinforced concrete in civil structures not in contact with water, for reinforced concrete for thrust blocks, etc.,
- ▶ C30/37 for watertight reinforced concrete in contact with water, wastewater etc., and where especially instructed by the Engineer,
- ▶ C35/45 for precast concrete structures,
- ▶ C45/55 for pre-stressed precast concrete structures.

2.2.3 Type of Cement

The type of cement used in each of the various works shall be standard brand Portland cement from a single approved source conforming to the requirements of Portland cement (CEM I) class CE I32.5, 42.5 or 52.5 in accordance to EN 197. Sulphate-resisting cement shall be used for infrastructure works and structures as specified in EN 197. The cement shall either be delivered in sealed bags marked with the manufacturer's name or in bulk consignments in a manner approved by the Engineer.

2.2.3.1 Test of Cement

Testing methods of cement are defined by EN 196.

The Contractor shall inform the Engineer on time about the intended delivery of cement and submit test certificates relating to each consignment of cement. Each certificate shall show that a sample of the consignment has been tested by the manufacturer or by an approved laboratory and that it complies in all respects with the Employer's Requirements.

If requested by the Engineer, the Contractor shall supply samples of cement taken on delivery to the Site, or during storage on the Site, for testing by a nominated laboratory free of charge.

Notwithstanding the receipt of test certificate and the approval of the Engineer, the Engineer may reject any cement as a result of further tests. The Engineer may also reject cement, which has deteriorated as a result of inadequate protection or other causes or in any other case where the cement is not to his satisfaction. The Contractor shall remove all rejected cement from the site without delay at his own expense.

2.2.4 Quality of Water

The water used for all purposes throughout the Works shall be potable, clean, fresh and free from objectionable quantities of silt, organic matters, alkali, salt or other impurities, and shall comply with the requirements of applicable standards.

The water used for mixing concrete and mortar, washing of aggregates and for curing the concrete, shall be from an approved source and shall contain no deleterious matter which significantly affects the reinforcement, setting time, strength or durability of the concrete or which has any effect on the appearance of the hardened concrete by discoloration or efflorescence.

The Contractor shall deliver to the Engineer, free of charge, samples of the water proposed for use in the Works for the Engineer to carry out such tests he may require to confirm its suitability. Samples will be delivered sufficiently in advance of the work for completion of the tests before the water is required for use and at such other times during the course of the Contract as the Engineer may direct.

If required by the Engineer, the Contractor shall at no extra cost to the Employer, treat the water taken from any other source to such a degree as may be necessary in order to render it suitable for mixing concrete and mortar.

2.2.5 Fine and Coarse Aggregates

Fine and coarse aggregates for concrete shall be obtained from sources approved by the Engineer. Fine aggregates shall consist of natural sand unless otherwise approved.

Aggregates for all types of concrete shall comply in all respects with EN 12620, ISO 6782. They shall be hard, strong and durable and shall contain no harmful material of sufficient quantity to affect adversely the strength or durability of the concrete or, in the case of reinforced concrete, to affect the reinforcement.

Fine and coarse aggregates shall comply with the following chemical requirements:

- ▶ fine and coarse aggregates shall not contain more than 0,10% and 0,05% by weight of chlorides (as NaCl),
- ▶ fine and coarse aggregates shall not contain more than 0,40% by weight of acid soluble sulphates (as SO₃),
- ▶ coarse aggregates shall be a minimum of 85% by weight calcium carbonate,
- ▶ fine and coarse aggregates shall not be potentially reactive with alkalis,
- ▶ fine and coarse aggregates in concrete elements exposed to wastewater shall be equivalent to high sulphate resistance of the cement. Appropriate aggregates are siliceous sand and gravel.

If these requirements cannot be met the Contractor shall adopt constituents for his concrete such that either:

- ▶ the Contractor shall notify the Engineer of his proposals for complying with this requirement at the time of commencement of the Works,
- ▶ the methods prescribed for complying with the first two points above shall be those set out in ASTM C 227, ASTM C 289, and ASTM C 1260.

If, in the opinion of the Engineer, the aggregates fail to comply with, or if there are doubts as to the uniformity of their compliance with the specified purity requirements, he will order all aggregates to be washed before use, at the Contractor's expense.

2.2.5.1 Aggregates

The grading of fine aggregates shall comply with applicable standards. The Contractor's attention is drawn to the fact that it may be necessary to combine two or more fine aggregates, or remove some fractions by hydraulic classification, in order to achieve the grading as specified.

The grading of coarse aggregate shall be within the limits given in applicable standards and the Contractor shall, if required by the Engineer obtain the specified grading by combining single sized aggregates in proportions to give the specified grading.

The maximum size of aggregates required will not normally exceed 32 mm. At least five separate size ranges of aggregate required as follows:

- | | |
|---------------------------|------------------------|
| ▶ fine aggregate | 0/2 mm |
| ▶ fine aggregate | 2/4 mm |
| ▶ medium coarse aggregate | 2/8 mm |
| ▶ medium aggregate | 8/16 mm |
| ▶ coarse aggregate | 16/32 mm |
| ▶ coarse aggregate | 32/45 mm mass concrete |

Each size of fine and coarse aggregate shall be stored in separate bins or on areas covered with steel plate, concrete or other hard and clean surface, which shall be self-draining and protected from contamination by earth or other deleterious matter.

Fine and coarse aggregates shall be stored in such a way so as to avoid the two materials from becoming intermixed.

2.2.6 Admixtures and Additions

Guiding standard shall be EN 480.

Where required or approved by the Engineer, the Contractor shall use admixtures such as plasticizers, retardants and/or additives such as pigments in the concrete. Proportioning and mixing of admixtures / additives thereof to be used in the concrete shall be in accordance with the manufacturer's recommendations and subject to the Engineer's approval.

Admixtures / additives shall only be those covered by a valid test mark and shall only be used under the conditions stipulated in the test certificates.

Admixtures / additives shall have no adverse effect on the concrete in particular the strength or durability of the concrete or the corrosion protection of the reinforcement.

Admixtures / additives shall be added to the batch in solution in a proportion of the mixing water according to the manufacturer's instructions. This solution shall be batched in such a manner that will ensure uniform distribution of additives throughout the batch during the specified mixing period. Admixtures / additives shall be suitable for use in contact with potable water after 30 days of concrete curing.

All admixtures / additives shall satisfy the requirements of the respective standards.

2.2.7 Concrete Mixing and Testing

The proportions of cement, fine and coarse aggregates and water proposed by the Contractor for the use in the Works shall be determined in accordance with the requirements set in standard for each class of concrete and shall be approved by the Engineer.

The minimum compressive strength and cement content shall not be less than required in the appropriate EN standard. If necessary to obtain the required strength, the Engineer may order the cement content of any class to be increased over the quantity specified in the standard. The Contractor shall furnish such increased quantities of cement at no additional cost to the Employer, if so ordered.

The quantity of water added to a batch of concrete shall be in accordance with appropriate EN standard, just sufficient to produce a concrete which in the judgement of the Engineer can be placed properly without segregation and which can be compacted by vibration to give the desired density, impermeability and smoothness of surface. The quantity of water shall be changed as necessary, with variations in the nature or moisture content of the aggregates, to maintain uniform production of the desired consistency. The consistency of the concrete shall be determined in accordance with EN 12350.

2.2.8 Concrete Mix Design

The various classes of concrete shall be designed by the Contractor with particular attention to durability, strength, workability and surface finish and to satisfy the Engineer with regard to these qualities. The content of all concrete shall be rigidly controlled and kept to the minimum required to obtain a workable concrete suitable for the nature of the work to be executed. Under no circumstances shall the free water cement ratio exceed the appropriate values given in the above standards.

The addition of proprietary admixtures intended to change the flow characteristics, cohesion or rate of setting need approval by the Engineer. No admixture shall contain more than trace levels of chloride ions.

Each Class of concrete mix shall be designed to have its mean strength greater than the specified characteristic strength. The Engineer may at his discretion approve a change in the Current Margin for the initial mix design if the Contractor produces evidence to show that he can satisfy the requirements for the determination of the mean 28 day compressive strength given in EN 12390-1.

No concrete shall be placed in the Works until the relevant mix has been approved by the Engineer. Approval will not be given to any concrete mix until it has been successfully subjected to Preliminary Mix Tests.

The Contractor shall carry out Preliminary Mix Tests as specified hereinafter in order to determine for each class of concrete shown in Table of Designed Concrete Mixes the minimum practicable water/cement ratio and the required mix proportions of the fine and coarse aggregate the necessary allowance being made for the moisture content of the aggregate. After the value of the water/cement ratio and the mix proportions have been approved by the Engineer, Trial Mixes shall be carried out by the Contractor as specified hereinafter. The water/cement ratio and mix proportions which have been approved as a result of the Preliminary Mix Tests shall be used throughout the course of the Works. The Contractor shall ensure that cube crushing strengths satisfies the compliance requirements specified hereinafter.

In concrete made with sulphate resisting cement the maximum total content of chlorides (as chloride ions) shall not exceed 0,2% by weight of cement and the total acid soluble sulphates (as sulphate ions) shall not exceed 4,0% by weight of cement.

Further tests shall be carried out if any feature of materials or mixes is changed during the course of the work.

2.2.9 Preliminary Mix Tests

The proportions of cement, aggregate and water determined by the Contractor in his mix designs shall be used in preliminary mixes of concrete made in the presence of the Engineer and tested for strength, workability and surface finish under laboratory conditions, observing the appropriate requirements, and to satisfy the Engineer concerning these qualities. Preliminary mixes shall be repeated with adjusted proportions as necessary until the concrete mixes meet the relevant requirements.

2.2.10 Trial Mixes of Concrete

Trial mixes of concrete shall be prepared and tested at the site by the Contractor in the presence of the Engineer after Preliminary Mix Tests have been completed and when the Engineer has approved the Contractor's mix design for each class of concrete. Trial mixes of concrete shall be mixed for the same time and handled by means of the same type of plant as the Contractor proposes to use in the Works.

Three separate batches of concrete shall be made for each class of concrete. Each batch shall comprise not less than 0,5 m³ of concrete, unless otherwise approved by the Engineer. Three cubes shall be made from each batch of concrete. The average strength of the nine cubes made for each class of concrete and tested after 28 days shall exceed the specified characteristic strength.

Unless otherwise approved by the Engineer, the Contractor shall carry out practical tests on the Site with trial moulds. The trial moulds shall be made for reinforced and plain concrete, of dimensions typical of the Works. The formwork face to the trial moulds for each class of concrete shall be designed to display all the relevant surface finishes intended for use in the Works. In making, transporting, placing, compacting and curing the Trial Mix concrete in the trial moulds, the Contractor shall observe all the relevant requirements. When curing has been completed, the trial moulds shall be stripped and the concrete thus revealed shall be submitted for the approval of the Engineer.

When a proposed mix has been approved, no variation shall be made in the mix proportions, or in the type, size, grading zone or source of any of the constituents without the consent of the Engineer, who may require further trial mixes to be made.

Where the Contractor intends to purchase factory-made pre-cast concrete units, trial mixes may be dispensed with, provided that evidence is given to satisfy the Engineer that the factory regularly produces concrete which complies with the Employer's Requirements. The evidence shall include details of mix proportions, water/ cement ratio, workability and strength obtained at 28 days.

2.2.11 Concrete Testing

The Contractor shall make all necessary arrangements for the sampling and testing of fresh and hardened concrete in accordance with the provisions of EN 1881 and shall secure all necessary apparatus labour materials and transport in the extent and numbers of samples required by applicable standards.

Slump tests shall be carried out at such times and places as the Engineer may direct and shall be used as a guide to the consistency of each class of mix. The degree of slump will be decided by the Engineer following Trial Mix Tests and the figure given shall be adhered to thereafter.

Crushing tests shall be carried out on concrete cubes formed in 150 mm moulds.

During the course of construction of the Works concrete test cubes in sets of four shall be made at such times and places as the Engineer may direct and in any case at not less than the average rate of one set of cubes per 20 m³ of concrete. Two cubes from each set shall be tested at an early age (normally 7 days) as approved by the Engineer and the results so obtained shall constitute part of the Contractor's quality control procedure. The remaining two cubes from each set shall be tested after 28 days and the average of these two results shall be taken as the Test Result for use in judging compliance with the characteristic strength requirements of the Employer's Requirements. Particular care must be taken to ensure that the test cubes are stored under uniform conditions throughout the year, including a complete covering of damp thick hessian sheet or similar approved material constantly sprayed with water whilst in the moulds and during any transit between the Site and laboratory, and also including subsequent storage in water kept strictly within the specified temperature range.

If the cubes fail to attain the required compressive strength as specified the parts concreted which they represented by the cubes shall be demolished, cut out, removed and replaced with concrete complying with the Employer's Requirements to the satisfaction of the Engineer.

The costs of sampling, making and curing Works test cubes together with the provision of moulds, all other necessary equipment and apparatus and the packaging and transport to the laboratory, shall be included in the prices.

All cubes shall be marked at the time of casting, with the date, class of concrete and other necessary markings to identify the part of the Works, from which they are taken.

2.2.12 Concreting in Hot Weather

The Contractor's attention is drawn to ACI 305. The Contractor's methods shall comply with the recommendations in that document as modified and supplemented below.

The Contractor shall take great care during hot weather (air temperature exceeding 25°C) to prevent early setting of the concrete causing augmented the cracking or crazing of concrete. The Contractor shall arrange for concrete to be placed in the early morning or late evening as directed by the Engineer.

The Contractor shall pay particular attention to the requirements specified herein for curing.

Formwork shall be shaded from direct exposure to the sun both prior to placing of the concrete and during its settings. The Contractor shall take appropriate measures to ensure that reinforcement in the section to be concreted is maintained at the lowest temperature practicable (spraying with water).

Concrete at placing shall have a temperature of not more than 32°C. If necessary, the Contractor shall cool the aggregates and mixing water by methods approved by the Engineer.

Where necessary the Contractor shall design, install and operate a cooling system by which cooling water is pumped through a piping system in order to decrease the heat of hydration during concreting. The proposal for such a cooling system shall be submitted to the Engineer for his approval well in advance of the concreting operations.

The temperatures of ambient air, concrete at various levels and intervals not exceeding 5 m and cooling water where applicable shall be measured by means of thermocouples and recorded with an appropriate and approved recorder.

In very hot weather, the Contractor may be required to cool formwork containing concrete by spraying with water. This shall be carried out where directed notwithstanding and whatever other measures the Contractor may have employed for curing of the concrete. All materials spray equipment and an ample supply of water for curing shall be ready on Site before any concreting starts.

2.2.13 Concreting in Cold Weather

Cold weather is defined as a situation existing at the Works, where either or both of the following conditions exist:

- ▶ the air temperature at the time considered is below 2°C,
- ▶ the mean daily air temperature over three or more successive days has dropped below 5°C,

Under no circumstances may concrete be placed in contact with frozen ground or formwork, or in contact with ice, snow or frost on the ground or on formwork or reinforcement. Concrete shall not be made with frozen materials.

Concreting may proceed in cold weather provided special precautions are taken to ensure that the surface temperature of the concrete at the time of placing is not less than 5°C for a succeeding period of at least:

- ▶ 4 days when the cement used in the concrete is ordinary Portland cement,
- ▶ 2 days when the cement used in the concrete is rapid hardening Portland cement.

Such precautions may include the following:

- ▶ warming the aggregates and heating the water, provided that the temperature of either does not exceed 35°C. Water and aggregates shall be mixed for a period sufficiently long for them to acquire a uniform temperature before cement is added,
- ▶ completely surrounding the freshly placed concrete with a cover and heating the enclosed air, which shall be kept moist. Draughts of hot or dry air shall not be directed at surfaces,
- ▶ insulating the formwork and finished concrete surfaces,
- ▶ providing screens to protect the concrete from air currents.

The Contractor shall provide the Engineer with details of the precautions he proposes to take to protect the concrete from the effects of low temperatures and with details of the methods he proposes to use to assess the correct timing at which such protection may be removed. No concreting shall be done in cold weather prior to the approval the Engineer for the proposed measures.

2.2.14 Compaction of Concrete

The Contractor shall regard the compacting of the concrete as a work of fundamental importance the object of which shall be to produce a watertight concrete of maximum density and strength.

Concrete shall be thoroughly compacted during the operation of placing and shall be thoroughly worked around the reinforcement and embedded fixtures and into corners of the formwork and moulds.

Mechanical vibrators shall be of immersion type, of frequency of not less than 6,000 vibrations per minute and as approved by the Engineer. A sufficient number of vibrators shall be used to handle the maximum rate of concrete production with a 50% allowance for stand-by units during any period of concreting. All operators handling vibrators shall be trained in their operation.

Vibrators shall be inserted into the uncompacted concrete vertically and at regular intervals. Where the uncompacted concrete is in a layer above freshly compacted concrete the vibrator shall be allowed to penetrate vertically for about 10 cm into the previous layer. Vibrators shall be withdrawn slowly from the mass of concrete so as to leave no voids. Internal type vibrators shall not be placed in the concrete in a random or haphazard manner nor shall concrete be moved from one part of the work to another by means of the vibrators.

Vibration shall not be applied directly or through the reinforcement to sections or layers of concrete which have hardened to the degree that the concrete flow in the formwork over distances is so great as to cause segregation and vibrators shall not be used to transport concrete in the formwork or shuttering. Vibration of concrete shall generally comply with the requirements specified in EN standard.

Every care shall be taken to see that the reinforcement and fittings attached to the shuttering are not disturbed, and that no damage is caused to concrete that has already set or to the internal face of the shuttering by using immersion type vibrators. In areas of congested reinforcement, it may be necessary to use small diameter pokers and the Contractor shall supply suitable sizes of pokers for each part of the work. Vibration of concrete by hammering the shuttering with hand tools is not permitted.

When placing concrete against horizontal or inclined elements of water stops they shall be lifted and the concrete placed and compacted to a level slightly higher than the underside of the water stop before releasing the water stop to ensure complete compaction of the concrete around the water stop.

The duration of vibration shall be limited to that required to produce satisfactory compaction without causing segregation. Vibration shall not be continued after water or excess grout has appeared on the surface.

Concrete shall not be disturbed after compaction and placing in its final position. Concrete that has partially set before final placing shall not be used and shall be removed from the site.

2.2.15 Protection and Curing of Concrete

Concrete shall be protected from damage by climate conditions (direct sunlight, rain, snow or frost), running water or mechanical damage during curing. All methods to be used for curing and protection of freshly placed concrete shall be subject to a prior approval of the Engineer.

The maximum and minimum ambient temperatures and humidity shall be measured and recorded each day by the Contractor. The records shall be made available for the Engineer's inspection.

All exposed surfaces shall as finishing proceeds be covered with a wet hessian sheet followed by a reflective polythene sheet. These shall be securely fastened around the edges and supported in order not to damage the finished concrete surface. As soon as practicable the hessian and polythene shall be lowered into close contact with the concrete and securely weighted or fastened down to prevent wind blowing underneath. The hessian sheet shall be maintained in a moist condition at all times and shall be inspected at intervals not exceeding 6 hours. Concrete shall be kept moist on exposed surfaces for a period of not less than 10 days or as approved by the Engineer.

Alternative methods of protecting and curing concrete may be approved by the Engineer. In any case liquid curing membranes shall not be used on exposed surfaces or where laitance is to be removed and aggregate exposed to provide a satisfactory bond for placing further concrete or mortar screeds.

Liquid curing membranes shall not be used where mortar, resin mortar, or joint sealant is to be applied.

Sufficient methods to afford full protection to a concrete pour shall be available at the place of work prior to the commencement of concreting.

2.2.16 Concreting Record

The Contractor shall keep complete, accurate and up to date records of the works on Site, for each day the sections of the works concreted:

- ▶ date, time, weather conditions and air temperature,
- ▶ results of all concrete tests including identification for which part of works the sampled material is representative,
- ▶ number of batches produced, weight and kind of cement used, volume of concrete placed, number of batches wasted or rejected,
- ▶ class of concrete, volume of concrete placed and number of batches used for each location.

The laboratory where concrete tests have to be carried out shall be approved by the Engineer and be accessible for the said parties at any time. The laboratory should preferably be placed at the Site.

2.2.17 Shuttering and Formwork

Timber or steel formwork shall be used to give the concrete the required shape. The formwork shall be of sufficient strength and rigidity to hold the concrete and to withstand the wet concrete weight, reinforcement weight, wind load together with all incidental dynamic effects caused by the pressure of vibration and ramming without deflection or deformation. The inside of the shuttering shall be well oiled and free from impurities and rubbish before any concrete is placed.

All shutters shall be provided with angle fillets so as to form splays on external angles unless otherwise specified or directed by the Engineer.

The full responsibility for releasing or removing formwork shall rest with the Contractor, whether or not a minimum period has been specified, and the Contractor shall as directed by the Engineer cut out and repair any weak or imperfect concrete found on inspection after removal of the shuttering.

2.2.18 Construction Tolerances

The following indicates the allowable tolerances for the construction of forms. Surface defects such as “blow-holes” and “honeycomb” concrete surfaces are considered as finish defects and are to be distinguished from tolerances indicated herein.

Leaning from established grades	15 mm
Leaning from established alignment	15 mm

Variation from the level or form grades indicated in drawing in slabs, beams, horizontal grooves and railing offsets.

Exposed in 3 m	10 mm
Backfilled in 3 m	20 mm
Variation in the thickness of slab:	- 2,5 mm; + 5 mm.
Variation in cross sectional dimensions of columns, piers, walls, beams and similar parts:	- 5 mm; + 10 mm.

Variation from the plumb or the specified batter in the lines and surfaces of columns, piers, walls and in arises.

Exposed in 3 m	10 mm
Backfilled in 3 m	20 mm

2.2.18.1 Foundations

A. Variation in dimensions in the plan

Minus 10 mm

Plus 20 mm

B. Misplacement or eccentricity: 2 % of the footing width in the direction of misplacement but not more than 25 mm.

C. Reduction in thickness - 2 %.

All visible exposed surfaces (e.g. top construction and columns) shall be “fair face” produced by using plywood linings. The maximum allowance deviations in surfaces when inspected by a template 1,5 m long are:

Gradual 4 mm

Abrupt 2 mm

Internal metal ties shall be reduced to a minimum. The ties shall be of the type designated for use for exposed surfaces and shall permit their removal to a depth at least 1,5 cm from the face of the wall without injury to the concrete. All fittings for metal ties shall be of such design that upon their removal the cavities which are left will be of the smallest possible size but not exceeding 2,5 cm in diameter.

Cavities shall be filled with cement mortar (preferably with anti-shrink additives) and the surfaces shall be left sound, smooth, even and uniform. Systems using pipes passing through the walls are not permitted unless otherwise approved by the Engineer.

Forms shall not be reused unless they are well maintained and repaired so as to produce the same surface produced by the first use. Special attention shall be paid to the water tightness and surface smoothness of the reused forms. Forms which are unsatisfactory in any respect shall not be reused.

2.2.19 Striking of Formwork

Forms shall be removed in such a manner as not to damage the concrete and shall take place at times to suit the requirement of the concrete strength, stresses in any stage of construction, curing and surface treatment.

Striking periods for cast in situ concrete:

- ▶ forms for vertical surfaces as beam sides, walls and columns shall not be removed before the elapse of 24 hours,
- ▶ forms serving as supports for slabs or beams (excluding any superimposed loads) should not be stripped before a number of days equal to $(2L + 2)$ days, where L is the length of span in meters, but not less than one week,
- ▶ for cantilevers, the striking period shall be taken as $(4L + 2)$ days where L is the cantilever length but not less than one week,
- ▶ the aforementioned periods can be reduced, subject to the organization discretion, in case rapid hardening cement is used or sufficient data on concrete strength are attained after placement would be made available.

2.2.20 Placing and Shaping of Reinforcement Bars

Bond, lap lengths and minimum radii of bends shall be in accordance with the applicable standards.

Before commencement of works in any of the elements, the Contractor shall submit to the Engineer the agreed number of copies of the detailed bending lists for approval. The lists shall indicate shape, diameter, length, number and weight of every bar in addition to the total weight of bars in every element.

The main reinforcement shall generally be of high-yield ribbed steel bars. Links to beams and columns shall be of plain round mild steel bars. All bar reinforcement shall be bent cold, before the bars are placed in position.

Splices shall be avoided as much as possible, welding of bars is not allowed and shall only be done with the explicit approval of the Engineer. If splices are necessary the bars shall overlap for a minimum length to sixty times the diameter of the bar measured along the straight part, and fifty times if the ends are hooked and tied together. In no case shall splices be made near the positions of maximum bending moment.

Mesh reinforcement shall overlap by a minimum of 2 meshes or 30 cm.

The bars must be connected with each other and with the stirrups by iron wire and must be supported by special bars and concrete spacers so as to ensure that they do not move during the concreting operations. Steel bar supports shall not be used in concrete with forms for exposed surfaces. Concreting of a section of work must only be done after the reinforcement has been approved and accepted by the Engineer.

All reinforcement, after it is bent and immediately before it is placed in the work, shall be well cleaned and made perfectly free from dirt, scale, loose rust, paint, oil, lime wash or any other coating.

Before concreting, all reinforcement shall be carefully cleaned of all set or partially set concrete which may have been deposited there during the placing of a previous lift of concrete.

In placing the reinforcement, care shall be taken to ensure that the cover of concrete on all reinforcement including links or stirrups is as specified hereafter, unless otherwise shown in the drawings or in the particular specifications.

2.2.21 Joints in Concrete

The positions of construction joints shall be indicated in the drawings and shall comply with the specifications.

In expansion joints, concrete faces shall be separated by a gap to accommodate estimated thermal expansion. Reinforcement shall be discontinuous and dowel bars provided with one half coated with bond breaking compound and the end provided with a compressible cap.

The concrete cover to reinforcement is specified as follows:

► Foundations	70 mm
Concrete exposed to the weather (above G.L.)	
► Beams, walls, columns etc.	30 mm
Concrete indoors:	
► Beams, walls, columns slabs, etc.	20 mm

Exposed surface forms shall be treated only with approved form coatings which do not affect the surface appearance or the concrete characteristics.

No shuttering shall be removed until the concrete has set sufficiently to withstand safely any stresses to which the structure may be subject. The removal of shuttering shall be carefully effected without any shock or vibration to the concrete.

No concrete shall be placed until the Engineer has approved the formwork in which it is to be placed. Such approval will not relieve the Contractor of his responsibility for the safety and efficiency of the formwork.

2.3 STEEL REINFORCEMENT

2.3.1 Standards and norms

The design shall be in accordance with the specifications included in this Volume and shall comply with all relevant EU standards (Eurocode, EN standards), and other relevant documentation forming part of the Tender and of the subsequent Contract. A list of the most relevant standards is provided in Volume 3, Section 1 - General Technical Requirements, Annex 1.

2.3.2 Design Requirements

In accordance with applicable standards:

- ▶ minimum reinforcement shall be used,
- ▶ steel bar size has to be limited,
- ▶ steel bar spacing has to be limited.

2.3.3 Types and Quality and Storage of Reinforcement]

Steel reinforcement (RF) for concrete shall consist of ribbed steel bars or ribbed steel wire fabric, except where otherwise shown. Quality of reinforcement steel shall be in accordance with applicable standards. The following strength classes shall apply according to EN 10027-1 and 2:

- ▶ steel bars: B 420 S and B 500 S,
- ▶ steel wire fabric: B 500 M.

The Contractor shall submit reinforcement detail drawings and calculations to the Engineer in accordance with Section for his approval.

The Contractor shall prepare test samples of steel reinforcement to be used in the Works. Test samples shall be taken in the presence of the Engineer and shall be of a size sufficient to carry out the tests as described below. They shall be tested in an approved laboratory and certified copies of the results of the tests shall be submitted to the Employer. The samples shall be tested for bending and tensile properties and the wire fabric also for weld shear strength. The methods and requirements for testing shall be carried out in accordance with the applicable Employer's Requirements. No steel reinforcement shall be used in the Works until the testing results have been approved by the Engineer. If ordered by the Engineer, test procedures shall be repeated at the Contractor's expense for any new supply of reinforcement during the course of the Works.

Storage of reinforcement shall be on racks or supports clear of the ground. Different types and sizes of reinforcement shall be kept separate.

2.3.4 Prestressing Steel

The quality of prestressing steel shall comply with applicable standards. The Engineer shall approve the tensioning method proposed by the Contractor.

2.3.5 Bending and Cutting Schedules

The Contractor shall prepare for his own use bar bending schedules and bar lists, cutting schedules and sheet lists for wire fabrics for each individual structure from the information given in the approved working Drawings and in the Employer's Requirements, and shall be responsible for ensuring that correct information is given when ordering reinforcement. Copies of these schedules, lists and orders shall be submitted to the Engineer for approval. Steel bar supports shall be included in the bending schedules.

The approval of the bar bending and cutting schedules, list, and orders shall not relieve the Contractor of his responsibility to execute the reinforcement fixing in accordance with the drawings and/or according to the requirements specified in standards.

2.3.6 Protection and Cleaning

Reinforcement shall be protected at all times from damage, and when placed in the structure, it shall be free from dirt, loose mill scale, rust scale, paint, oil or other foreign substance. All reinforcing steel shall be carefully cleaned of all set or partially set concrete, shutter oil or paint which may have been deposited during the construction of adjacent works.

2.3.7 Bending of Bars

Steel reinforcement shall be cut from straight bars free from kinks and bends or other damage and shall be bend cold by experienced competent workmen. Bars of diameter greater than 12 mm shall

be bent in a bending machine designed for the purpose and approved by the Engineer. Any reinforcing bar that has already been bent shall not be re-bent at the place of the previous bend.

2.3.8 Cutting of Wire Fabrics

Wire fabric reinforcement shall be cut straight from the sheets. The use of off-cuts in the Permanent Works will not be permitted.

2.3.9 Lapping of Bars and Wire Fabrics

Lapping bars and wire fabrics is permitted when necessary and approved by the Engineer. No welding of reinforcement shall be carried out unless authorised by the Engineer, welding and testing for reinforcement shall comply with the requirements specified in standards.

Unless otherwise specified, lap length of bars shall be at least 40 times the diameter of the larger bar, and laps shall be positioned in a staggered pattern.

Laps on the adjacent section of wire fabrics shall generally be carried out as follows:

- ▶ end to end by lapping the two pieces one full mesh (measured from the ends of the longitudinal wires in the other piece) and securing the two pieces together with wire ties placed at intervals of about 450 mm,
- ▶ side by side by placing the two selvage wires (the longitudinal wires at the edges of the fabric) one alongside and lapping the other, and by securing the two pieces together with wire ties placed at intervals of about 900 mm.

2.3.10 Fixing of Reinforcement

All reinforcement steel shall be accurately placed and fixed in its position and retained in that position during the placing of the concrete.

Spacer blocks for holding the reinforcement from contact with the forms, or adjacent reinforcement, shall be of dense precast concrete blocks of approved shapes and dimensions. The blocks shall be fitted with a semi-circular hollowing and double bent poured-in binding wires. The water tightness of these blocks must be at least similar to the concrete into which they are concreted. The use of pebbles, pieces of broken stone or brick or other materials will not be permitted.

Steel shall be bound and tied in its correct position using steel wire. Apart from any other requirement, the reinforcement, the reinforcing steel shall be fixed in such a manner that it will support its own weight and any loads which may be imposed upon it during construction without displacement, deflection, or movement of any kind.

In slabs provided with two or more layers of reinforcement, the parallel layers of steel bars shall be supported in their position by the use of steel chairs. Spacer blocks shall be placed at each chair to support the layers of reinforcement from the blinding concrete or shuttering.

The concrete cover to the nearest reinforcement exclusive of plaster or other decorative finish and concrete blinding shall be accordance with applicable standards unless otherwise stated in the Employer's Requirements for the relevant structure.

The distance between any two parallel bars except at laps shall not be less than 5 mm greater than the nominal aggregate size.

All reinforcement projecting from construction joints or likely to be exposed to the weather for long periods before concreting is commenced shall be covered with polythene blinding tape, cement grout or other materials to the surrounding concrete. Should in spite of these precautions rust staining occurs on any permanently visible surfaces, it shall be removed at once to the satisfaction of the Engineer.

To avoid reinforcement projecting from construction joints reinforcement boxes shall be used to connect reinforcement at construction joints wherever possible. Reinforcement boxes and covers shall be made of galvanised or black sheet steel.

2.4 FOOTPATHS

2.4.1 General

Adequate access shall be provided leading to every building/construction. The area in 110 kV substation will be finished with a layer of coarse aggregate. At least the following infrastructure shall be provided within the new ETS:

- ▶ walkways,
- ▶ outdoor stairs and access ramps,
- ▶ surface drainage.

Walkways shall consist of the following compacted components:

- ▶ tiled pavements,
- ▶ a bottom layer of sub-grade material, only where necessary,
- ▶ sub-base of granular material.

The sub-base and base in walkways shall be each as a minimum 150 mm thick, tiled pavements consisting of approved concrete slabs as minimum 50 mm thick. The tiles shall be laid evenly according to the lines and levels of the adjacent pavement. All tiles shall be of approved type, design and make and shall be firmly bedded on the underlying course and shall be laid against each other. Upon completion of the tiling, sand shall be strewed, and compacted with a mechanical vibrating machine of sufficient weight.

Sufficient manoeuvring space shall be provided at the substation building to facilitate installation or removal of equipment, maintenance etc. Ramps shall be provided at equipment access doors to enable a trolley to be driven into the building.

Outdoor stairs will be established in front the service door exit from the building to the substation area.

2.4.2 Earthworks

The earthworks shall generally be in accordance with item 2.1 Earthworks. In wet weather, particular attention shall be paid to the requirement that fill shall be compacted with a slight outward slope to ensure good run-off of surface water. The material excavated which is suitable for use in fill, shall be used for filling as far as practicable.

2.4.3 Concrete Access Ramps

In-situ cast concrete pavements shall be constructed of minimum 150 mm thickness and furnished with fine reinforcement of grid shape with Ø 8, 200 mm x 200 mm spacing. This concrete shall be placed either on 50 mm thick blinding layer of concrete or on 0,2 mm thick PV lining.

Expansion joints shall be provided together with contraction joints where walks about a structure, at changes in directions. Expansion joints shall be filled to within 20 mm of the surface with bituminous expansion joint material, and then filled flush to the surface with a joint sealing compound. The joint sealing compound shall be finished slightly concavely, and shall not be allowed to overflow the joint.

2.4.4 Tiled Pavements

Tiled pavements for walkways consisting of approved concrete slabs with a minimum thickness of 50 mm shall be laid on 20 mm of sand for final levelling. All slabs shall be of approved type and design and shall be firmly bedded on the underlying course and shall be laid against each other. Upon completion of the slabs sand shall be strewed, and compacted with a mechanical vibrating machine of sufficient weight.

2.4.5 Precast Units for Kerbs and Surface Drainage

Kerbs and drains units shall be supplied and laid along new retaining wall and constructed on Site. Curbs shall not be laid until 28 day strength of the pre-cast unit is attained. Curb sections are to be

set on compacted sub-grade. Any section deviating more than 1 mm of 1 m from line and level shall be lifted and re-laid. Grout up joints with mortar.

2.4.6 Surface Water Drainage

Provisions shall be made for the disposal of surface water from roofs and paved surfaces. Roof drainage shall be designed on basis of local hydro meteorological data for precipitation. Drainage from paved areas shall be connected to the Works water drainage system.

2.4.7 Concrete

The quality of concrete surface course, tiled pavement, kerbs and units for surface drainage must be according to item 2.2 of these Requirements.

3. ARCHITECTURAL WORKS

3.1 BUILDINGS

3.1.1 Scope of Works

The Contractor shall design and construct all buildings necessary for the correct dimensions to house the following components of the substation and to ensure an efficient operation of the substation. The minimum required facilities are as follows:

- ▶ substation building,
- ▶ traction transformer outpost.

The Contractor shall submit for Employer's approval the detailed design of the buildings including but not limited to: architectural, structural, air-conditioning and heating design, water and sanitation design with connection to cesspool and rainwater accumulation tank, adequate electric wiring for lighting, thermo and acoustic isolation, fire protection and alarm system.

Care must be taken that the heating and ventilation of the buildings, in which staff is not a continuously present, shall be adequate to ensure suitable environment (in respect to temperature and relative humidity) for the electrical equipment and electronic control equipment. The Contractor shall submit the design standards applied to the design to prove the adequacy of the solution proposed and shall submit detailed technical specifications.

3.1.2 General Requirements

The general requirements for building works shall include, but not be limited to, the following:

- ▶ the designs shall be in accordance with the applicable building, fire and planning regulations,
- ▶ the heating and ventilation of the substation building, in which staff will not be continuously present, shall be adequate to ensure a suitable environment (in respect to temperature and relative humidity) for the electrical equipment and electronic control equipment,
- ▶ the insulations shall be designed and laid according to the EN or equivalent norms (taking also into account the relevant manufacturer's instructions),
- ▶ interior walls shall generally be plastered and painted. Toilet, bathroom shall be tiled from floor to ceiling,
- ▶ suspended ceilings shall be provided in all offices and welfare areas,
- ▶ windows shall be double glazed with frames in plastic,
- ▶ doors shall be of interior or exterior quality as applicable, sheet steel or plastic laminate faced block board or of equivalent quality,
- ▶ external walls shall be rendered and painted with masonry paint or other approved finish,
- ▶ HVAC shall be provided to all operation rooms,
- ▶ floor finishes for administration rooms shall be of good quality vinyl tiles,

- ▶ floor finishes for control rooms shall be a suitable computer flooring system, approved by the Employer.

Building services shall include:

- ▶ low voltage and lighting,
- ▶ heating and air-conditioning,
- ▶ hot and cold water supplies,
- ▶ sewerage into cesspool,
- ▶ rainwater collection in to rainwater accumulation tank,
- ▶ the substation building shall be covered by a local area computer and telephone network with appropriate number of outlets to suit the accommodation provided. The connection points shall be wired for both telephone and computer network connections,
- ▶ the accommodation and minimum room sizes and indicated below are indicative only. The buildings shall be designed to accommodate the number of operation and maintenance staff required to operate the ETS satisfactorily,
- ▶ the building shall be provided fully fitted out and furnished. The Contractor shall submit his proposals for furniture and fittings to the Engineer for approval prior to the commencement of procurement. The Contractor shall supply furniture and fittings of appropriate quality consistent with health and safety requirements and the design life of the facility,
- ▶ all windows shall have blinds operated from within the building.

3.1.3 Substation Building

3.1.3.1 Finishes and Other Room Details

The building is to be provided over unit and office as shown in Volume 5. Finishes and other room details are given in the following table:

Substation Building	Technology Rooms	Office / Day Room
Roof	zinc-coated plate with a double standing seam	
Floor	concrete slab	anti-static PVC, or ceramic tiles
Walls	plastered and painted	plastered and painted or ceramic tiles
Ceilings	plastered and painted	plastered and painted
Doors	interior – timber / steel exterior - safety timber	interior – timber exterior - safety timber
Windows	plastic with grates	plastic with grates
Low voltage sockets	1 per 15 m ²	1 per 5 m ²
Telephone point	1 No.	1 No.
Fire Alarm Points	as required by Montenegrin legislation	as required by Montenegrin legislation

Table 1: Building finishes

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 2: Substation building rooms (minimum requirement)

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 3: Furniture and mobile equipment**3.1.4 Transformer Outpost****3.1.4.1 Finishes and Other Room Details**

The building is to be provided with equipment as included in the conceptual design. Finishes and other room details are given in the following table:

Transformer Outpost	Technology Rooms
Roof	Zinc-coated plate with a double standing seam
Floor	Concrete slab, steel construction with aggregate
Walls	Reinforced concrete with plaster and painting

Table 4: Transformer outpost finishes

Room Description
Transformer outpost T1
Transformer outpost T2
Access platform

Table 5: Transformer outpost rooms

3.2 MASONRY WORKS

The Contractor shall furnish all materials, labour and equipment to carry out all masonry and bricklaying works as shown in the drawings and as specified herein.

All materials and masonry works shall comply with the requirements specified in the applicable standards.

Before commencing any brickwork or blockwork, the Contractor shall submit samples of the blocks or the bricks for the approval by the Engineer.

All brickwork or blockwork which does not comply with these specifications and the samples approved will be rejected and shall be demolished and made good at the Contractor's expense.

3.2.1 Blockwork

Hollow blocks shall be manufactured in accordance with the preceding clauses on concrete and shall be properly cured before use.

The blocks shall have modular dimensions and shall include all closures, jamb units, headers and special shapes and sizes required to complete the work as shown in the drawings.

All walls and panels in blockwork are to be of sufficient strength and thickness in order to withstand superimposed loads, self-weight and wind pressure without distortion or cracking. The thickness, method and standard of workmanship and all related construction details shall be to the satisfaction of the Engineer.

Hollow blocks must be uniform in size, colour and compressive strength and shall be thoroughly watered before use, so that they do not absorb any water from joint mortar. Hollow blocks with broken edges or otherwise damaged shall not be used.

The blockwork shall be truly aligned and vertical. The joints must be staggered between the successive courses. Every joint shall be thoroughly filled with mortar and shall be 10 to 12 mm thick.

3.2.2 Mortar and Rendering

Mortar and rendering shall comply with technical data sheets and be mixed of 1 volume part cement and 3 parts of sand.

The cement mortar must contain at least 350 kg of Portland cement (Class 42,5) per cubic metre of finished mortar. Mortar quality shall be S15 (acc. LST 1346:1997) or higher.

28 days compressive strength has to be at least 150 kg/cm², (tested on cube 7,07 x 7,07 x 7,07 cm).

Cement lime mortar shall be of 1 part cement; 0,5 part lime; 4,5 part sand. The cement lime mortar must contain at least 240 kg of cement plus 140 kg of lime together per cubic meter of finished mortar.

28 days compressive strength has to be at least 100 kg/cm² (tested on cube of 7,07 x 7,07 x 7,07 cm).

The sand to be used shall be chemically and structurally stable and shall be clean and sharp.

The ingredients for cement, lime and sand shall be measured in proper gauge boxes on a boarded platform, the ingredients being turned over twice dry and twice while water is added through a hose. Alternatively, mixing may be by means of an approved mechanical batch mixer. For work requiring only small batches of mortar, mortar may be mixed by hand. The mixing time shall not be less than 5 minutes.

The mortar and rendering is to be mixed only in quantities as required for immediate use. Cement mortar shall be used within one hour of mixing and lime mortar within two hours of mixing.

3.2.3 Laying of Brickwork and Blockwork

In dry weather, all clay bricks and concrete blocks shall be well soaked before being used and the tops of walls left off shall be wetted before work is commenced.

All bricks and blocks shall be well-buttered with mortar before being laid and all joints shall be thoroughly flushed up as the work proceeds.

Brickwork shall be carried up in a uniform manner, no one portion being raised more than 1,0 m above another at one time, all properly bonded together and be levelled round each floor.

Generally brickwork, including facing, shall be built in Flemish bond. Half-brick walls, blocks and casings to cavity walls shall, unless otherwise described, be built in stretcher bond.

Alternatively, half-brick walls in facing shall be built with snap headers to match bond of solid walls.

Bats shall not be used except where required for bond.

Faced work shall be kept perfectly clean and no rubbing down of brickwork will be allowed, scaffold board shall be turned back during heavy rain and night to avoid splashing.

All masonry walls shall be adequately secured to allied structural columns and beams by means of approved non-corrodible metal lugs or anchors.

3.2.4 Partitions

All partitions shall be built with partition blocks, as described, and of the various thicknesses shown in mortar, properly bonded to side walls and at angles and intersections and wedged and pinned up to soffits with slates in cement mortar.

3.2.5 Plastering

The Contractor shall furnish all materials, labour and equipment required to complete plastering works as shown in the drawings and as specified in these specifications and according to approved samples of different kinds of plaster and stucco.

Scaffolding shall be constructed and maintained in strict conformity with the applicable rules and regulations and in such a manner as not to interfere with or obstruct the works of other trades.

Samples of all materials shall be submitted to the Engineer for approval prior to the application of all kinds of the plaster or stucco. Samples may be taken by the Engineer at any time from the plaster work in place. Areas represented by samples which show over standing will be rejected.

Plaster or stucco containing cracks, blisters, pits, checks or discoloration will not be acceptable. Such plaster or stucco shall be removed and replaced with plaster or stucco conforming to this specification and approved by the Engineer. Patching of defective work will be permitted only when approved by the Engineer, and such patching shall match the existing work in texture and colour.

On completion of the work, the scaffolding and equipment rubbish resulting from the work shall be removed from the site and the plaster or stucco shall be left in a clean condition.

3.2.5.1 Plaster Thickness

The plaster shall be of the following thickness, when measured from the face of the plaster base to the face of the finished plaster surface:

- ▶ metal lath: 15 mm minimum, when measured from the back of the lath Rib lath, thickness shall be 20 mm minimum,
- ▶ walls, ceiling: 15 mm minimum and 25 mm maximum.

3.2.5.2 Preparation

All metal grounds, corner bonds, screeds shall be carefully examined to see that they are straight, plumb level, square, or true to the required angles before the plaster is applied.

Plaster shall not be applied to masonry or concrete surfaces that have been coated with a bituminous compound or other water-proofing agents.

Masonry surfaces exhibiting high suction shall be evenly dampened to provide proper suction. Prior to plastering, sufficient time shall be allowed for surface suction to equalize.

Concrete surfaces to receive bond plaster shall be cleaned of all dust, loose particles and other foreign matter. Concrete surfaces shall have sufficient roughness to provide a proper bond.

If surfaces are not rough, they shall be hacked or bushed-hammered, or a dash coat of Portland cement grout composed of one part cement to 1 ½ parts of fine sand mixed to a mushy consistency shall be applied to the concrete surface, using a stiff fibre brush with a whipping motion. This coat shall be kept damp for at least three days immediately following its application of plaster then allowed to dry. Before application of plaster, the surface shall be evenly dampened, if necessary, to provide proper suction.

3.2.5.3 Mixing

Cement and sand for each batch shall be accurately measured and mixed dry until evenly distributed and until the mass is uniform in colour. No cracked lumpy materials shall be used. All batches shall be of such size that they can be entirely used within 30 minutes.

The water content shall be maintained at a minimum. Mixing shall be continued until plasticity is obtained.

Mortar that has begun to set shall not be used. Re-tempering will not be permitted.

3.2.5.4 Application

Surfaces to receive plaster shall be clean from dust, dirt or other particles that might interfere with a satisfactory bond.

Trowel finishing (smooth) shall be applied over the base coat scratched in thoroughly, laid on well, doubled back and filled out to a true, even surface. The finish shall be allowed to dry a few minutes and then shall be well-trowelled with water to a smooth finish, free from blemishes or irregularities.

Float finishes shall be applied over the base coat, scratched in thoroughly and laid on well. The final coat shall be made of stucco lustre, with proportions (by volume) of slaked lime to marble powder equal to 1:4. The lime will be strained together with water through a fine sieve and then mixed with the marble powder so as to obtain a firm plastic mixture.

The final coat of an external plaster shall be maintained wet by hosing with water.

Any damage or defect in the plaster shall be restored, and the entire plastering work, both interior and external, shall be delivered in perfect form and clean after the completion of all the work involved.

If any of the plaster work shows marks or surface fissures, swelling, cracks, capillary cracks, peeling-off, erosion or other defects prior to the provisional delivery, these defects shall be restored, and whenever judged necessary the areas, where defects have appeared, shall be cleaned.

3.2.5.5 Installation of Accessories

Base screed shall be placed 15 cm above the finishing floor, unless otherwise shown in the drawings. The screed shall be set level and true to line.

Corner beads shall be provided on external plaster corners, including plastered jambs and heads of recesses, door openings, windows, recesses and other corners where indicated in the drawings, corner beads shall be single lengths where the length of a corner or jamb does not exceed standard stock lengths.

Corner guards shall be installed at all exterior corners of walls, and columns in corridors and lobbies, except where tiles or marble is required, and shall be securely anchored to walls and columns. Plaster corners above corner guards shall have beads as specified above.

Plaster expansion joints shall be installed vertically on walls, one at every other column, in corridors and other spaces larger than one bay in either dimension and on corridors and other suspended ceilings on every other column line. The spacing between expansion joints should not exceed 5,0 metres in either direction and the area between separate sections should not exceed 20,0 square metres.

3.2.6 Joint Sealing

The materials used to hold in place the sealants as well as the prefabricated joint filler materials should be polyurethane foam or expanding polyethylene foam. Materials to be immersed in oil, asphalt or similar materials should not be used. In places where continuity is to be interrupted, and in order to avoid the possibility of joining, use should be made of polyethylene strips, masking tapes or other materials recommended by the manufacturer of the sealant.

The solvents and the cleaning materials shall be free of oil and in accordance with the recommendations of the sealant manufacturer.

Outdoor sealing compounds shall be used as follows:

Silicones shall be used for sealing vertical joints of concrete structures cast in-situ or of prefabricated concrete elements, as well as for parametrical seals.

Poly-sulphides made from a single component may be used for joints in vertical elements or ceilings, for sealing between dissimilar materials as well as for the filling of expansion joints.

Polyurethane made from two components shall be used for horizontal joints, for surfaces subjected to traffic and for concrete joints.

Indoors sealing compounds shall be used as follows:

Sealants with an acrylic base shall be used in fixed joints.

Silicones shall be used where movements of joints are anticipated due to dynamic loading.

Elastic silicone sealing compounds shall be used to seal the perimeters of bathtubs, washbasins, urinals and sealing fixed fixtures in bathroom and toilet installations.

3.3 WATER PROOFING AND DAMP PROOFING

The works to be performed under this section of specifications include the supply and installation of damp waterproof required for floors, walls, roofs and toilets.

Materials shall be delivered to the Site in manufacturer's original unopened containers with labels intact and manufacturer's brand and name clearly marked thereon.

Works shall be performed by specialized experienced subcontractors unless otherwise approved by the Engineer.

3.3.1 Materials

The following materials water proofing materials can be used during construction:

- ▶ oxidized bitumen,
- ▶ coated bituminous hessian,

- ▶ coated bituminous glass fabric,
- ▶ bituminous coated aluminium sheets,
- ▶ bitumen primer,
- ▶ PVC sheets.

3.3.1.1 *PVC Sheets*

PVC sheets shall be of flexible PVC conforming to applicable standard or of approved similar specifications. The tensile strength shall not be less than 15 N/mm². The propagation resistance shall be 80 N/mm².

3.3.1.2 *Installation of Flexible PVC Sheets*

PVC sheets shall be installed and welded in accordance with the manufacturer's instructions and approved by the Engineer. Manufacturer's detailed catalogues indicating procedures of installation and weld inspection shall be submitted to the Engineer prior to starting work.

3.3.1.3 *Water Proofing Systems of Specific Items*

Toilet

The waterproofing layer for toilets shall consist of two layers of bituminous glass fabric (1,8 kg/m²) and one middle layer of bituminous hessian fabric (3,5 kg/m²) embedded in four layers of oxidized bitumen (1,5 kg/m²). The horizontal damp proof course shall be protected by 2 cm cement screed. Primer shall be applied before laying of layers.

Watertight tub for receiving of accidental leakage of oil

Foil intended for insulation of oil substances inserted between two geotextiles weighing min. 300 g/m².

3.3.2 **Sealing Work**

Sealing work shall not be undertaken when ambient temperatures are below 4°C or above 32°C. Outdoor sealing work shall not be undertaken on rainy days.

Where sealant containing toxic materials is to be used indoors, adequate ventilation shall be provided.

Primers shall be applied where the manufacturer requires to do so.

Prior to the application of a sealant, the joints shall be thoroughly cleaned, and all foreign matters such as dust, oil, grease, water and surface dirt shall be removed.

Sealing shall be applied to joints with a minimum width of 6 mm and depth of 6 mm.

Joints in masonry or concrete:

The depth of the sealing compound must be the same as the width of the joint up to 13 mm wide. For expansion or other joints between 25 mm and 50 mm wide, the depth must not be greater than 13 mm. For joints more than 50 mm wide, the depth shall be as determined by the manufacturer of the sealing compound.

Joints in metal structures:

Joints between 6 mm and 13 mm wide must have a sealing compound 6 mm to 13 mm wide. Joints more than 25 mm wide must have a sealant up to 13 mm wide.

3.4 **THERMAL INSULATION**

3.4.1 **External Walls**

External walls shall be insulated (if necessary) with extruded polystyrene board at least 80 mm thick, fixed to the wall with plastic, insulation retaining discs with:

- ▶ thermal conductivity according to EN 13164 $\lambda_0 = 0,034$ W/mK,

- ▶ fireproofing according to EN 13501-1,
- ▶ freeze thaw resistance less than 1% according to EN 12087,
- ▶ diffusion resistance according to EN (μ) 12086,
- ▶ long-term moisture absorption less than <0,7 % according to EN 12087.

3.4.2 Perimeter Walls

Perimeter walls between the ground floor level and the external ground shall be lined with extruded polystyrene board at least 30 mm thick, fixed between the inner and outer wall with:

- ▶ thermal conductivity according to EN 13164 $\lambda_o = 0,034$ W/mK,
- ▶ fireproofing according to EN 13501-1,
- ▶ freeze thaw resistance less than 1% according to EN 12087,
- ▶ diffusion resistance according to EN (μ) 12086,
- ▶ long-term moisture absorption less than <0,7 % according to EN 12087.

3.4.3 Sloping roof

The thermal Insulation of sloping roof shall be at least 150 mm thick, with rock wool and:

- ▶ Thermal conductivity according to EN 13162 $\lambda_o = 0,035$ /mK,
- ▶ Fire resistance of class A1 according to EN 13501-1.

3.4.4 Vapour Barrier

If the insulation does not have attached its own vapour barrier to it, a special barrier shall be used of polyethylene 0,20 mm thick.

3.5 FLOOR, WALL AND CEILING FINISHES

The Contractor shall furnish all equipment, labour, materials and scaffolding necessary for the installation of decorative lining as shown in the drawings and as specified in this specification.

Prior installation, adequate samples of all materials, in the various dimensions and colours that are to be used in the work listed in this section, shall be submitted to the Engineer for approval.

Facing tiles indicated in the drawings for interior surface shall consist of: tiles, ceramic mosaic tiles, ceramic tiles, glazed ceramic wall tiles.

Table 1 Building finishes and Table 4 Transformer outpost finishes are indicative and represent the minimum requirements for finishes.

3.5.1 Ceramic Tiles

Ceramic tiles shall be 1st class. Tiles with chips, cracks or other defects will not be acceptable. Tiles shall be well-shaped with straight edges, perfectly flat and free from defects which affect appearance or serviceability. Colours shall be as selected from the manufacturer's standard colours and approved by the Employer.

3.5.2 Wall Tiles

Glazed ceramic wall tiles and trimmers for wall facing shall be approximately 9-12 mm thick. Tiles shall be in the size indicated in the drawings or approved by the Engineer and trimmers shall have matt glazed finish or exposed-to-view surface. Stops, returns, caps and special shapes shall be provided as required for sills, jambs, recesses, offsets and other conditions so as to provide a complete and neatly finished installation.

Glazed ceramic wall tiles shall be free from dark spots, fractures of the glaze, heavy accumulation of glaze, spots insufficiently glazed, frosted or crystalline appearance, or rough spots.

3.5.3 Floor Tiles

The floor tiles shall be acid resistant, tested according to ISO 10545-13, non-slippery, installed without or with gaps maximum 4 mm. Water absorption according to EN 14411 less than 0,5%;

breaking modules not less than 35 N/mm^2 . The tiles being vitrified throughout, they shall be very hard wearing and impervious to oils, alkalis and most commercial acids.

3.5.4 Floor Covering

The Contractor shall furnish all materials, labour, equipment and carry all operations in connection with floor covering works, completed as indicated in the drawings and as specified in these specifications.

Samples of materials proposed for use, as well as complete colour charts, shall be submitted to the Engineer and his approval shall be obtained before materials represented by the samples are delivered to the project Site.

3.5.5 Flexible Vinyl Tiles

The tiles shall be $30 \times 30 \times 0.3 \text{ cm}$, of homogeneous vinyl section, flexible and sufficiently dense to withstand loads of 14 kg/cm^2 .

3.5.6 Installation

Vinyl tiles shall be bonded and cemented to the sub-floor screed in a cold-weld system with an emulsified cutback rubber resin.

These floor coverings shall be bonded on sub-floor screed, where the distance between the under-floor surface and finished surfaces of flooring is greater than the thickness of these floor coverings. The price of the floor screed shall be included in the rate or price of floor covering.

No floor finish shall be laid unless a reliable moisture test shows that the screed is sufficiently dry to receive the covering. Cracked, loose, hollow or otherwise defective screeds shall be cut out and made good in such time as to allow a sufficient interval for drying out prior to the scheduled laying of the finished floor covering.

Tiles or sheets shall be laid out from the centre line of each space outwards and adjustments made along walls, partitions and borders, so as to symmetrize the pattern with a minimum of cut tiles. Joints between tiles shall be of uniform width.

3.5.7 Installation of Wall Tiles

The scratch coat for application as foundation coat shall be composed of 450 kg of Portland cement to one cubic metre of fine sand and shall be 3 mm thick and thoroughly damp-cured, and an interval not less than three days shall be permitted before the application of the second coat.

The second coat shall be composed, by volume, of one part Portland cement to $\frac{1}{2}$ part hydrated lime, to four parts sand, and shall be applied in sufficient pressure to cover well the entire area and form a good key, and shall have a finish suitable for reception of material used in setting tiles.

Wall tiles shall be set by trawling a thin coat of neat Portland cement on the float coat or by applying a skin to the back of each unit and immediately floating the tile into place.

Joints in wall tiles shall be ground full with coloured cement, and shall be tolled slightly concave.

The joints shall be straight, level, perpendicular and of even width. Vertical joints shall be maintained plumb for the entire height of the tile work. Each tile shall be brought to a true level and plane by uniformly applied pressure under a straight-edge or rubber-faced block. Tiles that are out of a true plane and misplaced shall be removed and reset. Damaged or defective tiles shall be replaced at the Contractor's own expense.

Upon completion, wall tile surface shall be thoroughly cleaned in a manner not to affect the tile surfaces.

3.5.8 Installation of Floor Tiles

Surfaces to receive tiles shall be clean and free from dirt, dust, oil, grease or other objectionable matter.

Tiles shall be laid out from the centre line of each space outwards and adjustments made along walls, partitions and borders, so as to symmetrize the pattern with a minimum of cut tiles. Joints between tiles shall be uniform in width and as specified for the tile installed. Cut tiles, misfits shall be replaced with properly cut tiles. Straight edges shall be accurately set to the lines and established and reset at suitable intervals to keep the joints parallel over the entire area.

Setting beds for floor tiles shall be composed, by volume, of one part Portland cement to five parts fine sand, to which not more than 1/10 part hydrated lime may be added.

Joints shall be greater than 2 (two) mm wide. After the installation has hardened sufficiently, misplaced tiles shall be repositioned and reset, and damaged or defective tiles shall be replaced.

3.5.9 Grout Floor Topping

Grout shall be mixed at a ratio or 1:2 (1 part of cement, 2 parts of sand) and shall as a minimum be 3 cm thick. The grout shall contain 400 kg of Portland cement per cubic metre of finished grout. Provision (joints, reinforcement, etc.) shall be made so to avoid damages by shrinkage (i.e. cracks between the floor and the grout or in the grout).

Surfaces of floors to which cement grout topping is to be applied shall be smoothed or slightly grooved according to the direction of the Engineer. In technology rooms, the topping shall be applied after the installation of the technologies.

The concrete for floors shall be wetted before applying the cement flooring. The finished flooring shall be kept wet for at least one week. The excess water shall then be swept off. A 1:1 cement/water mixture or approved other bonding agent shall be applied to the floor surface before grouting is executed. The finished grout floor topping shall be duly cured.

Where the cement grout topping is also the floor finish, it shall receive a final silicate solution sealing treatment to have a dust free floor.

Irregularities or deviations from level in the concrete subfloors shall be compensated for in the thickness of the grout topping at the Contractor's expense.

3.5.10 Insulation Application

Insulation shall in general be placed on the cold side of electrical "outputs", ducts, pipes, such as ventilation and other service equipment. The widths of the insulations shall be exactly side-by-side. The insulation shall be cut to fit all inside and outside corners as well as irregular spaces. The insulation pieces shall follow one another without leaving gaps except for the case of expansion joints.

3.5.10.1 Blanket Type Insulations

Insulation blankets shall be placed in walls or in ceilings with a metal frame or external lining. The insulation shall fit between the frame and the lining pieces. The width of the insulation shall be as needed for an exact fit so that the insulation stays in place by friction alone. The intermediate spaces between frames or the voids between walls and lining shall be fully insulated.

Insulation placed above false ceiling shall be supported from the ceiling frame. The insulation pieces shall be cut with a width equal to the distance between the suspension wires and shall fit tightly together.

3.5.10.2 Board Type Insulation

The insulation to be placed between metal linings and brickwork or concrete walls shall be cut and placed so as to fit exactly between the lining members. The insulation shall be secured in place with flanges of the metal lining and with metal brackets or glue, according to the manufacturer's instructions. A gap of at least 20 mm shall be maintained between the insulation and the brickwork or the concrete wall.

In brick walls with a void between two sides, the insulation shall be placed in the void and against the inner side, with the large dimension of the boards in the horizontal direction and with alternately overlapping vertical edges. The insulation shall be anchored in place with mechanical clamps and shall fit tightly around objects that may be introduced in the void.

The insulation shall be placed at the same time as the outer side is being erected. The void should be temporarily covered to protect the insulation until the wall is completed.

For brickwork and concrete walls, the glue shall be applied according to the instructions of the manufacturer of the insulation and the placing of the board shall be further secured with mechanical clamps at distances recommended by the manufacturer of the insulation.

Before the application of an asphalt coat, the wall surface shall first be primed. Following that, the nearside and the edges of the insulating material are immersed in hot asphalt and the board is placed against the primed surface.

Each insulation piece shall come into close contact with its adjacent piece, except for the cases of an expansion joints. Insulation shall also be placed around objects that may be introduced in the void.

3.5.11 Grouting

Before grouting of stanchion or machine bases, the Contractor shall take the following action:

- ▶ inform the Engineer,
- ▶ clean all holes, openings or recesses and the top of foundations from all dirt, mud, water oil or other extraneous matter.

Bases shall be accurately positioned and levelled and a frame shall be placed in position around the base plate. The grout, which shall be of such consistency so as to ensure the complete filling of all voids, shall be injected. The bolts shall not be tightened before seven days after grouting.

Mortar and fine concrete grouting shall contain not less than 400 kg of Portland cement per cubic metre of finished volume. The granular size of aggregates shall not exceed 6-8 mm in thin mortar grouting and 16 mm for gravel in fine concrete grouting, which shall be used for filling of greater volumes.

For anchorage at bolts, inserts, and the like to be cast into prepared holes or recesses in hardened concrete an expanding mortar shall be used, if so ordered by the Engineer or specified by the supplier of equipment.

The mortar shall consist of cement, sand and water to which is added an expanding compound of approved manufacturer.

Mixing shall be carried out in strict accordance with the manufacturer's instructions and the resulting mix shall be such as to produce an expansion of 3 to 5 mm when measured on a test sample 50 mm in diameter and 600 mm in length.

Before placing the mortar, the hole or recess in question shall be thoroughly cleaned and the surface of the hardened concrete scratched to produce a rough surface. The surface at the hardened concrete shall then be moistened prior to placing any mortar.

The finished mortar shall be prevented from drying out by suitable covering similar to curing of concrete.

3.6 WINDOWS AND DOORS

The Contractor shall furnish all labour and materials necessary for the installation of all windows and doors and related items necessary to complete the windows and doors indicated in the drawing and described in this specification.

All windows and doors shall be furnished complete with all necessary hardware, anchors, glass and miscellaneous equipment as herein specified.

Before commencing fabrication, the Contractor shall submit the respective shop drawings and specifications for window and doors, showing their distribution, function and construction to the

Engineer for his approval. Notwithstanding this approval being obtained, the Contractor will be held responsible for proper fabrication and installation.

Before fixing the Contractor shall submit samples of the door mountings and the window furniture to the Engineer for approval.

Doors to electrical rooms, and process rooms shall be provided with locks, which can be unlocked from the outside by keys only. From the inside of these rooms the doors shall be easy to unlock without a key. In addition the doors shall be provided with an opening device, which can be operated by knee, elbow or by a person lying down. All doors shall be of the same fire resistance as the room. The transport aisles and doors shall be wide enough to allow passage of all equipment without difficulty.

All outer doors and windows must be burglar resistant.

All locks for the outer and inner doors must form a master key system. There must be a single key for each lock and two superior hierarchy levels of master keys. Details are to be clarified with the Engineer in time before supply. The locks must fulfil the requirements of safety class 5 according to EN 1303 Building hardware - cylinders for locks - requirements and test methods. The Contractor shall deliver at least 5 single keys for each lock and 3 pieces of all master keys.

Building finishes in table 1 are indicative and represent the minimum requirements for windows and doors.

3.6.1 Windows

Window frames shall be furnished and installed complete with anchors and metal stops for glazing. Stops shall be mitre-cut and dipped for countersunk flathead fasteners.

Generally, the windows will be required to open inward. Window sashes more than one meter high shall be provided with three hinges, each 14 cm long. In cases where the sashes rotate along horizontal or vertical axes, those axes shall be of heavy bronze and must have 2 hinges. Locking bars have to be built in covered. Where required the windows shall be dust-tight.

The Contractor may propose other materials. The Engineer, however, reserves the right to reject any such proposal in case durability of at least 10 years under the local conditions is not proven to his satisfaction.

3.6.2 Doors

All doors and frames shall be shop fabricated and shop assembled, where possible. Temporary stiffeners, spacers, and other accessories necessary to facilitate handling and accurate erection shall be provided. After fabrication, all tool marks and other surface imperfections shall be filled and ground smooth. Outside doors shall prevent against burglary and vandalism.

Protection against potential vandalism shall be in accordance with EN 1627 Windows, doors, shutters. Burglar resistance. Requirements and classification, resistance class WK 5 but if required by the Employer, WK6 without any additionally payment.

3.6.2.1 Fire Rating and Labelling

Doors and frames specified or shown as fire-rated shall bear a UL label indicating the type of rating for which they are certified. Designs and construction of such products shall have specific UL approval according to current procedures for the specified fire rating, either 30, 60, 120 or 240 minutes as shown respectively as required by the relevant local standard. Hollow steel doors and frames for fire-rated openings shall conform to EN standards.

3.6.2.2 Materials for Doors and Frames

All exterior doors and frames shall be fabricated entirely of galvanised steel. Other doors and frames, unless otherwise specified or shown, shall be fabricated of prime quality, commercial grade, cold-rolled steel.

3.6.2.3 Priming and Painting

The doors and frames shall be chemically treated to ensure maximum paint adhesion and shall have all exposed surfaces painted with a rust-inhibitive primer after fabrication.

The outside steel doors shall be made of cold rolled annealed steel sheet that resists expansion and contraction, as a minimum 2,0 mm thick.

The two steel sheets shall be fixed on well-framed steel sections welded electrically together. The final thickness of the doors shall be at least 40 mm. Where necessary, sliding doors shall be provided with a sliding system to be approved by the Engineer.

The locking shall be drill-resistant, single point lock assembly with either a cylinder and thumb turn or double cylinder, complete with five keys. Details are to be agreed with the Employer.

The door frames shall be manufactured from 2,0 mm thick zinc plated mild steel with a double rebate profile. A minimum of 4 fixings per jamb and 2 fixings to header. Fully welded corner joints.

Doors that exceed 1,80 m in height shall be furnished with three hinges, each 10 cm long, welded electrically to the doors. The spaces between the two steel sheets of the doors shall be filled with felt or other insulating material approved by the Engineer. Where required the doors have to be dust-tight.

3.6.3 Glazing

All glass shall be free from bubbles, air holes, scratches and other defects. The application for single or double glazing and for special purposes of wired glass, limited safety glass, insulating and sun reflecting glass has to be in accordance with the respective local conditions and shall be approved by the Engineer. The minimum glass thickness shall be 4(3) mm. Glass samples shall be submitted to the Employer for his approval before any orders are placed.

For glazing steel sashes the glass shall be firmly secured and well bedded with a first-class quality metal sash putty, and all necessary metal beads or clips being used.

For glazing timber sashes the glass shall be firmly secured and well bedded with first-class quality linseed oil putty. All putty must be of permanent plasticity under the given local conditions.

The glass edges shall enter everywhere at least 3 mm into the putty behind the window frames edge, the window frames must be duly prepared before being glazed.

3.6.4 Installation

Windows and doors shall be installed and adjusted by experienced and qualified window and door erectors and using only skilled window and door mechanics. All units shall be installed without forcing into prepared openings. Installation shall be in accordance with manufacturer's instructions and the approved shop drawings, setting of the units at the proper elevations and locations, plumbs, level in alignment, proper bracing of frames to prevent distortion and misalignment. Protection of ventilators and operating parts against accumulation of cement, lime or other building materials by keeping ventilators tightly closed and wired to frames. Protection of aluminium from dissimilar materials as herein before specified.

All exterior metal joints between members of units, frames, mullions and mullion covers shall be set in a mastic sealant of type recommended by the manufacturer. Remove excess mastic before it hardens.

Anchor all units to masonry or other adjoining or adjacent construction as shown on details of approved shop drawings. Where units set in prepared masonry openings, place the necessary anchorage during progress of wall construction. Anchors and fastening shall be built into anchored or bolted to jamb of openings, and shall be fastened securely to the units of frames and to the adjoining construction. Unless otherwise detailed, anchors shall be spaced not more than 0,50 metres apart on heads, jambs, and sills.

All anchors shall have sufficient strength to hold members firmly in position.

After the units have been installed, all ventilators and hardware shall be adjusted to operate smoothly and be weather-tight when ventilators are closed and locked. Hardware and parts shall be lubricated as necessary.

Care shall be taken in handling the units during transportation and on the job site. Store all units upright on pieces of lumber in a dry location, and under cover. After installation, protect all units from damage during subsequent construction activities.

Metal surfaces of the units shall be cleaned on both the inside and outside of all mortar, plaster, paint and other foreign matter to present a neat appearance and to prevent fouling or earthing surfaces, weather stripping or the operation of hardware. In addition, units shall be washed off with a stiff-fibre brush, soap and water thoroughly rinsed with clear water. Where aluminium units have become stained or discoloured, they shall be cleaned or have finished restored in accordance with the recommendations of the Engineer. Discoloured units that cannot be satisfactorily required shall be replaced with new units at no additional cost to the Employer.

3.6.5 Timber Doors

3.6.5.1 General Instructions

Manufacture, delivery and install doors made of timber. All dimensions have to be checked in situ prior to manufacturing and installation.

3.6.5.2 Hardware

Hinges, locks, handles, keeps, screws shall provide stabile and long lasting use of doors under exploitation in public facilities. Hardware shall be fixed to frame and sash, fastened to the steel reinforcement. Hardware and multi locking mechanisms shall be manufactured according to EN 12209:2003. Handles, locking systems and hinges shall be manufactured of metal or alloy, resistant to corrosion and durable in regard to surface finishing.

3.6.5.3 Installation

Doors work installation shall be carried out as indicated in the drawings and following the manufacturer specifications and instructions. Provision of scaffolding should be made where indicated in the drawings. Doors fixed frames shall be fastened to the walls by use of appropriate bolts entering the wall or other supporting element, at least on two points per side. Use of foaming material for additional fastening and gap filling is recommended with final cut out of material surplus after expansion and hardening.

3.7 ROOF CONSTRUCTION

3.7.1 General Remarks

All wood structure and substructure elements shall be fungus protected, and fire proof coated using a propriety system. The maximum moisture content of wood structure allowed is 12 %. All joint metal elements shall be galvanized. Nails, screws, bolts and nuts shall be of stainless steel. All visible part of wood shall be planed.

3.7.2 Sloping Roof Construction

Roof timber structure shall be of solid sawn rafters and beams of first class quality softwood. Visual strength grading of softwood shall be in accordance with applicable EN / ISO standards.

If trussed rafters are used, they shall be according to code of practise. Metal hangers for the connection of timbers shall be hot dipped galvanised steel. All nails shall be corrosion resistant.

Sloping roofs shall be designed as “warm roofs”. This means that the insulation shall follow the line of the sloping roof, not the ceiling slab over the top floor.

Timber boarding 24 mm thick, or OSB panels 22 mm thick, shall be used to form a complete covering of the sloping roof over the rafters. Water proofing above boarding shall be vapour membrane and shall be fire proof class according to EN standards:

- ▶ vapour conductivity according EN ISO 12572: $> 1200 \text{ g/m}^2 \text{ 24h}$,
- ▶ waterproofing according to EN 1928: $> 1500 \text{ mm UV stability: 4 month}$.

Thermal Insulation between rafters shall be of 100 mm thick rock wool.

A slope wood batten shall be vermin treated timber 28x48 mm. Longitudinal wood batten shall be vermin treated timber 28x48 mm.

3.7.3 Steel Sheet Roof Cover

The mounting clamps and fasteners, ridge capping, flashing and roof security system shall be supplied by the same manufacturer of the roof panels. The roof panels shall be installed in accordance with the manufacturer's guidelines with the appropriate tools. The Contractor shall submit to Engineer for his approval the method statement.

Roof covering shall be made of self-supporting insulated metal sheet panels, plastic coated.

Snow guard and catwalk shall be a proprietary system attached to the roof cladding without any penetrating screw-holes.

3.8 PLUMBING INSTALLATION AND SANITARY FITTINGS

3.8.1 General

The work to be carried out comprises as minimum the following:

- ▶ pipe work for hot and cold water,
- ▶ internal drains,
- ▶ insulations of pipes,
- ▶ sanitary equipment,
- ▶ rain water system, gutters, down pipes,
- ▶ sewers and sewage disposal system, including connections,
- ▶ drainage and vent pipe system.

The word "piping" shall mean the inclusion of all pipes, fittings, nipples, valves, and all required accessories, supports, anchors, guides, pipe sleeves, etc. for a complete, safe and operational network.

3.8.2 Water supply facilities

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

The Contractor shall submit for the Employer's approval the dimensioning of the system taking into account the number of personnel that will be working on the plant.

All the materials shall be of a first class quality and carry a quality guarantee that the material is equivalent to the relevant EN standards. Before using the materials, the Contractor must obtain the approval of the Engineer.

Warm sanitary water shall be supplied by electric boilers. Each water pipe passing through an external wall shall be insulated, in order to prevent freezing by using protective material.

3.8.3 Toilet Water Sewerage System

Sewerage from the building will be disposed of by means of HT-PP polypropylene sewerage pipes with rubber gaskets, and nominal pressure PN6, of adequate diameter and through manholes to join the cesspool. Excavation, installation of external sewerage: underground pipes, will be performed according specifications for external sewerage system.

The sewerage system shall be constructed according to the relevant EN standards so as to carry the flow by gravity on continuous slopes to the local cesspool.

The pipes must be readily accessible for cleaning by rodding all along. At higher levels, the pipes must have rodding outlets at each bend and at the end of horizontal lines for ease of cleaning. All pipes must be continuously falling to prevent the accumulation of sediments in the line. For this reason they must be securely fixed at regular intervals.

The following sizes present the minimum requirements for pipe diameters: vertical stacks shall be of 110 mm diam. for toilets, and 70 mm for washbasins. Connections of toilets have to be made of 100 mm diam. pipe.

Rodding outlets must be placed at each vertical stack at 600 mm above the floor. In toilets, where the rodding outlets would be situated behind double walls, a tiled hatch shall provide easy access. Horizontal sewerage pipes being under the floors and going towards the vertical stack shall have a slope of 2,0 to 2,5 %, while the slope of the horizontal pipes connecting stacks to the external collective manholes must have a slope of 1,5 to 1,7%.

3.8.4 Storm Water Drainage

As that there is not any water supply system in the location intended for the new ETS, it is proposed to capture 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, to which rainwater will be carried by downpipes from the roof of the substation building. The tank cannot be supplied from the draining of paved areas!

3.8.5 References for the Sanitary Equipment

All sanitary equipment is to be selected from manufacturers which support applicable EN standards, according to the requirements of the Engineer and as shown in the drawings. It is to be installed strictly in accordance with the instructions of manufacturers. Sanitary equipment comprises the following:

- ▶ wash basin with water taps,
- ▶ water taps,
- ▶ water closet suite with a seat and lid,
- ▶ toilet paper holder,
- ▶ towel rail,
- ▶ shower with thermostatic mixing valve,
- ▶ wall mirror,
- ▶ cupboards,
- ▶ room designation signs.

3.8.6 Requirements / Workmanship

All connections for taps, mixer taps, showers, water closet has to be provided with a stop valve. Pipework exposed to direct sunlight will not be allowed.

Brackets and supports shall be provided strictly in accordance with the standards and manufacturer's recommendations.

Shut-off valves shall be provided in a system so that the building can be isolated from the remainder of the system.

Where pipes pass through walls or floors and are exposed to view, split plates shall be fitted. Such plates shall be chrome-plated, of modern design and approved pattern.

The Contractor shall furnish and install all sleeves to be built in for the passage of pipes through structures. The sleeves shall project 6 mm beyond the finished face and shall be firmly secured. The free space between the pipe and the sleeve shall be packed at each end to provide an efficient, airtight fire- and noise seal. Pipe sleeves shall project at least 3 cm above floors.

The Contractor shall provide emptying point on the water systems in the building. The emptying point shall be located at a low point in the system.

3.8.7 Testing of Plumbing Systems

3.8.7.1 General

All plumbing, piping, equipment and fixtures installed under this contract shall be inspected and tested before insulation is installed, by the Contractor in the presence of the Engineer, and approved before acceptance. All labour, material and equipment required for testing shall be furnished by the Contractor. The Contractor shall be responsible for all repairs and retesting as required. All instruments and other equipment whose safe pressure range is below that of the test pressure shall be removed from the line or blanked off before applying the tests. Prior to performing hydrostatic tests, (see below), all lines shall be "blown" free of all loose dirt and foreign particles. The lines shall then be thoroughly flushed with water at a sufficient flow rate and period to ensure complete cleaning of the lines of all dirt, scale, and foreign matter. Satisfactory cleaning and flushing of the lines shall be subject to approval by the Engineer.

3.8.7.2 Water System

Upon completion of the roughing-in and before setting fixtures, the entire hot and cold water piping systems installed under this contract shall be hydrostatically tested at a pressure of not less than 10 bar for 2 hours and proved tight at this pressure. Where a portion of the water piping system is to be concealed before completion, this portion shall be hydrostatically tested separately in the same manner as prescribed for the entire system.

3.9 HVAC SYSTEM

3.9.1 General

Design of heating and ventilation installations shall be based on local climate conditions, on any special equipment requirements and the following minimum requirements in the various areas. Heat losses calculation shall be done according to ISO / EN 6946, 7345, 9246, 9229, 1011 – 1/2, 13789, 14683.

The heating system in the building shall be electrical by means of electrical convectors.

3.9.2 Room Split Air Conditioner

Split air conditioning units with the following characteristics shall be installed:

- ▶ 3,4 kW cooling capacity room split air conditioners,
- ▶ provide room temperature of at most 24°C,
- ▶ external part of the unit shall be relatively hidden on the facade, installation to be approved by the architect,
- ▶ internal units shall be on the wall, 2,5 m high,
- ▶ drainage of the condensed water, free of the external wall, below the indoor unit,
- ▶ working fluid of these units shall be 134a, or 407c.

3.10 PAINTING

The Contractor shall furnish all equipment, labour and materials and carry out all operations in connection with painting. Painting includes emulsion, enamels, stains, varnishes, sealers and other coating organic or inorganic, whether used as prime, intermediate, or finish coats.

All paint used in the permanent work and its various ingredients shall be subject to such tests and analyses as may be thought proper by the Engineer, and for this purpose the Contractor shall provide such unbroken samples in the original tins as may be required.

Paints shall be applied in a regular manner and in accordance with the directions of the manufacturers. A paint pattern with selected colours shall be approved by the Engineer before application of paint. Period for coats specified by the manufacturer shall be adhered to. Coats shall have different degrees of the specified colours to indicate full application of each coat.

3.10.1 Materials and Workmanship

All paints shall be obtained in the colours specified by the Engineer, made ready, and shall in all cases be obtained directly from the original makers in their trade cases. Where special thinners are required, they shall be obtained from the makers of the paint.

All work shall be done in workmanlike manner, so that the finished surface will be free from runs, drips, ridges, waves, laps and unnecessary brush marks. All coats shall be applied in such a manner so as to produce an even film of uniform thickness. Welds and rivets shall receive special attention to ensure that they receive an adequate thickness of paint. Thoroughly experienced workmen shall do all painting.

3.10.2 Preparation of Surfaces

Surfaces shall be cleaned from oil grease dirt, mill scale, rust, slag or flux, deposit, dirt and other materials by using special solvents conforming to International Specifications and blast cleaning. Special attention shall be taken to prevent rusting and/or contamination of cleaned surfaces.

3.10.2.1 Metal Surfaces

Metal surface shall be completely cleaned from oils, grease, paints, salts and pollutants in general, using a cleaning solvent. Loose rust and loose oxide scales shall be removed. The surfaces shall be primed with an organic zinc primer.

Galvanised surfaces shall be cleaned from solvents by using water. Water and detergents shall be used for dirt and chemicals, and a solvent for other dirt in general.

3.10.2.2 Concrete and Masonry

Concrete surfaces shall be cleaned from dirty materials, loose or superfluous mortar, as well as from residues of unsuitable oils used to remove the forms and from materials used for the preservation of concrete. If necessary the surface will have to be cleaned by sandblasting. Cracks and other types of defects, too big to be covered with paint must first be properly filled.

Masonry shall be cleaned from dirty materials, loose and superfluous mortar, and be perfectly dry. Cracks and any defects too large to be remedied with putty shall first be made good.

3.10.2.3 Plastering

Plastering has to be hard and dry. Plastered surfaces must be tested as to humidity with a hydrometer and no painting should take place if the humidity content does not comply with the recommendations of the relevant manufacturer.

Sand, mould and loose particles shall be removed and surface defects shall be repaired before proceeding with the painting.

Cracks and holes shall be repaired with putty which provides a good bond with the existing plaster, and then be smoothed with sandpaper.

Plaster surfaces shall first be covered with a priming coat. If the primer does not dry in a manner to give a uniform lustre to the entire surface, the areas showing an increased absorbability shall be primed locally anew before proceeding with the application of other coats.

3.10.2.4 Wooden Surfaces

Wooden surfaces shall be polished with sandpaper; any loose edges shall be removed, and be finally brushed to remove dust.

Knots, circular cracks and visible resinous stains shall be cleaned and filled with putty. The surfaces shall receive a priming coat and subsequently any nail holes, seams and joints shall be filled with putty matching the final colour. The surfaces shall then be polished with fine-grade sandpaper and brushed to remove the dust.

3.10.3 Application of Materials

The mixing of ready-made paints or materials must be complete. Paints shall be applied with brushes, rollers or spray guns without the use of air and as recommended by the manufacturer.

The humidity of the surfaces to be painted shall be measured with an electronic hydrometer. No painting shall take place if the surface humidity exceeds following values:

- ▶ plaster, brickwork, concrete 12 %
- ▶ wooden surfaces 15 %

The Contractor shall study and carefully follow the directions given on each container regarding the minimum and maximum allowable temperatures of the surfaces to be painted. No painting work shall be undertaken if the temperature of the surface is below 10°C or above 38°C, and if the relative humidity is more than 90 %.

Adequate and continuous ventilation shall be ensured during the painting of interior areas. If needed, there should also be heating to maintain the interior ambient temperature above 10°C 24 hours prior to, during and 48 hours after the painting.

The paint shall be carefully spread according to the manufacturer's instructions. The thickness of the wet coat should be checked periodically with a special instrument. No drippings, unpainted areas, swellings or other defects should be present. The finished surfaces should have a uniform lustre, colour and texture.

Each coat of paint should be left to dry completely before the application of the next one. At least 24 hours should elapse between two successive coats on each surface, except if the manufacturer of the paint specifies otherwise.

Interior metal surfaces should be evenly polished with sandpaper between successive coats in order to create a smooth and polished surface for the final coat.

Surfaces that will not be painted should be protected from paints.

Electrical wall plates, metal pieces of frames, handles, locks, etc., fixtures and fixings shall be removed before painting. These items shall be carefully stored, cleaned and replaced to their proper position at the end of the painting work. The cleaning of metal parts should not be attempted with solvents that may harm their permanent enamel. Items that cannot practically be removed shall be covered.

Grills, caps and inspection covers of electrical and mechanical equipment shall be removed and painted separately.

Bare pipes, conduits, junction boxes, special supports, collars and brackets shall be primed and painted.

All conduits and electrical equipment exposed within painted areas shall be painted if judged necessary. The colour and the texture shall match those of the adjacent surfaces.

The equipment, conduits, cables and in general any exposed network shall be painted according to colour codes required by the relevant technical specifications. This work also includes arrows indicating the direction of flow, inscriptions with names of identification, numbering, etc. The colour codes used shall be in agreement with the relevant specifications.

The Contractor is under the obligation to proceed with the quality control regarding the quality of the painting and to conform to the following special requirements:

3.10.3.1 Checking the Surfaces Intended for Sandblasting Cleaning

The Contractor shall regularly proceed with calamine detection tests using the "copper sulphate" method.

3.10.3.2 Checking the Thickness of the Wet Coat

Each painter shall be provided with an approved type of measuring instrument so that he may check the progress of the painting.

3.10.3.3 Detection of Unpainted Points in Steel or Iron surfaces

The Contractor shall use a suitable and approved method for detecting unpainted pores created by the painting system through tests on test plates.

The sweep voltage in the high voltage (dc) equipment shall not exceed half the voltage needed to create a spark within the entire specified painting system.

Painting areas of steel structures that have been damaged shall be mechanically rubbed with a wire brush to clean the bare metal, and the edges of the healthy paint shall be polished with sandpaper to create an even slant.

Subsequently, the painting system shall be applied to restore the paint in the damaged areas to the original thickness and type. Each coat of the new painting shall overlap the existing coat by at least 50 mm.

Painted surfaces with drippings from arc welding or from concrete or with different pieces stuck on the surface shall be cleaned or washed to immediately remove the offending items. Any repairs or restorations of a damaged surface to its original state shall take place before the surface is repainted. For the repair of damaged epoxy layers, a suitable material shall be used supplied by the manufacturer of the original layer and shall be applied according to the instructions of the supplier.

3.11 FIRE PROTECTION

The substation building should be protected against fire hazard in accordance with the applicable standard.

All works shall be executed according EN 671 and also it shall meet the requirements of the local water and fire-fighting company.

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

3.11.1 Portable Fire Fighting Appliances

Provision shall be made for fire protection equipment in the form of portable (hand held or trolley mounted) fire extinguishers and fire blankets, together with mounting brackets and sufficient materials to ensure a 50 % recharge.

The units shall generally accord with local regulations and shall be approved by the local fire officer.

3.12 FENCING AND GATES

3.12.1 General

The fence shall surround all the site.

3.12.2 Fences

The permanent fence shall consist of galvanized steel mesh (standard 50 x 50 mm) and three rows of barbed wire above the steel mesh. The steel mesh is 2,40 m high. The distance between the barbed wire from another is 0,10 m. Total height of the fence 2,70 m. The poles bearing the barbed wires bend in 30° from vertical to the project Site.

Fence poles per 3,00 m shall be of galvanised iron pipe Ø 100 mm, t = 6 mm. The steel mesh shall be secured to the posts at 0,30 m intervals along the height of the posts and the chain link fence shall be

supported by 3 fixing wires strung from post to post. Furthermore the steel mesh and posts shall be embedded in concrete foundations.

3.12.3 Gates

A two-part wing gate is to be installed at the entrance to the site.

The gates are to be manually operated. The gates are 2,70 m high. The construction materials are galvanized tubular steel frame \varnothing 50 x 3,65 mm and galvanised steel mesh as is used for the fence. Gate posts galvanized tubular steel \varnothing 150 x 5,00 mm.

The gates shall be complete with all fittings such as drop bolts; back catches, locking bars, lock plates and lock including three keys. The gates have to be provided with locks of cylinder type.

3.13 SIGNPOSTS

The signs for the Plant will be under the following headings:

1. plant entrance, layout plan and main directions,
2. danger and warning signs,
3. internal signs for all rooms, buildings and plant equipment,
4. explanatory signs.

Each of the sub-sections will be distinguishable, while sub-section 2 will be in accordance with all local regulations. Sub-section 4 will be developed for places where explanations might be given. All signs will be in Montenegrin language.

The erection and installation of signposts shall be carried out in accordance with current prevailing specifications.

3.14 LANDSCAPING

3.14.1 General

Prior to commencement of any landscaping work, the Contractor shall submit to the Engineer for approval his detailed proposals for landscaping including the proposed species of grass, trees and shrubs.

3.14.2 Material

3.14.2.1 Top Soil

The existing topsoil stripped from the Site and stored in heaps adjacent to the Works may be reused provided it has not become contaminated and is free of rubble and debris. Where insufficient site topsoil is available additional humus shall be imported from an approved source. Where the upper layer of natural soil is poor in organic matter, it shall be improved to a minimum depth of 250 mm by adding either clay or sand or silt to create a loamy soil texture consisting of 40% sand (size > 0,05 mm), 30% silt (size 0,05 – 0,002 mm) and 30% clay (size < 0,002 mm).

3.14.2.2 Grasses

Type of grasses shall be proposed by the Contractor and approved by the Engineer. Where the topsoil shall be sown with grass seed, the top 75 mm of the topsoil shall be brought to a fine tilt suitable for seeding, and sowing shall be carried out as soon as practicable after completion of top soiling having due regard to the season and the weather conditions.

After the seed has been sown uniformly, they shall be raked and lightly rolled into the surface. The young grass shall be kept free from weeds and any bare patches shall be re-seeded until an even close turf is established. The grass shall be watered and rolled as required and maintained in good condition.

3.14.2.3 Trees and Shrubs

Trees and shrubs shall be of the species proposed by the Contractor and approved by the Engineer and shall be of the best quality and free from diseases. They shall be young stock or in the case of shrubs, they may be established seedlings or cuttings. All must be sufficiently mature to survive transplanting from the supply nursery. The root systems of all plants shall be maintained intact in the soil in which they have been grown and may be supplied in containers.

3.14.3 Existing Trees

3.14.3.1 Inspection of Retained Trees

All trees and shrubs to be retained shall be inspected jointly by the Engineer and the Contractor at the commencement of the Contract and a list of trees to be retained shall be agreed. Any tree found to be diseased, dead, dying or unsafe shall be felled and uprooted subject to the prior approval of the Engineer.

3.14.3.2 Tree Felling

Existing trees and shrubs where directed by the Engineer shall be cut down and all stumps and main roots shall be grubbed up. All planting thus dealt with shall be either burnt in situ or removed from the Site.

3.14.3.3 Protection of Retained Trees

During the execution of works, the existing trees and shrubs that are to be retained shall be adequately protected from all operations and from animals. Small trees and shrubs generally shall be surrounded by adequate temporary fencing to safeguard their trunks and foliage. Large trees shall have suitable screening round their trunks, and low branches shall be protected by temporary fencing or barriers to prevent damage. Construction materials shall not be stored close to or within the branch spread of any tree or shrub. Existing ground levels shall be maintained.

3.14.3.4 Maintenance of Retained Trees

The retained trees and shrubs shall be maintained during the Contract and pruned at completion, having due regard to the appropriate time of year for such work to be carried out. Maintenance shall include removing snags, dead wood and fronds, sealing cavities and irrigating as required to ensure the continued health of existing planting.

3.14.3.5 Replacement of Damaged Trees

Should any retained tree or shrub be damaged as a result of the building operations then it shall be replaced by the Contractor by an equivalent mature tree or shrub of the same variety.

3.14.4 Implementation of Landscaping

3.14.4.1 Preparation of Ground

The areas to be landscaped shall be brought to final ground levels less the depth required for top soil or other surfacing and all surplus material shall be disposed of offsite.

3.14.4.2 Cultivation of Ground

The Contractor shall relay 250 mm thick topsoil. Any deficiency in the topsoil shall be made up with imported topsoil. Prior to replacing topsoil areas of the Site which are to be prepared for grass planting shall be thoroughly broken up by deep raking and cross raking to a depth of 450 mm. The retained topsoil may be used as filler to the final ground level subject to the approval of the Employer being first obtained. The imported topsoil shall be used if the existing topsoil is insufficient or unsuitable. Where new and replacement trees or shrubs are to be planted in agreement with the

Engineer, holes 1 m deep below the final ground level shall be excavated in each case. These shall be filled with soil and topped with 250 mm of top soil. Sand filling shall be thoroughly mixed with 10 kg manure before placing.

3.14.4.3 Time for Planting

In programming the planting work, the Contractor shall take due regard of the accepted seasons for planting.

3.14.4.4 Top Soil Dressing

The top soil ready to receive planting shall be given a dressing of manure at a rate of 5 kg/m². After spreading uniformly on the surface the manure shall be thoroughly mixed into the top soil.

3.14.4.5 Planting of Trees and Shrubs

Prior to planting holes for trees and shrubs shall be prepared and filled twice with water. Plants shall be watered in their containers so that the soil and the roots are kept in a moist condition. Plants shall then be removed from their containers and their root ball complete with soil set in place and the holes backfilled and the plants firmly trodden in. Soil shall not be allowed to rise above the original container level and the ground level around the trunk or stem shall be set below adjacent ground to retain irrigation water. All species of tree and shrubs where required shall be provided with supports during planting. These shall take the form of timber stakes of adequate strength driven into the ground adjacent to the trunk or stem without damage to roots. Wide hessian strips shall be used to tie the plant securely but not tightly to the support.

Where shrubs are to be planted in groups to provide ground cover, individual plants shall be spaced as follows:

Size	height when grown	spacing
Small	less than 1m	500 - 600 mm
Medium	1 - 2 m	900 - 1200 mm
Large	over 2 m	1800 mm

3.14.4.6 Irrigation

After planting of native tree and shrub species they shall only be irrigated twice and thereafter only as required. Non-indigenous species shall be irrigated regularly until handover to the Engineer. Grassed areas shall be irrigated immediately after planting and regularly thereafter until handover.

3.14.4.7 Maintenance

All new plants and grassing shall be maintained after planting. This shall take the form of irrigation, restacking, pruning, weeding, tilling, etc. to ensure sufficient growth is achieved by all plants up to handover to the satisfaction of the Engineer. Once grassed areas are sufficiently established they shall be kept cut or mown to provide a uniform depth of growth. Edges of grassed areas shall be trimmed as necessary. All new plants and grassed areas shall be protected to prevent damage from workmen, builder's plant, equipment and animals, by the use of temporary fencing or other suitable means.

3.14.4.8 Replacement

Any trees, shrubs or areas of grass which fail to satisfactory growth or wither and die shall be replaced. The responsibility for the irrigation and maintenance of these replacement plants shall remain with the Contractor until such time as they exhibit satisfactory growth.

4. STRUCTURAL STEEL AND IRON WORK

4.1 GENERAL

The work to be performed under this Section consists of prefabrication and erection of various steel structures as shown in the drawings or specified or directed by the Engineer like main or auxiliary steel construction, stairs, etc. It shall include manufacturing, transportation, testing, furnishing and erection of all materials, equipment and accessories required for completing the specified structural steel works. It shall comprise, but shall not be limited to, the following parts: column base plates, columns, beams, girders, bearing plates, loose lintels, trusses, purlins, chequered plates, gratings, railings, ladders for base plates, all field rivets and bolts, electrodes for welding, anchor bolts, and protective painting against corrosion.

The Contractor shall strictly observe the following specifications and shall carry out all work in a skilled and workmanlike manner in keeping with modern methods of construction.

4.1.1 Design

Calculations by the Contractor for the design of any structure shall be prefaced by a statement explaining the principles of design and the type of analysis adopted. The statement shall also indicate the codes of practice and specifications upon which the design is based.

Any computer programs used in the design process shall be fully described, and details of input and print-out shall be presented in an easily understandable form. Program manuals and any instructions to program users shall be made available to the Engineer upon request. Where any such program cannot be demonstrated to have been fully checked or where the Engineer considers it necessary, the Contractor shall run such test examples as the Engineer may choose in order to verify the completeness and accuracy of the program.

4.2 STANDARDS AND NORMS

The design shall be in accordance with the specifications included in this Volume and shall comply with all relevant EU standards (Eurocode, EN standards), and other relevant documentation forming part of the Tender and of the subsequent Contract. A list of the most relevant standards is provided in Volume 3, Section 1 - General Technical Requirements, Annex 1.

4.3 SHOP DRAWINGS

The Contractor shall prepare shop drawings of all structural steel parts for approval by the Employer. The preparation of these drawings and the structural computations for them shall not be subcontracted without the Employer's permission. All such drawings shall show the dimensions of all parts, method of construction, sectional areas welding and all other details. The welding procedure for making each joint shall be approved by the Engineer before the work is started.

These drawings shall give the necessary information for the fabrication, erection and painting of the structures on the basis of the accepted standards. Pockets and depressions likely to hold water shall be avoided in the design and if not avoided shall be properly drained.

All parts of the works shall be designed and manufactured in accordance with the latest recognized rules of workmanship and modern engineering practice. The regulations, standards and guidelines listed in these specifications shall be respected in the design, calculation and execution.

All items dependent upon constructional tolerances such as hatch cover, grating and hand railing shall be fabricated from measurements taken at site after concrete has been placed.

The Contractor shall furnish complete fabrication and erection drawings for the tendon duct banks and embedded steel plates, complete with distribution steel.

No fabrication shall be conducted until the shop drawings together with the structural analysis have been approved by the Engineer. A specified number of sets of finally approved drawings shall be furnished to the Engineer.

The scale of shop drawings shall not be smaller than 1:20; for details from 1:10 to 1:1.

The Contractor shall not be released of his responsibility and guarantee because the drawings and structural computations have been approved by the Engineer.

The structural calculations to be submitted shall contain at least the following details:

- ▶ loads and horizontal thrust on which the calculation is based,
- ▶ dead weight,
- ▶ type of material of the main structural parts and means of jointing,
- ▶ measurements and cross-sections of all essential structural elements,
- ▶ maximum stresses as well as maximum pressures on supports and moments of all individual structural elements and of their joints,
- ▶ evidence of stability,
- ▶ deflection of the main supporting structures.

4.4 DESIGN LOADS

Structures shall be designed to withstand the loads exerted by the plant and components included for dynamic effects, where applicable.

All loads used in the design, including those of substation and components, shall be clearly indicated in the design calculations.

Wind pressures on structures, plant and cladding shall be calculated in accordance with EN 1991-1-4.

The Contractor shall submit global and local wind pressure coefficients to the Engineer for approval before commencing the actual design of clad structures.

The Contractor shall allow for temperature variations among components of structures as well as in the structure itself. Due account shall be given to the effects of direct sunlight on structures which could cause high temperatures in exposed steelwork.

4.5 DEFLECTION LIMITS

The deflection of all or part of a building shall be limited so as not to impair the strength or efficiency of the building or of its contents, nor will be unsightly or cause damage to the finish or inconvenience to the occupants.

Deflection of the members listed in the table below shall not exceed the tabulated limits, unless the Contractor can demonstrate to the Engineer's satisfaction that greater values would not be detrimental to the performance of the structure.

Beams	Deflection due to imposed loads
Cantilevers	length/180
Beams carrying plaster finish	span/360
Roof beams not carrying plaster finish	span/200
Purlins and sheeting rails	to suit the characteristics of the sheeting
Columns	Horizontal deflection
Each storey, top of column, brick or plaster cladding	height/300
Single storey portal framed structures, with metal cladding	height/90

Table 6: Deflection limits

4.6 GENERAL PRINCIPLES

Structures may be designed either by the working stress approach, using un-factored load against a working stress (generally limited to $0,7 \times$ yield stress) as specified in the relevant standard, or by the limit state method. Structures designed to the limit state method shall be designed by considering the limit states at which they would become unfit for the use for which they are considered and applying appropriate safety factors to provide an adequate degree of safety and serviceability.

The overall design concept shall give due regard to the fact that the structure as a whole will be required to be as a three-dimensional entity. The layout of its constituent parts, including the steel members, the other structural elements, the foundations and the connections between each component, shall be such as to produce a strong and stable structure.

The structure shall be checked for the effects of all possible vertical and horizontal loads, both acting in conjunction and separately as appropriate, using factored loads when checking strength and stability to a limit state analysis and un-factored loads when checking deflections or strength and stability using a working stress approach.

The structures shall be designed to be capable of accepting without overstress a reasonable amount of extra loading due to any cause including extra services, heavier cladding, or other appurtenances that may reasonably be added during the life of the structure.

Structures shall be designed such that undue reliance is not placed on 'key' elements (a key element is one whose removal tends to prejudice the ability of the whole structure to survive). The removal or damage of such elements shall not entail collapse of more than a limited part of the structure. Structures will not be considered to be adequate if, in the event of abnormal loading, accident or misuse, the damage to the structure is out of proportion to the magnitude of the event.

The design shall take account of the need for stability of both the framework and the individual elements at all stages of erection. Where temporary bracing is required it shall be checked for the effects of all loadings that may arise during erection including those due to erection equipment and its operation. Such bracing shall be clearly indicated in the drawings together with clear instructions as to the appropriate stage of removal.

4.7 MATERIALS AND WORKS

4.7.1 General

All materials and structural parts to be supplied, erected or installed and accordingly become an incorporated part of the structure shall be new and unused, unless otherwise specified elsewhere in the Tender Document.

Materials shall be standardized as far as possible. Materials and structural parts which are not standardized shall comply with the relevant site requirements and shall only be used with the approval of the Employer.

All material shall be the best of their respective kinds, free from all imperfections that might impair their strength, durability and appearance. All materials shall meet the current applicable specifications. All material shall be well finished bars, plates, strips, angles, rolled sections, extruded sections, pipes, etc., as indicated and specified, clean and free from all scale, flake rust and rust pitting. Cast iron shall be tough grey iron. Accessories for connection of cast iron shall be of steel, unless otherwise noted. Materials required or indicated to be galvanized shall be so treated only after fabrication.

All steel used in structural steel work and steel flooring shall be electric welded steel S37 with minimum yield strength 2400 kg/cm^2 and crushing tensile strength 3700 kg/cm^2 .

4.7.2 Standards of Material

The material shall be standardized as far as practically possible. The quality of the material shall comply with relevant EU standards. Particularly for:

- ▶ structural steel,
- ▶ mild steel bolts,
- ▶ high strength bolts,
- ▶ welding,
- ▶ rivets,
- ▶ nuts and washers,
- ▶ cast iron (tensile strength no less than $14,2 \text{ kN/cm}^2$).

All structural steel members shall receive shop protective coating against corrosion either by galvanizing or by paint; however, lead based paint shall not be applied.

Where steel shall be galvanized, the execution of the galvanization shall comply with EN 10143 as applicable.

Prior to the protective coating with paint, the surface of the steel members shall be treated as specified. The first protective coat shall be applied before assembling and the second protective coat immediately after assembling. Blemished areas have to be touched up before the second coat is applied.

4.7.3 Structural Steel Parts

The following materials shall be furnished and installed under consideration of the present regulations:

- ▶ structural steel parts of all and any profiles and shapes,
- ▶ columns, beams, purlins, trusses, steel doors and steel door frames, and rails,
- ▶ hatch covers, chequered plates, gratings, stairways, platforms, ladders, guard railing and handrails for various features,
- ▶ anchor bolts, anchorage systems and pipe sleeves, pipe and cable hangers, bolts, nuts, washers, inserts, screws, clips, rivets, welding electrodes,
- ▶ any and all other necessary accessory and appurtenant miscellaneous metal work that is required but not listed herein or shown in the drawings and which is not paid for under other items within the Tender.

4.7.4 Bolts and Rivets

Bolts: Material for all bolts shall meet the requirements of the relevant EN standards or other equivalent ones. Connection bolts may be raw or galvanized unfinished machine bolts as specified in the detailed description. When galvanized, the depth of threads shall be sufficient to give a free fit. Semi-finished machine bolts may be used in lieu of unfinished bolts, if required to obtain the fit as specified.

Locknuts: shall be galvanized locknuts of the auxiliary type to be used with standard nuts.

The use of gusset plates shall be kept to a minimum. Where connections are such that the elimination of gusset plates would increase the eccentricity of the joint beyond a reasonable amount, gusset plates shall be used. The corners of web members shall be clipped where necessary to eliminate or reduce eccentricity in joints.

If possible, where gusset plates are used, web members shall be connected to the main members with at least one bolt. Where fills are required at two or more adjacent holes, a single plate fill shall be used instead of ring fills. Structures shall be so designed and detailed that all parts will be accessible for inspection and cleaning. Pockets or depressions which would hold water shall have drain holes.

High tension bolts: Bolts, nuts and washers shall conform to the requirements as to chemical composition stated in the respective standards for high-tension bolts.

Nuts: Steel for nuts and washers shall be made according to the relevant standards meeting the requirements pertinent to the bolts.

Rivets: The steel for rivets shall be made by open-stove, basic-oxygen or electric-furnace process. The rivets shall conform to the hardness requirements of the respective standard specifications of EN / ISO or similar other standards.

4.7.5 Welding Rods

For any welding work, only the appropriate welding rod, either arc or gas, shall be used. The tensile properties shall conform to the material to be welded as specified in the respective standards.

The electrodes for arc-welding shall be classified on the base of mechanical properties of the as-welded deposited weld-metal, type of covering, welding position of the electrodes and type of current. Only heavily coated electrodes shall be used for manual welding.

4.7.6 Cast Iron

Cast iron shall be close grained, tough and uniform in character and shall be cast from the best grey pig and scrap iron. It shall be of tensile strength of not less than 142 N/mm².

4.7.7 Protective Painting

All steel members to be delivered to Site shall bear protective painting. This protective painting shall be done in accordance with general practice and recognized methods, the manufacturer's instructions and according to the standards specified. No lead-based protective coating shall be used.

4.8 EXECUTION OF WORKS

4.8.1 General

The steel work shall be carried out in a workmanlike manner and in accordance with the relevant standards. All parts shall be accurately assembled and erected as shown in the drawings or as described in the Specifications, and all match made by the workshop shall be carefully followed. The materials shall be carefully handled so that no part shall be bent, broken or otherwise damaged. For the execution of erection works, only skilled and qualified erectors, welders or mechanics shall be assigned.

All materials shall be straight and free from kinks or bends. Shearing and cutting by torch or electric arc shall be performed carefully, and all portions of work which will be exposed to view after completion shall be finished neatly. Miscellaneous metal work shall be free from dirt, rust, scale, grease and oil, when embedded, and all exposed surfaces or portions shall be painted as provided in the applicable clauses of these Specifications.

The erection staging and scaffolding shall be properly provided with coverings and barriers and shall guarantee safe working.

4.8.2 Shop Errors

Material wrongly fabricated, so that its erection in the field necessitates extra work, shall be the responsibility of the Contractor who shall pay the entire cost of correction of shop errors and the replacement of wrongly fabricated materials.

4.8.3 Structural Steelwork

Structural steelwork shall comply with the provisions of EN 1993-1 or of equivalent standards.

Welding shall be carried out by qualified personnel and to the satisfaction of the Engineer.

Unless otherwise described in the Contract, metal-arc welding shall comply with applicable EN / ISO standards.

The temperature of steels welded shall not be less than 10°C when welding is commenced.

The heat control techniques shall be such as to ensure that the flame cut surfaces of steel are free from cracks, local hardness and any defects which would be detrimental to the finished work.

The paint for the protection of structural steelwork shall be approved by the Engineer and used strictly in accordance with the manufacturer's instructions.

Painting works other than shop-applied protective coating shall be performed according to the relevant Technical Specification.

Where the paint is damaged back to bare steel, this should be either power wire-brushed or shot blasted and then painted as specified above.

Steel surfaces which will have concrete cast against them shall be left unpainted. The surfaces shall be thoroughly wire brushed to remove loose rust, mill scale and surface contamination.

The treatment of interfaces to be joined by high strength friction grip bolts shall be as described in the Contract. Paintwork shall be stopped off at a distance of 75 mm from the joints and all interfaces shall be cleaned by hand wire brushing before assembly.

All bolt holes shall be accurately spaced, care being taken to ensure the exact correspondence of the holes. Holes unless otherwise shown shall not exceed the diameter of the rivet or bolt by more than 2 mm for bolts and rivets up to 24 mm diameter and 3 mm for bolts and rivets exceeding 24 mm diameter and where close tolerance or barrel bolts are used by more than 0,15 mm.

All anchor bolts shall be rustproofed by a method approved by the Engineer.

Unless otherwise specified, holding down bolts shall be fitted with plate washers as follows:

- ▶ 75 mm x 75 mm x 10 mm thick for bolts up to 20 mm diameter,
- ▶ 100 mm x 100 mm x 10 mm thick for bolts larger than 20 mm diameter and up to 30 mm diameter.

Plate washers for bolts larger than 30 mm diameter will be specially prescribed.

All rag bolts and holding down bolts shall be accurately held in position by templates during concreting.

4.8.4 Shopwork

Structural steel shall be fabricated in accordance with the following requirements:

Straightening of material: Before being laid out or worked in any manner, structural material shall be straight and shall be cleaned of all rust and dirt. If straightening is necessary, it shall be done by methods that will not injure the metal. Sharp kinks or bends shall be a cause for rejection of the material.

Shearing and cutting: Shearing and cutting shall be performed carefully and all portions of the work, which will be exposed to view after completion, shall be finished neatly. Re-entrant cuts and copes on beams or channels shall be filleted after cutting where this does not alter the geometry required for proper function. Cutting torches shall not be used, unless otherwise specifically approved.

Holes: All holes in structural steel may be punched to full size, unless otherwise specified. If the thickness of the material exceeds the diameter of the hole, then the hole shall be drilled. At the option of the Contractor, holes required to be drilled may be sub-punched and reamed. All holes shall be clean cut and without torn or ragged edges. All burrs resulting from reaming or drilling shall be removed with a tool making a 1,6 mm bevel. All holes shall be cylindrical and perpendicular to the member. Where necessary to avoid distortion of the holes, holes close to the points of bend shall be made after bending.

Punching: For punching to full size, the diameter of the punch shall be 1,6 mm larger than the nominal diameter of the bolt and the diameter of the die shall not be more than 1,6 mm larger than the diameter of the punch. For sub-punching, the diameter of the punch shall be 4,8 mm smaller than the nominal diameter of the bolt, and the diameter of the reamed work shall be such that after reaming, no punched surface shall appear in the periphery of the hole. Refill of a limited number of mispunched holes by welding will be permitted, but only after specific approval of such repairs. Where approval is given to refill mispunched holes by welding, the steel adjacent to the holes shall be heated immediately prior to welding. After the holes have been filled by welding, the welded area and the steel adjacent to the welded area shall be heated to relieve stresses; the welded area shall be ground flush, and the holes shall be punched as required.

Reaming and drilling: Where holes are reamed and drilled, the diameter of the finished hole shall not be greater than the nominal diameter of the bolt plus 1,6 mm. Refill or a limited number of misreamed or misdrilled holes by welding will be permitted subject to the same provisions outlined in the preceding paragraph for mispunched holes.

Accuracy of punching, reaming and drilling: All holes shall be spaced accurately in accordance with the Contractor's detail drawings and shall be located on the gauge lines. The maximum allowable variation in hole spacing from that indicated on the detail drawings for all bolt holes shall be 0.8 mm. Reaming or excessive drifting to match inaccurate holes will not be permitted. Poor matching of holes shall be cause for rejection.

4.8.5 Shop Welding

All shop welds shall be carried out by welders qualified for the work, under proper supervision. The Engineer may call for test welder's capabilities, though machine welding should be used whenever possible. The work shall be properly prepared for welding and the correct sequence adhered to. The pieces shall manipulate to ensure down hand welding for all shop joints.

4.8.6 Shop Assembly

The structures shall be pre-assembled in the shop to such an extent as to ensure proper field erection. Reaming of inaccurate holes will not be permitted. A reasonable amount of drifting will be allowed in assembling. Shop-assembled parts shall be completely dismantled for shipment.

4.8.7 Shipment

The Contractor shall prepare all materials for shipment in such a manner as to protect them from damage in transit and shall be responsible for and make good any and all damage due to improper preparation or loading for shipment. All parts of the work shall be suitably packed for shipment by sea. Where necessary, double packing shall be used in order to prevent damage and corrosion during transportation, unloading and reloading and during intermediate storage. All identical members shall be tied together in bundles convenient for shipment and handling. All bolts, nuts and washers shall be packed in containers. In packaging bolts, each container shall include only bolts of identical size and length. In packages of washers, each container shall include only washers of identical size and

thickness. On arrival of structural steel parts (such as columns, beams, girders, frames, lintels, railings, chequered plates, etc.), they shall be checked for damages. Any structural member that has been damaged in the course of shipment or handling to an extent of seriously affecting the properties of the members and cannot be repaired or aligned shall be immediately brought to the Engineer's attention. Should the Engineer determine that any structural member is not repairable then the Contractor will be notified to furnish a new member.

4.8.8 Erection

Before the commencement of erection, the Contractor shall closely inspect the Site and all the foundations and other structures at and on which parts of the work supplied under these specifications will be installed. He shall check the conformity of the foundation with erection drawings. The result of this check shall be transmitted to the Engineer in sufficient time to allow any errors to be corrected before the commencement of erection. The Contractor shall be responsible for the accurate establishment and maintenance of building lines, benchmarks and required elevations for the proper erection of steel works at the Site.

Before erection, all parts of the work shall be cleaned from all contamination such as dust, sand, rust, loose mill scale and other dirt.

The Contractor shall provide storage and handling areas for the intermediate storage of parts for the structure. The necessary space for these facilities will be provided on the site.

The stores shall be weather-proof, with good ventilation and solid floors. The floors of the stores and the storage areas shall be designed to carry the loads imposed on them by the parts to be stored.

The following parts shall be stored inside close stores:

- ▶ bolts, pins, tools, insulation materials, electrical parts and parts with electrical devices attached, electric motors, instruments, welding material and equipment, all small parts and all parts of the work which have already been finish painted insofar as these require no unusual large space requirements.

All individual pieces shall be marked with the correct designation shown in the Contractor's detail drawings. Marking shall be done by stamping the marks into the metal before galvanizing, if so stipulated, and shall be clearly legible after galvanizing. In designating members in shop drawings, the Contractor shall endeavour to use as few designations as possible and each member of identical size and detail shall have the same designation, regardless of its position in the structure.

The erection of the parts of the work shall be properly carried out and in accordance with the erection instructions of the manufacturer or with the currently valid regulations concerning material handling, welding, etc. Machines and bedplates shall be erected true and grouted in. Any hollows or internal spaces shall be provided with drains.

Hammering that might injure or distort the members shall not be permitted. The members shall not be overstressed during the process of erection. Bearing surfaces to be in permanent contact shall be carefully cleaned before the members are assembled or erected. In bolted connections, the bolts shall be drawn tight and secured by lock washers. Erection bolts and pins shall be furnished by the Contractor.

All embedded miscellaneous metalwork shall be set accurately in position and shall be supported rigidly to prevent displacement during the placing of concrete.

All parts of the work are to be protected from the time of delivery until final approval against damage of any kind.

Special care shall be taken not to injure the skin of galvanized or specially treated surfaces during erection. Care shall be taken to prevent or remove any rust streaks or foreign matter deposited on galvanized surfaces during storing or transport or after erection.

Anchor holes shall be executed using approved methods. Anchor bolts shall be manufactured according to detailed approved drawings and shall be erected accurately within the allowable

tolerances. Grouting shall be ready made high strength epoxy grouts as conforming to the General Specifications.

4.8.9 Site Welding

All site welding shall be carried out by the electric arc process, with coated electrodes. The welding plant shall be of modern design and of ample capacity to provide the required current to each welding point without appreciable fluctuations.

The welding procedure and proposed electrodes for making each joint shall be approved by the Engineer before the work is started and the Contractor shall make such trial as the Engineer may require demonstrating the soundness of the proposed method and the competence of his workmen. Whenever possible all welding shall be done in the down hand or horizontal-vertical position. All parts to be welded shall be accurately prepared so that upon assembly they will fit closely together. After assembly and before the general welding is commenced, the parts are to be tack-welded with small fillet welds. The tack-welding must be strong enough to hold the parts together but small enough to be covered by the general welding.

4.8.10 Footings

Foundation bolts and plates or steel stubs shall be provided for all columns and shall be firmly keyed and grouted into concrete foundation blocks.

Erection shall include the setting of all columns and bases, and erection of all structural steel as called for under the Contract for furnishing and delivery of structural steel.

The Contractor shall set column bases and beam plates on steel wedges or angle screeds (shims), to accurate elevations approximately 4 cm clear of masonry or concrete; these shall be grouted by the mason. Wooden wedges shall not be used. The Contractor shall also set anchor bolts to be concreted in by the civil works contractor.

Anchor bolts and other identical items of structural steel required to be built into concrete with instructions and/or templates for their installation shall be delivered to the respective trades in proper time to avoid delays of the work. The structural steel erector shall verify the positions of anchor bolts before concrete is poured.

4.8.11 Column Base Setting

Levelling of base plates shall be done by means of levelling screws. Setting procedures shall be as approved by the Engineer.

Grouting shall be in accordance with chapter "Concrete and Reinforced Concrete" of this Specification.

4.8.12 Aligning and Plumbing

The Contractor shall provide all necessary guys and braces to ensure the alignment and stability of the structural steel members until all are properly connected and riveted. All temporary guys and bracings shall take care of all dead load, wind load, seismic load and erection stresses, and shall remain in place until, in the opinion of the Engineer, they can be removed without danger to the stability of the structure.

As the work progresses, it shall be the responsibility of the Contractor to plumb up and level all members. No field connection shall be done until as much of the structure as will be stiffened thereby has been properly aligned. No column, after erection, shall have an error from the plumb exceeding 1 to 1000 for the total height of the columns.

Approved steel gauges of the stud type shall be provided to enable the Engineer to carry out such checking of members as may be considered necessary.

4.8.13 Sheet Metal

Workmanship shall conform to the best standards of practice in modern sheet metal shop, and the work shall be accurately formed to the dimensions and shapes indicated in the drawings. Formed, moulded, and cut members shall finish with true, straight and sharp lines and angles, and where intercepting each other, shall be coped to an accurate fit and soldered where required.

Sheet metal work shall be formed, fabricated and installed to provide for expansion and contraction. Exterior work shall be finished water and weather-tight, and flat and lap seams shall be made in the direction to flow.

4.8.14 Grounding, Bonding

Approved means shall be provided for fixing and bonding copper strips to the steelwork at sufficient points to secure efficient grounding. Grounding connections shall be made to a vertical face clear of the soil; foundation bolts shall not be used for their attachment. The treatment of copper grounding strips prior to their attachment to steel structures shall be to the Engineer's approval.

4.8.15 Chequered Plates

Chequered plates for floors and platforms shall be of thicknesses and locations as indicated in the drawings. Chequered plates that are to be removable shall be provided with two lifting holes, and size of plates shall be such as to afford easy handling; other plates shall be provided with fasteners as shown in the drawings. All plates shall rest flat on their supports without rocking. All edges of plates shall be ground or cut, smooth and straight with 3 mm clearance between plates. Unbraced chequered plate shall be stiffened with angles, where required. Cut-outs and openings required for chequered plates shall be shop formed and reinforced to dimensions and locations shown on approved drawings or to the Engineer's instructions.

The Contractor shall furnish banding strips or angles for openings required to be cut out in the field, as well as all other necessary accessories for chequered plate required for field installation.

Where chequered plate is shown on drawings to be furnished with grating, it shall be securely shop welded.

4.8.16 Grating

Steel grating shall be of the welded type, rectangular pattern and of sizes as indicated in the drawings.

Gratings shall be hot-dipped galvanized after fabrication. All gratings indicated as removable shall be bolted or clipped to supports. Sizes of grating shall be such as to afford easy handling. The Contractor shall cut, as shown on all approved drawings, neat, circular or square openings for the passage of pipes, ducts, etc., through gratings.

It shall band all openings with 6 mm steel plate of height to match toe plate height where shown, otherwise with 15 cm width, and weld the band to each intersecting member of grating.

The Contractor shall furnish the necessary material for all other cut-outs or openings to be performed in the field; provide toe plates at all unprotected open sides at ends of grating and where shown on drawings. All gratings shall be arranged so that bars in either direction are in line.

Bearing bars shall be of depth required to support the design loads at allowable stresses and a deflection not exceeding 1/250 of span length.

4.8.17 Pipe Railings

Unless otherwise specified, pipe railings shall consist of standard black steel pipe with flush, continuous, welded joints, ground smooth. Horizontal-run pipe handrail shall be of heights as indicated in the drawings, with intermediate rails located midway from the top rail to top of the toe plate, toe channel, or curb. Exposed bottom ends of pipe posts shall be closed where required in the drawings. A pattern of symmetry shall be accomplished when locating pipe posts and in no case shall the distance between the centres of posts exceed 2,00 m.

Wall pipe and handrail shall be returned to a wall and be provided with necessary secure anchors. The Contractor shall provide necessary handrail brackets of malleable iron and anchors. All accessories such as floor flanges, etc., required for pipe railing shall be furnished.

4.8.18 Ladders

The Contractor shall provide where indicated in the drawings steel ladders to heights and accesses as required. Side rails shall consist of 65 mm by 12 mm flats, and 18 mm diameter rungs, installed into the side rails and securely welded. Rungs shall be 45 cm long between side rails and spaced 30 cm on centres. Ladders shall be securely fastened at top and bottom into the wall and shall have intermediate clips or flats and fastenings spaced not more than 1,80 m apart. Clips or flats shall be riveted or welded to the side.

4.8.19 Angle or Channel Frame for Floor Openings

Steel angle and/or channel frames shall be provided for all openings in the sizes and shapes indicated. The Contractor shall provide anchors securely welded to each side of the steel frame or as otherwise indicated in the drawings. All corners of frames shall be mitred and continuously flush-welded.

4.8.20 Manhole Covers and Frames

All manhole covers and frames shall be of the sizes and details as indicated in the drawings. Frames and solid covers shall be of tough grey cast iron for light-duty application or as otherwise required and provided with a lift ring and properly machined for seating to prevent rocking.

4.8.21 Bolts

All metal parts shall be secured by means of bolts and nuts and screwed rods. Bolts and nuts shall be of steel with hexagonal heads.

When in position, all bolts or screwed rods shall project through the corresponding nuts, but such projection shall not exceed three threads. Where cutting off bolt or screwed rod ends on site is required by this provision, the threads and cut ends of these shall then be painted with bitumen based, or other approved paint.

The length of the screwed portions of bolts shall be such that no screw thread may form part of a shearing plane between members.

Taper washers shall be provided where necessary. Where fitting bolts are not required, no bolt hole shall be more than 1,6 mm larger than the diameter of the bolt, but after galvanizing, sufficient clearance shall be left for insertion of the bolts. For large diameter bolts, such as foundation bolts, the clearance shall be to the approval by the Engineer.

As far as possible, bolt heads rather than nuts shall be on the outer faces of the structural members.

4.8.21.1 Expansion Bolts

Wherever "cinch" anchors or expansion bolts are evidently required to secure members, cinch anchors, as made by an approved manufacturer shall be furnished and used. The number of units used shall be as required by the stress on the bolts. Bolts shall be hot-dipped galvanized, after which the threads shall be run down.

4.8.21.2 High-Tension Bolts

Bolts, nuts and washers shall conform to the requirements and to chemical composition stated in the respective standards for high-tension bolts.

4.8.21.3 Anchor Bolts

Bolts, nuts and washers shall conform to the requirement of the current edition of EN / ISO specifications. All bolts, nuts and washers required for erection shall be furnished with the structural

steel and included in the proposed price. Anchor bolts shall have a minimum yield of 250 N/mm² and shall comply with applicable standards.

4.8.21.4 Bolt Assembly

All field connections shall be made according to applicable specification for structural joints using above mentioned bolts. Connections shall be of the friction type using high strength steel bolts. Mating faces of friction connections shall be prepared as shown in the drawings or as specified by the Engineer. Field connections shall be accurately fitted before the bolts are tightened. Drifting shall only be such as will bring the parts into position without endangering holes to be enlarged or steel to be distorted. All non-matching holes shall be drilled and reamed. After joints are fitted properly, bolts shall be tightened by the turn-of-nut method.

In connections with parallel faces or slopes smaller than 1 in 20 washers may be eliminated. Where slopes are bigger than 1 in 20 smooth bevelled washers shall be used.

4.8.22 Shop Connections

Generally, all shop connections shall be welded. Welding electrodes shall conform to the applicable EN or ISO standards, latest edition. The Contractor shall prepare and submit for approval the welding procedures for all shop and field welds and shall not proceed with fabrication until the Engineer's approval is obtained. For welding of any particular type of joint, the welder may be tested by the Engineer. The standard accepted shall be as described in the "Code of Welding in Building Construction" of the American Welding Society or any other code subject to the Engineer's approval. All full penetration welds shall be ultrasonically tested by qualified personnel. The Contractor shall keep records of all tests and submit them to the Engineer. All steel parts that are required to be galvanized shall not be welded on after galvanising. Where bolted shop connections are indicated or allowed, BS heavy hexagonal head bolts with heavy semi-finished nuts shall be used.

4.8.23 Field Connections

Field connections shall be of the friction-type connections for BS bolting with heavy hexagonal head bolts. Connections at building expansion joints must be slotted with shoulder bolts with locknuts. The slots shall be of sufficient length for movement of the sliding member in both directions from the neutral position by 25 mm.

Where no reactions or moments are called, the connections for indicated sections shall be designed with a maximum number of fasteners of minimum M 22 diameter, unless governed by material thickness or otherwise detailed in the drawings. No connections shall have less than two bolts.

Diagonal bracing shall be properly drawn by shortening the member 1,5 mm for every 30 cm of the member length. The connections at the end of bracings shall meet develop the force due to the design load, but not less than 50% of the effective strength of the member. If no load is indicated, the latter condition shall govern.

4.8.24 Rivets

All rivets shall be driven with pneumatic hammers. All loose, eccentric or other defective rivets found upon inspection shall be removed as directed and replaced to the Engineer's satisfaction and at the Contractor's expense. Hand passing or throwing of rivets is desirable, but any other method of conveying rivets from the forge to driving point must be approved by the Engineer. No cold rivets shall be driven.

Assembled parts shall be brought into close contact, and drift pins shall be used only for bringing members into position, not to enlarge or distort holes.

Correction of minor misfits and a reasonable amount of reaming and cutting of excess stock from rivets will be considered as a legitimate part of erection. Any error that may occur in shop work which prevents the proper assembling and fitting of parts by moderate use of drift pins, or a moderate amount of reaming and slight chipping or cutting shall immediately be called to the

attention of the Engineer, and approval of the method or procedure of correction shall be obtained or such method or procedure shall not be employed. The use or cutting torches to enlarge or alter rivet holes shall be prohibited.

4.8.25 Cast-Iron Work

Castings shall be made of tough, grey iron, conforming to EN or ISO standards, sound and free from warp, holes and other defects that would impair their strength and appearance. Thickness of metal and details of assembly and supports shall give ample strength and stiffness. Exposed surfaces shall have a smooth finish and sharp, well-defined lines and arises. Necessary rabbets, lugs and brackets shall be provided so that work can be assembled in a neat fit. Joints exposed to weather shall be formed to exclude water collecting or intrusion. Fastenings shall be concealed where practicable. Holes shall be drilled or reamed for bolts and screws. Castings shall be thoroughly cleaned by sandblast or other effective means before shop painting or acceptable protective coating is applied. The tensile strength shall not be less than 142 N/mm².

4.8.26 Welding

Welding, when required and approved by the Engineer, shall be done by qualified welders, who have been previously tested according to approved standards to do this type of work. All techniques pertaining to welding shall conform to approved standards for arc and gas welding in building construction.

All welds shall be as shown in the detail drawings and shall be made in such a manner that residual shrinkage stresses will be reduced to a minimum and that no stress relieving treatment will be required.

The Contractor shall carry out welding, torch-cutting and drilling work on steel structures only with the approval by the Engineer. If mountings or suspension attachments for erection purposes are attached to the steel structure, they shall be removed by the Contractor after work is completed and the steel structure restored to a proper condition by grinding away the welded seam surplus material and other deformities and by painting.

Surfaces to be welded shall be free from loose scale, rust, grease, paint, and other foreign material except that mill scale which withstands vigorous wire brushing may remain. A light film of linseed oil may likewise be disregarded. Joint surfaces shall be free from spurs and tears.

No welding shall be done when the temperature of the base metal is lower than -30°C. At temperatures between 0°C and -30°C, the surfaces of all areas within 10 cm of a point where a weld starts shall be heated until they are too hot to be touched before welding will be carried out.

Finished members shall be true to line and free from twists, bends and open joints.

Arc welding equipment shall be of a type which will produce proper current so that the operator may produce satisfactory welds.

Electrodes shall be classified according to the specified types and shall be suitable for positions and other conditions of intended use in accordance with instruction of the manufacturer which shall be shown on the container.

4.8.26.1 Welding Procedure

Welding operations shall be carried out in compliance with a proper welding procedure approved by the Engineer and/or such inspecting entity nominated by the Employer, e.g., API 650.

This procedure shall include the description of the following points:

- ▶ composition of basic metal,
- ▶ definition of welding techniques proposed (arc, arc-argon, submerged arc, manual, automatic, semi-automatic or with coated electrodes),
- ▶ type of added material (electrodes, wires, arc submerged in powder or as gas flux, indicating mechanical or chemical properties),

- ▶ preparation of assemblages bevel angle, root face clearance, support,
- ▶ method used for preparing studs,
- ▶ sequence of weld runs and diameter of added wire, current and voltage to be used, type of welding sets,
- ▶ horizontal or other positions used (welding positions, e.g. vertical up, overhead, vertical down, etc.),
- ▶ inspection positions to be applied,
- ▶ X-ray procedure,
- ▶ any required thermal preparations (pre-heating, stress relieving, tempering, hardening).

4.8.26.2 Welding Standard

Welding, when required and approved by the Engineer, shall be done by qualified welders, who have been previously tested by approved standards to do this type of work. All techniques pertaining to welding shall conform to EN 287 and EN 288 or other applicable standards.

4.8.26.3 Qualifications of Welders

The welders to perform the welding work shall be qualified according to tests required by the API Codes, or any other tests as requested by the Engineer and no welder shall perform any welding work, unless approved by the Engineer.

4.8.27 Galvanizing

4.8.27.1 Cleaning for Galvanizing

After the shop works have been completed and accepted, all material to be galvanized according to the specifications shall be cleaned of rust, loose scale, dirt, oil, grease, and other foreign substances in accordance with the provisions stipulated under Section A of these specifications. Particular care shall be taken to remove slag from welded areas.

4.8.27.2 Galvanizing of Steel Members

After being cleaned, the material shall be zinc-coated (galvanized) in accordance with applicable standards. Where members are of such lengths that they cannot be dipped in one operation, great care shall be exercised to prevent warping.

Finished compression members shall not have lateral variations greater than one-thousandth of the axial length between the points which are to be supported laterally.

Finished tensile members shall not have lateral variations exceeding 3 mm for each 1,50 m of length. Sharp kinks or bends will be cause for rejection of the material.

4.8.27.3 Galvanizing of Hardware

Bolts, nuts, washers, locknuts and similar hardware shall be galvanized in accordance with the relevant standards. Excess particles shall be removed by centrifugal spinning.

4.8.27.4 Straightening after Galvanizing

All plates and shapes which have been warped by the galvanizing process shall be straightened by being rerolled or pressed. The material shall not be hammered or otherwise straightened in a manner that will injure the protective coating.

If the material has been harmfully bent or warped in the process of fabrication or galvanizing, such defects shall be a cause for rejection.

4.8.27.5 Repair of Galvanizing

Material on which galvanizing has been damaged shall be re-dipped, unless the damage is local and can be repaired by soldering or by applying a galvanizing repair compound, in which case the compound shall be applied in accordance with the manufacturer's instructions.

Soldering shall be done with a soldering-iron using 50/50 bar solder (tin and lead). Surplus flux or acid shall be washed off promptly and the work shall be performed so as not to damage the adjacent coating or the metal itself. Any member on which the galvanized coating becomes damaged after having been dipped twice shall be rejected.

4.8.28 Shop Painting

All steel parts such as steel structures, girders, frames, chequered plates, grids, railings, latticed members, gratings, bars and plates of any kind, etc., shall be sand-blasted down to white metal according to the provisions of chapter "Painting" of these specifications.

Before assembly of the different structural parts, surfaces shall be coated with epoxy polyamide metallic zinc-rich according to specifications.

Shop priming: two coats at an "Epoxy Polyamide Metallic Zinc-Rich" coating according to specifications.

Mating surfaces of friction connections shall be prepared as specified. No paint, which will prevent proper welding, shall be used within 5 cm of indicated field welds.

4.8.29 Field Painting

After assembly, welding spots shall be ground smooth, the first coat shall be repaired and a second coat similar to the above-mentioned shall be provided.

Isolation of non-compatible metals shall be provided in all installations by giving the metal a coat of asphalt and an isolation barrier (i.e. asphalt impregnated felt) to prevent contact with dissimilar metals, masonry, concrete or plaster.

Galvanized structural steel parts except girders and gratings shall also be provided as mentioned above.

All field rivets, bolts and welds, and all serious abrasions to the shop coat shall be spot painted with the same material used for the shop coat or an equivalent, and all mud, grime and other firmly attached foreign and objectionable matters shall be removed. Then, a thorough coat of approved field paint shall be applied to all steel work, except when steel comes in contact with concrete.

After erection, the finish coat of painting on Site shall be carried out in accordance with the painting specifications and any damage restored.

4.9 TESTS AND PROPERTIES

Tests and Properties for steel and iron works are in Volume 3, Section 4 Testing, Operation, Maintenance and Training Requirements.

4.10 AUXILIARY WORKS

4.10.1 General

Unless otherwise specified, all and any kind of works, materials, equipment, services, safety measures, etc., as well as and if so requested by the Engineer, all tests and samples required for the completion of the work shall be included in the unit prices.

4.10.2 Auxiliary Works

Further to the above, auxiliary works to be included in the tender for structural steel shall comprise, among others, the following works and commitments:

- ▶ establishment of structural analysis, shop drawings and all details for the designed steel structure or any components,
- ▶ supply and manufacturing of the structural elements and members,
- ▶ transportation from manufacturing plant to Site including packing, handling, off-loading, adequate storing and protection against damage and spoiling,
- ▶ shop coating of the structural members against corrosion,
- ▶ all erection equipment for assembling the steel structure,
- ▶ all connecting components, such as bolts, rivets, nuts, washers, shims, welding rods, etc., required for completing the job,
- ▶ all drilling, welding, wedging, plumbing, levelling, alignment etc., required for completing the job,
- ▶ training of welders, if required,
- ▶ provision of all instruments, gauges and other appliances for inspection and testing of the structures by the Engineer or any assigned entity including all ancillary access supports.