भारत हेवी इलेक्ट्रिकल्स लिमिटेड
(भारत सरकार का उपक्रम)
BHARAT HEAVY ELECTRICALS LIMITED
(A Govt. of India Undertaking)

TCN – 01

Ref: PSER:SCT:KLN-C1911:TCN-01 Date: 17-07-2018

| | | |
|---|---|---|
| Sub | Tender Change Notice (TCN) - 01. | |
| Job | Package-11: Civil, Structural & Architectural works (except pile, pile cap, pedestal and associated works) for Non Plant Buildings including Green Building for 2x660 MW Maitree STPP Rampal, Bangladesh. | |
| Ref | 1.0 | Tender no PSER:SCT:KLN-C1911:18. |
| | 2.0 | BHEL's NIT, vide reference no PSER:SCT:KLN-C1911:6940 Date: 05-07-2018. |
| | 3.0 | Other References, if any. |

With reference to above, following points/ documents, relevant to tender, may please be noted and complied with while submitting offer.

1) Bidders are requested to note that Technical Specification of file name "2.1-SCT-KLN-C1911-VOL-IF-TCC-TS-Section C" attached again.

2) Revised `No deviation certificate' as per enclosed Annexure-2. Bidder shall submit no deviation certificate as per enclosed format only.

3) All other terms & conditions shall remain unchanged.

Thanking you,

Yours faithfully,
for BHARAT HEAVY ELECTRICALS LTD

Sr. Engineer (SCT)

Encl: As Above.

पावर सेक्टर पूर्वी क्षेत्र (मुख्यालय)
POWER SECTOR EASTERN REGION, DJ-9/1, SECTOR-II, SALT LAKE CITY, KOLKATA - 700 091
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# BANGLADESH-INDIA FRIENDSHIP POWER COMPANY (PVT.) LIMITED

# 2x660MW MAITREE STPP, RAMPAL

# BANGLADESH

## VOLUME – II B

## CIVIL, STRUCTURAL & ARCHITECTURAL WORKS

## PE-TS-421-600-C006 R02

## SECTION C
## SPECIFIC TECHNICAL REQUIREMENT


**Bharat Heavy Electricals Limited**
**Project Engineering Management**
**PPEI Building, Power Sector,**
**Plot No. 25, Sector 16A,**
**Noida-201301**

# Contents

# 1.0 Civil Works

This specification covers the design, manufacturing, supply, erection, commissioning and handing over of the complete civil works for the entire specified power plant.

It is to be emphasized, that this specification does not enumerate or describe all the materials and equipment to be supplied and all the services to be performed. However, the civil works shall be complete in every respect and shall ensure safe and reliable operation of the Plant. This means, all material and equipment shall be provided as required to make a complete, properly functioning installation and shall conform to the highest standards of engineering design and workmanship.

Contractor shall read the parts of specification relevant to contract and shall ignore other parts of specification. In case of ambiguity between BOQ, Part C and Part D of specification, the following priority for acceptance of items may be followed:
a) BOQ
b) Specific technical specification (Part C)
c) General technical specification (Part D)

## 1.1 General

This section covers the design, construction and supply of all civil works including building services and fire fighting works of the specified power plant.

The various buildings and parts of the Project must form an architectural, structural and functional unit. Special attention must be paid, in addition to basic design and construction, to the aspects which are specific to climate and local requirements.

The buildings and structures shall be designed with due respect regarding the need for inspection, maintenance, cleaning and repair and able to operate for long-time periods with a minimum of inspection, adjustment and repair.

All material shall be new and of the best quality suitable for working under the conditions, variations in temperature and load encountered in service without undue distortion or deterioration or the occurrence of undue stresses in any part, such as to affect the efficiency and reliability of the plant.

The Contractor is not allowed to use the works, materials or furniture or parts thereof for temporary purposes without the written consent of the Employer.

The conceptual and detailed plant configuration of the various components shall be proposed by the Contractor, subject to the approval of the Employer to suit the requirements of the supplied equipment, under consideration of the existing situation, as well as the tie-in points. In doing so, adequate safety clearances, fire compartments, favorable layout of the plant components for monitoring and maintenance and any other requirements of up-to-date power plant construction shall be taken into account.

Optimization can be executed by the Bidder/Contractor while finalizing layout during basic/detail engineering subject to BIFPCL approval.

# 2.0 Civil Design Criteria

## 2.1 Codes and standards

The engineering and execution of all the civil works shall be based on the latest editions and revisions of the applicable codes and standards as listed in **Section D**.

If any standard contains a provision, which is inconsistent with a provision in another standard, the more stringent in respect of quality shall apply. In case of selection of equivalent international code instead of the code specified in the documents, the same shall be used only after approved by BHEL/BIFPCL.

### 2.2.2 Architecture

Architectural Design and detailing Aspects of all buildings shall be rendered through professional services of an Architect of reputation having experience in similar kind of works and familiar with vernacular architecture of Bangladesh.
For detail working drawings preparation, in house pool of architects may be utilized.

The overall architectural character of main plant buildings e.g. Administration Building, Auditorium, Main Gate Complex, Canteen Building and Service Building shall be architecturally treated in such a way that it presents an overall image befitting the image of the Employer as a reputed international Power Company, comparable with international buildings of repute and yet, incorporates a pleasing composition of mass and void with suitable and functionally designed projections and recesses.

All external and internal finishes shall be modern finishes as per international standards and latest construction technology. Buildings shall be designed considering the climatic condition, building orientation, landscape design, interior design, to meet the International Building Code and the vernacular architecture. The overall architectural character shall be in sympathy with the local environment and in harmony with the local culture

Requirements and international fire safety regulations and shall incorporate sustainable Building Design features like energy efficiency, solid waste management, water conservation and recycling etc. Service building, Administration Building, Auditorium and Canteen Building shall be designed as Green Buildings compliant to minimum LEEDs Gold rating. Certification of buildings is in the scope of Contractor.

All Buildings with RCC Roof and suitable/sufficient space shall be designed for installation of Solar Photovoltaic Panels on roof tops for Renewable Energy Purpose.

All public buildings like administration building, auditorium, main gate complex, canteen building, service building (the list may be finalized/ extended during design phase) shall be furnished with reinforced concrete stairs. The minim width of the flight shall be min 1500mm, risers" 150mm and threads 300mm.

All public buildings like administration building, auditorium, main gate complex, canteen building, service building (the list be finalized/extended during design phase) shall be designed incorporating the provision of barrier free environment for physically disabled persons.

All buildings shall be provided with toilets and drinking water facilities as per international building code requirements.

Buildings shall be designed as Intelligent Buildings with futuristic concepts with Standardized Components and incorporating Building Information Management System (BIMS, for details, refer clause no. 2.3.11). Aesthetic Treatment shall be designed with a view to develop responsible structures, acceptable to the Community and visually pleasing for next 25 to 30 years Landscaping shall be designed to take care of rain water harvesting and

ground water recharging.
An intelligent building may be understood as a building which makes use of technology & process to create a building that is safer and more productive for its occupants and more operationally efficient for its owner. It involves Energy Efficient Design, Sustainable Construction Practices, Access Control & Monitoring, Lighting Control, Energy Information & Management Systems etc.

Interiors of the buildings shall be designed based on functional requirements and shall interface smoothly with Mechanical & Electrical Services, so as to

have an ergonomically designed and visually stimulating environment.

The Bidder shall submit a convincing architectural concept along with tendering documents, for guideline see **Annex C.**

Detailed working drawings, perspective views, walkthrough views and model (to scale) of the entire plant shall be submitted after contract award.

### 2.2.3 Design loads

The following design loads shall be considered for the design of buildings and structures:

- **Dead load**
  Dead load is defined as the weight of all permanent construction including walls, foundations, floors, roofs, ceilings, partitions, stairways, and fixed service equipment and shall be calculated according to BS EN 1991-1-1 or equivalent (e.g. DIN EN 1991-1-1) and the Bangladesh National Building Code, whichever is more stringent.

  For heavy industrial work, this would include equipment, vessels, including internals, pipes, valves, and accessories, electrical and lighting conduits, switchgear, instrumentation, fireproofing, insulation, ladders, platforms, and other similar items. Equipment and piping should be considered empty of product load when calculating dead load. The gravity weight of soil overburden shall be considered as dead load.

- **Erection dead load**
  The erection dead load is the weight of the equipment at time of erection plus the weight of the footing, pedestal and overburden soil.

- **Live load**
  Live load is defined as the weight superimposed by the use and occupancy of the building or other structure, but not permanently attached to it. For industrial design, live load can be defined as the load produced by personnel, moveable equipment, tools, and other items placed on the structure, but not permanently attached to it. Design shall be done for the actual plant live loads or the live loads specified in according to BS EN 1991-1-1, (or equivalent DIN EN 1991-1-1) or the Bangladesh National Building Code, whichever is more stringent.

  Unless specified otherwise, or required due to erection, operation and maintenance the minimum live load values for floors and roofs given in Table below shall be considered.

The Employers consent is required in all cases for reductions of load

carrying capacities and for exceeding the permissible stresses.

**Minimum requirements for live loads [kN/m$^2$]**

| | Slabs and secondary supports | Gratings [2] | Main girders | Supports, e.g. columns, walls, brackets, etc. | Foundations |
|---|---|---|---|---|---|
| **1. Reinforced concrete structures** | | | | | |
| 1.1 at road level in areas used by large vehicles | 15<br>SLW 30[3]) | 5 | 15<br>SLW 30[3]) | 10 | 10 |
| In areas of major assembly work at their access roads | SLW 60[3]) | | SLW 60[3]) | | |
| 1.2 Machinery floor for storage of heavy machine parts | 30 | 10 | 20 | 20 | 20 |
| 1.3 Heavy intermediate floor slabs | 10 | 5 | 10 | 7,5 | 7,5 |
| 1.4 Medium intermediate floor slabs | 7,5 | 5 | 7,5 | 5 | 5 |
| 1.5 Light intermediate floor slabs | 5 | 5 | 5 | 5 | 5 |
| 1.6 Roofs | 1,5 | | 1,5 | 1,5 | 0,75 |
| | | | | | |
| **2. Steel structures** | | | | | |
| 2.1 Heavy platforms | 15 | 10 | 15 | 10 | 10 |
| 2.2 Medium platforms | 5 | 5 | 5 | 5 | 5 |
| 2.3 Platforms and walkways in Conveyor galleries | 5 | 5 | 5 | 5 | 5 |
| 2.4 Light platforms and walkways | 2,5 | 2,5 | 2,5 | 2,5 | 2,5 |
| 2.4 Roofs | 1,5 | | 1,5 | | 0,75 |

1) Figures in kN/m²
2) The loads shown are used for determining the load for structural analysis but not for dimensioning the gratings
3) Truck loads according to DIN 1072

Areas designated for different loadings on the same floor shall be clearly and permanently marked.

- **Crane/hoist load**
  Crane/hoist loads shall be considered as live loads. The vertical and horizontal loads from cranes/hoists shall be as per the supplier"s loading data. In the absence of specific information, the following minimum horizontal loads shall be considered at the location of each wheel:

  - transverse surge = 20 % of static wheel load
  - ii) longitudinal surge = 10 % of static wheel load.
- **Product load**
  The load shall be defined as the gravity load imposed by liquid, solid, or viscous materials in vessels, tanks, equipment or piping during operation.

- **Test load**
  The test load shall be defined as the gravity load imposed by any method necessary to test vessels, tanks, cranes, equipment or piping.

- **Thermal load**
  Thermal loads shall be defined as forces caused by changes in temperature (ambient temperatures see Section B0). The primary source of thermal loads in an industrial plant is the expansion or contraction of vessels and piping. Another source of thermal loads in a structure is the expansion or contraction of the entire structure or individual structural components.

- **Truck load**
  Structures accessible to trucks shall be designed to withstand the gravity, lateral and impact effects of truck loading. Truck loading shall be SLW 60 or equivalent as per relevant standards or codes.

- **Soil load**
  Soil loads shall consist of lateral earth pressures. Active and passive coefficients for lateral pressures shall be obtained from the project soils report. The weight of soil shall be considered as dead load.

- **Hydrostatic load and buoyancy**
  Hydrostatic load is the load due to water pressure. The design of structures shall include hydrostatic loads when applicable. The buoyancy load is equal to the weight of the volume of displaced water.

- **Wind load**
  The wind load calculation for the buildings and structures shall be as per Bangladesh National Building Code -2012, Part 6, Chapter 2.4.

Basic wind Speed, V, shall be taken as 73 m/s, Three-second gust at 10 m above ground in exposure C, having a return period of 50 years.

- **Earthquake load**

  All buildings, structures and foundations shall be designed and adopt necessary earthquake design criteria.

  The Project site is exposed to seismic conditions. The area is in Seismic Zone 1 as determined by the Bangladesh National Building Code (BNBC-2012).

  Related to Soil Type as identified to Soil Investigation Report, the effect of local soils on earthquake ground motion shall be determined.

  For site class S1 and S2, as expected for this project, site specific studies shall be carried out to determine Design acceleration response spectrum.

  Values regarding Soil Factor shall be verified during Soil Investigation.

- **Dynamic loads**

  Each structure shall be designed to withstand the effects of vibration and impact to which it may be subjected. Each structure and foundation supporting a compressor, turbine, pump or other machinery having significant dynamic unbalance shall be designed to resist the peak loads specified by the manufacturer. Vibration amplitudes of the supporting structure or foundation shall be kept within acceptable limits for dynamic forces that occur during normal machine operation. In the case of a tall and slender structure, there may be a need to investigate the dynamic effects of wind gusts. The vibration pad for absorbtion of vibration due to rotating or reciprocating machine shall be suitably designed to reach maximum thickness of material required and its complete spreading below entire foundation.

  In the dynamic analysis, the following codes are to be considered: DIN 4024, ISO 1940-1 and ISO-10816. The vibration amplitudes & velocities, if not specified by the manufacturer, shall follow ISO-10816.

- **Impact loads**

  When a structure, structural component or connection is subjected to moving or vibrating loads which do not warrant a dynamic analysis, the following impact loads shall be considered:

| | |
|---|---|
| Elevator machinery | 100% machinery weight |
| Shaft or motor driven machinery | 50% machinery weight |
| Reciprocating machinery | 20% machinery weight |
| Overhead travelling crane<br><br>• Vertical force<br><br>• Lateral force<br><br>• Longitudinal force | Crane load shall be considered as live load, when applying this load the following impact load shall be considered as per BS 6399:PART 1 EN 1991 or equivalent.<br><br>25% of maximum wheel loads for cab operated crane. 10% of maximum wheel loads for pendent operating crane.<br>20% of the weight of the trolley and lifted load (but exclusive of other parts of the crane.<br>10% of maximum wheel loads. |
| Truck loads | Impact effects of truck loading shall be considered according to BS EN 1991-1-7 6399: PART 1 or equivalent. (e.g. DIN EN 1991-1-17) |
| Vertical force | 20% of lifted loads |

- Load combinations
  Design load combinations shall be generally in accordance with the relevant British standard or equivalent. The load combinations shall include the erection loads and crane test loads also.

## 2.2.4 Deflections

The maximum allowable deflections under the serviceability loads shall be as given below, if not other requirements due to functionality of the structures shall be followed, e.g. for transfer points and trestles of conveyor belt:

**a) Structural steel**

| | |
|---|---|
| Cantilevers | L/180 |
| Beams carrying plaster | L/360 or 20 mm, whichever is less |
| Other beams (except purlins and sheeting rails) | L/200 |

| | |
|---|---|
| Top of columns (single floor) | H/300 |
| Top of columns in each floor (more than one floor) | H/300 |
| Crane gantry girders | |
| Vertical | L/600 |
| Horizontal | L/500 |
| (where L: span/H: Height) | |
| Purlins and sheeting rails | L/200 |

**b) Concrete structures**

L/500 or 20 mm (whichever is less)

## 2.2.5 Settlements

Settlements have to be calculated according to BS EN 1997-1 or equivalent and to be monitored.

The following requirements for settlements shall be applied:

- Max. settlement 25 mm,
- Max. differential settlement 1/500 rad.

## 2.2.6 Stability

All ground stability analysis should be based on data given in the soil investigation report.

Ground stability of structures has to be calculated according to BS EN 1997 - 1 or equivalent.

Embankment stability analysis shall be calculated according to BS 6031 or equivalent.

Stability of masonry wall shall be checked according to BS 5628 or equivalent.

The structures shall be designed and checked using a factor of safety of 1.50 for stability against overturning and sliding under the permanent loads and 1.2 under the temporary loads.

For Buoyancy the structures shall be designed to fulfill the purpose and follow BNBC.

## 2.2.7 Miscellaneous metal works

**Stairways**

Main stairways shall be min. 1250 mm wide.

Riser max. 180, Tread min. 260, and Local stairway shall be min. 1200 wide. The number of steps between flights shall be limited to 12.

Head clearance min. 3000 mm for air conditioned buildings, and min. 3500mm for non-conditioned buildings.

Head clearance of toilets shall be designed as per good engineering practice and applicable regulations.

The requirements of the specific local codes of procedures and the Local Authority requirements have to be respected by the Contractor.

**Steel ladders other than companion way ladders**

Rung: round bars of 20 to 50 mm diameter
Rise: 250 mm
Width: 400 mm

Safety cages shall be provided if height exceeds 2.5 m and the ladder design shall comply with BS 5395: Part 3.

**Handrails**

Handrails shall be min. 1100mm high. Design to follow BS 5395: Part 3/BS 4592-0:2006+A1:2012 or equivalent.

**Gratings**

Gratings shall be hot-dip galvanized and comply with BS 4592: Part 1 & 2 or equivalent.

**Chequered plates**

Chequered plates shall be minimum 6 mm thick mild steel.

## 2.2.8 Drainage systems

**General**

The drainage systems will consist of open reinforced concrete drains for stormwater and surface drainage and piping for other drainage systems and reinforced concrete culverts for street crossings. In general, drainage systems shall be designed in accordance with BS 6367 or equivalent, the Bangladesh National Building Code 2012 and all relevant Local Authority requirements.

The drainage shall be separated into the following systems:

- storm water and surface drainage
- sanitary sewage reticulation
- oily water drainage
- chemically polluted water drainage.

**Rain run-off**

Rainwater runoff shall be determined in accordance with the relevant Bangladesh Standards by considering the maximum rainfall intensity of 95 mm/hr for a one hour rainfall with 50 year return period. The maximum surface rainfall shall be considered with 349mmper day.
water shall be collected in a storm water pond located outside the Plant The (indicated on Indicative Plant Layout). The Pond is not in scope of EPC-Contractor.
The Tie-in point of the system will be at the pond. In addition, contractor may develop retention basins/ponds for rainwater to be used for spraying the coal stockyard and landscape irrigation, in the plant area.

Sizing of ditches and pipes shall be determined by using Manning`s formula, using the following Roughness coefficient N for the various types of material:

| Type | Roughness efficient N |
|---|---|
| Concrete pipe | 0.014 |
| Plastic pipe | 0.013 |
| Vitrified clay pipe | 0.013 |
| Smooth concrete channels | 0.014 |

**Gradient**

Drains shall have the following minimum gradient:

- open ditch for storm water drainage l/1000
- sanitary sewage drainage pipes l/150
- oily water drain pipes l/200
- chemically polluted water drains/pipes l/250
- other drainage systems l/400.

However, the sectional shapes have to be determined by the water carrying requirements and must have the most favorable hydraulic qualities so as to remove the drain water in a proper manner without settlements.

**Velocity of flow**

Minimum velocity 0.80 m/s (to maintain self cleaning)

## 2.2.9 Road works

Plant access roadways shall be designed to accommodate AASHTO HS-20 semi-truck loading with impact added. Parking areas for cars and light trucks shall be designed for AASHTO H-10 loading. The roads shall be designed to sustain the maximum loads from the vehicles likely to use them during construction and throughout the life of the facility including articulated vehicles and transporters used for the removal and replacement of major items of equipment during maintenance.

The following requirements shall be met:

- single lane 3.75 m with solidly compacted shoulders of 1.50 m at each side all along (Total width 6.75 m)
- double lane 7.5 m with solidly compacted shoulders of 2.25 m at each side all along (Total width 12 m)
- patrol roads 3.75 m with solidly compacted shoulders of 1.50 m at one side all along Patrol road is to be constructed inside Plant boundary (Total width 5.25 m).
- minimum kerb radius at junctions shall be 10 m for double lane roads and 4 m for single lane/patrol roads
- cross-falls shall be 2.5% from one side to the other
- maximum longitudinal slope shall be 1:25.
- The roads and paving shall be laid to falls leading the storm water to gullies and to the discharge system and shall also comply with the Local Authority requirements.

All road/pavement shall be plain jointed concrete pavement (JCP) designed as per AASHTO. The road shall be provided as follows:-

- Subgrade
  The area for the roads shall be cleared of any material or obstructions and the top layer removed to a depth of 300 mm (or more if the design so required). Any ruts or soft areas caused by improper drainage conditions, hauling or any other cause shall be corrected and rolled to the required compaction before sub-base is placed thereon. The formation shall be compacted to 85% relative density (ASTM D-4253 and D-4254) for free draining soils containing less than 15% by weight finer than 75 micron sieve non plastic material or 98% of the maximum density as determined by ASTM D-1557 for soils containing more than 15% material passing the 75 micron sieve.

- Subbase course
  A layer of 250 mm granular sub-base shall be provided. Sub-base material shall be crushed rock or other approved local material like brick metal having suitable properties (materials passing 425 micron sieve when tested in accordance with AASHTO or British Standard should have Liquid Limit and Plasticity Index of not more than 25 and 6 respectively) and confirming to the following grading

| Sieve [mm] | Percentage by Weight Passing |
|---|---|
| 75 | 100 |
| 37.5 | 85 - 100 |
| 10 | 45 - 100 |
| 5 | 25 - 85 |
| 0.6 | 8 - 45 |
| 0.075 | 0 - 10 |

  The material shall be spread evenly on the preceding material in layers not exceeding 150 mm compacted thickness.

  The sub-base shall be compacted by approved plant to a dry density, which shall not be less than 98% relative compaction until movement of the surface ceases and the surface is closed. The CBR value shall be at least 30% at the optimum moisture content.
  Brick aggregates shall be made of overburnt bricks or brick bats and free from dust and other foreign materials. The LAA( LOS ANGELES ABRASION) value for coarse aggregate either from bricks, gravels or stone shall not be more than 50% and AIV AIV(Aggregate Impact Value) shall not be more than 40%. The water absorption shall be less than 18%.
- Base course
  100 mm thick dry lean concrete (DLC) of grade C8/10 shall be provided as base course. A layer of 125 micron plastic sheet shall be laid over the PCC layer.

- Pavement slab
  Pavement concrete slab of grade C25/30 shall be laid over the sub-base. The thickness of pavement slab shall be as per the design requirement conforming to AASHTO. Transverse contraction joints shall be provided at 4 m c/c spacing alongwith dowel bars. Longitudinal contraction joints shall be provided at 3.75 m spacing (for double lane road only) alongwith tie bars.

**Chlorides and sulphates**

The level of chlorides and sulphates in the wet mix sub-base shall be within the following limits:

| | Maximum by weight | |
|---|---|---|
| | **Sub-base** | **wet-mix road base** |
| Acid soluble chloride (NaCl) | 3.5% | 0.5% |
| Acid soluble sulphate ($SO_3$) | 2.0% | 0.5% |

**Shoulders**

The shoulders for double lane road shall be raised with kerbs at the edge of the road. The shoulders for single lane road and patrol road shall be at the level of the road top.
The shoulder shall consist of 150 mm thick granular layer. The material used for shoulders shall comply with the specification for wet mix as following:
The wet mix material shall consist of crushed gravel or crushed rock and shall be suitably proportioned to conform to the following grading:

| Sieve [mm] | Percentage by Weight Passing |
|---|---|
| 50 | 100 |
| 37.5 | 90-100 |
| 20 | 60-80 |
| 10 | 40-60 |
| 5 | 25-40 |
| 2.36 | 15-30 |
| 0.6 | 8-22 |
| 0.075 | 0-8 |

Road construction shall consider all required measures to avoid different settlements.

- Main approach road to BTG and BOP from main gate complex shall be : Double Lane Road
- Access Roads to buildings/facilities inside BTG area shall be:
  Single lane road for access roads to minor structures and double lane road for access to main equipment. Road shall be suitable for expected traffic.
- Access Roads to buildings/facilities inside BOP area shall be:
  Single lane road for access roads to minor structures and double lane road for access to main equipment. Road shall be suitable for expected traffic.
- Patrol road shall be as suitable for purpose

## 2.3 Scope of Supplies and Services

This section sets out the scope of civil works and installations covered by this specification as well as the requested supplies and services, but without excluding other necessary components and services not mentioned.

### 2.3.1 General

The Contractor shall supply and erect all buildings, structures and systems which are necessary to support, to protect and to provide the required environmental conditions for the entire plant including roads, security fencing and any other measures needed for safe and practicable operation of the plant.

Social and sanitary rooms in the appropriate size and arrangement shall be provided wherever required due to usage of the building, minimum in the buildings as per 2.3.2.

The following types of works have to be considered, but without excluding other necessary works and services not mentioned:

- all necessary surveys
- all necessary soil investigation required in addition to the investigation works carried out prior to the EPC Contract
- all other investigations and studies necessary for the design and execution of civil works (drainage system, flooding possibility of the site, safety measures, etc.)
  If Bidder/Contractor is of the option that design criteria are sufficient for design, no further drainage study is required.
  Flooding possibility of site shall be investigated.
- site organization works for the entire project execution phase including but not limited to:
  - arrangements of all temporary and permanent surfaces allocated for the new plant
  - temporary buildings for offices, stores, workshops, sanitary rooms, canteen and kitchen, first aid station, etc. offices for the staff of the Employer, creche, safety centre & field quality assurance lab, prayer room, visitor habitations
  - open area for future maintenance works
  - security installation on the site, including temporary fencing; temporary bridges, etc.
  - access roads and outdoor storage facilities
  - temporary water
  - temporary electricity supply
  - temporary storm water drainage and sewage system
  - final cleaning of the temporary and permanent plant sites to the full satisfaction of the Employer
  - housekeeping and cleaning of the sites during construction and equipment erection/testing works
  - temporary fire fighting facilities for the entire execution phase of the project
  - provision and maintenance of lay-down area including access roads

    (Temporary facilities can be located within site installation area. Un-leveled/un-filled land outside plant boundary can be provided to the Contractor for temporary accommodations of Contractors' labors or laydown. Exact acquisition line will be furnished before award of contract. Employers temporary accommodation shall be inside the plant boundary. Labour camp shall be located outside the plant boundary on BIFPCL land, e.g. north of boundary.)
- site fill on the location of all required buildings and areas
  Leveling and Grading is required under the Contract. Contractor shall make himself familiar with the site, to estimate the effort.
- structural and civil engineering design of all buildings, structures, foundations including the complete structural and dynamical analysis, design, execution and workshop drawing
- Third Party Verification of structural documents, including the complete structural and dynamical analysis, design, execution and workshop drawings

All structural documents e.g. calculation, formwork drawings, reinforcement drawings, steelwork drawings requires 3rd Party verification.
Verification shall consider Structural Stability, Ultimate Limit State and Serviceability Limit State.
An appropriate local design consultant, having similar work experience would be appreciated.

- removal of all debris, underground obstacles (if any) and surplus materials to approved dumping locations
- earthworks, permanent drainage works, soil exchange (if needed), refilling works on the plant site and on the additional areas allocated for temporary works
- all ancillary works and installations necessary for the execution of civil works, such as but not limited to: sheet piling, dewatering, fencing, signs, scaffoldings, etc.
- permanent roads, paved areas, footpaths, etc. on the plant site
- piling works
- execution of complete building, foundations and structures necessary for the installation of the indoor and outdoor equipment of the plant
- execution of all finishing and indoor installation works (such as doors, windows, wall cladding and rooting) painting and coating works, sanitaries, plumbing, ventilation-and air conditioning works, fire fighting, sanitary works, sewage, electrical lighting-and lightning, earthing, etc.
- supply of all necessary furniture, housekeeping small equipment (kitchen, refrigerators, exhaust installations, etc.), laboratory equipment, etc.
  This Phrase is related to Employer‟s and Engineer‟s office and Living accommodation, as specified under B.9.3.
  Details shall be defined by Bidder/Contractor and shall be subject to approval by BIFPCL during basic/detail engineering.
- Every working place shall be equipped with a computer, connected to a local network with connection to the plant computer network.
- execution of all necessary outdoor works for water supply, sewage and drainage works, fire fighting, earthing etc.
- all necessary crane and hoist girders, pipe and cable bridges and supports according to the requirements of the electrical and mechanical installations.

## 2.3.2 Buildings and structures

### 2.3.2.1 Steam turbine building

The steam turbine building shall be sized to accommodate the steam turbine generator(s) together with all associated facilities and ancillary plant installations.

Measures shall be taken to avoid the transmission of vibrations due to

equipment and rotating machines (mainly steam turbines, feedwater pumps) to the building structure. These measures shall mainly be separate reinforced concrete foundation to be insulated from the remainder of the structure either by shock absorbing joints or vibration control systems typically consisting of spring elements and viscodampers to prevent the transmission of vibrations.

The building shall be served by overhead traveling crane(s). Capacity and Number of cranes as per requirements of heaviest lift.

At ground floor level access ways for traffic with heavy trucks shall be provided.

At all levels toilets for operation and maintenance staff shall be provided.

Within the Steam Turbine Building the main electrical components of the project shall be accommodated:

- unit switchgear and I&C
- auxiliary switchgear
- central control room.

Next to the Central Control Room additionally to the required technical rooms such as switchgear room, relay rooms for electronic panels battery rooms, relay rooms, computer room, UPS and DC equipment room, DCS engineering rooms, the following rooms have to be provided:

- 1 (one) office
- tea kitchen
- archive/storage room
- engineering diagnostic room
- toilets for operators (male and female).

**Description of building:**

| | |
|---|---|
| • structure: | steel structure |
| • floors: | Groundfloor with intermediary platforms/levels |
| • flooring: | reinforced concrete with suitable hardener and special oil resistant coating; TG hall combination of granite and heavy duty vitrified tile |
| • foundations: | according to the soil investigation report and Special Technical Requirements of Foundations; special attention has to be paid for the safe transmission of dynamic loads and vibrations to the underground 230 |
| • external wall: | mm thick brick walls or autoclave aerated concrete blocks with plaster finish up to 3.0 m or autoclave |

| | |
|---|---|
| aerated concrete blocks from floor level and | double skin metal cladding above.<br>For architectonical appearance, inside in addition<br><br>single skin metal cladding from operating floor up to EOT Crane girder<br>External walls on transformer side shall have<br>250 mm thick RCC wall up to 5.0 m height as fire barrier wall, with single skin metal cladding above 5.0 m up to turbine floor. From turbine floor to crane girder level, double skin cladding will be provided. |
| • internal wall: | 230 mm thick brick walls or autoclave aerated concrete blocks or autoclave aerated concrete blocks with plaster finish |
| • roof: | double skin metal roofing or as applicable |
| • doors: | self closing sandwich steel doors with insulation |
| • roller shutters as required | |
| • windows: | double glazed aluminum |
| • entrances: | electrical driven roller shutters |
| • ventilation: | natural/mechanical |
| • louvers: | aluminum alloy |
| • lifting equipment: | travelling crane (see mechanical section). |

The battery room shall be equipped with:

- cleaning sink minimum size 580 x 450 mm
- emergency shower with eye wash
- acid resistant floor and drain
- sink outlets and floor drains shall be chemical resistant and piped into the chemical drain system.

False floors and suspended ceilings wherever required.

Electrical hoist designed for the transport of the electrical and control panels.

Finishes: The control room shall be of noble appearance. Flooring of the control room shall consider electrostatic problems (suitable earthing mats where required). Powder coated metal false ceiling with noise reduction factor (0.5) shall be implanted. Airlocks of glass or at least with visions shall be provided. The lighting shall be adequate and in accordance with the arrangement of the individual working places.

The design of finishing works will comply with the requirements of the code of procedures with regard to the mirroring effects, lighting of working places, shadowing etc.

The minimum head clearance for the control room shall be 3650 mm.
The front towards the operation floor shall be fully glazed.

Turbine Generator foundation shall be finished with chemical resistant, anti-slip, abrasion resistant rubber flooring. Areas considered for maintenance purpose shall be marked permanently including the allowable bearing capacity as per structural calculation. Bearing Capacity shall consider maximum loads as per Operation and Maintenance Concept.

Operating floor of Main Power House shall be finished with Granite Stone and General Circulation/Movement area shall be provided with Vitrified Ceramic Tile flooring. Unit control Room & Control Equipment Room shall have Vitrified Ceramic Tiles floor with pattern."

This Specification shall be applicable for flooring; other surfaces are not considered here.

### 2.3.2.2 Steam generator and air heater building

The Steam Generator and Air Heater Building may be of open or semi-open installation.

**Description of building:**

- foundation: according to the soil investigation report and Special Technical Requirements of Foundations
- floors: as required for proper O&M access
- flooring: reinforced concrete in ground floor, metal grating in other floors
- structure: steel structure
- walls: double skin metal cladding (if necessary, else single skin metal cladding)
- roof: double skin metal roofing (if necessary, else single-skin metal casing)
- lift: 1 passenger & goods lift with a minimum capacity of 4,000 kg to the highest accessible platform
- hoist: outdoor hoist arrangement at one side for long items.

## 2.3.2.3 CENTRAL WORKSHOP

**General**

The area for the workshop shall be about (but not limited to) 3,000 $m^2$ overall, designed for all maintenance facilities with related services e.g. offices, locker and sanitary rooms. The clear height shall be minimum 6m. However the clear height shall be determined by requirement of overhead travelling crane clearance.

The workshops will allow all required works for daily maintenance and repair, which can be executed at site. The building will have enough capacity for the personnel of the plant which usually is employed in the workshops and for external personnel in case of major inspections or repairs.

Partitioned areas with suitable work benches, equipment and racking shall be provided for:

- mechanical workshops (welding, machine, overhaul)
- electrical workshops
- I & C workshops
- civil workshops (carpenters, etc.)
- air conditioned plant room
- tool rooms
- 1 meeting room 35 m² each,
- 5 offices for technical and admin. personnel (15 m² each)
- Sanitary equipment as below.
- locker rooms
- kitchen.

The complete workshop areas shall be designed for the use of fork lifters with a minimum lifting capacity big enough for the heaviest part to be handled.

Overhead travelling cranes shall be provided in the area of the workshops.

**Description of building:**

- structure: steel structure
- floors: one
- flooring: reinforced concrete with hard screed topping carborundum type (25 mm thick heavy duty cement concrete tiles) with oil resistant epoxy coating (300 micron thick)
  WCs tiled; offices with PVC flooring,
- foundations: according to the soil investigation report and Special Technical Requirements of Foundations
- external wall: double skin metal cladding
- internal wall: 230 mm thick brick walls or autoclave aerated concrete blocks with plaster finish
- roof: double skin metal sheet roof
- doors:
  - main entrance: electrically operated rolling shutter
  - external: self closing sandwich steel doors with insulation
  - internal: wooden doors with steel frames
- windows: double glazed aluminum
- air conditioning: centralized air conditioning,
- ventilation: natural/mechanical
- sanitary equipment in the office area:
  - showers in changing room
  - eastern WC with cleaning brush in toilet
  - western WC with cleaning brush in toilet
  - bowl urinal in male toilet
  - wash basins in toilet

**Special design criteria**

The minimum load bearing capacity of ceilings and floors shall be as defined in BS 6399: Part 1 or equivalent and in Section "General technical requirements" of this Specification.

The live loads for ground floor shall be min. 50 kN/$m^2$.

## 2.3.2.4 Dozer maintenance shed

**General**

The area for the Dozer Maintenance Shed shall be about (but not limited to) 500 $m^2$ overall, designed for all routine maintenance on mobile equipment with related services e.g. washing area, storage area locker and sanitary rooms.

The workshops will allow all required works for daily maintenance and repair, which can be executed at site. The building will have enough capacity for the personnel of the plant which usually is employed in the workshops and for external personnel in case of major inspections or repairs.

**Description of building:**

- structure: steel structure
- floors: one
- flooring: reinforced concrete with hard screed topping carborundum (25 mm thick heavy duty cement concrete tiles) with oil resistant epoxy coating (300 micron thick)
  WCs tiled; offices with vitrified tile flooring
- foundations: according to the soil investigation report and Special Technical Requirements of Foundations
- external wall: double skin metal cladding
- internal wall: 230 mm thick brick walls or autoclave aerated concrete blocks or autoclave aerated concrete blocks with plaster finish
- roof: double skin metal sheet roof
- doors:
  - main entrance: folding doors with motor drive
  - external: self closing sandwich steel doors with insulation
  - internal: wooden doors with steel frames
- windows: double glazed aluminum
- air conditioning: decentralized air conditioning,
- ventilation: natural/mechanical
- sanitary:
  - showers in changing room
  - eastern WC with cleaning brush in toilet
  - western WC with cleaning brush in toilet
  - bowl urinal in male toilet
  - wash basins in toilet

**Special design criteria**

The minimum load bearing capacity of ceilings and floors shall be as defined in BS 6399: Part 1 or equivalent and in Section "General technical requirements" of this Specification.

The live loads for ground floor shall be min. 30 kN/$m^2$.

## 2.3.2.5 Operation and maintenance storage building

**General**

The area for the Operation and Maintenance storage shall be about (but not limited to) 3000 $m^2$ overall, designed for required storage with related services e.g. locker and sanitary rooms.

Partitioned areas with suitable, equipment and racking shall be provided for:

- small spare parts store
- spare parts pallet store
- large spare parts store
- 2 (two) offices for store keeper (15 m² each)
- sanitary equipment as below
- locker rooms
- tea kitchen.

The dimensions of the building shall be adequate to accommodate all different types of racks for goods and spare parts necessary for the operation of the Plant as specified in **Section B12**.

Heavy material store shall be single storey building, free of columns for easy movements of material. Light material store shall be double storey building. 1 No. of Goods lift with a capacity of 1,000 kg with rated speed of 0.5m/s shall be implemented.

A part of light material store shall have facility for storing electronic equipment/instruments.

Lifting devices shall be provided as required for heaviest part.

- structure: reinforced concrete,
- floors: one/two floors
- flooring: reinforced concrete with hard screed topping carborundum (25 mm thick heavy duty cement concrete tiles) with oil resistant epoxy coating (300 micron thick); WCs tiled; offices with PVC flooring
- foundations: according to the soil investigation report and Special Technical Requirements of Foundations
- external wall: 230 mm thick autoclave aerated concrete blocks with metal cladding
- internal wall: 230 mm thick brick walls with plaster finish
- roof: double skin metal sheet roof
- doors:
- main entrance: electrically operated rolling shutter
  external: self closing sandwich steel doors with insulation
  internal: wooden doors with steel frames
- windows: double glazed aluminum
- sanitary:
  - showers in changing room
  - eastern WC with cleaning brush in toilet
  - western WC with cleaning brush in toilet
  - bowl urinal in male toilet
  - wash basins in toilet

## 2.3.2.6 Administration building

**General**

The area for the Administration Building shall be about (but not limited to) 5,000 m² overall, designed as 4 G+3 storey building for administration purpose with related services e.g. locker and sanitary rooms.

2 panoramic elevators shall be provided in the building.

The top floor of the building shall be reserved for provision of IT and satellite communication services.

The building shall house:

- a representative entrance and waiting hall and an information desk
- head of plant office (50 m²) incl. restroom and 2 assistant offices (20 m²)
- HOP Conference Hall (50m²)
- 6 Head of Department offices (25 m²) with each 1 assistant offices (10 m²)
- 11 Middle level executive offices (10 m²)
- 84 Workstations/Halls
- meeting rooms at each floor (30 m² each)
- archive (30m²)

- electrical rooms, as required
- library (50 m²)
- print room (20 m²)
- sanitary facilities
- prayer room (30 m²)
- canteen (150 m²)
- recreation room for the number personnel mentioned here above,
- first aid center with medical support facilities (2 rooms 30 m² each).
- gym (35 m²)
- model & exhibition room (70 m²).

Furniture for this building is also in the scope of the Contractor as per local practice.

Medical support facilities are also in the scope of the Contractor as per requirements due to Bangladesh regulations.

**Description of building:**

| | |
|---|---|
| | reinforced concrete<br>3 to 4 floors |
| • structure: | see below |
| • floors:<br>• flooring: | according to the soil investigation report and Special Technical Requirements of Foundations |
| • foundations: | 230 mm thick brick wall or autoclave aerated concrete blocks or autoclave aerated concrete blocks with aluminum composite panel cladding |
| • external wall: | 230 mm thick brick walls or autoclave aerated concrete blocks with plaster finish |
| • internal wall: | internal stairway |
| • access: | representative double plain door |
| • doors:<br>  • external:<br>  • internal: | aluminum glazed doors and wooden doors with steel frames<br>double glazed aluminum with internal sun shades |
| | centralized air conditioning |
| • windows: | natural/mechanical |
| • air conditioning: | |
| • ventilation: | • showers in changing room |
| • sanitary equipment in the office area: | • eastern WC with cleaning brush in toilet<br>• western WC with cleaning brush in toilet<br>• bowl urinal in male toilet<br>• wash basins in toilet |
| • finishes: | For this building prestigious finishes shall be provided. The offices shall have vitrified tile flooring; in the manager‟s office carpet flooring, fabric wall coverings, and decorative suspended ceilings with lighting fittings embedded. Floor and walls of the kitchen future and recreation room shall be fully tiled. Entrance hall and stairs with polished granite stone flooring. The shower cabins to have partition walls with doors. |

## 2.3.2.7 Service building near turbine hall

**General**

The area for the Service Building shall be about (but not limited to) 5,500 m² overall, designed as 5 G+4 storey building for administration purpose
with related services e.g. locker and sanitary rooms.
2 lifts with 16persons capacity shall be implemented.
A direct connection from Service Building to Turbine Hall shall be provided at Turbine Floor Level from the top floor (5th floor) of the Service building.
The building shall house:

- head of O&M (35 m²) incl. restroom and assistant offices (12 m²)
- HOP Conference Hall (50 m²)
- 8 Head of Department offices (25 m²)
- 31 Middle level executive offices (10 m²)
- 109 Workstations/Halls
- meeting rooms at each floor (30 m² each)
- archive (30 m²)
- electrical rooms, as required
- library (50 m²)
- print Room (20 m²)
- drawing hall (30 m²)
- prayer room (30 m²)
- canteen (75 m²)
- recreation room for the number personnel mentioned here
- first aid center with medical support facilities (2 rooms 30 m² each)
- gym (35 m²)
- locker and dressing rooms with showers and toilet rooms for the following personnel (Percentage ladies/men 25%/75%): • own personnel: 205
  - foreign personnel: 25
- electrical Laboratory (60 m²)
- C&I Laboratory - pneumatic (40 m²)
- C&I Laboratory - instrument(40 m²)
- 5 Department stores (60 m²).

  Furniture for the building is also in the scope of the Contractor as per local practice.

  Medical support facilities are also in the scope of the Contractor as per requirements due to Bangladesh regulations.

- floors: 3-4 floors
- flooring: see below
- foundations: according to the soil investigation report and Special Technical Requirements of Foundations
- external wall: 230 mm thick autoclave aerated concrete blocks with aluminum composite panel cladding
- internal wall: 230 mm thick brick walls with plaster finish
- access: internal stairway
- doors:
  - external: representative double plain door
  - internal: aluminum glazed doors/wooden doors with steel frames
- windows: double glazed aluminum with internal sun shades
- sanitary equipment:
  - showers in changing room
  - eastern WC with cleaning brush in toilet
  - western WC with cleaning brush in toilet
  - bowl urinal in male toilet
  - wash basins in toilet
- finishes:

The offices shall have vitrified tile flooring covering; in the manager‟s office carpet flooring, fabric wall coverings, and suspended ceilings with lighting fittings embedded. Floor and walls of the kitchen future and recreation room shall be fully tiled. Entrance hall and stairs with natural stone or ceramic tiling. The shower cabins to have partition walls with doors.

### 2.3.2.8 Local service buildings including control room

Service Buildings including Control room shall be provided at the following locations:

- near coal handling unit
- near ash handling unit/jetty
- near FGD/ESP
- near Oil handling plant
- near intake structure
- near water treatment plants
- near cooling tower.

The buildings shall house:

- control room as per functional requirement 2 offices for technical personnel (15 m² each)
- electrical rooms

- locker and dressing rooms with showers and toilet rooms for 10 workers. (Percentage ladies/men 25%/75%).

Buildings can be constructed as single storey building, floor height shall be as per requirements and BNBC.

**Description of building:**

- structure: reinforced concrete
- floors: one floor
- flooring: see below
- foundations: according to the soil investigation report and Special Technical Requirements of Foundations
- external wall: 230 mm thick brick walls or autoclave aerated concrete blocks with plaster finish
- internal wall: 230 mm thick brick walls or autoclave aerated concrete blocks with plaster finish
- doors:
  - external: self closing sandwich steel doors with insulation
  - internal: wooden doors with steel frames
- windows: double glazed aluminum with internal sun shades
- air conditioning: centralized air conditioning
- ventilation: natural/mechanical
- sanitary equipment in the social area:
  - showers in changing rooms
  - eastern WC with cleaning brush in toilets
  - western WC with cleaning brush in toilets
  - bowl urinal in male toilets
  - wash basins in toilets
- finishes: The offices shall have vitrified tiling covering; fabric wall coverings, and decorative suspended ceilings with lighting fittings embedded. Floor and walls of the kitchen future and recreation room shall be fully tiled. The shower cabins to have partition walls with doors.

## 2.3.2.9 Canteen

The central canteen shall be a building for workers and staff members shall be located suitably in the plant with an area about (but not limited to) 1000 m² overall. The building shall house the restaurant with all kitchen facilities and related services e.g. locker and sanitary rooms.

This building shall be a one storey building with attractive appearance. It consists of a reinforced concrete structure with concrete block walls, reinforced concrete floors and roof.

The following rooms shall be accommodated in this building:

- dining hall with partition for senior executives and others (250 persons in total at a time)

- kitchen approx. 100 m²
- wardrobe
- store
- cooling storage
- locker rooms
- sanitary rooms (toilets, showers)
- air conditioning room
- entrance
- electrical rooms.

  Wardrobe is also in scope of Contractor and shall be suitable for seize of canteen, floor height shall be as per requirements and BNBC.

**Description of building:**

| | |
|---|---|
| • structure: | reinforced concrete |
| • floors: | one floor |
| • flooring: | see below |
| • foundations: | according to the soil investigation report and Special Technical Requirements of Foundations |
| • external wall: | 230 mm thick brick walls or autoclave aerated concrete blocks with plaster finish |
| • internal wall: | 230 mm thick brick walls or autoclave aerated concrete blocks with plaster finish |
| • doors: | |
| • external: | representative double plain door |
| • internal: | aluminum glazed doors/wooden doors with steel frames |
| • windows: | double glazed aluminum with internal sun shades |
| • air conditioning: | centralized air conditioning |
| • ventilation: | natural/mechanical |
| • waste water | grease trap |
| • sanitary equipment in the social area: | • showers in changing rooms<br>• eastern WC with cleaning brush in toilets<br>• western WC with cleaning brush in toilets<br>• bowl urinal in male toilets<br>• wash basins in toilets |
| • finishes: | The floor finishes shall be cement screed with different top finishes as vitrified tiling (60 cm x 60 cm) with skirting for dining and wardrobe and glazed non-slip vitrified tiles (60 cm x 60 cm) for kitchen and store. Glazed non-slip ceramic tiles (20 cm x 20 cm) for sanitary areas. Entrance with natural stone with skirting. |

## 2.3.2.10 Auditorium

The area for the Auditorium shall be about (but not limited to) 1,000 $m^2$ overall, designed for a seating capacity of minimum 250 persons and related services e.g. sanitary rooms.
This building shall be a one storey building with attractive appearance. It consists of a reinforced concrete structure with concrete block walls, reinforced concrete floors and roof.
The following rooms shall be accommodated in this building:

- entrance hall with exhibition area
- information desk
- auditorium (clear headroom of min. 4.00 - 8.00 m, variable) incl. stage
- tea kitchen
- sanitary rooms (toilets)
- air conditioning room, as required
- electrical rooms, as required.

**Description of building:**

| | |
|---|---|
| • structure: | reinforced concrete |
| • floors: | one floor |
| • flooring: | see below |
| • foundations: | according to the soil investigation report and Special Technical Requirements of Foundations |
| • external wall: | 230 mm thick brick walls or autoclave aerated concrete blocks with plaster finish |
| • internal wall: | 230 mm thick brick walls or autoclave aerated concrete blocks with plaster finish |
| • doors: | |
| ◦ external: | representative double plain door |
| ◦ internal: | aluminum glazed doors/wooden doors with steel frames |
| • windows: | double glazed aluminum with internal sun shades |
| • air conditioning: | centralized air conditioning |
| • ventilation: | natural/mechanical |
| • sanitary equipment in the social area: | ◦ eastern WC with cleaning brush<br>◦ western WC with cleaning<br>◦ bowl urinal in male toilet<br>◦ wash basins |
| • finishes: | • For this building prestigious finishes shall be provided. The floor finishes shall be polished granite stone flooring in entrance hall and exhibition area, non-slip fully vitrified ceramic tiles (20 cm x 20 cm) for toilet, tea kitchen. Auditorium with carpet first quality, false ceiling and wall paneling.<br>First quality means best quality suitable for this purpose. |

## 2.3.2.11 Water and waste water treatment buildings

The buildings accommodate the water and waste water treatment facilities with a laboratory and sanitary facilities.

**Description of building:**

- structure: steel structure
- floors: one
- flooring: reinforced, water tight concrete, with acid-resistant coating or tiling, as applicable
- foundations: according to the soil investigation report and Special Technical Requirements of Foundations
- external wall: double skin metal cladding
- internal wall: 230 mm thick brick walls or autoclave aerated concrete blocks or autoclave aerated concrete blocks with plaster finish
- roof: double skin metal sheet roof
- doors:
  - external: self closing sandwich steel doors with insulation
  - internal: wooden doors with steel frames
- windows: double glazed aluminum
- air conditioning: decentralized air conditioning,
- ventilation: mechanical

Laboratory with suspended ceiling tiled walls and floor. Laboratory has to be air conditioned and provided with fume extraction hood cabinet

Chemical unloading station (only slab and roof)

- structure: reinforced concrete
- floors: one
- flooring: reinforced, water tight concrete as per applicable codes and standards, with acid-resistant coating or tiling, as applicable
- foundations: according to the soil investigation report and Special Technical Requirements of Foundations
- external wall: none, only reinforced concrete columns
- roof: reinforced concrete

Ring foundations for tanks shall be provided.

Special requirements for R/O building/room regarding HVAC shall be considered as per table in Section B12.6

Pits, tanks and basins will not require covering.

All wet areas (indoor and outdoor) and acid-alkali prone areas shall be provided with chemical-resistant catchments pits systems connected to the waste water tanks of the process waste water system. Acid resistant coating or tiling shall be provided in the catchments zones, subject to the approval of the Employer.

All water retaining structures shall be constructed as water tight concrete as per applicable international Codes/ standards e.g. DIN 1045-2:2008–08 and DIN EN 206-1:2001-07.

### 2.3.2.12 Fire station

This building accommodates the equipment for fire fighting described in the mechanical section.

In addition office, small duty room and maintenance room with window units shall be provided.

Space for fire engine truck and other equipment, such as trailer etc. as required, shall be provided.

**Building description:**

- structure: reinforced concrete
- floors: one floor
- flooring: reinforced concrete with hard screed topping carborundum type (25 mm thick heavy duty cement concrete tiles) with oil resistant epoxy coating (300 micron thick)
- foundations: according to the soil investigation report and Special Technical Requirements of Foundations
- external wall: 230 mm thick brick walls or autoclave aerated concrete blocks with plaster finish
- internal wall: 230 mm thick brick walls or autoclave aerated concrete blocks with plaster finish
- doors:
  - main entrance: electrically operated rolling shutter
  - external: self closing sandwich steel doors with insulation
  - internal: double plain steel door
- windows: double glazed aluminum with internal sun shades
- air conditioning: centralized air conditioning
- ventilation: mechanical/louvers

Next to the fire station a drill tower shall be provided.

### 2.3.2.13 Pump houses

The structures of the following pump houses are included under this item:

- fire water pump house
- Fire water booster pump house
- Foam pump house
- portable water pump house
- ash water recirculation pump house
- HCSD pump house
- service water pump house
- Fuel Oil pressurizing pump house
- Fuel Oil unloading pump house
- other specified pump houses not included above
- concrete structure with fill-in blockwork and concrete roof.

Alternatively a structural steel structure, with metal cladding and roofing can be provided.

The building is divided in sections including a local switchgear room, if required.

Pump Houses shall be provided with an overhead crane with the capacity of the heaviest lift.

For pump houses other than cooling water and plant water intake appropriate cranes shall be employed to handle the heavy equipment; specific design shall be based on the equipment layout requirements and must comply with Section B0.

All requirements to enable Operation and Maintenance shall be considered. Adjacent to pump houses maintenance bay shall be provided.

## 2.3.2.14 Chlorination

The chlorination buildings accommodate the chlorination installation for the production of the hypochlorite solution.

Chlorination facilities shall be erected at the plant area and near the Intake structure, if applicable.

**Building description:**

- structure: reinforced concrete
- floors: one floor
- flooring: reinforced concrete, with acid-resistant coating where required;
- foundations: according to the soil investigation report and Special Technical Requirements of Foundations
- external wall: 230 mm thick brick walls or autoclave aerated concrete blocks with plaster finish
- internal wall: 230 mm thick brick walls or autoclave aerated concrete blocks with plaster finish

- doors
- external Double plain steel doors
- internal Double plain steel doors
- windows Double glazed aluminum
- air conditioning Decentralised air conditioning
- ventilation mechanical

### 2.3.2.15 H2 generation plant building

The H2 Generation Plant building shall accommodate the equipment for the production H2, as described in **Section B12**.

**Building description:**

- structure: reinforced concrete
- floors: one floor
- flooring: reinforced concrete, with acid-resistant coating where required
- foundations: according to the soil investigation report and Special Technical Requirements of Foundations
- external wall: 230 mm thick brick walls or autoclave aerated concrete blocks with plaster finish
- internal wall: 230 mm thick brick walls or autoclave aerated concrete blocks with plaster finish
- doors:
  - external: double plain steel doors
  - internal: double plain steel door double
- windows: glazed aluminum
- air conditioning: decentralized air conditioning
- ventilation: mechanical

### 2.3.2.16 Compressed air building

The building shall accommodate the equipment as described in **Section B12**.

**Building description**

- structure: light-weight steel structure
- floors: one
- flooring: reinforced concrete, with acid-resistant coating where required
- external walls/roofs: double skin metal sheet cladding/roofing
- ground floor: reinforced concrete with acid resistant finishing
- doors: double plain steel doors
- windows: double glazed aluminum

- ventilation: mechanical
- air conditioning: decentralized air conditioning.

## 2.3.2.17 FGD related building and structures

**FGD absorber**

According to **Section B3** the absorber shall be made of steel with respective lining. All necessary foundations resting on piles shall be provided as per structural analysis.

The Contractor shall provide a structural steel staircase with an elevator to reach all relevant platforms of the absorber.

**FGD pump and blower building**

The FGD pumps and blowers shall be housed in a separate building consisting of structural steel with insulated corrugated metal cladding and insulated and water tight roofing.

The various levels shall be created by reinforced concrete slabs with screed of industrial type and suitable epoxy coating.

**Limestone silo and unloading facilities**

The intermediate limestone silo shall be made of reinforced concrete.

Beneath the silo the crusher and milling systems and the limestone slurry preparation system shall be installed. The area below the silo shall be housed inside a structural steel building with insulated trapezoidal cladding.

The limestone silo shall be constructed on the jetty.

The unloading for the vessels shall be via coal conveying system to limestone storage.

The Contractor shall provide all necessary foundations and related civil works for the lime stone system.

**Hydro cyclone and limestone slurry building**

This building shall house the hydro cyclone station and the limestone slurry tanks.

The building shall be of a steel structure with insulated metal cladding.

A staircase shall be provided to reach all necessary platforms.

The Contractor shall provide all foundations and related civil works for the building and necessary mechanical and electrical installations.

**Gypsum silo**

The gypsum will be stored in an intermediate gypsum silo next to the plant, and transported via pipe conveyer to gypsum silo next to jetty.
The gypsum silo shall be a reinforced concrete silo on columns which are arranged such that loading of trucks and ships is possible. The silo shall be provided with all foundations and other structural elements needed for the mechanical installations. The Silo shall be located at the jetty.

The gypsum silo shall be equipped with an elevator of industrial type with a capacity sufficient for all operation and maintenance cases, leading up to the various platforms required for service and up to the top level of the gypsum store.

The gypsum not meeting the requirements shall be stored in an open storage area surrounded by a reinforced concrete wall which is protected by a steel liner in the lower portion against damage by front wheel loaders.

**Emergency drain tank**

The emergency drain tank shall consist of an enclosed steel structure on foundations according to the structural analysis.

## 2.3.2.18 Stack

One chimney with one outer structure (outer shell) of reinforced concrete each designed to be free standing against static and dynamic wind loads for two internal separate flue gas ducts shall be provided, including all necessary foundations, coatings, etc..

The height of the chimneys based on Bangladesh Standards for Gaseous Emission from Industries or Projects, of the Environment Conservation Rules 1997, shall be minimum 275 m.

The parameters required (e.g. maximum and minimum exit velocities) for finalisation of flue diameter and chimney height shall follow requirements of EIA and requirements of Section B3.

The diameter of the chimneys depends on the diameters of the inserted flue gas ducts. In all levels a clear space of at least 1 m between the chimney structure and the flue gas ducts shall be maintained. In this area the lift and staircase shall be integrated.

The design of chimney stack shall be checked & verified by wind tunnel test at a reputed institute, having prior experience of conducting such type of test.

Reinforced concrete designed in accordance with the recommendations of ACI-307 and CICIND (International Committee on Industrial Chimneys). Standard and strong anti-corrosion protection, UV-resistant and acid and heat resistant paint shall be applied on the outside. Color and selection of bands shall be to the requirements of the relevant authority.

Roof area shall be tiled with acid resistant tiling.

The structure shall be sturdy and well founded to enable it to support both the expected wind and earthquake loads as well as the temperature stresses. Preferably the structural analysis of the system shall be done in one system including outer shell, foundation plate and piles.

All concrete parts below ground level shall be protected outside by a waterproof membrane and protection board as specified.

The lift shall be of industrial type, installed at the inside of the chimney¨s concrete surface with a nominal carrying capacity of 500 kg. It shall travel from ground floor to each platform for service and maintenance except roof slab platform. From last platform to roof of chimney (approx 6 m), shall be accessed by a cage ladder. Inserts shall be provided as required for monitoring the stack gases.

Flue gas monitoring platforms, intermediate duct supporting provisions, landings and maintenance platforms with access shall be provided.

Galvanized steel ladder located in the space between the concrete

shel1 and ducts shall be provided from the ground level to the top of the stack. Galvanized steel floor grating landings shall be provided, as required for Maintenance and operation, including a 360 degree landing at the test ports and at aircraft warning lights levels.

Additional external platform at aircraft warning lights levels shall be provided, if required due to operation and maintenance works.

Installations necessary for rescuing persons have to be assured in the whole area of the chimney.

The flue gas pipe can be either be of GRP or alternatively of carbon steel coated externally and with a suitable internal liner (Pennguard System or similar) or Stainless Steel.

In case Bidder/Contractor will provide GRP flue gas liners, Codes and Standards as mentioned in section B5 shall be followed.

The design shall consider all operating conditions like Design Pressure, Design Temperature, etc.

Liners shall be designed to with stand all internal and external loads.

In case Bidder/Contractor will provide Flue liner material Austenitic stainless steel of designation UNS 31727, it shall be conforming to ASTM A240/A240M.

Finalizing the material for chimney flue liner, construction methodology and sourcing as per relevant codes/standards is in the scope of Bidder/Contractor. Supplier with traceable experience for this work shall be proposed by Bidder/Contractor and shall be subject to approval by BIFPCL during basic/detail engineering.

Flue gas liners shall be adequately insulated as per requirements **Section B0**.

Expansion joints shall be implemented as per requirement. Construction of joints shall follow international codes and standards.

A stainless steel stack cap and galvanized louvers, doors, and other openings with miscellaneous steel frames shall be provided.

Drainage system for condensates (inside the flues) and rainwater (from the roof top) shall be provided with appropriate treatment.

Aircraft warning lights, earthing, lightning protection, lighting and other

electrical installations for maintenance shall be installed. The local regulations and ICAO regulations shall be followed.

**Building description**

- structure: reinforced concrete structure
- surfaces: coating and protection painting inside and outside
- foundation: a reinforced concrete ring beam or block/slab on piles as stipulated by the results of the soil investigations
- floors: galvanized steel gratings on structural steel, all galvanized and painted
- stairs: open grid steel flooring mounted on galvanized steel structures inside the concrete structure
- railing: Along the steel gratings, around the various openings and for the stairs and ladders tubular steel railings of galvanized and painted tubular steel shall be provided.
- access and escape routes: Access shall be made by galvanized steel ladders with safety cages. For all escape routes the local regulations have to be followed. All ladders and stairs shall be secured by platforms and railings.

Note-1:Tension piles might be used. Piles must be suitable and tested for tension loads.
Note-2: Painting philosophy as follows would be accepted:

- Top 50 m of the outside surface of the shell shall be painted with acid and heat resistant paint (Polyurethane) in alternate bands of signal red and white color. The remaining portion of the outside surface of the shell shall be painted with Synthetic enamel paint in alternate bands of signal red and white color.
- Inside the shell does not require painting. Flue gas liner shall be insulated and protected, that no acid and heat attack shall be expected to concrete shell.

### 2.3.2.19 Laboratories

Laboratories shall be incorporated in the main buildings wherever required, such as water treatment building, as specified in B6 etc. One centralized laboratory for overall analysis e.g. coal analysis, gypsum analysis, etc. shall be provided. Contractor shall provide concept for location of laboratories. The laboratory rooms shall have suspended ceilings and tiled floors and shall be air conditioned. It shall be furnished with work benches, chemical fumes exhausting systems, acid proof sinks linked with acid collecting tanks-respective connected to neutralization systems and shall have different rooms for different tasks e.g. for tests related to the water and waste water treatment or test related to coal or oil, etc. Secure storage rooms for chemicals and emergency shower facilities are required.

### 2.3.2.20 Oil unloading station and forwarding pump house

The fuel unloading station shall accommodate the following: It shall be possible to unload several road tankers at the same time. Final requirements are to be determined by Contractor according **Section B4** and **Section B0**. The unloading pumps shall be installed 45 cm above the road level.

The station shall consist of a reinforced concrete slab (treated against oil leakages) and sunshade of about 6 m height. The sunshade shall be of steel covered with trapezoidal steel sheets. The floor scale shall be provided with retaining and discharge facilities for oil leakages.

The pump house shall be of solid reinforced concrete structure towards the tank yard and lightweight steel structure in the opposite site. The requirements of the valid rules and standards for the design and construction of fuel unloading stations especially with regard to the fuel oil catchment pit and fire protection have to be strictly respected by the Contractor.

## 2.3.2.21 400/230 KV GIS control building

The sizes of the control building have to be determined according to the requirements for the electrical and instrumentation/control equipment. The following rooms shall be accommodated in this building:

- battery room
- offices
- store
- sanitary tea kitchen
- AC/DC-Distribution rooms
- control room
- telecommunication, metering and SCADA rooms
- medium voltage rooms

**Description of the building**

- structure: reinforced concrete
- floors: one
- flooring: reinforced concrete, vitrified tile flooring
- foundations: according to the soil investigation report and Special Technical Requirements of Foundations
- external wall: 230 mm thick brick walls with metal cladding
- internal wall: 230 mm thick brick walls with plaster finish
- roof: insulated-watertight RC roof
- doors:
  - external: self closing sandwich steel doors with insulation
  - internal: aluminum glazed doors/wooden doors with steel frames
- windows: double glazed aluminum
- finishes: The control room shall be of noble appearance and receive e.g. sound absorbing wall cladding and suspended ceiling.
- air conditioning: centralized air conditioning
- ventilation: natural/mechanical
- sanitary-equipment: toilets for ladies and gents consisting of
  - western type WC with cleaning brush
  - eastern type WC with cleaning brush
  - bowl urinal
  - wash basin
  - hot air hand drier.

The battery room shall be equipped with:

- cleaning sink minimum size 580 x 450 mm
- emergency shower with eye wash
- acid resistant floor and drain
- Sink outlets and floor drains shall be chemical resistant and piped into the chemical drain system.

False floors and suspended ceilings wherever required. The control room(s) shall have windows with sunshades and may be divided with a glass wall into two sections. Flooring of the control room to consider electrostatic problems (to provide suitable earthing mats where required) and the ceiling to be sound absorbing. Airlocks of glass or at least with visions shall be provided.

Electrical hoist designed for the transport of the electrical and control panels.

Finishes: the control room shall be of noble appearance and receive e.g. sound absorbing metal wall cladding. The lighting shall be adequate and in accordance with the arrangement of the individual working places. Windows to be double glazed aluminum PVDF coated.

The design of finishing works will comply with the requirements of the code of procedures with regard to the mirroring effects, lighting of working places, shadowing etc.

## 2.3.2.22 400/230 KV GIS building

The GIS buildings shall consist of a steel structure with trapezoidal metal panels for external walls and roofs. The floor shall be a concrete foundation.

**Description of the building**

- structure: steel structure
- floors: one
- flooring: reinforced concrete
- foundations: according to the soil investigation report and Special Technical Requirements of Foundations
- walls: single skin metal sheet cladding
- roof: single skin metal roofing
- doors:
  - external: self closing sandwich steel doors with insulation
- windows: double glazed aluminum
- ventilation: natural/mechanical.

## 2.3.2.23 HCSD - building

The building shall accommodate the equipment for high concentrated slurry disposal, as described in **Section B04**.

**Building description**

- structure: reinforced concrete
- floors: one floor
- flooring: reinforced concrete
- foundations: according to the soil investigation report and Special Technical Requirements of Foundations
- external wall: 230 mm thick brick walls or autoclave aerated concrete blocks with metal cladding
- internal wall: 230 mm thick brick walls or autoclave aerated concrete blocks or autoclave aerated concrete blocks with plaster finish
- roof: double skin metal sheet roof
- doors:
- main entrance:
  external: folding doors with motor drive
  internal: self closing sandwich steel doors with insulation
  wooden doors with steel frames
- windows: double glazed aluminum
- air conditioning: centralized air conditioning, if required
- ventilation: natural/mechanical

## 2.3.2.24 Main gatehouse

The main gatehouse located inside of the plant site serves for control of the entrance. From the working place the gate keeper shall be able to watch the areas in the front and behind the gate house and to release the pedestrian and vehicle gates.

The main gate house symbolizes the entrance of the plant and shall be of a good esthetical appearance.

Electrically operated Mild steel (MS) gates are included in the scope.

The following rooms shall be accommodated in this building:

- security staff offices
- time office incl. time machine
- reception area
- lounge
- safety induction center.

Floor area shall be suitable for purpose and Floor height shall be as per

requirements and BNBC.

**Description of building:**

- structure: reinforced concrete structure
- floors: one
- flooring: vitrified tiling
- external wall: 230 mm thick brick walls or autoclave aerated concrete blocks with paster
- internal wall: 230 mm thick brick walls or autoclave aerated concrete blocks with plaster
- doors:
  - external: self closing sandwich steel doors with insulation
  - internal: wooden doors with steel frames
- windows: double glazed aluminum
- ventilation: mechanical
- air conditioning: decentralized air conditioning
- sanitary equipment: toilet with 1 WC and 1 wash basin.

## 2.3.2.25 Secondary gatehouses

On Plant area secondary Gatehouses shall be located at the following locations:

- near Jetty Area
- on additional location for labor entrance/ any suitable place.

The gate houses, serves for control of the entrance. From the working place the gate keeper shall be able to watch the areas in the front and behind the gate house and to release the pedestrian and vehicle gates. The building shall be provided with the guard room a small office and a sanitary room. Electrically operated Mild steel (MS) Gate is also included in the scope.

Floor area shall be suitable for purpose and Floor height shall be as per requirements and BNBC.

**Description of building:**

- structure: reinforced concrete structure
- floors: one
- flooring: vitrified tiling
- external wall: 230 mm thick brick walls or autoclave aerated concrete blocks with metal cladding
- internal wall: 230 mm thick brick walls or autoclave aerated concrete blocks with plaster
- doors:
  - external: self closing sandwich steel doors with insulation
  - internal: wooden doors with steel frames
- windows: double glazed aluminum
- ventilation: mechanical
- air conditioning: decentralized air conditioning
- sanitary equipment: toilet with 1 WC and 1 wash basin.

## 2.3.2.26 Construction sheds

On the plant area 30 small, partly enclosed buildings (closed by three sided, and open to one side, covered by roof sheet) shall be provided as permanent construction sheds for repair and maintenance issues.

Office and store shall a building structure, whereas the workplace is just a covered area.

The locations shall be:

- 8 pcs near ID-fan - chimney area
- 6 pcs near turbine hall - 0.00 mm
- 2 pcs near cooling water pump house
- 6 pcs near coal handling control room
- 4 pcs near ash handling control room
- 4 pcs near jetty.

The sheds shall consist of:

- office (15 m²)
- store (20 m²)
  workplace (50 m²), only covered.
  Floor height shall be as per requirements and BNBC.

**Description of building:**

| | |
|---|---|
| • structure: | reinforced concrete structure |
| • floors: | one |
| • flooring: | PVC tiling or equivalent |
| • external wall: | 230 mm thick brick walls or autoclave aerated concrete blocks with metal cladding |
| • internal wall: | 230 mm thick brick walls or autoclave aerated concrete blocks with plaster finish |
| • doors: | self closing sandwich steel doors with insulation |
| • windows: | double glazed aluminum |
| • ventilation: | mechanical |
| • air conditioning: | window/split air conditioning system |
| • sanitary equipment in the office area: | • eastern WC with cleaning brush in toilet<br>• western WC with cleaning brush in toilet<br>• bowl urinal in male toilet<br>• wash basins in toilet |

For these structures, pre-engineered structures can be used.

## 2.3.2.27 Maintenance workshops

On the plant area Maintenance Workshops shall be provided as permanent construction sheds for repair and maintenance issues.

The locations shall be:

- mill maintenance workshop (70 m² with EOT)
- mill maintenance workshop (with cylinder holding fixtures, sand blasting facility)
- fan maintenance bay (with monorail)
- coal handling plant workshop cum office building with min. area 900 m². The workshop shall be in addition to the central workshop.

Where applicable, workshops can be combined with other facilities.

Floor area shall be suitable for purpose and floor height shall be as per requirements and BNBC.

**Description of building:**

- structure: steel structure
- floors: one floor
- flooring: concrete or paving
- walls: double skin steel cladding
- roof: double skin galvanized steel sheet
- doors: sandwich steel doors with insulation
- windows: double glazed
- ventilation: mechanical
- air conditioning: window/split air conditioning system.

## 2.3.2.28 ESP CONTROL ROOM BUILDING

**Description of building:**

- structure: concrete structure
- flooring: concrete or paving
- External walls: 250 mm thick Aerated concrete blocks
- Internal walls: 250 mm thick brick wall
- roof: concrete
- doors: sandwich steel doors with insulation
- windows: double glazed

## 2.3.3 Outdoor foundations and structures

### 2.3.3.1 Transformer bays

Oil-filled transformers shall be supported on reinforced concrete foundations.

Provision shall be made for the catchment of oil spillage and fire deluge water. Appropriate measures are to be made to prevent pollution of the environment by leading of ejected oil.

The foundation supporting the transformers shall incorporate transformer rails. Each transformer foundation shall be provided with slope and raised borders, enclosing an oil retention basinpit in which the oil content of the transformer can be carried in the event of an oil leak. The oil retention basin shall be sized to hold the oil capacity of the largest transformer, rainwater and water from fire fighting system. The basin shall be adequately coated Above the oil pit a min. 20 cm thick gravel layer on a steel grating shall be provided. The retention basins shall drain into a central oil separator conforming to VDE-Standard or equivalent. Water from the separator shall drain to the site drainage (process waste water) system.

A deluge system shall be installed.

The transformer bays shall have reinforced concrete fire walls towards the neighboring buildings and between each other –if applicable- and security fencing on the other sides with personnel gates to the front.

### 2.3.3.2 400/230kV GIS

The civil portion of the 400/230kV GIS consists of foundations, transformer foundation, control building, GIS building, Bus duct supports, tower & gantries and equipment support structures etc.

The transformers bays shall be provided, as described above.

The sizes of the control building have to be determined according to the requirements for the electrical and instrumentation/control equipment. It shall be constructed as reinforced concrete and brickwork building.

The GIS buildings shall consist of a steel structure with trapezoidal metal panels for external walls and roofs. The floor shall be a concrete foundation.

Details for tower and gantries and support details of outdoor switchyard equipment will be described in electrical part.

The complete Area shall be fenced off from site. The access shall be from Main Plant. Additional access from outside direct to the 400/230 GIS is not required.

### 2.3.3.3 Other outdoor foundations

The following foundations shall be included under this clause:

- for dust filter (electrostatic precipitator or fabric filter plant)
- for flue gas desulphurization plant
- for supporting structures of pipes/cables, etc.
- for outdoor switchgear supports and gantries
- for air condensers and coolers (as applicable)
- for other outdoor structures not explicitly mentioned above.

The foundations shall be of reinforced concrete designed and constructed according to the recommendations of the soil investigation report.

### 2.3.3.4 Foundations of various storage tanks

The foundations of the following storage tanks are included under this item:

- potable water storage tanks
- demineralized water storage tanks
- service water tanks
- condensate tanks
- feedwater tanks
- foam storage tanks
- fire fighting water
- neutralization buffer tanks - if applicable
- other specified tanks not included above, e.g. Section B6.

The tanks shall be founded 0.60 m above surrounding level on ring foundations of reinforced concrete and a well compacted layer of fine graded asphalt concrete of 50 mm thickness with max. grain size of 5 mm.

On the ground beside the tanks (other than the potable water storage tanks), concrete slabs with raised borders are to be provided which shall collect all the leakages. These slabs are to be adequately protected against the chemical attack involved.

### 2.3.3.5 LFO/HSD storage tank

Care should be taken to ensure that no pollution of groundwater through oil may occur and that all precautions for fire protection are taken. The LFO/HSD storage tank has to be installed as individual tank farm bund. The dewatering system of the oil catchment area of the substation shall be provided with a locking system, which should be activated during the unloading phase at the tanks.

- tank foundations:

  The tank shall be founded 0.40 m above tank yard level on ring foundations of reinforced concrete and a well compacted layer of fine graded asphalt concrete of 50 mm thickness.
- bund of LFO/HSD:

  The bund and floor are to consist of reinforced concrete. The whole tankyard shall be isolated by a non-rotting oil and water-proof foil laid on the soil. The top protection for the insulating foil shall be achieved by concrete slabs. The joints responsible for absolute water and oil tightness between foundations and oil bund must not be endangered by possible settlements.
- In case of storage tank including a double bottom, a double wall (second wall in steel serving as spilling basin) up to the top of the tank and a roof covering the two walls, the bund can be omitted.
- drainage:

  The tank farm floor is to be sloped and provided with drainage channels so that trouble-free drainage of rainwater into the oil separators is possible. No oil should get into the rain water line even when an oil separator is overfilled.

### 2.3.3.6 Cable and pipe ducts/pipe bridges

For cables and pipes the Contractor shall provide ducts in such areas where installation above ground is not possible or advisable. Cables and pipes shall be laid in separate ducts. In general, ducts shall be avoided, as appropriate.

Pipe bridges shall be provided for supporting and routing of various pipes and electrical cables between the plant components.

Pipe sleepers are also acceptable, as long as all aspects due to accessibility and head clearances are fulfilled.
Details will be discussed during design stage.

### 2.3.3.7 Covered car parks

The following parking provision shall be foreseen:

- in the area of the administration building: min. 75 shaded car parking lots and 75 unshaded car parking lots
- in the area of the service building: min. 75 shaded car parking lots and 100 unshaded car parking lots
- in the area of the central canteen: min. 50 shaded car parking lots and 50 unshaded car parking lots
- in the area of the auditorium: min. 75 shaded car parking lots and 75 unshaded car parking lots (when auditorium is near administration Building, number of car parks can be reduced)
- in the workshop and other areas: min. 50 unshaded car parking lots
- in different areas of the plant: min. 50 shaded motor-bicycle parking lot
- dividing stripes shall be marked.

### 2.3.3.8 Open storage area

A free area (one no.) of min. 2500 m², paved with interlocking blocks (for heavy traffic) shall be arranged in the immediate vicinity of the workshop/store for the future installation of a camp of containers used during the maintenance works of the plant equipment.

The design of the area shall consider the loading and space requirement of minimum 20 standard containers. To the scope of works belong the water, electrical power, telephone as well as sewage facilities necessary for the connection of the above-mentioned container. The area shall be enclosed with chain link fence with pedestrian and vehicle gate.

### 2.3.3.9 Underground services

**Pipe & cable channels**

Channels for pipes and cables shall be of reinforced concrete and must be watertight. Dimensions of the box shape channels shall be such that adequate working access and ventilation could be available to maintenance staff. The ducts shall be designed to comply with the fire protection requirements and shall withstand soil pressure and any live loads that may be imposed on the channels. Particular attention shall be paid to satisfactory expansion and settlement joints.

For drainage purposes the ducts shall be provided with slopes of a minimum 0.3% towards accessible pump sumps. An automatically controlled sump

pump shall be permanently installed for any sump which is found to need pumping.

Hot dip galvanized anchor rails at a spacing of 1.5 m shall be provided on the internal walls of the channels to support cable racks. Minimum required distance between power and instrumentation cables and between cables and pipes shall be observed. Heavy duty removable covers shall be provided at access points to the cable channel.

For smaller quantities of cables PVC pipe sleeves shall be placed from one manhole to the next.

**Pipe laying under roads**

Where it becomes necessary to lay a pipeline across and under a road the Contractor may install a permanent liner at a safe depth.

The liner shall be designed for the likely ultimate loadings and may be of spun concrete or steel. The diameter of the liner shall be adequate for the number of pipelines as required to accommodate and for possible maintenance requirements.

**Cable and pipe ducts, trenches, tunnels outside building**

Generally cables shall be placed directly below ground buried in a depth of at least 0.8 m below ground. All necessary measures shall be taken at road crossings to protect cables against damage.

The necessity of providing cable and pipe ducts, trenches and/or tunnels and their possible routing are all as outlined in the relevant parts of the specification for electrical and I&C works.

*General*

For construction of cable and pipe ducts, trenches and/or tunnels the requirements of DIN 1045, DIN 1054 (or equivalent ISO – EN Codes), BS EN 1992-1-1, BS 6031 or approved equivalent standards shall be complied with.

For large numbers of cables and pipes the Contractor shall provide ducts, trenches and/or tunnels in such areas where installation by directly burying or above ground on racks is not possible or advisable. Cables and pipes shall be laid in strictly unit-wise separated ducts, trenches and/or tunnels.

The ducts, trenches and/or tunnels are to be constructed of reinforced concrete according to the requirements of clause “Concrete works” specified herein, and must be watertight and non-buoyant under the prevailing groundwater conditions. Particular attention must be paid to satisfactory expansion and settling joints. The walls and covers of the ducts, trenches and/or tunnels must be designed and reinforced to withstand the prevailing soil & water pressure, the relevant traffic loads and the weight of suspended cables and pipes.

The ducts, trenches and/or tunnels are to be provided internally with hot dip galvanized anchor rails every 1.5 m for the easy attachment of clips and cable racks. Plugging and shooting of fixing devices are permissible only in isolated cases and are subject to the Employer"s agreement. All ducts, trenches and/or tunnels covered by removable covers will have to be provided with metal protection angles protecting on one hand the edges of removable covers and on the other hand the edges of the duct walls beside the removable covers. Every attempt shall be made to locate the ducts, trenches and/or tunnels away from roads in order not to disrupt or endanger traffic during subsequent necessary work such as overhauls and repairs. The corners of the duct walls in the vicinity of junctions, inlets and bends must be "rounded-off" so that no damage is suffered by the cables when they are being drawn in – allowing for their minimum bending radii.

If the bottom of slab of a duct, trench or tunnel is below groundwater level, the slab shall have a slope and openings in the slab for natural drainage.

For drainage purposes the cable and pipe ducts, trenches and/or tunnels shall be provided with sumps and slopes (min. slope 0.3%) towards the sumps. Where necessary, pumps with automatic water level control shall be provided within the sump. Sumps which are likely to be dry most of the time may subject to the Employer"s approval be designed for pumping by portable pumps to be provided by the Contractor.

If a culvert(s), and/or tunnel(s), trench(s) or any other underground services are crossing streets, the street shall be constructed as a bridge for truck loading without effecting the underground structures.

All open trench concrete covers shall be pre cast (not cast in-situ) using straight moulds. Covers shall be adequately reinforced to withstand the induced loads; with cover to reinforcement not less than 15 mm (reduced concrete cover due to weight constraints). The trench cover soffits shall receive a bituminous seal coat.

*Small cable & pipe ducts/trenches*

Where approved removable covers may be used for small ducts and trenches. The covers may be chequered plates, gratings internal or precast concrete slabs outside.

*Dimensions of cable & pipe ducts trenches*

Dimensions of ducts and trenches shall be appropriate to accommodate the installation of the cables and pipes with their required spacing and for the space required for their maintenance. Ducts and trenches with removable covers may not have any access manholes

**Covers, trash gratings, climbing irons**

Shaft and manhole covers shall be made from cast iron or reinforced concrete, of watertight construction, with or without dirt traps, to suit local

requirements. All covers shall be approved for loading as expected from the likely traffic conditions. The dimensions of trash gratings shall be those determined by proper structural design. Trash gratings shall be of cast iron.

The type and choice of climbing irons shall meet the requirements of BS 1247, BS EN 13101 or other approved standards. Only corrosion protected materials shall be used. Where shafts are constructed of reinforced concrete, the step spacing shall be 330 mm, and for brick shafts as close to that spacing as possible subject to the brick courses. Climbing irons shall be staggered, maintaining a horizontal axial spacing of 300 mm.

### 2.3.4 Outdoor facilities and installations

#### 2.3.4.1 Potable water system

The scope of this section is to supply with potable water all buildings, which require sanitary and potable water, see also **Section B6**.

Foundations for storage tanks shall be provided.

The scope of this system includes all equipment required for the potable water system including piping for hot and cold water lines, water heaters, drinking fountains, valves, insulation and lagging, hungers and supports. Emergency showers and eye wash stations will be provided as required e.g. in the chemical feed area and station battery rooms and shall be supplied with potable water.

#### 2.3.4.2 Service water system

The scope of this section is to supply with service water to all locations which require service water, see also **Section B6**.

Foundations for storage tanks shall be provided.
The service water tank shall also be designed to serve for the purpose of the fire fighting water needs as described in **Section B12**.

The scope of this system includes all equipment required for the service water system including piping, valves, insulation and lagging, hungers and supports.

#### 2.3.4.3 Storm water drainage system

For the entire plant, a complete storm water drainage system is required. A substantially maintenance-free and, above all, an operationally safe installation must be guaranteed. The surface water drainage shall include all necessary open channels, gutters, down pipes, gullies, traps, catch pits, manholes, etc. and shall incorporate the plant drainage requirements.

Stormwater shall be drained by gravity. If this is not possible, necessary pumping stations with sand traps are to be provided. For each pumping station the pumps are to be provided with stand-by pump of 100% capacity.

Rainwater run-off from plant area shall be directed through drains, channels and culverts into a storm water collection pond. The size of the storm water collection pond shall be capable for rain water run-off. The volume shall be determined by EPC Contractor.

Any excess rain water during the monsoon season will overflow into the river.

During heavy rainfall site can get flooded with storm water carrying effluents from ash dyke, coal settling pond etc. It shall not be naturally discharged into river or low lying area without any treatment.

#### 2.3.4.4 Sanitary sewage drainage system

Sanitary sewage from administration, control, workshop buildings etc. shall be discharged in the sewage drainage system. The wastewater shall be treated in a Sewage Treatment Plant. For further Details see **Section B6**.

#### 2.3.4.5 Sewage treatment plant

The Sewage treatment Plant shall be provided as described in **Section B6**.

It shall comprise beside the required components also a small building for the pumps and the local electrical panels. The basins will be concrete structures and the building shall be a concrete /block work structure.

The plant shall be designed to ensure that the effluents will have the quality which is required to allow the re-use for irrigation.

For this purpose the water shall be stored in a storage basin of suitable size with overflow to the central effluent monitoring sump CEMS. The water will be removed periodically by means of tank truck.

#### 2.3.4.6 Fire water retention, if applicable

Spent fire fighting water shall be contained. The required retention volume shall cover the total water amount of the connected systems during defined operation time. This shall be achieved by respective thresholds and other up stands to form a containment of sufficient volume. Furthermore the rain water and fire fighting water retention basin shall be used to collect fire water from the drains of sealed outside areas.

The total fire water retention volume shall be based on the fire fighting water demand and duration according to NFPA 850.

Tanks with flammable or hazardous content shall have a bund structure creating sufficient retention volume. In the assessment of the total fire extinguishing time where such tanks are involved in the fire, account shall be taken of the collecting capacity present in this area including the volume of oil discharged in the event of a leakage.

### 2.3.5 Coal and ash handling and storage facilities

#### 2.3.5.1 Handling facilities

The civil portion of the coal and ash handling facilities consists of foundations. Weather protecting metal roof on steel structures, junction tower, etc., and structures for the hoppers and the like are described in **Section B4**.

#### 2.3.5.2 Coal yard

**Coal storage**

The coal storage shall be suitable for coal demand of 90days. The final size shall be determined by EPC-Contractor.

The coal yard shall be constructed for 2 x 660 MW. An area for additional coal yard for further extension shall be reserved in Layout.

Soil replacement and ground improvement shall be carried out for the coal storage area to have the required safe bearing capacity with negligible relative and absolute settlement characteristics. The minimum height of storage shall be considered as 13.00 m.

A coverage for the whole coal storage area has to be considered. The coal yard coverage shall be complete in all respects, including foundations and installation of steel structure and metal roof and sheeting. Sand piles and pre-loading of the entire storage area for a period as required may be the most economical and effective way to achieve the required results. The ground improvement work shall be started as early as possible to achieve the required results.

For steel structures, Tubular steel can be used. Usage of intermediate column is dependent on concept for stocking and reclaiming. Collision of equipment with column is not acceptable.

The improved sub grade shall be well compacted to the required lines and levels before sealing it with an impermeable layer of high density membrane. At least 300 mm layer of clay of high plasticity index shall be

laid on the impermeable membrane. The clay layer shall be covered with a minimum 250 mm layer of well graded gravel sub-base. Perforated high intensity pipes shall be recessed into the gravel layer to form a close grid of drainage system. The drainage system shall be prevented from clogging by using suitable geo textile cover or proven filter criteria according Terzaghi. Finally, the gravel layer shall be covered with a layer of minor quality coal of a minimum 200 mm thickness.

For collecting the storm water and spray water from dust suppression a drainage system shall be provided. The drainage system will drain into trenches around each coal pile thus be connected to drain into a separate coal drainage settling pond. The basin shall be founded on well compacted selected soil after removal of the existing top soil and weak subsoil. Complete with fully sealed reinforced concrete lining, the pond shall be constructed at a level that will be best suited for gravity flow of the drainage water. Slope of drainage lines shall consider long term settlement of coal storage area. Suitable removable type covers of the drains shall be provided.

A water spray system for dust suppression shall be provided.

**Coal transfer towers/coal crusher building**

The civil works for the coal crusher buildings, the coal sampling units and all corner towers and conveyer bridges shall comprise foundations and drainage systems required.

Where necessary, pile foundations or other deep foundations shall be provided.

The system shall be fully enclosed. Proper access shall be provided.

To prevent any dust accumulation, horizontal surfaces shall be avoided.

Provisions for regularly washing of structures and floors shall be made along with proper drainage.

All civil works for the crusher building and transfer towers shall be provided to meet the requirements of the mechanical and electrical installations and as described in **Section B4**.

Measures shall be taken to avoid the transmission of vibrations due to equipment (mainly crushers) to the building structure. These measures shall mainly be separate reinforced concrete foundation to be insulated from the remainder of the structure by vibration control systems consisting of spring elements and viscodampers to prevent the transmission of vibrations.

Unbalanced forces due to equipment shall be considered.

**Building description:**

- structures: structural steel frame
- foundations: piled foundations for steel columns (see also and the results of the geotechnical investigation results)
- base floor: reinforced concrete with slopes to gullies and drainage, coating according to the regulations
- external walls: 230 mm thick brickwall with plaster finish up to 0,9 m or autoclave aerated concrete blocks from floor level and double skin metal cladding above. Metal cladding from the top to the last operating floor shall be provided.
- roof: galvanized steel structure with metal cladding water proofing.

**Coal conveyor**

All civil works for the coal conveyors shall be provided to meet the requirements of the mechanical and electrical installations. If for structural reasons required deep foundations shall be taken into account for conveyor belt supports.

The system shall be fully enclosed. Proper access shall be provided.

To prevent any dust accumulation, horizontal surfaces shall be avoided.

Provisions for regularly washing of structures and floors shall be made along with proper drainage.

**Coal conveyor bridges**

The civil works for the coal conveyer bridges shall comprise foundations, steel structure and drainage systems required.

Where necessary, pile foundations or other deep foundations shall be provided.

The system shall be fully enclosed. Proper access shall be provided.

To prevent any dust accumulation, horizontal surfaces shall be avoided.

Provisions for regularly washing of structures and floors shall be made along with proper drainage.
Structural analysis shall be performed for both conveyors running with 100% loading.

All civil works for the crusher building and transfer towers and coal

conveyor bridges/gallery shall be provided to meet the requirements of the mechanical and

electrical installations and as described in **Section B4**.

**Building description:**

- structures: structural steel frame
- foundations: piled foundations for steel columns (see also and the results of the geotechnical investigation results).
- base floor: reinforced concrete with foundations, coating according to the regulations
- external walls: 230 mm thick brickwall with plaster finish up to 0,9 m or autoclave aerated concrete blocks from floor level and double skin metal cladding above.
- roof: steel structure with metal cladding water proofing.

**Coal stacker/reclaimer**

The civil works for the coal stacker/reclaimer shall comprise all foundations and civil works required for the equipment described in **Section B4**. Where necessary, pile foundation or other deep foundations shall be provided.

Construction shall consider all requirements due to long term settlement, e.g. adjustments of the equipment runway.

**Covered coal yard**

The coal sheds shall be of structural steel columns and roof trusses with a metal roof and metal sheet siding. Foundations with piled foundations for the steel columns, according to the geotechnical investigation. The profile of the roof shall follow the profile of the coal handling equipment. Each coal pile shall be covered separately. The distance between the steel columns shall be approximately 80 m, the height of the roof at about 40 m (for a coal pile of about 50 m width), the two cantilevers connected with a joint at the highest point must not be symmetrically depending on the size of coal handling equipment used. However the size and shape of the coal shed shall be finalized as per the requirement of coal stock pile and subject to BIFPCL approval. It may also be noted that internal column within coal stock pile area shall not be acceptable.

Any collision of the stacking and reclaiming machines with the shed must be safely avoided in any operational case.

The take-out of the coal yard shall be considered as option 4.1, see **Section B4**.

2.3.5.3 Ash pond

An Ash Pond of 25 acre shall be provided exclusively for storage of High Concentrated Slurry Disposal (HCSD).The peripherical structures will require additional area of around 18 acres located around ash pond. The system shall include starter dyke storage lagoons and overflow lagoon dyke construction, ash slurry pipe line, drainage system, ash water recirculation pump house, seepage water pump house and maintenance roads on top of dyke embankment & all around the outer perimeter of dyke at natural ground.

The average ground level on proposed land is RL=1.0m. The height of the starter dyke shall be approx. 5.60 m. Provisions shall be made for construction of further raising dykes to extend the storage volume of ash. The minimum height of storage shall be considered as 13.00 m in center of ash pond.

The starter dyke shall be constructed in such a way to maximize ash storage and considering seismic influence. Ash dyke embankments can be designed as an earthen dam as per relevant code. Depending on the type of the soil for the embankment construction, it may have either of the following sections:

i. a homogeneous section with internal drainage arrangement of sand chimney and sand blanket
ii. a heterogeneous section consisting of an inner impervious core and outer shell of available soil.

Based on the properties of soil and fill material, the stability and seepage analysis shall be carried out. The design shall be done for ultimate height and the unutilized as to be stored. Soil Improvement shall be considered, if required to minimize settlements of the dyke and inside the pond. The bearing capacity in the area shall be as required, but not less than
100 kN/m².

The ash pond shall be provided with impermeable liner in compliance with legal regulations. The liner may be natural or synthetic depending upon the substrata encountered and the permeability of soil. Toe drain shall be provided all around the periphery of outer dyke, where applicable. An RCC peripheral drain shall be provided to guide the seepage water from toe drain into seepage water sump and the same shall be pumped into Over Flow Lagoon (OFL). Toe drain shall be connected to peripheral RCC drain suitably at regular interval.

Water escape structure for decantation, method of discharge and recirculation of decanted water shall be provided as per requirement. For the escape of excess rain water from storage lagoon, spillway type structures shall be provided. The spillways along with energy dissipating device on downstream side shall be designed to discharge the excess rain water from the OFL and storage lagoon.

Height of Overflow Lagoon shall be specified by Bidder/Contractor, approx.4.00m

Internal drainage arrangement and toe drain around the dyke shall also be provided. Suitable Protection measures from back water of river shall be provided all around the ash dyke.

In addition, on downstream (D/S) slope of the embankment, stone pitching with inverted fliter arrangement shall be provided from GL to HFL plus 1.0m height of dyke embankment. Provision shall also be made to protect the upstream slope of embankment. Rock-toe with toe drain shall be provided at the toe of the embankment all around the ash dyke.

Dust suppression system for ash pond shall be provided, as required to ensure IFC guideline requirements.

The overflow of storm water shall be disposed of properly; reutilization in the power plant shall be encouraged as far as possible.

The Contractor shall provide a simple and effective filling concept, which will allow proper settling effect during all stages of the progressing fill of the pond and which shall keep the exposed ash surface to a minimum at all times. In order to monitor the performance of ash dyke during construction and operation, instruments should be installed at suitable locations.

All pump houses shall be protected for flooding, therefore the finish floor level of pump houses shall be the same as for plant levels.

**Weighbridge**

A weighbridge for weighing bulk goods to be brought in or out of the plant shall be provided in the area of the main entrance/gatehouse, which can be changed during design stage.

The scope of supply includes the design, delivery, installation and commissioning of the mechanical civil and data capturing and transporting system for one weighbridge to be installed at the gate house and consist of the following:

- weighbridge with a length of 12.0 m and 30 tones capacity
- reinforced concrete trough designed to support the weighbridge including drainage provision connected to the sewage system of the plant, all necessary embedded part for anchoring, sleeves, base plates etc.
- accessories including load cells, weigh indicators, arrestors and all devices necessary for proper operation of the weighbridge
- transponder system complete with all accessories
- 2 units of vehicle barriers with all accessories
- outdoor printer complete with printer stand with waybill depository boxes and accessories
- traffic light complete with all accessories
- message sign board to be installed in the gate house
- data processing system and communication equipment complete with computer, data switches and software for the control of weighbridge transactions
- all cabling between the weighbridge and the control desk.

### 2.3.6 Roads, paving and surfacing

The road system must be arranged in such a way that free- flowing traffic is guaranteed. Wherever possible, cross roads are to be avoided. The following asphalt roads shall be provided:

Road connections to the different buildings are to be provided.

Sidewalks shall be provided from roads to interconnect all facilities and all building doors. The walkways shall be reinforced concrete and shall be prepared with an adequate depth of compacted base course and shall be at minimum of 1.5 m wide. Walkways will be formed with slopes and/or steps at the correct level to drain storm water.

The area around the buildings and outdoor auxiliary plant, which are used infrequently, the lay down areas for small loads, the footpaths, the parking areas, etc. shall be paved with interlocking concrete blocks.

Entire area from transformer yard to chimney shall be provided with paving in combination with interlocking concrete blocks and high wearing resistant concrete. RCC paving of minimum 150 mm thick with C20/25 grade concrete, over an underbed as specified herein shall be provided. RCC paving shall be designed as rigid reinforced concrete pavement for the crane/ vehicular/ equipment movement loads which the paving has to bear. The underbed for paving shall consist of preparation and consolidation of sub-grade to the required level, laying of stone soling of 200mm compacted thick with 63 mm and down aggregate with interstices filled with selected sand followed by 75 mm thick 1:3:6 PCC (1 part cement, 3 parts sand and 6 parts stone aggregate) with 40mm nominal size aggregate.

Surfaces of unbuilt and remaining areas within the site boundary which are neither built nor paved shall be adequately leveled and covered with topsoil to allow proper landscaping. Road signs, traffic signs, road surface marking and guardrails shall be provided as per authority requirements for traffic in industrial areas.

The works shall include temporary site access roads from the existing outer roads.

After finishing of construction works all temporary site access roads used by the Contractor shall be reinstated to the original standard i.e. the standard after refurbishment.

### 2.3.7 Landscaping

There shall be comprehensive landscape development in entire Plant area to create a pleasant and healthy environment. The scope of work for landscape and horticulture work shall include supply and planting of trees, shrubs, hedges/edges/borders, grass lawn around different areas, buffer and peripheral plantation etc. The scope shall also include supply and installation of all landscape furniture i.e. park benches, gazebos, landscape fountain and water bodies, landscape pavers/ tiles etc. and all associated electrical and mechanical works/items and all other work required for completion of landscape development.

The landscape design and drawing shall be developed by competent Landscape Architect. The landscape shall use the suitable plants and trees preferably local trees, plants, and shrubs. There shall be provision of pathways in and around the landscaped area, with suitable provision for disabled persons.

Around the pathways and roads, trees shall be planted. Rainwater harvesting for the entire Plant Area shall be integrated within the landscape development. There shall be provision of irrigation system for irrigation of landscaped area. Intense landscape with four water body development shall be provided near the following areas:

- main gate complex
- administration building
- service building
- canteen building.

All other open areas of plant, which are not covered by buildings, structures, roads, lay-down areas, graveled areas, etc., shall be planted with shrubs and grass.

Around the coal yard, trees shall be planted in order to limit dust contaminations.

Landscaping shall be considered within the plant boundary. Entire Plant Area is to be considered for Landscaping with Intensive Landscaping around Entrance Gate, Administration Building Complex, Canteen Building, Service Building and in front of A-row of MPH.

Green belt development outside plant is not in scope of Bidder/Contractor.

### 2.3.8 Main entrance area outside the plant

In the Area of the main Gate a welcome and waiting complex shall be provided.

The area shall consist as a minimum of:

- 3 helipads
- Restroom, min 30 m²
- 160 car parks, shaded
- 34 truck & trailor parks
- 6 shops
- prayer hall, min 6 m²
- toilet building, min 15 m²

The structures shall fulfill the technical requirements as stated in this specification.

All buildings shall be equipped with electricity, HVAC, telephone connection, etc. Structure shall be designed to fulfill the purpose and follow BNBC

### 2.3.9 Employer's and Engineer's office (temporary structure)

A temporary Employer˝s and Engineer˝s Office (separate structure) of. 2800 m² for minimum 100 engineers, meeting rooms and social rooms for minimum 50 persons, furniture, copy machine, kitchen shall be provided and maintained throughout the construction period. A combination with other facilities should be avoided. Structures shall not be removed after completion of the works. Area shall be designed as depicted on indicative general layout and as per Bidder/Contractors experience. Proposal shall be submitted by Bidder/Contractor and is subject to approval by BIFPCL during basic/detail engineering phase.

Offices shall be provided for:

- Site Manager (40 m²)
- Discipline Site managers (25 m²)
- Middle level executive offices (10 m²)
- Workstations/Halls.

Every working place shall be equipped with a computer, connected to a local network with common printer.

These offices shall be separate permanent reinforced concrete structures, according to the civil specifications. The offices shall be ready for occupation latest 8 weeks following the commencement of the works at the site.

Kitchen shall be equipped with cupboard, refrigerator and heating plate, or electric oven, china and tools, dish washer, glasses and coffee machine, etc.

Sun shaded car parks, helicopter Pad septic tank and cesspool shall be included as well as a temporary elevated water tank. AC window units and sufficient power supply shall be included.

The following additional equipment shall be made available in sufficient number:

- automatic telephone exchange (domestic/international lines)
- telephone installed in each room
- telefax machine
- CAD work stations
- min 2 colour printer for drawings up to A0 size
- min 10colour printers for documents size A4 & A3 photocopying machines for A4 & A3
- PC‟s with related processor, network for data exchange, storage, •internet browser and standard office software.

This equipment shall be state-of-the-art and furniture shall be of 1st class standard; all are subject to approval by the Engineer. The Contractor shall provide the offices with electricity, water, coolers and refrigerators.

All office supplies, operating and maintenance costs for the offices and the installed equipment shall be at the Contractor‟s expense, for the whole period of contract the full service of the equipment with consumables (toner cartridges, paper, etc.) and the billing cost of telephone, telefax and internet browsing.

Customer will provide clear land for construction of employer‟s office with in project premises.

### 2.3.10 Living accommodation

The Contractor shall construct living accommodation made of reinforced concrete, according to the civil specifications for the Employer‟s and Engineers site supervision staff. Layout and finishing materials shall be approved by the Engineer.

All accommodation shall be situated close to the construction site and consist of 30 independent houses (each with 3 bedrooms with all required rooms and the consequent floor area) located near the project site.
Customer will provide clear land for construction of employer‟s living accommodation with in project premises.
Location/layout shall be proposed by Bidder/Contractor, and will be subject to approval by BIFPCL during basic/detail engineering.

These houses shall have fully furnished living and bedrooms, kitchen etc. completely equipped (TV, stereo, stove, refrigerator, dish-washer, washing machine, ironing board and kitchen utensils) and bathrooms.
No common recreation facility or separate boundary is required.
They shall be supplied with water, electricity, air conditioning and telephone and connected to a drainage system so as to provide immediate utilization.

All running expenses such as water, electricity, telephone, maintenance, cleaning, etc. shall be at the Contractor‟s expense.

If this accommodation is not available in the specified time, the hotel expenses incurred by the Engineer‟s representatives during the corresponding period shall be at the Contractor‟s expense.

Time period for providing accommodation shall be 8 weeks following the commencement of the works at the site.

These houses shall be for the sole use of the Employer‟s and the Engineer‟s representatives up to issue of the last preliminary acceptance certificate of the power and desalination plant.

Ten houses shall remain available during the warranty period plus 3 months extra period.

### 2.3.11 Building information management system (BIMS)

A BIMS shall be provided. The BIMS shall be a SCADA system to collect all relevant data from various subsystems to enable a centralized visualization with unified HMI graphics throughout different subsystems.

The system shall support standard interface protocols for signal exchange. The system shall be interfaced to following subsystems: HVAC, Weather station, Fire detection, Access control system, CCTV, Elevator emergency call systems, etc.

The BIMS shall provide functionalities to optimize energy usage and minimize energy consumption of buildings by e.g. lighting and HVAC controls. It shall support automatic or timed control of events (such as switching on/ off dedicated lighting areas, operating shading equipment such as shutters, and similar). It shall ensure a clear and easy operation and support the optimization of the work flow of the building maintenance personnel. The system shall provide alarm and event logging as well as report generating facilities.

One (1) normally unmanned operator station shall be installed in the office of the facility management department. Automatic alarms shall be generated and sent to the maintenance personnel via SMS and/ or e-mail.

## 2.4 Special Technical Requirements

### 2.4.1 Basic requirements for all civil works

- The design of all structures under this contract shall be such that differential and total settlements or other movements shall not exceed acceptable limits and full provision shall be made for all expansion and other joints. The design shall be to the approval of the Employer.
- Structural members subjected to flexure shall be designed to have adequate stiffness to limit deflections or any deformations that affect strength or serviceability of a structure adversely. The maximum allowable deflections of structural members shall be in accordance with the relevant design standards and/or the limits prescribed by the machinery manufacturers.
- The superstructures and foundations subjected to vibrations (the primary source of these vibrations being the unbalanced forces generated by rotating or reciprocating equipment) shall be designed such that Vibrations will be neither intolerable to personnel, and will not cause damage to the machine or structure. The natural frequency of the whole of the superstructures and foundations or parts thereof and all structures adjacent thereto shall not coincide with the operating frequency of the vibrating plant.

- The dimensions of all the buildings shall be such as to provide adequate space for the safe installation and proper operation, maintenance and repair of all plant and equipment.

- Throughout the works all floor slabs above rooms containing electrical equipment shall be watertight. No drain pipes or water pipes are permitted to pass through these rooms.

- All materials used in the works shall be of the best quality of their respective kinds as specified herein, obtained from sources and suppliers approved by the Employer.

- The work shall be carried out by competent personnel skilled in their various trades.

- Suitable access to the roofs of the buildings by means of galvanized steel stairs shall be provided for maintenance and firefighting purpose.

- All rooms with fire hazard shall be provided with suitable emergency exits.

Proper access roads with footpaths shall be provided to bring in all the equipment and to take it out in case of maintenance. These access roads shall be suitable for the vehicles which will be used (cars, forklifts, trucks/trailers etc.) to reach up to the point of unloading of the equipment.

- Safe, convenient and straight forward accesses and means are to be provided to take equipment in and out of all rooms, at all levels using suitable stair wells and suitable electric hoists. The dimensions of rooms, stairwells, doors, etc. shall be designed to suit the a.m. transport concept.

- An appropriate serviceable and functional master key system for the whole

plant shall be supplied and installed.

- Before starting of design works, the Contractor shall submit to the Employer for approval a **project design manual** containing the design data, the design criteria and the standards for all civil works. All loadings considered in the design shall be justified with supporting details.

## 2.4.2 Site organization and preparatory works

### 2.4.2.1 Site services during construction and testing phases

**Contractor's temporary site buildings & accommodation**

All buildings and equipment provided in accordance with this requirement shall be made available within 8 weeks following the commencement of the works at the site and must not be removed without the prior approval of the Employer.

All temporary buildings, structures, and equipment must be removed from the site to the Employer‟s approval and the site returned to its original state. All resulting debris shall be removed to an approved dumping area to the Employer‟s satisfaction.

The Contractor shall propose an area to the approval by the Employer for his site organization in the limits allocated for this purpose, for the storage of plant, equipment and materials during the execution of the Contract. The Contractor shall be responsible for the off-loading, transporting and handling of all the plant and equipment and materials needed for the purpose of the Contract.

Within the proposed area the Contractor shall provide and maintain an office appropriate to the efficient management and control of the project by his own staff.

The Contractor is to provide a site first aid station including an ambulance fitted with all essential facilities and the needed medical and paramedical personnel. The station shall be made available for the use of all personnel who shall be employed on the site for overall project works.

**Site fire protection**

See section Fire Fighting

**Temporary latrines and ablutions**

The temporary toilets and ablutions shall be provided for the use of the Contractor and his subcontractors.

The Contractor shall also include in his Contract the disposal of the sewage resulting from all temporary toilet and ablution facilities.

**Temporary electricity and water supplies**

The Employer will provide an interface for electricity demand for the Contract works. The Contractor shall provide the cables and equipment for construction power at Site, together with the supply to the Employer's and Engineer"s site office.

**Base case:**

Power supply for construction purposes will be provided at 33 kV voltage (2 no. of lines). The same will be extended to the Contractor for him to develop 33/11 kV sub-stations and construction power supply comprising of:

- Two (2) 5 MVA, 33/11 kV step-down transformers,
- Two (2) 11 kV switchgears,
- 11 kV main ring, design according to plant layout, construction requirement and schedule,
- 11kV/415 V step-down transformers (number and sizes as required according to plant layout, construction requirement),
- Two (2) 11 kV feeders (minimum 630 A), for usage of the Employer.

For improved reliability these feeders shall be connected to separate 11 kV bus systems at 33/11 kV sub-stations.

The electricity prices/power tariffs for the case of 33 kV voltage level are defined in the **Annex C**.

Further preliminary details regarding provided construction power system are shown in **Annex C**.

Construction Water:

Supply of construction water is in the scope of Contractor. It is not allowed to use ground water. For construction, only river water suitably treated for his purposes shall be used.

**Security fencing including gates and barriers**

Main plant and Township Boundary wall will be constructed by Employer. It consists of 3m high, plastered brick work with barbed wire on top. Location and Details are shown in **Annex C**.

All facilities, which are erected outside of the boundary wall, e.g. jetty area, intake structure, etc shall be enclosed by a boundary wall including access gates. The standard shall comply with boundary wall as provided by Employer.

Contractor shall propose suitable arrangement in line with his layout to secure the area from unauthorized access, except in ash pond area, subject to BIFPCL approval.

Watch Towers:

a) Watch towers to be provided at max. distance of 600 m and at every corner/bend.
b) Construction of Tower as per requirements, minimum 3 x 3 m area, 25 m height and external staircase.
c) Watch tower shall be RCC structure.

Fencing round Contractors material storage etc. shall be done by Contractor as required.

**Site visit**

Site visits by the Bidder are mandatory to.

- get sufficient knowledge about the conditions at the site
- get sufficient knowledge about the reachability of the site
- determine the effort of site investigation to be done by the Bidder.

Site visits have to be announced at least two days before targeted visit at BIFPCL. Transport to the site has to be organized by the Bidder.

**Site preparatory works**

Site was filled up to RL +5.50m in 2014. RL shall be considered same as M.S.L The surface of filling is uneven (more than +/- 10 cm). Swampy areas at the surface or below may be found. The contractor has to replace the swampy, soft soil with filling material (less than 5% silt).

Consolidation of soft soil/clay and settlement of soil has not finished yet. Required works in respect of leveling, filling, drainage, preloading, etc. shall be considered by Contractor in his work program.

Area of ash pond will not be filled by contractor. After checking the suitability the site the area shall be leveled and compacted by filling and cutting to a final level to be established upon a site survey.

**Survey works**

The coordinates of the envisaged site location are stated in **Annex C**.

The Contractor shall carry out close grid survey of the site to set up Plant Datum.

Plant elevation shall be defined as follows:

- finished ground level of the plant + 5.00 M above MSL
- plant level (turbine hall plinth level) + 5.60 M above MSL
- final level of road + 5.15 M above MSL
- final level of landscaping + 5.00 M above MSL
- final level of paving of power house block + 5.00 M above MSL.

Finished floors of the power island buildings at ground level shall be fixed at 0.00 m Plant Datum (PD), subject to optimization by the Contractor, and this PD being at least 0.60 m above ground level.

The Employer will furnish to the Contractor site investigations performed prior to the EPC Contract.

Nevertheless the Contractor shall carry out the necessary topographical survey works in order to obtain the following information:

- location of the plant site relative to the existing bench marks of the area
- establishment of site boundaries with site levels
- installation of site bench marks
- preparation of a site survey report, with the description of survey works, methods applied and survey map(s) on scale 1:500, showing the results with the location of bench marks
  The levels have to be given in an adequate scaled grid line system.

Moreover the Contractor shall carry out a bathymetric survey and all investigations required for the intake and outfall structures.

The full responsibility of the investigations to be carried out lies with the Contractor.

**Geotechnical investigations**

Geotechnical investigation at the site of the works has been carried out for the Employer (see **Annex C**). The investigation comprised boreholes with soil sampling, SPT testing in the main areas of the plant.

Geotechnical investigation data available as of now is of preliminary nature.

The existing information about subsoil conditions, quality of filling, water levels in the ground etc. are for information only, and is not binding during execution phase.

In case the Bidder needs more information for proper calculation of works during bidding process, additional investigations can be performed on his own expense. There are no restrictions about the investigations.

**The Bidder/Contractor is responsible for any matter of subsoil, filling and water in the ground.**

In general the subsoil conditions can be described as follows: top layer filled sand (with unknown silt content), underlying layers of clay, underlaying fine sand.

Hence, contractor has to carry out detail geotechnical investigation at his own cost. Methodology and Specification of investigation is subject to approval by the Employer Special attention should be paid to Seismic Parameters. Related to Soil Type as identified to Soil Investigation Report, the effect of local soils on earthquake ground motion shall be determined.

For site class S1 and S2, as expected for this project, site specific studies shall be carried out to determine Design acceleration response spectrum.

**Seismic Study**

The seismic study shall be performed by an accredited consultant with adequate references and experiences in equivalent projects.

Study area

The study area is defined with a radius of 200 km (incl. safe distance) around the power plant location at Mongla.

Geological structure model

The following data shall be obtained for the model:

- large-scale plate tectonic exposure for the study area
- small-scale micro plates are to be described or excluded
- existing faults, dislocations, drops and lineaments in the deeper and shallower subsurface
- lithological as well as stratigraphic structures for the deep subsurface layers up to Holocene boundary.

Based on the information, a litho-stratigraphic 3D model of the subsurface shall be developed up to the Holocene boundary.

Earthquake

All documented earthquakes in the study area shall be listed with their magnitude-height. A differentiation between the respective focal depth and the location of the epicenter (shallow or deep tremor) shall be considered. From the available seismic data, the energy values of the shear waves (maximum and average values) at the construction site shall be derived. Furthermore, the wave intervals between 4.0 s up to 10 min must be taken into account. Subsequently the thus obtained values must be transferred to the soil parameters.

Soil parameters

The grain size distribution, density and water content for the depth profiles of the boreholes and / or soundings shall be described in order to assess the possibility of a tendency to liquefaction of the soil. The soil must be tested for its damping characteristics in the laboratory. Transformations in the geotechnical characteristics must be documented.

All test results have to be evaluated for every individual building component of the proposed power plant complex according to the British Standard or the DIN EN ISO 1998 sheets 1- 6. Based on this evaluation recommendations for the construction of the individual components have to be given.

## 2.4.2.2 Earthworks

**General**

This section applies to all earthwork required for the construction of buildings, structures, pavements, road works, landscaping and burying service lines in the ground.

The Contractor shall satisfy himself as to the ground conditions on the site including the nature of the strata to be excavated, obstructions, possibilities of flooding and such like and shall allow for all provisions necessary to carry out the work in the most suitable manner.

Furthermore, this division applies to excavation works in connection with pavement, roadwork and landscaping.

**Leveling & grading**

**Fill materials**

The fill materials used are to be examined and approved. Excavated materials can be used if they fulfill the requirements as specified in Tender Documents. Material approval is required on site.
Source for fill material shall be determined by Contractor. All works related to transport and handling of filling material is in the scope of Bidder/Contractor.

- **Select fill**
  Select fill shall have the following properties:
  Well graded, non-cohesive and nearly silt free (silt content not greater than 5%; up to 10% tolerated, except below footings of structures), soils free of organic matter (limit 2%). Decomposing or compressible materials shall not be used.
  The material shall be of such nature and character that it can be compacted to the specified densities. It shall be free of highly plastic clays, of all materials subject to decay, decomposition or dissolution and of cinders or other materials which will corrode piping or other metal. The intention is to use select fill below structures, roads, parking areas etc.

- **Ordinary fill**
  Ordinary fill shall have the following properties:
  Natural inorganic soils: Organic matter less than 3%. For other properties see under 'Select fill'.
  The intention is to use ordinary fill for non-built areas.

- **Special fill**
  Special fill material shall be gravel or crushed rock.
  The intention is to use special fill e.g. as sub-base material for tanks, roads and switchyard areas.

Density requirements for filling shall be as follows:
80% relative density (ASTM D-4253 and D-4254) for free draining soils containing less than 15% by weight finer than 75 micron sieve non plastic material or 95% of the maximum density as determined by ASTM D-1557 for soils containing more than 15% material passing the 75 micron sieve.

**Execution**

The works shall be excavated either by hand or by use of excavating plant and tools acceptable to the Employer.

**Safety precaution**

The Contractor shall be responsible for all necessary safety measures. Proper strutting, sheeting and bracing, stabilization and protection of slopes, methods of excavation to reduce risks of slides, etc. shall be to the Contractor's debt.

**Over excavation**

If somewhere, and for any reason, excavation is executed beyond the established lines and without the Employer's previous approval, the Contractor shall at his own expenses backfill with approved material (including required compaction) or with lean concrete.

**Stockpiles and disposal**

Excavated material from the Works selected by the Employer for re-use shall be placed immediately in its final position, if possible, or otherwise may be stockpiled or deposited on Site as directed by the Employer.

Contractor shall remove the excess earth and deposit the excess earth at a location outside the plant boundary duly and in accordance with the local and environmental regulations and subject to BIFPCL approval

**Preparation of foundations**

All surfaces on which or against which concrete is to be poured shall be carefully cleaned and roughened and shall be free of any detrimental impurities, organic matter or unsuitable material to the Employer's satisfaction.

The surface shall be free of oil, stagnant or running water, mud, loose rock, residue and impurities or any other improper material.

Immediately after excavation, all such surfaces shall be moistened and treated as directed by the Employer and then protected by means of a lean concrete layer, 5 cm in thickness. No concrete is to be poured until formation is inspected and approved by the Employer.

**Backfilling**

Foundations and structures shall be backfilled with approved material compacted in layers by suitable equipment until optimum stability has been obtained to the satisfaction of the Employer. Compacting shall be carried out by means of pneumatic or mechanical rollers or other compactors of a type previously approved by the Employer.
Density requirements shall be as follows:

| | |
|---|---|
| • under buildings and structure foundations and slabs<br>• under roadways and parking areas<br>• under transformers and other major foundations | 85% relative density (ASTM D-4253 and D-4254) for free draining soils containing less than 15% by weight finer than 75 micron sieve non plastic material or 98% of the maximum density as determined by ASTM D-1557 for soils containing more than 15% material passing the 75 micron sieve. |
| • embankment | 80% relative density (ASTM D-4253 and D-4254) for free draining soils containing less than 15% by weight finer than 75 micron sieve non plastic material or 95% of the maximum density as determined by ASTM D-1557 for soils containing more than 15% material passing the 75 micron sieve. |

The thickness of fill layers, number of passes and type of equipment to be used shall be proposed to the Employer after compaction tests have been made.

Backfilling of foundation work shall be carried out only after foundations have been inspected by the Employer.

**Soil replacement**

The material to be used for replacement of soil shall not contain soluble or swelling components such as clays, or organic matters. Sand gravel mixtures of favorable grain size distribution shall be used in exchange.

Prior to the commencement of work, samples shall be taken from the anticipated borrow area and tested in respect of Proctor density, optimum moisture content, grain size distribution and content of soluble matters.

The fill material shall be placed in horizontal layers of no more than 25 cm in compacted thickness. The fill moisture content shall be controlled and adjusted in order to achieve a maximum of compaction.

The fill material shall be compacted by vibratory roller (min. weight 20 t).

**Tests and properties**

The Control of working and tests operations shall be carried out by the Contractor according to the respective standards in the presence of the Employer.

## 2.4.2.3 Foundations

**General**

Foundation design shall be based on approved geotechnical investigation report. The Contractor shall submit a detailed design for the foundation to the Employer for approval. The bid price for the piling shall be lump sum and shall remain firm irrespective of the type design.

Once the final plant layout has been established by the Contractor, he shall carry out a more detailed geotechnical investigation. The scheme of geotechnical investigation shall be prepared by the Contractor and will be subject to the Employer's review and approval

Information from the soil investigation performed in the year 2014 at this site is provided to the Bidders for information. Bidder may note the presence of thick deposit of soft clay as revealed through borelogs attached. The onus of correct assessment/ interpretation and understanding of the existing subsoil condition/data is on the Bidder. The Bidder should note that nothing extra whatsoever on account of variation between soil data collected by Employer and that found by the Bidder during additional soil investigation or during execution of works, shall be payable.

A study of soil liquefaction potential shall be performed using parameters from the geotechnical investigation performed by the Contractor and subject to the Employer's review and approval.

Special measures have to be taken if the results of soil and laboratory tests prove chemical aggressive conditions.

The soil conditions met during the foundation works are to be checked by the Contractor's soil engineer, recorded and compared with previous results. If essential differences occur, the Contractor has to inform the Employer and to propose further measures.

Immediately prior to concreting, the Contractor has to verify the specified soil conditions below the foundation level by a sounding.

Design of the foundations shall be in accordance with the latest DIN/Euro codes and/or other approved standards and codes of practice including the following:

| | |
|---|---|
| DIN 1054 | Subsoil: Permissible loading of subsoil; Load Testing of Piles (2005-01, Section 8). |
| DIN 1626 | Welded circular steel tubes subject to special requirements, technical delivery conditions. |
| DIN 1629 | Seamless circular steel tubes subject to special requirements, technical delivery conditions |
| DIN 4014 | Part 1: Bored piles: construction procedure, design and bearing behavior<br>Part 2: Bored piles: large bored piles: construction procedure, design and bearing behavior |
| DIN 4026 | Driven piles: Construction procedure, design and bearing behaviour. |

Furthermore, the ICE Specification for Piling and Embedded Retaining Walls (latest edition) shall be observed**.**

From the detailed study of the sub-surface ground conditions, the type of foundations required for each location shall be determined to suit the loads imposed.

The foundation/soil improvement could include any of the following:

- shallow foundations on existing ground/improved ground
- sand piles
- bored cast-in-place concrete piles
- driven piles
- vacuum consolidation.

The Contractor may propose any other type of foundation and ground improvement as required provided the proposal is based on proven engineering and acceptable standards and codes of practice. As a part of the design of the works and after fully detailed ground investigations, the Contractor shall submit for the Employer˝s approval a comprehensive foundation plan for the works proposing the type of foundation for each part of the works.

The mentioned pile capacity (Annex C) shall be read only as assumption and shall be considered for information only. Employer does not take any responsibility for these values.
It is in the scope and responsibility of the Bidder/Contractor to execute a soil investigation and perform his own design with related pile load capacities.
Responsibility related to soil remains with the contractor

The turbine/generator pedestal foundations shall be independent of the enclosing turbine building foundations.

All large tanks shall be dimensioned so that their aspect ratio (height/diameter) is less than about 0.4. The tanks can then be supported on ring type foundation under perimeter walls. The Contractor shall demonstrate the adequacy of the ring beam foundation, without piles, from total and differential settlement and will be subject to Employer's review and approval.

**Dewatering**
During the foundation works the excavated areas, foundation levels and pits are to be kept free of water down to at least 1.0 m below the foundation level.

**Damp proof course and Waterproofing**
All foundations, footings and slabs in contact with ground water shall be of water tight concrete in accordance with DIN 1045 or equivalent approved standards and shall be protected against water action and rising damp in accordance with:

- DIN 18195
- DIN 18336.

All foundations, footings and slabs in contact with ground shall receive a bituminous coating.
Damp proof course (DPC) thickness shall be applied to brick and block walls at about 300 mm above ground level to check rising damp. The DPC shall be in accordance with DIN 18195 or equivalent approved standards.

**Pitwall stability**
The excavated pit sides, walls or slopes have to be stable and established with respect to safety regulations.

**Settlement and expansion joints**

Joints are to be arranged in such a way that stresses and strains caused by settlements, temperature, differential settlement, etc. do not adversely affect the structures. The settlement joints shall run through the complete structure down to foundation level, the expansion joints however shall stop on the top level of foundations.

The joint width shall be at least 2 cm.

Settlements of all relevant structures shall be measured, recorded and shown in diagrams according to BS EN 1997-1 or other equivalent standards.

**Foundations at different depths**

Foundations at different levels should be based beyond a load spread angle of 30° (against the horizontal).

**Safety against uplift**

For all parts of the structures extending into the ground water, safety against uplift has to be guaranteed during all execution stages.

**Soil replacement**

If unsuitable soils are encountered below the foundation level or basement floor, they are to be replaced by suitable layer-wise compacted material down to the bearing soil.

## 2.4.2.4 Piling works

These specifications cover the requirements for the materials, the installation and the realization of bored cast-in-place concrete piles with grouting at the base, if required, and driven piles.

The piling works and design shall be in accordance with BS EN 1997-1 or equivalent.

Two types of piles foundation can be proposed and quoted by the Contractor: driven piles or cast-in-place bored piles.

The net vertical pile capacity computed from the soil investigation report is used to determine the maximum test load in case of piles testing.

**Bored cast-in-place piles**

The piles are drilled up to the depth indicated by the pile drawing submitted by the Contractor and approved by the Employer. For each pile, the Contractor draws up the geo-technical profile of the drilling with description of the strata and samples taken for each stratum as mentioned in the piling record item of these specifications. A representative sample from each stratum will be kept in tight packing until the end of the works.

A suitable type of drilling equipment shall be provided in order to penetrate obstacles (e.g. boulders) which may be met during the execution of the piles.

Generally drilling operations shall be carried out in such a way as to avoid any disturbance of the surrounding soil. A temporary casing shall be installed to the full depth of the borehole. The bottom of the casing shall always be kept sufficiently below the excavated borehole bottom, in order to prevent inflow or loosening of the adjacent soil.

When drilling below the groundwater table inside the casing shall always be maintained above the natural groundwater level by at least 1.5 m, i.e. water has to be added accordingly.

Just before reinforcing and start of concreting the pile foot is to be cleaned out so that no disturbed, loose or weak soil remains below the pile tip.

**Driven piles**

The weight of the falling mass must always be adequate to take down the piles at the depth defined at the project.

In case of damages to the adjacent piles, for example observation of concrete raising in the neighboring piles, the Contractor must alter the driving sequence.

The pile driving is carried out following a sequence in order to avoid, as much as possible, an increasing of the driving resistance for the last piles. Each pile has to be driven continuously until the specified depth has been reached.

The Contractor immediately informs the Employer in case any unexpected change in driving characteristics occurs and proposes methods to solve the problem. A detailed record of the driving resistance over the full length of the nearest available pile will be taken if required by the Employer.

The Contractor gives adequate notice and provides all facilities to enable the Employer to check driving resistances; a set of blows recordings is taken only in the presence of the Employer unless otherwise approved.

The final set of blows has to be recorded for each pile either as the penetration in millimeters per 10 blows or as the number of blows required to produce a penetration of 25 mm (see item on piling record of these specifications).

**Staking out-tolerances**

The landmarks to be used for the implementation of the piles must be effective, solid and well protected.

The method of location of the piles is a duty of the Contractor. The setting out has to be carried out from the main grid lines of the respective structures.

The maximum allowed deviation of the piles center from the theoretical location shown on the setting out drawing is 50 mm in any direction. The maximum permitted deviation of the completed pile from the vertical is 20 mm per meter (2.0%).

**Cut-off**

The piles are to be concreted up to a minimum of 60 cm above the cut-off level. The cut-off must eliminate all polluted or poor characteristics concrete at the top of the pile and should be carried 10 cm into sound concrete.

The concreting of the raft may start only after the cut-off of the pile and after obtaining a satisfactory resistance of the pile concrete.

The cut-off must be carefully performed according to a method approved by the Employer. The concrete in the head of the pile shall be carefully broken away from the reinforcement, which shall then be cleaned and bent as shown on the drawings or as directed. The concrete surface at the cut-off level shall be horizontal, plane and free from all loose aggregate.

**Piling Records**

For each pile, a piling record book giving the main checked values during execution shall be drawn up and updated by the Contractor with all the work hazards and incidents. That record book shall be submitted daily to the approval of the Engineer as the execution proceeds.

This record book shall include for each pile details on:

- location, reference number (corresponding to the number fixed on the drawing), type and diameter of the pile;
- length of the temporary casing;
- date and hour of start and end of each operation drilling, reinforcement setting, concreting;
- level from which the pile is bored or driven (platform level);
- level at the pile base;
- top level of the concreted pile before the cut-off operation;
- used materials (driving or drilling tools, concreting equipment);
- cleaning results of the bottom of the hole before putting down the reinforcement cage and before concreting;
- nature and description of the encountered soils;
- poured concrete volume and theoretical volume (measured concrete curves);
- behavior, workability, fluidity of concrete, results of the compression tests;
- water level within the hole before concreting;

- for driven piles, the refusals corresponding to the three last sets of blows (10 hammer blows) shall be noted for each pile; for one pile from each 20 piles, a driving diagram shall be drown up;
- type of boring-chisel, lengths of piles where chisel has been used.

Records shall be submitted in duplicate to the Engineer every following working day until 9 a.m.

The Contractor shall submit to the approval of the Employer/Engineer a proposal of piling record sheets including all the details mentioned above.

**Pile tests**

The Contractor shall carry out pile tests on a minimum of 0.5% of total no. of working piles of each type. The piles to be tested shall be to the approval of the Employer.

The tests shall include as minimum:

- compression load test at piles
- lateral load test at pedestal piles.

In addition, at least one Test Pile for each of the main structures shall be tested and approved before the commencement of the working piles for that structure.

The maximum test load shall be 2.5 times the working load for Test Piles and 1.5 times the working load for tests on working piles.

The loading materials and equipment, the measurement devices and procedures shall all be to the approval of the Employer. All tests shall be carried out only under the supervision of an experienced and qualified supervisor familiar with the test equipment and test procedure. All personnel operating the test equipment will have been trained in that field. The number of increments of load shall be a maximum of 25% of the design load,, with a decreasing of load down to zero after each increment.

In the case of a test failing to meet the set criteria, the Contractor shall propose for the approval of the Employer his plan for the necessary changes in the pile design without any cost implication to the Employer.

## 2.4.3 Concrete works

### 2.4.3.1 General

The concrete works shall be based on applicable approved codes and standards.

In general, the concrete for foundations shall be Grade 30. The type of cement to be used shall satisfy the requirements of the relevant international and local Standards or equivalent.

All materials used for concrete and reinforced concrete structures shall be of the best quality and free of defects likely to undermine the strength and shorten the service life of the works. The materials furnished shall comply with the agreed standards with the requirements of the soil investigation report regarding the aggressively of soil and water and with all requirements set out in these Specifications. The high sulfate content according water analysis shall be considered for concrete in contact with sea water.

All materials shall be stored and handled in a manner that will prevent contamination and/or deterioration. Deteriorated and/or contaminated material shall not be used for the concrete and shall be removed from the site at the expense of the Contractor.

All aggregate and sand used in the production of concrete shall be thoroughly tested for silica alkaline reaction, flakiness, aggregate crushing value etc.

The design and execution of the works shall consider a minimum development, the corrosion risks and the durability of the concrete and be based on the latest applicable approved codes and standards as listed in **Section B0**.

### 2.4.3.2 Materials for concrete

**Cement**

The cement used for concrete, reinforced concrete, mortar, grout and plaster (acid or see water resistant) works shall be Ordinary Portland Cement unless noted otherwise. The cement shall comply with EN 197-1. The manufacturer's test certificate will normally be accepted as proof of compliance with Specifications but the Employer may order further tests as specified in the relevant standards. The Contractor shall bear all expenses required for the preparation, dispatch, and tests of the samples.

The cement for underground concrete shall be Sulphate resisting type

(cement type V) as per ASTM C150 or equivalent.

All accepted cement shall be delivered to the site in strong, sealed, waterproof containers unless written approval to the contrary is given. All cement delivered shall be marked in accordance with standards, stating the following particulars: type of cement, strength category, manufacturer, weight, quality control marking, date and transport data.

The cement shall be protected against all impurities and dampness during transportation and storage on the site. Sufficient cement shall be stored on site to ensure continuity of the works and to allow testing of any consignment before it is required for use. All cement shall be fresh when delivered. Cements of different types shall not be mixed one with another. Consignments shall be used in order of delivery.

Cement shall be stored in bags or in unopened containers on a dry, raised platform in a well ventilated but watertight building.

Cement shall be kept in the store until actually required for use on the works and any cement temporarily placed near the mixer shall be adequately protected. Cement stored on site for a period longer than two months shall be laboratory tested before use.

**Water**

The water shall be clean and free of salt, oil or acid, organic material or other matter harmful to the finished product and shall be from a source approved by the Employer. The Contractor shall undertake tests to determine the sulfate content and acidity of the water and make adequate arrangements to deliver and store sufficient water at the work site for use in mixing and curing the concrete. Water shall comply with the requirements of BS EN 1008 or equivalent.

**Aggregates**

Materials used as aggregate shall be obtained from a source known to produce aggregate satisfactory for concrete and shall be chemically inert, strong, hard, durable, of limited porosity and free from adhering coats, clay lumps or organic impurities that may impair the strength or durability of the concrete. Aggregate shall comply with and be tested in accordance with the requirements of BS 812, BS 882, BS 1199 and BS 1200 or equivalent.

Each size of aggregate shall be separately stored in a manner that will prevent contamination, intermixing and/or segregation. The equipment and methods of handling aggregates shall be such as to prevent deterioration and contamination of the stockpiles.

Frequency of testing the aggregates shall be at least as follows:

| Frequency of testing | | |
|---|---|---|
| **Test Type** | **Coarse Aggregate** | **Fine Aggregate** |
| Grading of each | Daily | Daily |
| Grading of combined aggregates | Daily | Daily |
| Specific gravity | 7 days | 7 days |
| Magnesium sulphate soundness | 30 days | - |
| Clay silt and dust content | Daily | Daily |
| Shape (elongation and flakiness) | Twice a week | - |
| Los Angeles abrasion | Initially only | Initially only |
| Moisture content | 2 days | Daily |
| Drying shrinkage | Initially only | Initially only |
| Organic impurities | 30 days | 30 days |

Fine aggregate shall be clean natural sand or sand derived by crushing stone and shall consist of hard, dense, durable uncoated particles. Sand derived from stone unsuitable for coarse aggregate shall not be used as fine aggregate.

The grading of the aggregates shall be such as to produce a concrete of the specified proportions, which will work readily into position without segregation and without the use of excessive water content. Grading shall be controlled throughout the work so that it conforms closely to that used for the preliminary tests.

Washing, screening, classifying and other operations on the fine aggregate required to meet this specification shall be done by the Contractor. Washing is required if the content of salt and other impurities adhering to the aggregates exceed the level given in the standards.

Coarse aggregate shall be crushed or uncrushed gravel or crushed stone and shall be free of decomposed stone, clay, earth or other deleterious substances. The specific gravity of the coarse aggregate shall be not less than 2.5 $t/m^3$. Aggregate of crushed natural stone is deemed adequate if the stone reveals a crushing strength of 1000 $kg/cm^2$ when tested. Friable, flaky and laminated pieces, mica and shale shall only be present in such quantities as not to affect the strength and durability of the concrete.

The grading of coarse aggregate for concrete shall comply with the requirements of BS 882 or equivalent. Samples of aggregates shall be submitted to the Employer, together with a sieve analysis showing the proportion by weight passing sieves. Should it become necessary to change the source or characteristics of the material supplied, this shall only be done after additional tests.

**Concrete additives**

If necessary, concrete additives approved by the Employer could be used to improve consistency, workability, quality and strength of the concrete.

Waterproof concrete and mortar shall be used where necessary. Waterproofing shall be achieved by an approved brand of additive, which shall be used in accordance with the manufacturer's instructions.

Plasticizer/ superplasticizer cum water proofing additives of approved make shall conform to BS 934 or equivalent international standard

Accelerating and retarding additives shall only be used in case of necessity and after obtaining the written approval of the Employer.

In addition to the Concrete Additives mentioned in this clause bidder may use fly ash to improve quality of concrete.

**Plasticizers and air entraining additives**

Plasticizers and air entrainers are intended to reduce bleeding of free water at the surface. It shall only be used after the written approval of the Employer and in accordance with the manufacturer's instructions.

## 2.4.3.3 Concrete mixes

The mix proportions shall be determined by proper mix design based on the requirements for strength, workability and the particular site in which the concrete shall be placed. The design of mixes shall be based on the principles of BS 5328 or equivalent (e.g. DIN 1045), BS 8500 in addition to BS EN 206 and the British Building Research Station Publication: “Design of Normal Concrete Mixes”.

Before concreting commences, the Contractor shall make trial mixes to determine the mix proportions required to produce the strengths specified for each class of concrete and for each degree of workability required to allow placing transporting and compacting of the concrete. Only materials which the Contractor intends to use for concreting shall be used in the trial mixes.

Test cubes from trial mixes shall be made and tested in accordance with BS 1881 or equivalent (e.g. DIN 1048 Part 2).

The amount of water used in the concrete shall be adjusted as required to ensure such a consistency that it can be readily transported, placed and compacted without segregation of the materials or bleeding of free water at the surface. Addition of water to compensate for stiffening of the concrete before placing shall not be permitted. Consistency of the concrete shall be

checked by slump tests and shall not exceed the values given by BS 5328, BS 8500 in addition to BS EN 206 and BS 1881 or equivalent. Admixture for concrete to achieve requires slump shall conform to BS EN 934.

The cement and aggregate shall be thoroughly mixed in a batch-type pug mill mixer. The capacity of the mixer shall not be less than 1 (one) cubic meter. Partly set or excessively wet concrete shall not be used. No concrete shall be mixed by hand except some small quantities approved by the Employer, the proportion of cement in this case being increased by 10%.

The Contractor shall establish and maintain a field laboratory on the site and this laboratory shall be available at all times to the Employer. The laboratory shall be adequately equipped to ensure that all necessary testing work can be carried out in compliance with the standards.

## 2.4.3.4 Strength of concrete

All test cubes shall be made and tested for compressive strength in accordance with BS 1881 or equivalent.

The minimum required strength for different classes of concrete is as follows:

| Grade | Characteristic strength N/mm$^2$ | Lowest grade for compliance with appropriate use |
|---|---|---|
| 7 | 7.0 | lean concrete |
| 10 | 10.0 | plain mass concrete |
| 15 | 15.0 | reinforced concrete with lightweight aggregate |
| 25 | 25.0 | reinforced concrete with dense aggregate |
| 30 | 30.0 | reinforced concrete with dense aggregate (in contact with seawater, waste water and below ground level) |
| 35 | 35.0 | reinforced concrete with dense aggregate (Turbine Foundation, Boiler feed Pump Foundation) |
| 30 | 30.0 | pre-stressed concrete with post-tensioned tendons |
| 40 | 40.0 | pre-stressed concrete with pre-tensioned tendons |
| 50 | 50.0 | precast concrete members |

The characteristic strength shall be determined from test cubes of 150 mm nominal size at an age of 28 days.

| | |
|---|---|
| Mass concrete filling | C 8/10 |
| PCC below pilecap/foundations including TG foundations, Fan foundation and all vibratory foundations | C 10/15 |
| Pipe encasement | C 16/20 |

| | |
|---|---|
| PCC below Paving incl. plinth protection | C 10/15 |
| RCC in grade slabs | C 20/25 |
| Boiler/ESP area paving | C 20/25 |
| RCC for superstructure works in structural steel Buildings | C 30/37 |
| RCC in foundation and water retaining structures including piles | C 30/37 |
| RCC in superstructure works in RCC buildings | C 30/37 |
| RCC for dynamic foundation including column/deck (TG, Mill, Fan and BFP) | C 30/37 |
| Precast RCC trench covers | C 40/50 |
| Encasement of Base plate/Steel columns/ Wall beams | C 20/25 |
| Drain / cable trench | C 25/30 |

### 2.4.3.5 Transport of concrete

Immediately after mixing, the concrete shall be conveyed to the place of use as rapidly as possible using methods, which will prevent the segregation, loss or contamination of materials. The concrete shall be placed and compacted within 30 minutes of the addition of water to the mix. Any concrete left unplaced after this time shall be rejected and removed from the site.

The concrete shall be transported in clean metal buckets, barrows, dumpers, or trucks. Before using concrete pumps, placer pipelines, chutes or spouts it is necessary to have the written approval of the Employer.

### 2.4.3.6 Concreting operations

All concreting methods shall be subject to the approval of the Employer.

Concrete placing shall not be started until the Employer has approved all preparation of forms, reinforcement, joints and all mixing, conveying, spreading, curing, finishing and protection equipment.

Concrete shall be placed in the forms as close as possible to its final position in a single operation to the full thickness of slabs and beams and shall be placed in horizontal layers, not exceeding 2.5 m height in a single pour in walls, columns and similar members.

The Contractor shall organize the pouring of concrete in such a manner that once concreting of a section has started the operation shall be continuous and each operation shall be completed prior to a stoppage.

Where specified on the drawings, construction, expansion or contraction

joints shall be provided and the concrete shall be poured continuously between two adjacent joints. No other joints than shown on the drawings shall be permitted. Stoppage (cold) joints formed between two concreting operations separated by more than six hours time shall be subject to the same treatment as the construction joints.

Concrete which has partially hardened shall not be exposed to injurious vibration or shock, except for controlled re-vibration where specified. When concreting of a certain large structural element is specified strictly as to be poured continuously, then the concreting operations shall be organized for day and night working, in long shifts, as necessary.

Ultrasonic pulse velocity test shall be carried as per BS EN 12504 for the top decks of all machine foundation viz. TG substructures, BFP foundation, ID, FD and PA FAN and mill foundations to ascertain homogeneity and integrity of the concrete.
As concrete is being placed it shall be compacted by mechanical vibrators, to obtain a dense material free from honeycombing and without water or air holes.

The Contractor shall ensure that the vibrators are used in such reinforcement is not displaced, the formwork not damaged and no segregation caused, but complete compaction of the concrete is achieved.

The concrete face shall have the finishes indicated on the drawings or in the present Specifications. The finished surface of the concrete shall be sound, solid and free from honeycombing, protuberances, air holes or exposed aggregate. No plastering, cement wash, mortar or paint shall be applied to cover defective concrete surfaces.

**Construction, expansion and contraction joints**

The number of construction joints shall be kept as low as possible consistent with reasonable precautions against shrinkage. Concreting shall be carried out continuously up to construction joints.

Where it is necessary to introduce construction joints, careful consideration shall be given to their exact location, which shall be indicated on the drawings. Alternatively, the location of joints shall be subject to agreement between the Employer and the Contractor before any work commences.

Immediately prior to recommencement of concreting on a joint, the surface of the concrete against which new concrete will be cast shall be free from laitance and be roughened to the extent that the largest aggregate is exposed but not disturbed. Care shall be taken that the joint surface is clean immediately before the fresh concrete is placed against it.

Expansion joints, contraction joints and otherwise permanent structure joints shall be provided at positions shown in the drawings. Joints shall be straight and vertical, except where otherwise specified and concrete surfaces on both sides of the joint shall be flush. Where necessary, water stops of a type approved by the Employer shall be embedded in the concrete. To ensure a good tightness with or without movement of the joints, the PVC water stop shall be provided with anchor parts. The PVC water stops at construction joint shall be 150 mm wide and 6 mm thick and at expansion joint shall be 230 mm wide and 8 mm thick.

In case of expansion joints, preformed bitumen impregnated fibre board shall be used as joint filler. The joints shall be sealed with bitumen sealing compound, however in case of liquid retaining/carrying structures, two parts polysulphide sealant or silicon sealing compound shall be used.

**Concreting at night**

When approval is given to carry out concreting operations at night or in places where daylight is excluded, the Contractor shall provide adequate lighting at all points of mixing, transportation and placing of concrete.

**Concreting in high ambient temperature**

For concreting in high ambient temperatures the “ACI Standard 305 – Concreting in Hot Weather” shall apply.

The Contractor shall take special measures in the mixing, placing and curing of concrete; alternatively all pouring and finishing works shall be done at night. These measures shall include the shading of aggregates, spraying of aggregates with water, cooling of the mix constituents (introduction of ice to the mixing water) and reduction of transportation time to the minimum.

During pouring suitable measures shall be provided to prevent setting of concrete placed in contact with hot surfaces. All concreting areas, formwork and reinforcement shall be shielded from the direct sun rays and sprayed with water when necessary.

The temperature of fresh concrete used for top decks of TG foundation shall not exceed 25 degree Centigrade when placed. For maintaining the temperature of 25 degree centigrade in the top decks of TG foundation, crushed ice shall be used in mixing water and cooling of aggregate.

**Concrete subject to chemical attack**

Concrete with increased resistance to chemical attack shall meet the provisions of DIN 1045 or equivalent. Liquids, soils and vapours aggressive to concrete should be judged in accordance with DIN 4030 and be classified according to 'mild', 'severe' and 'very severe' attacks.

The resistance of concrete to chemical attack depends on its imperviousness. The concrete must be at least sufficiently dense to ensure that the maximum depth of water penetration tested according to DIN 1048, does not exceed 6 mm in the case of mild attack nor 3 mm when exposed to severe attack.

Concrete, which is likely to be exposed to severe chemical attack for a prolonged period shall be suitably protected by an adequate coating system, and this shall be subject to the Employer˝s approval.

All vertical concrete surfaces in contact with soil shall receive two coats of bituminous coating @ 1.7kg/sqm with 1% antistripping compound. Soffit and side of foundations shall be protected by means of suitable membrane installation. For basements of buildings and water tight basins protection of concrete surfaces below ground level shall consist of an approved self-adhesive pressure sensitive membrane. The membrane shall adhere to all concrete surfaces, including undersides of structures and other surfaces where concrete is cast in contact with the membrane. The membranes shall be installed strictly to the manufacturer˝s instructions. The membranes shall extend 150 mm above ground level.

All exposed concrete surfaces above ground (foundations, superstructures, etc.) shall be protected by epoxy coating with a compatible primer penetrating into the concrete. The epoxy coating must be able to bridge the maximum allowable crack width. The minimum thickness of this coating shall be 300 microns.

Alternatively, where appropriate the concrete surfaces shall be protected with approved tiles. In case any structural parts of concrete are likely to be exposed to chemical attack, crack width for such structural parts shall be designed not to exceed the dimension prescribed by the coating manufacturer.

**Concreting under water**

Underwater placing of concrete may be allowed for un-reinforced components, or as approved by the Employer. The placing being performed exclusively with stationary tremies and shall be in accordance with the requirements of relevant standards.

The min. cement content shall be increased by 50 kg/$m^3$ for underwater concrete.

Underwater concrete is to be placed continuously without interruption.

The concrete is to be placed in such a way that is does not fall freely through the water. The tremies must at all times dip sufficiently far into the freshly placed concrete to ensure that the concrete emerging from the tremie does not come into contact with the water. All work connected with the placing of concrete under water shall be designed, directed and inspected with due regard to local circumstances and purposes. Work shall not proceed until all phases and methods to be used in the placing operations have been approved

by the Employer.

**Protective measures for concrete**

In general the cover of rebars shall be as per BS EN 1992-1-1 or equivalent taking into account the site conditions (high temperature, humidity).

Immediately after the compaction of the concrete has been finished, the Contractor shall ensure adequate protection from the weather. Excessive drying can lead to crack formation as a result of plastic contraction. The concrete surface shall be covered with a layer of sacking, canvas, straw mats or similar absorbent material, special protection sprays or a layer of sand kept constantly moist for at least 14 days.

Curing compounds or other methods of preventing evaporation may be used if approved by the Employer.

Where large sections of concrete are poured, special precautions subject to the approval of the Employer shall be taken to reduce and dissipate the heat generated by setting and hardening of the concrete.

**Repair of damaged or defective concrete**

Concrete which has completed its final setting shall be inspected by the Employer and any cracks, honeycomb areas, segregations, etc. shall be marked. No repairs shall be carried out until so directed by the Employer.

**Dimensional tolerances**

The permissible tolerances shall comply with the BS 5606 and BS EN 1992-1-1 or equivalent.

## 2.4.3.7 Finishing of concrete surfaces

The concrete face shall have the finish indicated on the drawings or in the specifications.

All surfaces, which may come into contact with oil or oily water, will have to be adequately protected (paint, etc.). The finished surface of all concrete work shall be sound and free of defects. No plastering, cement wash or mortar shall be applied to cover defective concrete faces.

The fairfaced concrete in superstructure which is placed against shuttering shall be rubbed down with a carborundum stone immediately upon removal of the shuttering to remove fins or other irregularities. The face of the concrete for which shuttering is not provided, other than slabs, shall be smoothed with a wooden flat to give a finish equal to that of the rubbed down face where shuttering is provided. The cavities left by formwork fixing devices shall be made good closing the hole with plastic plugs and epoxy mortar. In watertight concrete structures the formwork fixing devices shall be of such a design as not to leave any holes after removing the shuttering.

All exterior corners of reinforced concrete shall be chamfered at least 25 mm x 25 mm, at stair treads 10 mm x 10 mm.
The top or final surface of all concrete works shall be finished by screeding, or floating, or trowelling or grinding, or tooling as approved by the Employer.

Dry cement or cement and sand shall not be used to dry excess water on the concrete surface.

Floors and slabs, which are required to be finished smooth, shall be trowelled just before the setting of the concrete.

| | |
|---|---|
| Screeding: | This shall be executed by moving a straight edge or template by hand or by mechanical means immediately after compaction of the concrete. |
| Floating: | This shall follow screeding, but shall not be started until some stiffening of the concrete has taken place. |
| Trowelling: | Where specified as necessary, floating shall be followed by finishing until a smooth surface free from defects is obtained. |
| Grinding and tooling: | Where specified, the methods to produce the desired surface shall be approved by the Employer. Grinding and/or tooling shall not start until the concrete has hardened sufficiently to prevent dislodgment of the aggregate. |
| Chiseling: | Wherever possible all chiseling works shall be carried out with mechanical devices. Manual chiseling may be required at difficult points. |

**Exposed concrete surface treatment**
Exposed concrete surface of a structure shall be coated with an approved clear silicone water repellent suitable for application on the concrete.

## 2.4.3.8 Formwork

**Design and construction**
For the proof of stability and for the type of formwork and support framing used, BS 3809, BS EN 13168:2012+A1:2015 or equivalent shall be used.

The formwork and the supporting structure shall be so dimensioned as to be able to withstand all vertical and horizontal forces safely shall be sufficiently rigid to maintain the forms in their correct position and to be true to shape and dimensions so that the final concrete is within the limits of the dimensional tolerances specified in Clause "Dimensional tolerances" herein.

The Contractor shall submit for the approval of the Employer the calculations, designs and details of the methods adopted and materials proposed for the formwork.

Removable type formwork shall be used for all cast-in-situ concreting works. In case lost formwork shall be used, approval from Client is required.

Forms shall be constructed from steel or from sound timber well seasoned and free from shakes. Plywood lining for forms shall be of timber, which is resin bonded and water repellent. Formwork surfaces in contact with

concrete shall be free from adhering grout, projecting nails, splits or other defects.

Joints shall be sufficiently tight to prevent the leakage of cement grout.

Before concrete is placed, all formwork shall be inspected to see if it is built according to the approved plans and to see if it has been cleaned and is free of sawdust, shavings, dust, mud, earth or other contamination and properly oiled. Contact surfaces of panels shall be treated with a suitable release agent (e.g. non staining mineral oil) where applicable. Surfaces, which are not oiled, shall be wetted thoroughly to prevent warping.

If the formwork for columns is erected to the full height of the columns, one side shall be provided with openings for concreting in order to guarantee a proper compaction of the poured concrete.

Formwork for walls and elsewhere shall be arranged for a as large as possible concreting height of one floor level in a single pour. Where necessary, panel openings shall be provided in the forms for cleaning, inspection, access of vibrators, etc.

Before placing of concrete, bolts, ties and fixings shall be positioned and all devices used for forming openings, holes, pockets, chases, recesses, etc. shall be fixed to the formwork carefully.

Where concrete surfaces will be exposed to view (permanently exposed surfaces) the formwork shall be such as to produce a completely true, smooth surface, free from perceptible irregularities or to show clearly the desired texture. Such formwork shall be marked on drawings as "Fair-faced Formwork".

Internal spacers and ties, if any, shall be so arranged that after removing of the forms no holes shall extend through the concrete, in the case of watertight concrete or be closed by plastic plugs and epoxy mortar in all other cases. All formwork will be inspected and approved by the Employer before concrete placing commences but this shall not relieve the Contractor of any of his responsibilities under the contract.

Formwork shall not be removed until the concrete has sufficient strength to carry its own weight plus any constructional or design loads which it is likely to be subjected to it with a normal factor of safety. It shall be removed in such a manner that no shock or damage shall result to the concrete.

Before removal of the formwork the concrete shall be examined and removal shall proceed only on the instructions and under the supervision of a competent person.

The minimum period for striking the formwork (cast-in-situ concrete made with Ordinary Portland Cement) under specified conditions may be taken as follows:

- soffit formwork to slabs 4 days (*)
- soffit formwork to beams 10 days (*)
- vertical formwork to columns, walls and large beams 1 day
- props to slabs 10 days
- props to beams 14 days
- (*) props left under

Extreme care shall be taken to avoid chipping of corners during removal of formwork.

## 2.4.3.9 Reinforcing steel

Reinforcing steel used in reinforced concrete shall be of grade B500B conforming to BS 4449 latest.

All reinforcement shall be hammered free of scale, scraped and wire brushed free of all loose rust and after such treatment shall be within the margins allowed by the Standards. The reinforcing steel shall be free of oil, grease or preservative coatings.

The Contractor shall supply the Employer with the manufacturer's certificate stating the process of manufacture and a test sheet giving the results of each of the materials purchased and, when required, the chemical analysis and all tests as specified in the relevant standards.

In particular it shall be possible to derive the following data from the stress-deformation curves:

- ultimate tensile strength

- guaranteed yield stress
- permissible stress
- elongation.

Reinforcing bars shall be transported and stored so that they remain clean, straight, undamaged and free of corrosion, rust or scale.

Reinforcement shall be cut and/or bent in accordance with BS 8666 or equivalent standards.
Reinforcement shall be accurately fixed and secured against displacement in the position shown in the drawings by means of spacers, chairs or other supports in order to maintain the reinforcement in its correct position, within a tolerance of 3 mm. For the distance between the bars (horizontal and vertical distances), the requirements according applicable standards shall be observed. Jointing of reinforcement bars by welding on site shall be avoided if possible, but where necessary the requirements of BS EN 1992-1-1 or equivalent standards have to be observed.

Where reinforcement is to remain exposed to the weather for a prolonged period, a thick cement grout shall be applied to the bars.

**Grounding of reinforcement**
Reinforcement shall be grounded according to the requirements laid down in other parts of these specifications.

## 2.4.3.10 Durability of concrete

All measures necessary in the design and selection of materials including the following shall be taken to ensure the required durability of concrete for the various concrete elements:

- Maximum crack width in the design of all reinforced concrete for structures in contact with water or chemicals and for major structures shall be kept below 0.20 mm. This value might have to be varied depending of the required coating system (e.g. stack).
- In general, reinforcement for cast-in-place concrete shall have a minimum cover of 40 mm. However, cover for thin panels like concrete slabs, concrete walls etc shall be 25 mm. For concrete in contact with the ground or sea water, the minimum cover shall be 75 mm.
- specify clearly location of expansion and construction joints and their surface preparation
- specify foundation surface coating and of concrete surfaces above ground
- specify type of cement appropriate for the ground water, the soil conditions and ambient temperatures
- use smaller size reinforcing bars well distributed in the tensile zone
- limit the tensile stress in reinforcement

- ensure adequate slope for concrete surfaces likely to receive rainwater or chemicals
- provide chamfers at all concrete edges
- provide strict measures for concrete curing to prevent plastic shrinkage and thermal gradients resulting from early age heat of hydration of the fresh concrete.

## 2.4.3.11 Roof -Waterproofing

Roof water proofing treatment shall be as follows:

a) For roofs having structural slope:
Over the top surface of sloped R.C.C. slab extruded polystyrene insulation of 75 mm thickness shall be provided. Top surface of polystyrene block shall be finished with 15mm thick cement plaster (1:4). Over the finished surface PU based water proofing treatment shall be applied. This treatment shall include one coat of polyurethane or any other equivalent material based primer with an application rate of minimum 6 sq.m per litre and two successive liquid coatings of high solids content urethane pre-polymers or equivalent material based finish coats as per relevant ASTM standards to form an elastomeric membrane with overall dry film thickness of 1.5 mm. Top of the elastomeric membrane shall be finished with 25mm thick PCC (1:2:4) cast in panels of maximum 1.2 x 1.2m size and reinforced with 0.56mm dia galvanised chicken wire mesh and sealing of joints using sealing compound. However, chequered concrete tile flooring 22 mm (min.) thick of approved colour and shade shall be provided for path way of 1 meter width for access of personnel and handling of equipment and for the entire area of the roof where equipment like AC /Ventilation plant, cooling towers, etc. are provided in place of PCC wearing course. Equipment shall be installed on raised pedestal of minimum 30 cm height from the finished roof to facilitate maintenance of roof treatment in future.

b) For roofs having no structural slope:
Screed concrete 1:2:4 (1 part cement, 2 part sand, 4 parts of aggregate by volume) having minimum 25mm thickness at the lowest point of the slope shall be laid over R.C.C. Over the top surface of screed extruded polystyrene insulation of 75 mm thickness shall be provided. Top surface of polystyrene block shall be finished with 15mm thick cement plaster (1:4). Over the finished surface PU based water proofing treatment shall be applied. This treatment shall include one coat of polyurethane or any other equivalent material based primer with an application rate of minimum 6 sq.m per litre and two successive liquid coatings of high solids content urethane pre-polymers or equivalent material based finish coats as per relevant ASTM standards to form an elastomeric membrane with overall dry film thickness of 1.5 mm. Top of the elastomeric membrane shall be finished with 25mm thick PCC (1:2:4) cast in panels of maximum 1.2 x 1.2m

size and reinforced with 0.56mm dia galvanised chicken wire mesh and sealing of joints using sealing compound. However, chequered concrete tile flooring 22 mm (min.) thick of approved colour and shade shall be provided for path way of 1 meter width for access of personnel and handling of equipment and for the entire area of the roof where equipment like AC /Ventilation plant, cooling towers, etc. are provided in place of PCC wearing course. Equipment shall be installed on raised pedestal of minimum 30 cm height from the finished roof to facilitate maintenance of roof treatment in future.

## 2.4.4 Structural steel works

### 2.4.4.1 Materials

All ferrous materials, their dimensions, forms, weights, tolerances, chemical and mechanical properties, shall be the best of their kind, complying with relevant international Standards.

All structural steel material shall be grade S275-JR+AR for Rolled sections & plates upto 20mm thickness, S275-J0+N for plates above 20mm and S275-J2+N for plates used in Gantry girder as per BS EN10025-2.

In the case of structural steel work, care shall be taken that all parts in the assembly fit accurately together and corresponding parts shall preferably be interchangeable.

The Contractor shall submit to the Employer for approval the country of origin and manufacturer of the steel he proposes to supply.

The structural steelwork and testing shall comply with the relevant clauses of BS 4, BS EN 10162, BS 4360 and BS 6323, BS EN 10025-1:2004, BS EN 10130:2006 or equivalent standards.

Each steel part shall be marked with the manufacturer's name or trademark.

The steelwork shall be manufactured by a specialist firm approved beforehand by the Employer. As much of the work of manufacturing of the steelwork as is reasonably and technically practicable shall be executed in the manufacturer's works, and facilities for inspection by the Employer shall be provided.

All steelwork before and after manufacturing shall be smooth, undeformed, straight and free of cracks, twist and burrs. All steelwork shall be cut and fabricated to a tolerance of ± 1.5 mm in its length. All plates shall be truly at

right angles to the longitudinal axis of the section. No work shall be painted, packed or dispatched from the manufacturer's works until it has been inspected and complies with or has been certified to comply with all the tests and requirements of the standard applicable to the material specified and until it has been inspected and approved.

**Tests**

The manufacturer's test certificate for all steelwork shall be supplied to the Employer. The certificates shall state the manufacturing process and shall include a test sheet giving the results of the mechanical tests and the chemical composition. The Contractor shall provide free of charge any supplementary tests reasonably required by the Employer. Steel which do not conform to the specified standards shall be rejected at the expense of the Contractor. No steelwork shall be delivered from the manufacturer's works until it has been tested and the results comply with the requirements of the relevant standards.

## 2.4.4.2 Workmanship

**Tolerances**

Care shall be taken to ensure that the tolerances specified on the drawings or the relevant standards are worked to. The erection tolerance for cleated ends of members connecting steel shall be not greater than 2 mm at each end. No work shall be painted, packed or dispatched from the manufacturer's works until it has been tested and complies with all requirements of the standards.

**Cutting**

Cutting may be by shearing, cropping, sawing or machine flame cutting. Hand flame cutting shall be avoided. If rolled products for steel structures under predominantly static loading are cut by flame-cutting or shearing there will generally be no need for a finishing operation if the cut surface is free of defects.

**Bolting**

The threaded portion of each bolt shall project through the nut by at least one thread. Approved high strength friction grip bolts, preferably the type with indicated load, shall be used where specified and shall be tightened strictly in accordance with the manufacturer's instructions and the relevant regulations. The surfaces in contact shall not be painted and shall be free of oil , dirt, loose rust, burrs and other defects, which would prevent proper seating of the parts or interfere with the development of friction between them. When connections are made using high strength friction grip bolts the relevant standards shall be observed.

**Welding**

The execution and testing of welding shall be in accordance with BS EN 1011-1, BS EN 1011-2 or equivalent standards.

All welds, unless otherwise stated shall be continuous minimum 6 mm fillet weld and shall be dressed smooth, free of porosity, cracks, holes and finished to match adjacent surfaces. When welding operations are completed, all welding flux shall be removed without delay. Cooling of welds shall not be accelerated by any special measures.
Site welding shall be restricted to the absolute minimum. Site welding is subject to approval by Employer. The examination of welded work and the inspection of welds during and after manufacture shall be carried out by responsible specialist welding engineers. Welding shall be carried out by expert trades men and in strict accordance with the current code of practice.

**Painting**

Surface treatment and painting before and after delivery to site shall be in accordance with Section B0.

Parts to be encased in concrete shall not be painted or oiled. Surfaces inaccessible after shop assembly shall receive the full-specified protective treatment before assembly.

**Erection**

The Contractor shall supply all suitable plant, hoisting gears and tackles for the erection of the steelwork and shall provide all temporary baulks, struts, shores, etc.

Steelwork damaged due to inadequate precautions being taken during the storage, transport and erection of the steelwork shall be made good to the satisfaction of the Employer at the Contractor's expense.

All shop connections shall be made by electric welding. All site connections shall be bolted unless otherwise specified in drawings or directed by the Employer.

Encased steelwork and steel in foundations shall be solidly encased in concrete with a minimum cover of 100 mm. Anchors of the required structural strength shall be used as holding down anchors in concrete foundations for columns. Sole plate of the column shall be grouted with low shrinkage grout of 50 mm nominal thickness.

Top of pedestal for building structures will be kept at lower level so that column base plate together with gussets and stiffeners remain below FFL.

The column bases as well as column section shall be encased in concrete above FFL as per following:

a) Open area :300mm above paved level
b) Covered area : 150mm above FFL
c) Stair and ladder pedestal will be kept 200mm above FFL.
d) Pedestals to steel column for equipment structures:
   i) Equipment in open area : as required (minimum 300mm)
   ii) Equipment in covered area: as required (minimum 150mm)

The grout shall be shaped with an inclination of 45°from the lower edge of the sole plate to avoid stagnant water.

**Rejection**

Any steelwork, which in the opinion of the Employer is not in accordance with the requirements of the standards or with the specifications, shall be mandatory rejected and removed from the site at the Contractor's expense.

## 2.4.4.3 Small non-structural steel parts

**General**

This Clause refers to the specifications covering the provision of all materials and labor in relation to supply and manufacture on site of articles made of steel or cast iron.

All steel structures and parts specified under this clause shall be hot dip galvanized and painted according to **Section B0.**

The list of small items to be furnished shall contain but not be limited to the following:

- steel sections, bent plate sections and square bars for construction of:
  - metallic stairs, platforms and walkways
  - railing for stairs, platforms, walkways and protective around floor openings
  - corner and edge protection for concrete steps and concrete
  - structural parts such as columns, beams, removable cover slabs, etc.
  - support of any equipment foundation
  - joint covers
  - anchors, ties, hangers, inserts, slots, embedded steel parts, etc.
- steel pipes and plain round bars for making guardrails and ladders
- steel plates, chequered and/or flat, for fabrication of removable covers
- open steel grating for metal steps, platforms, and walkways.

**Materials**

The requirements for materials of structural steel specified herein are applicable to all steel sections, bars, plates, pipes and any sections as far as their quality, source, dimensions, mechanical characteristics and their delivery, handling, storage and tests on site are concerned.

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## 2.4.4.4 Roof and wall cladding

**Metal cladding**

The insulated sandwich roof and wall construction shall consist of a double skin construction, rear ventilated and comprising the following:

**Internal liner profile:** trapezoidal profile min. 0.75 mm thick.

The internal sheet shall be a multilayer, protected metal system consisting of a trapezoidal galvanized steel substrate, heavy epoxy base coat and an internal decorative coat as follows:

**Substrate**

Hot-dipped galvanized steel substrate, with a minimum zinc coating weight of 275 g/$m^2$ total both sides. The steel substrate shall be min. 0.75 mm thick.

**Pre-treatment**

After cleaning, a ”chemical conversion” of the zinc coating to a non-metallic surface with corrosion inhibiting and adhesion additives shall be applied.

**Primer**

Nominal 8-micron thick anti-corrosive pigmented epoxy primer applied to both sides of the sheet.

**Epoxy barrier coat**

Nominal 70-micron thick TF Epoxy Barrier coat with special flexibilizer compounds applied to both sides of the sheet and baked to a hard corrosion resistant finish.

**Internal decorative coat of the interior profiled liner**

Nominal 20 micron stoving polyester decorative finish on inner exposed face of the sheet.

**External weathering profile:** trapezoidal profile min. 0.75 mm thick

The sheeting unit shall be a multilayer, protected metal system consisting of a trapezoidal galvanized steel substrate, heavy epoxy base coat and a high build weather coat of polyurethane as follows:

**Substrate**

Hot-dipped galvanized steel substrate, with a minimum zinc coating weight of 275 g/$m^2$ total both sides. The steel substrate shall be min. 0.75 mm thick.

**Pre-treatment**

After cleaning, a ”chemical conversion” of the zinc coating to a non-metallic surface with corrosion inhibiting and adhesion additives shall be applied.

**Primer**

Nominal 8-micron thick anti-corrosive pigmented epoxy primer applied to both sides of the sheet.

**Epoxy barrier coat**

Nominal 70-micron thick TF Epoxy Barrier coat with special flexibilizer compounds applied to both sides of the sheet and baked to a hard corrosion resistant finish.

**External weather coat**

Nominal 40 micron thick urethane exterior coating on outer exposed face of the sheet pigmented in one of the standard colors of the manufacturer's color range.

**Insulation core:** 60 mm (minimum) thick non-combustible material like glass wool or similar of density not less than 16 kg/$m^3$.

**Requirements for roofs**

These requirements apply to all roofs (not only for roof cladding).

The roof construction is to be such that, with due allowance for the climatic conditions and any air conditioning plant installed in the rooms, and with the intended use of the rooms taken into account, no damp will penetrate into the materials used.

All roofs must have a minimum sound absorbing index of 20 dB (A) and a maximum heat transmission coefficient of 0.45 W/$m^2$K. Appropriate insulation materials will have to be used to achieve the a.m. figures.

Bidder/Contractor shall provide insulation as required to fulfill requirements due to heat insulation or noise restrictions.

Bidder/Contractor shall provide a concept showing the requirements of each building to ensure that the design fulfils requirements of specification, local requirements, related codes and standards and EIA requirements.

Roof surfaces are to be designed with a min. slope of 3% for concrete roofs and 5% for metal roofing.

All roofs shall be suitable constructed to serve for PV-Modules. The roofs shall be able to mount the supporting structure and provide sufficient arrangements for operation and maintenance.

**Requirements for walls**

These requirements apply to all walls (not only for wall cladding). External walls are to be constructed that, taking into account the climatic conditions and any air conditioning plant installed in the rooms as well as the manner of use of the rooms, no damp will penetrate the walls. All external walls must have a minimum sound-absorbing index of 20 dB (A) and a maximum heat

transmission coefficient of 0.75 W/$m^2$ K. Appropriate insulation materials will have to be used to achieve the above mentioned figures.

Bidder/Contractor shall provide insulation as required to fulfill requirements due to heat insulation or noise restrictions.

Bidder/Contractor shall provide a concept showing the requirements of each building to ensure that the design fulfils requirements of specification, local requirements, related codes and standards and EIA requirements.

The walls shall not allow the passage of rain or moisture into the building. The walls shall be provided with all necessary horizontal and vertical damp-proof courses and flashings.

## 2.5 Masonry works

Autoclave aerated concrete (AAC) block masonry conforming to Category I of BS EN 771-4:2011+A1:2015 shall be used for external/internal masonry works. All external walls shall have a minimum sound-absorbing index of 20 dB (A). All external walls shall have a maximum heat transmission coefficient of 0.75 W/(sqm K). Autoclave aerated concrete (AAC) block masonry shall have minimum compressive strength of 4MPa.

Masonry work with brickwork shall be conforming to relevant BS code.

Encasement of structural member shall be done by brick/AAC block masonry work around flanges, webs etc. and filling the gap between steel and masonry by minimum 12mm thick mortar. Encased members shall be wrapped with chicken wire mesh with a lap of 50mm.

## 2.6 Plastering

The mix for plastering shall be as follows:

1. Outside plaster : 18mm thick in two coats in cement mortar 1:6
2. Inside plaster : 12mm thick in cement mortar 1:6
3. Concrete ceiling plaster: 6mm thick in cement mortar 1:4

Parapet, Chajjas over window and door heads, architectural facias, projections etc shall be provided with drip course in cement sand mortar 1:3.

## 2.7 Finishing works

**Floor and wall finishes**

The finishing works to be applied for the buildings and structures of the plant are listed below. Buildings or rooms not included, or special items, must be agreed with the Employer.

**Floor finishes (typical)**

| Room | Floor Finishes |
|---|---|
| Switchgear rooms | Epoxy screed (trowel applied minimum 5 mm thick) and epoxy seal coat |
| Neutralisation pit | 115 mm thick Acid Resistant bricks over 6 mm thick under bed of potassium silicate mortar |
| Pump house floors, cable vaults | Cement concrete flooring with metallic hardener |
| Rest room, toilets, kitchen mess room | Glazed non-slip fully vitrified ceramic tiles (7 mm thick). |
| Offices | Vitrified ceramic tiles (10 mm thick) |
| Corridors, stairs, landings | Vitrified ceramic tiles (floor tiles with epoxy grout) (7 mm thick) |
| Battery rooms | Acid resistant tiles (20 mm thick) |
| Control room, relay rooms, electrical equipment | Heavy duty PVC(2mm thick) sheeting on false floor (if required)<br>Vitrified ceramic tiles in main control rooms |
| A/C Plant rooms | Carborundum (25 mm thick heavy duty cement concrete tiles) |
| Instrument/electrical workrooms | Heavy duty PVC tiles (6.5 mm thick) |
| Stores workshop, mechanical work room and store room | Carborundum (25 mm thick heavy duty cement concrete tiles) with oil resistant epoxy coating (150 micron thick) |
| Transformer pits | Oil-proof hard-wearing epoxy coating (150 micron thick) |

- Total Floor finish (including underbed of cement mortar and top finish) shall be 50mm thick.
- Granite stone shall be 18 mm thick of approved color.

**Internal Finish**

| Area/Location | Internal Wall finish | Ceiling finish |
|---|---|---|
| Control rooms, LVAC rooms, computer rooms, restroom, administration areas, offices and similar rooms, corridors, instrument and electrical workrooms, mechanical workroom and storeroom. | Plaster, two coats of acrylic emulsion paint over polymer based putty | Acrylic distemper where no false ceiling is provided<br><br>For control room of Power House, combination of glass fiber gypsum plaster board (GRG) (12 mm thick) and pre coated (color) Aluminum false ceiling |
| Switchgear rooms, HVAC mechanical plant rooms, stores, pump houses, compressor house, air washer, Air handling room, cable vault and workshop | Fair faced block/brick work, cement wash (2 kg cement mixed to 1 Liter of water), two coats of acrylic distemper | Acrylic distemper |
| Toilets, washrooms, locker rooms, kitchen, etc. | Glazed ceramic tiles upto a level of 2.3m. Plaster and two coats of acrylic emulsion paint over polymer based putty in the remaining height | Acrylic distemper |
| Lead acid Battery room, waste treatment plant, laboratory, rooms where any chemicals are stored, handled or prepared. | 20 mm thick Acid resistant tiles over potassium silicate based cement mortar upto 1.2m height. Plaster and two coats of chlorinated rubber acid resistant paint over chlorinated rubber zinc phosphate primer in the remaining height | Two coats of chlorinated rubber acid resistant paint over chlorinated rubber zinc phosphate primer |
| Oil canal, oil room and other areas where oil spillage is likely to occur | Plaster and Epoxy based oil resistant paint (150 micron thickness) over epoxy primer upto 1.2 m height. Acrylic distemper on the remaining height | Acrylic distemper |

**External Finish**
The external finish of buildings with Autoclave aerated concrete blocks masonry (where no metal cladding or Aluminum composite panels are required as per the individual building description given above) shall be two coats of acrylic based weather coat paint.

## 2.8 Sanitary installations

The Western WCs closet seats and covers are to be of plastic of a color to match the tiles. The WCs shall be provided with hand spray with angle valve and hand trigger, 100 cm long hose, toilet roll holders made of chromium-plated brass to be fitted within convenient reach.

The Asian Squatting WCs are to be white ceramic plates (500 x 400 mm approx.) with raised treads for flush installation at floor level. The WCs shall be provided with hand spray with angle valve and hand trigger, 100cm long hose, toilet roll holders made of chromium-plated brass to be fitted within convenient reach.

Washbasins, minimum size 58 x 45 cm, are to be provided with a mixing tap. Above each washbasin is to be provided one mirror, minimum size 70 x 50 cm and one soap dispenser for fluid soap.

Bowl urinals are to be fitted with flushing devices.

Each toilet is to be equipped with one push button operated hot air hand dryer provided with overheating protection.

All rooms where leakages of liquids may occur (pump rooms, wash rooms, toilets, shower rooms, battery rooms, etc.) are to be provided with adequate floor drains, even if this does not result from the relevant civil drawings and/or from the written part of the specification.

## 2.9 Doors

**Metal doors**
All internal and exterior and safety doors shall be made of 45 mm thick flush design with double steel sheet walls, insulated with mineral wool.

Minimum nominal dimensions of doors shall be as follows:

| | |
|---|---|
| Single leaf doors: | width 1.01 m x height 2.135 m |
| double doors to rooms housing valves pumps and similar equipment: | width 2.2 m x height 2.135 m |
| double doors to rooms housing electrical equipment: | width 2.2 m x height 2.5m |

Steel parts of the doors shall be protected in accordance with the relevant section of the specification for coating of steel surfaces. All doors shall be fitted with approved locks and self closing mechanism.

Fire rated doors shall be all in accordance with the applicable regulations and standards and shall have glazing panel of the same fire resistance as that of the door: G30 or G90 to match T30 or T90.

All doors and gates shall be installed such that rain water penetration is avoided.
All doors shall meet the requirements of the applicable standards/ Bangladesh National Building code

Wooden doors shall be solid core flush door shutter having 35mm thick homogenous particle board conforming to Bangladesh National Building Code

Aluminum doors and windows shall be anodized and electro color coated as per relevant BS code.

Aluminum composite panel shall be of 4 mm total panel thickness with PVDF based coating.

All toilet doors shall be 25 thick PVC doors.

**Roller-shutter doors**

Large openings to buildings shall be fitted with electrically operated rolling shutters as appropriate. An escape door shall be provided next to each rolling shutter. The shutters shall be of double walled hollow sections of galvanized steel protected with coating in accordance with the **Section B0**.

Hand crank with continuous chain reel shall be fitted to operate the door by hand in case of emergency.

## 2.10 Windows

All windows shall be aluminum with double glazing which meet the requirements of the applicable standards/ Bangladesh National Building code. Each window shall have side and bottom sash fitting and shall safely absorb an impact force of at least 7.5 kN. Scissor type stay shall be designed to prevent the sash from dropping in case of malfunctioning.
The windows shall be resistant to pelting rain. Approved sunshade system shall be provided for windows facing east, west and south.

Window sill shall be of aluminum matching in color with that of the window on the outside and with the color of the room on the inside. Fastening devices for safety harness shall be provided on the exterior of the building for windows which cannot be cleaned from inside the building or from the floor outside.

### Glazing

1. Glazing of doors and partitions shall be done with 5.5 mm thick clear float glass. However, 12mm thick BWP particle board shall also be provided in some locations. However, the external doors shall have Hermetically sealed double glazing of of 6mm thick clear toughened glass on inner side and 6mm thick reflective toughened glass on outer side
2. Hermetically sealed double glazing of 4 mm thick float glass shall be used for windows located in ground floor and at accessible floors.
3. Windows and ventilators located at higher elevation where frequent replacement is not feasible, shall have hermetically sealed double glazing of 6mm thick clear toughened glass.
4. For glazing between Air Conditioned and Non air conditioned areas composite double glazing shall be 24mm thick consisting of 6mm thick clear toughened glass on inner side and 6mm thick reflective toughened glass on outer side. The two glasses shall be separated by 12mm air-gap and hermetically sealed by beading of anodized aluminum with outer edge sealed with silicon sealant.
5. 4mm thick single glazing of ground glass shall be provided for toilets.

## 2.11 Aviation warning lights

Aviation warning lights shall be provided for the stack and on all tall buildings and structures in accordance with the aviation safety requirements.

## 2.12 Earthing and lightning protection

All buildings and structures shall be provided with an adequate earthing and ightning protection system (see **Section B7**).

## 2.13 Roads and surfacing

**General**

The actual thickness of road-courses shall be calculated based on the results of the soil investigation, loads, intensity of traffic, design life, etc. the thickness of road-courses shall be in no case less than those of the existing roads in the zone of the plant.

The design of all pavements shall conform to the requirements of the American Association of State Highway and Transportation Officials (AASHTO), and Local Highway Requirements or local standards whichever is more stringent.

**Foundation bed**

The requirements for the particular road type and the recommendations of the soil investigation report have to be observed.

**Wearing course**

The requirements for the particular road type have to be observed as per the local standards and codes.

**Compaction of sub-grade**

The area for the roads shall be cleared of any material or obstructions, which in the opinion of the Employer might adversely affect the stability of the fill or pavement, and the top layer removed to a depth of 300 mm (or more if the design so required).

Any ruts or soft areas caused by improper drainage conditions, hauling or any other cause shall be corrected and rolled to the required compaction before sub-base is placed thereon.

The formation shall be compacted to a dry density of at least 95% of the maximum dry density.

**Tests for sub-grade**

The sub-grade compaction test and in-situ dry density tests on each layer of compacted material shall be carried out at an average of not less than 2 per 100 m length of carriageway.

**Sub-base**

Sub-base material shall be crushed rock or other approved local material having suitable properties and confirming to the following grading:

| Sieve [mm] | Percentage by Weight Passing |
|---|---|
| 75 | 100 |
| 37.5 | 85 - 100 |
| 10 | 45 - 100 |
| 5 | 25 - 85 |
| 0.6 | 8 - 45 |

| Sieve [mm] | Percentage by Weight Passing |
|---|---|
| 0.075 | 0 - 10 |

The material shall be spread evenly on the preceding material in layers not exceeding 150 mm compacted thickness.

The sub-base shall be compacted by approved plant to a dry density, which shall not be less than 98% relative compaction until movement of the surface ceases and the surface is closed. The CBR value shall be at least 30% at the optimum moisture content.

**Wet mix road base**

Wet Mix road base material shall consist of crushed gravel or crushed rock and shall be suitably proportioned to confirm to the following grading as approved by the Employer:

| BS Sieve Size [mm] | Percentage by Weight Passing |
|---|---|
| 50 | 100 |
| 37.5 | 90 - 100 |
| 20 | 60 - 80 |
| 10 | 40 - 60 |
| 5.00 | 25 - 40 |
| 2.36 | 15 - 30 |
| 0.600 | 8 - 22 |
| 0.075 | 0 - 8 |

The final surface shall be shaped and finished true to line and level within a tolerance of + 10 mm to the levels shown on the drawings.

**Placing of road base**

The compaction procedure and plant shall be proved by trials at the commencement of the Works.
Road base material shall be placed and spread evenly, without delay, using a paving machine or spreader box, operated with a mechanism which level off the material at an even depth and it shall be spread in layers not exceeding 150 mm compacted thickness. Segregation shall be avoided during transport and placing and any segregation evident after compaction shall be corrected by vibrating in non-plastic fines or made good by removing and replacing with properly graded material.

The road base shall achieve a minimum dry density of 98.1% of the maximum laboratory dry density.
Before placing the next construction layer or applying prime coat, the road base shall be mechanically swept, then cleaned with compressed air to remove loose material. As soon as possible after cleaning of the surface, the oad base shall be sealed by the application of a prime coat as specified.

**Chlorides and sulphates**

The level of chlorides and sulphates in the sub-base and wet mix road base shall be within the following limits:

| | Maximum by weight | |
|---|---|---|
| | **Sub-base** | **wet-mix road base** |
| Acid soluble chloride (NaCl) | 3.5% | 0.5% |
| Acid soluble sulphate ($SO_3$) | 2.0% | 0.5% |

**Hard shoulders**

The material used for any hard shoulders shall comply with the specification for wet-mix road base.

**Segmental Concrete Paving Block Surface**

For the stipulated requirements of the laying of the segmented concrete paving block surface, it is assumed that the sub-grade or sub-base has been properly constructed, that there are no soft or unstable areas and that the sub-grade or sub-base has been trimmed to within ±10mm of the specified level.

*Laying Pattern*

Unless otherwise approved, all blocks shall be laid in herringbone pattern. The blocks shall be laid against the edge restraint shown on the plans in order to prevent the outward migration of blocks. Areas against kerbs, manholes, etc. requiring infilling and which exceed 25% of a full block unit shall be filled with units cut to size using a mechanical or hydraulic guillotine, bolster or angle grinder. Infill areas constituting less than 25% of a full block area and of 25 mm minimum dimension shall be filled with

25 MPa concrete. Smaller areas shall be filled with cement mortar having proportions of 1 sack cement to 130 litre of good quality mortar sand.

*Bedding Sand*

Except for mine sand, sand for the bedding layer shall comply with the following grading limits:

| SIEVE SIZE (mm) | % PASSING |
|---|---|
| 9,52 | 100 |
| 4,75 | 95 -100 |
| 2,36 | 80 - 100 |
| 1,18 | 50 - 85 |
| 0,600 | 25 - 60 |
| 0,300 | 10 - 30 |
| 0,150 | 5 - 15 |
| 0,075 | 0 - 10 |

Mine sand may be used where experience has shown it to be satisfactory. The moisture content of the sand shall be 5 - 8%. Bedding sand shall be maintained in a loose condition and protected against pre-compaction. Any pre-compacted areas shall be removed and replaced. The loose sand-bedding layer shall be evenly laid and shall not be used to fill hollows in an uneven subgrade or subbase surface. The compacted sand layer shall have a thickness of not less than 15 mm and not more than 35 mm.

*Block Laying*

All blocks shall be laid true to line and level. Full blocks shall be laid first, care being taken that joint lines are straight and square. Disturbance of laid blocks shall be prevented and any areas distorted or damaged shall be lifted and re-laid by the Contractor. The maximum joint width shall be limited to 5 mm.

*Compaction of Blocks*

After laying the blocks, a mechanical flat plate vibrator shall be applied to the surface of the blocks to bed them. For block thicknesses up to and including 80 mm the vibrator shall be capable of producing a centrifugal force of approximately 7 to 16 kN at a frequency of approximately 75 - 100 Hz, the plate area being between 0,2 m² and 0,4 m². For greater thicknesses the required centrifugal force shall be 16 - 20 kN at a frequency of approximately 75 - 100 Hz, the plate are being between 0,35 and 0,5 m². Compaction of blocks shall follow block laying as closely as possible, but shall not be attempted within 1 m of the laying face. At the end of each day compaction must be completed up to within 1 m of the working face. All blocks damaged during the compaction process shall be removed and replaced. Sufficient passes shall be made to compact the block pavement fully and to produce an even surface. The number of passes shall, however, not be less than two.

*Jointing Sand*

Joints between blocks shall be filled with a 50-50 sand-cement mixture. The jointing sand shall pass a 1,18 mm sieve and contain 10 - 50% material

passing the 75 μm sieve. The sand shall be free of soluble salts or contaminants likely to cause efflorescence or staining. After initial vibration, joint filling sand shall be uniformly distributed over the surface of the pavement and brushed into the joints. Further passes of the plate vibrator shall be made to fill the joints, more sand being spread over the surface if required.

Excess sand shall be removed before the pavement is opened to traffic.

*Surface Tolerances*

Surface tolerances on the finished paving are based on the layer directly below the bedding sand complying with:

a) maximum deviation in surface level from the true surface level to be ±10 mm;
b) maximum deviation from a 3 m straight edge placed on the surface to be 10 mm, except where vertical curves necessitate a greater deviation;
c) the finished paving shall be so laid as to create a regular and smooth appearance.
d) Surface tolerances shall be as follows:

- maximum deviation in surface level from the true surface level to be ±10 mm, except immediately adjacent to gullies, where the tolerance shall be +3 mm and 0 mm
- maximum deviation from a 3 m straight edge placed on the surface to be 10 mm, except where vertical curves necessitate a greater deviation
- levels of adjacent blocks shall not differ by more than 3 mm
- the line of the pattern shall not deviate more than 15 mm from a 3 m straightedge.

*Site Clearance*

Before the pavement is opened to traffic the area shall be cleared of all debris and other waste and left in a tidy condition.

*Weed/Ant Poison*

An weed and ant poison approved by the Employer, shall be applied to the sand layer strictly in compliance with the manufacturer"s specification prior to block laying.

**Gravel Wearing Course Surface**

For this type of road surface, the road base shall be of an approved Gypsum gravel with a grading complying with a G4 quality natural gravel, the finished surface of which acts as the wearing course surface.

**New and existing pavement joints**

Where new bituminous pavement is required to join into existing road construction, each layer of existing bituminous course shall be cut back to a clean vertical face and coated with hot bitumen of a grade suitable for the

purpose immediately before laying the new bituminous material.

The existing pavement layers shall be cut back to form a stepped pattern. The lower layers of bituminous courses shall be prepared to receive the new covering coats by removal of dust and deleterious materials by air jetting or other approved means, and shall be coated with bituminous tack coat.

Exposed existing road base surfaces shall be scarified then re-compacted and sealed with bituminous prime coat in accordance with road base specification.

**Bitumen macadam**

Aggregate shall be hard, clean, durable crushed rock or gravel, and sand and shall be obtained from approved source which shall not include quarries containing significant proportions of weather bed, decomposed or extensively fractured materials.

Coarse aggregate is defined as that fraction retained on a 3.5 mm sieve. It shall have physical properties, which do not exceed the following test values:

| | Wearing course | Base course |
|---|---|---|
| Aggregate crushing value | 20% | 25% |
| Flakiness index | 25% | 30% |
| Elongation index | 25% | 30% |
| Water absorption | 2% | 2% |

Separate coarse and fine aggregate fractions shall be tested for soundness.

Wearing course shall be of min. 40 mm finished thickness; the aggregate grading shall be as follows:

| Test Sieve [mm] | Grading (20mm nominal size) % by weight passing |
|---|---|
| | |
| 28 | 100 |
| 20 | 95 - 100 |
| 14 | 70 - 90 |
| 10 | 55 - 75 |
| 6.3 | 40 - 60 |
| 3.35 | 25 - 40 |
| 1.18 | 15 - 30 |
| 0.075 | 2 - 6 |

**Composition of bitumen macadam**

Mixes shall be submitted for approval and proved by means of laboratory, plant and field trials.

The designed mixes shall comply with the following:

| | Binder Course | Wearing Course |
|---|---|---|
| Voids in mix [%] | 7 - 10 | 5 - 8 |
| Voids in mixed aggregate [%] | 14 - 20 | 14 - 20 |
| Minimum stability [kg] | 750 | 1000 |
| Flow (mm) | 2 - 4 | 2 - 4 |
| Minimum stability flow ratio [kg/niTn] | 270 | 320 |
| Bitumen content [% of total mix] | 3.3 - 4.0 | 3.5 - 4.2 |
| Voids filled with Bitumen [%] | 48 - 60 | 48 - 60 |

**Mixing and laying**

The aggregate and bitumen shall be mixed in an approved plant of the batch type. Constituents shall be proportioned by weight; the bitumen may be proportioned by a metering pump.

Bitumen and aggregates shall not be heated to above 150°C and 170°C, respectively, and the temperature difference between them at the time of mixing shall not exceed 15°C. The mixing temperature shall be established from the bitumen viscosity/temperature graph. Approved facilities for continuous measurement of temperatures shall be provided.

Bitumen macadam shall be transported in clean vehicles. Dust, coated dust, oil or water may be used on vehicle bodies to facilitate discharge, but the amounts shall be kept to a minimum and any excess shall be removed by tipping or brushing.

Immediately after arrival at the site, the macadam shall be supplied continuously to the paver and placed without delay.

Joints in wearing course shall be offset by at least 300 mm from parallel joints in the layer beneath.

A priming coat of petroleum/bitumen shall be applied to the road base at the rate of 0.55 to 7 l/m², before placing macadam. The binder course shall not be laid until the priming coat has been cured.

The binder course shall be prepared to receive the wearing course by removal of dust and deleterious materials by air jetting or other approved means.

**Interlocking paving blocks**

Footpaths and areas to be paved with interlocking concrete blocks shall be excavated and placed with 300 mm depth of compacted material at the exact levels and falls required for the finished work.

If parts of the base are found to be unstable the Contractor shall excavate further to a firm bed and fill with layers of fine crushed rock or aggregate, thoroughly compacted. The upper surface of the base shall reflect the exact profile, fall or contour of the final paving, irregularities shall not be

compensated by varying the depth of sand bedding.

Compaction of formation and base for interlocking concrete slabs shall be as Clauses (Compaction of Sub-Grade), (Road Base), (Tests on Sub-Base and Road Base).

A stable edge shall be provided to retain the paving units and sand bedding by means of pre-cast concrete edging unit or kerbs set in-situ concrete. The sand bedding shall be a fine, well graded sand in a dry to moist condition and laid to an uncompacted thickness of 50 mm.

The mix for paving blocks shall contain a water-repelling additive.

The paving blocks shall be laid in accordance with the manufacturer‟s instructions and shall be compacted at completion of each day‟s work.

The interlocking block shall be a minimum of 80 mm thick and of grade C25/30 and the concrete quantity must be approved by the employer.

**Site surfacing**

The area of site not covered by buildings, structures, roads and paving, plants, etc. shall be leveled and covered by a single layer of drainage geotextile membrane topped by a layer of 30 mm uniform gauge gravel of minimum 15 cm thickness after compaction.

**Kerbs**

All roads shall be provided with kerbs.

Kerbs, channels, edgings and quadrants shall be cast generally to BS EN 1343 or equivalent. They shall be cast to the required radius for all curves not less than 10 meters.

Raised kerbs shall be laid with a 6 mm gap and pointed with I to 3 polymer modified cement mortar above road level only. Concrete bedding and backing to kerbs shall be cast in-situ to the dimensions shown on the drawings.

Flush kerbs shall be similarly laid and jointed or may be cast in-situ. The outside comer of the kerbs shall be chambered.

Marginal strips and kerbs shall be protected against covering or splashing with bitumen or cement. Kerbs and manhole frames shall be primed before bituminous macadam is laid.

All raised kerbs shall be alternately painted black and white in the plant area and at junctions.

**Traffic signs**

Traffic signs shall be reflectorized and shall comply with the latest revision of the latest Bangladesh standard.

Number, type and position of the signs have to be as agreed with the Employer.

Mounting posts shall be of circular hollow steel section structural steel. Single post signs will generally be cast directly into a concrete base.

**Guardrails**

Guardrails shall be provided where the occupants of a vehicle or passers-by can be endangered by a vehicle leaving the road.

Guardrails are to be used also to protect pipes and structures located at traffic areas and are to be designed to withstand impact forces in accordance to the traffic type and speed.

Railings shall be of galvanized steel, which shall be epoxy-painted in addition. Plastic guideposts with glass reflector elements shall be used where required.

**Road drainage system**

The drainage system of the roads shall comply with the respective standards.

The arrangement of the drain lines discharge collectors shall suit the traffic requirements, simplicity and reliability, having maintenance facilities to make sure that the system is working properly.

## 2.14 Fences and gates

The following fences shall be provided:

- internal fences around different plant components (open storage area, switch yard, etc.).

**Internal fences**

Chain link fences shall be constructed of plastic coated galvanized steel wire and shall be of such manufacture that when any one segment is cut remaining segments within the pattern retain their rigidity.

Overall height of the fencing shall be 2.4 meters (1.8m plastic coated galvanized steel wire mesh + 0.6m barbed wire) above ground level. All mesh shall be of plastic coated galvanized steel wire of minimum 8 gauge (including PVC coating). Line wires shall be of plastic coated galvanized steel wire of the same gauge to adequately support the mesh rigidly. Line wires shall be provided at the top and bottom of the mesh and at two evenly

spaced intermediate levels. The line wires shall be attached to the supporting posts. The top wire shall be doubled, making five line wires in all. Mesh and line wires shall comply with BS 4102 or equivalent standards.

Supporting posts and struts shall be of precast reinforced concrete of grade C40/50. The posts shall be set in concrete in the ground. The posts shall have cranked tops set at 45° outward to the posts, to which shall be attached three strands of galvanized barbed wire. Droppers shall be fitted at the center of each bay of fencing, to prevent the wires bunched together. Intermediate posts shall be provided at centers not exceeding 3 meters. Corner posts and struts shall be provided at all changes in direction.

The fences shall be connected to the earthing system.

**Gates**

Along the internal fences mentioned above an adequate number of single-leaf pedestrian gates and double-leaf hinged gates shall be provided.

The height of these gates shall correspond to the height of the adjacent perimeter fences.

Gates shall comply with BS 1722 or equivalent standards and shall be constructed of plastic coated galvanized chain link mesh on a plastic coated galvanized RHS or tubular steel frame, with three strands of barbed wire across the top on cranked galvanized extension arms.

Gateposts shall be made of plastic coated galvanized RHS section and set in concrete in the ground. Gate hinges (pivots) shall be heavily galvanized and plastic coated.

All gates shall be provided with locks.

Also the gates shall be connected to the earthing system.

## 2.15 Intake and pump houses

See **Section B5**.

## 2.16 Outdoor facilities

### 2.16.1 Potable water system

Drinking water pipelines shall be constructed to BS 8558, BS EN 806 or equivalent.

For water piping the material listed in BS 3505:1986 shall be used.

For the water storage tank glass-fibre reinforced polyethylene shall be used providing the materials satisfy the requirements of the appropriate standards. Any material used shall meet the requirements of the World Health Authority with regard to harmful influences on the drinking water. They shall not promote the formation of algae or the growth of bacteria in water.

The materials used shall be UV-resistant and withstand any climatic conditions to which they are exposed.

The tank shall be covered and provided with sun protection as well as a visible outside water level gauge and automatic float control.

Glass-fibre reinforced material shall meet the requirements laid down in the "Voluntary Product Standard" of the National Bureau of Standards (US Department of Commerce) or other relevant internationally recognized standards.

## 2.16.2 Storm water drainage

Storm water drainage shall be supplied for all buildings, roads, paved areas etc. in accordance with the local rainfall conditions. If possible by gravity only, lifting or pumping stations shall be avoided.

All storm water and fire-fighting water has to discharge over sand traps to be collected in a retention basin, whether it is polluted or not and send to external disposal or sent to the stormwater pond.

## 2.16.3 Oily water drainage/separators

The tank farm, the transformer enclosures and the workshop have to have provisions to collect oily water and to treat it in one or more oil separators.

## 2.16.4 Chemical drainage

The drainage from battery rooms and similar shall not be connected to the storm water systems, but to the chemical drainage system, connected to the neutralization tank tank or to the waste water tanks.

## 2.16.5 Manholes

Manholes shall be provided for the above-described drainage systems, at each change in gradient or direction, and at maximum intervals of 50 m. The diameter of manhole shall be chosen as a function of the pipe cross section. Either prefabricated or cast-in-situ concrete manholes may be used.

Shaft and manhole covers shall be made from cast iron and reinforced concrete, of watertight construction, to suit local requirements. Shaft and pit covers shall have a test load suited to the traffic conditions. Trash gratings shall be of cast steel.

## 2.16.6 Piping material for outdoor systems

**General**

- Tubes and fittings of other materials shall be used only if they are in conformity with local regulations and with the approval of the Employer.
- All materials shall comply with the regulations regarding quality and dimensions and shall be adequate for the required work.
- Materials and structural parts not standardized shall be subject to the approval of the Employer"s Engineer prior to use.
- All pipes and joints shall be marked indelibly immediately after taking from the moulds.
- The marking shall include:
  - name of manufacturer
  - date of manufacturing and serial number
  - nominal diameter and pipe class.

**Unplasticized Polyvinyl Chloride (UPVC) pipes**

UPVC pipes conforming to BS 3505:1986 shall be used for water supply and storm water and sewerage purposes. Pipes couplings and pipe fittings of UPVC shall have a uniform dark gray color throughout.

Pipes for rainwater downtake shall conform to Class C as per BS 3505:1986.

UPVC pipes conforming to BS EN 13476 shall be used for sewerage purposes.

## 2.17 Pipe and cable ducts

The ducts are to be constructed of reinforced concrete and must be watertight. Particular attention must be paid to satisfactory expansion and settling joints. The walls and covers of the ducts must be designed and reinforced to withstand the soil pressure and the relevant traffic loads. The ducts are to be provided internally with hot dip galvanized anchor rails every 1.5 m for the easy attachment of clips and cable racks. All ducts covered by removable covers will have to be provided with metal protection angles.

Pipe ducts shall be big enough for maintenance. Trench and cover shall be designed for the relevant traffic loads.

For drainage purposes the cable and pipe ducts shall be provided with slopes (min. slope 0.3%) towards accessible pump sumps. The pump sumps in which will be frequently water will have to be provided with permanently installed automatic pumps.

### 2.17.1 Pipe bridges/racks

Structure of pipe bridges shall be of galvanized steel and shall consider reasonable heights for under passing and impact loads due to traffic. Floors and stairs shall be galvanized steel grating. Along the pipe bridge, around the various openings and for the stairs tubular steel railings of galvanized steel shall be provided.

Access shall be made by steel stairs and/or from the various plant items. For escape purposes a clear width of min. 1.00 m and minimum headroom of 2.20 m shall be provided along the pipe bridge. All fittings, apparatus and parts requiring maintenance must be easily accessible via stairs (only in exception cases via ladders) and must be secured by platforms and railings. Minimum headroom of 2.20 m and a clear width of min. 1.00 m must be assured everywhere and no dangerous objects must protrude into the accessible areas. When are crossed, care must be taken to ensure a clear headroom of min. 8.00 m for the main access roads, 6.00 m for any other road and a clear width not less than the road width.

The structure must be sturdy and well founded to enable it to support both, the pipe loads as well as the horizontal and vertical pressures and tensile stresses at the fixed points. Sliding bearings must ensure an adequately long travel without jamming. The settlements of pipe bridges must be kept to a minimum in order to avoid unacceptable stresses in the pipes.

## 2.18 Synthetic filter fabrics

Where filter membranes or geo-textiles are required, only non-woven needle-punched fabrics shall be used. In this process discrete long fibre is mechanically interlocked by a barbed needle-punching operation. The filter fabrics shall be installed permanently as required.

## 2.18.1 General requirements

**Resistance to chemical attack**

The material shall experience no significant change in its physical, chemical or engineering properties under the influence of oil, sulphates, chlorides, acids and alkalis in the forms and concentrations, which are present in soils, brackish water and groundwater to be found at the site.

**Resistance to biological attack**

The material shall be resistant to bacterial attack, fungus, insects and vermin etc.

**Stability under ultraviolet light**

The material shall incorporate sufficient resistance to ultraviolet light that its physical properties shall satisfy the specification after exposure for a period of up to 30 days of full sunlight in summer at the site.

The Contractor shall propose for review methods of storage and laying of the material which will ensure that exposure is not more than half of the manufacturer's recommended maximum exposure period for conditions at site.

**Drinking water suitability**

The material shall be of such quality that drinking water is not affected.

**Supply**

Filter fabrics shall be supplied in rolls of at least 3.5 m width and shall be jointed in accordance with the manufacturer˝s specification. Roll length of each fabric shall be such as to lay one strip complete in one operation, without jointing, each of the various separate sloping and horizontal lengths involved (e.g. for the shoreline protection, placing direction vertical to the coastline). Rolls of adequate standard lengths shall be supplied for this purpose.

**Material approval**

The Contractor shall demonstrate before use that the proposed materials, from all the proposed sources of supply, meet the specification. Such demonstrations (laboratory tests) shall be performed or stated by an approved official laboratory for materials testing. The results shall be

summarized and interpreted in a report and presented to the Employer for approval.

**Filtration properties and pore size distribution**

Filter fabrics shall be permeable and have a mean pore size not greater than 0.3 mm and a pore size for a fraction of 90% not greater than 1.0 mm, retaining at least 50% of material with a particle size in the range of 0.06 mm to 0.2 mm. The pore size distribution shall be determined by appropriate methods in accordance with good engineering practice.

**Permeability**

The transverse filter fabric permeability range shall be k = 5 x 10 - 4 m/s and 5 x 10 - 3 m/s at a loading of 0.5 bar (50 kN/$m^2$).

**Mechanical and hydraulic filter stability**

3 samples shall be taken from the filter fabrics used for every kind of soil to be tested. The fabric shall be fastened as the bottom of at least 15 cm diameter and 10 cm high PVC-cylinders where these tools are filled with 1500 g of dry soil to be tested each. These cylinders shall be submerged 40 cm into water and lifted up reciprocally every 30 seconds for 34 hours. The sand penetrated through the fabric shall be measured after 4, 9, 24, 29 and 34 hours where the penetrated sand shall be not more than 2.5 g in the last 10 hours. The water volume passing the above sample shall also be measured at above intervals. After the end of the test, two fabric samples shall be taken from each cylinder and their reduced permeability shall be measured which might be caused by soil particles penetrated into the fabric. This permeability still shall be more than of the natural soil.

**Weight**

In respect of hydrodynamic reversing flow conditions the fabric weight shall be equal or greater than l000 g/$m^2$ (at 20° C and 65 percent humidity) for shoreline protection and scour protection.

## 2.18.2 Tensile properties of filter fabrics

The tensile strength of the filter fabric shall be verified in any direction (longitudinal and cross) under a uniformly applied load. The following laboratory tests shall be performed on wet samples, which have been fully submerged in water for a period of 48 hours before testing.

**Plain strain test**

This test shall be carried out according to ISO 13934 but with a 20 cm by 20 cm fabric sample, restrained from reduction in width by laths on the two tensioned sides of fabric with steel pins penetrating fabric. The tensile strength of the material shall not be less than 1.2/1.6 KN over a 200 mm width and the breaking strain shall exceed 50/70%.

**"Grab" tensile test**

The 25 mm „"grab" tensile strength shall be not less than 1.0 KN. Tests shall be carried out in accordance with ISO 13934.

### 2.18.3 Testing frequency

The thickness, weight, permeability and tensile properties (plain strain test) shall be carried out once at start of works and then on every 5000 $m^2$ of each material used. The samples shall be taken from the material at the site and tested by a specialized official institution to be approved by the Employer. More tests may be required if above tests fail or there are doubts about fabric quality.

## 2.19 Technical schedules

The following technical schedules constitute part of the specification. The data and requirements specified in the respective forms are to be adhered to and the required data of the forms are to be completely filled in. The completed technical schedules are to be submitted with the Bid:

2 TS Technical Schedules

## 2.20 Other Miscellaneous Works

PVC Pressure release valves and under drainage arrangements shall be provided below the forebay slab of CW pump house and CW water channel to prevent uplift.

Coal Bunker (inside Mill Bunker Building) shall be of MS while the hopper shall be of MS with stainless steel (grade SS 304) lining. The SS lining in hopper portion shall be 6 mm thick, cold rolled, annealed & pickled and skin passed. 308L and 309L electrodes/fillers shall be used for welding stainless steel to stainless steel and stainless steel to mild steel respectively.

Pre-formed flexible open ended bellow strap of neoprene shall be provided between top of bunker and bottom of tripper floor to avoid coal dust leakage / escape. The bellow strap shall be of minimum 200 mm wide under un-stretched condition and shall be of minimum 2mm thick.

## 2.21 Additional requirement for Green buildings

Green Buildings are to be designed to be compliant to minimum LEEDs Gold rating.
Additional requirements for Green building are as follows:-

- All necessary documentation (certificates, manufacturer declarations) in regards to the recycled content, distance of manufacture, other special requirements for green building etc shall be provided.
- Top 40 cm of fertile soil in areas of green building shall be excavated, stacked separately and re-layed in specified areas post building construction through contour trenching, mulching etc. In case of no fertile soil, soil test report from lab shall be submitted confirming the non fertile nature of soil.
- The cement used for concrete, reinforced concrete, mortar, grout and plaster should be done with Portland Pozzolona Cement with flyash content of minimum 25%. Raw material used in the cement shall be extracted/manufactured within 800 Km distance from the site.
- Course and fine aggregates used in the concrete, grout, plaster etc shall be extracted/manufactured within 800 KM distance from the site.
- Reinforcement shall be with post consumer recycled content of minimum 40%.
- Volatile organic compound (VOC) limits of Adhesives, Sealants and Sealant Primers must comply with South Coast Air Quality Management District (SCAQMD) Rule #1168. VOC content test certificate or technical specification from manufacturer for adhesives, sealants and sealant primers shall confirm that SCAQMD prescribed testing standards for determining VOC content are followed.
- Source of teak tree and frame manufacturing shall be within 800 Km from site.
- Raw material source and manufacturing of particle board shall be within 800 KMT from project site.
- All composite wood products should not contain urea formaldehyde.
- Raw material used for AAC blocks manufacturing and manufacturing facility need to be within 800 Km from project site.
- VOC of all paints shall not exceed Green Seal Standard GS-11
- Flooring tiles shall be certified by Floor Score standard (except natural stone like kota, granite etc.,)
- Recycled content shall be minimum 20% for tiles with material source and manufacturing within 800 Km from site.
- All carpet shall be CRI certified.
- Adhesives and Sealants VOC content test certificate or technical specification from manufacturer shall confirm that SCAQMD prescribed testing standards for determining VOC content are followed.
- All false ceiling material with material source and manufacturing shall be within 800 Km from site

# 3. Induced draft Cooling Tower

The major civil works of Induced draught cooling tower are as listed below.

i) Foundation of cooling tower
ii) Basin Wall and Floor
iii) Cells, Distribution System and Stack

iv) Cold Water Outlet Channel
v) Fills
vi) Fills Supporting Structure
vii) Painting To Concrete Surfaces
viii) Stairs
ix) Paving
x) Water proofing of structures and construction joints
xi) Structural steel works
xii) General appurtenant works of a Civil & Structural Engineering nature.

## 3.1 MATERIALS OF CONSTRUCTION

Reinforcing steel used in reinforced concrete shall be as per equivalent.

Concrete: C25/30 for cooling tower foundation and superstructure
C40/50 for precast elements

The staircase shall be of structural steel. All steel used for walkways and stairways shall be hot dip galvanised and fabrication in accordance with ASTM A123.

## 3.2 MINIMUM THICKNESS OF STRUCTURAL CONCRETE ELEMENTS:

The actual thickness of the structural elements shall be as per design calculation. However the following minimum thickness shall be followed for the structural concrete elements:

| | | |
|---|---|---|
| a) Foundations | : | 350 mm |
| b) Louvers and walkway | : | 100 mm |
| c) Basin walls | : | 150 mm |
| d) Pre cast cover slab | : | 100 mm |
| e) Fan cylinder | : | 125 mm |
| f) Hot Water Plank | : | 80 mm |

## 3.3 STRUCTURAL ANALYSIS AND DESIGN:

The entire cooling tower is visualized to consist of frames in transverse and longitudinal Directions. The columns at the bottom shall be assumed to be fixed for the analysis of frames. The analysis shall be done for dead, live loads and lateral loads due to wind or seismic forces.

The design of C.W. Basin, outlet channel, sludge pit and Hot Water Basin shall be designed for cracked condition keeping crack width as mentioned below as per BS EN 1992-1-1-2004

The crack width shall be limited to.

a) 0.2 mm for all reinforced concrete structure in contact with water or chemicals.

C.W. basin shall be designed for the following conditions:

(i) Water pressure inside up to the design level and no earth pressure outside

(ii) No water pressure inside and earth pressure outside.

SPECIFIC DESIGN ASPECTS:

CONCRETE WORK

**3.4.1.** BASIN, WALL AND FLOOR

All walls and slab below ground level shall be of water proof concrete. The floor of cooling tower basin shall be sloped to a silting pit to permit flushing and drainage of the floor area. Cooling tower internal columns and posts shall extend to bottom of the concrete basin.

The floor of the basin shall be sloped to minimum 1 in 80 towards the sludge drains. The required slope shall be achieved by screed. Drainage arrangement of basin shall be provided suitably.

3.4.2 CELLS, DISTRIBUTION SYSTEM AND STACK

Cooling tower cells shall consist of RCC columns, beams and walls. Hot water distribution channel shall also be of RCC and covered with suitably designed precast / cast - in - situ concrete slab.

Cell division partition walls shall be cast - in - Situ RCC.

### 3.4.3 PAINTING TO CONCRETE SURFACES

All concrete surfaces in direct contact with water/ water spray/moist air shall be applied with two coats of bitumen @ 1.7 Kg/sqm. All concrete surfaces subject to water/ water spray/moist air up to and including Fan Deck slab level including basin slab, inner faces of cladding walls, all faces of cell partition wall, all faces of columns, all faces of beams (both cast in situ and precast), bottom surface of fandeck slab for counter flow tower and both surface of fandeck slab for cross flow tower, inner face of fanstack, all faces of hot water basin (for cross flow tower) etc shall receive the said coating after cleaning and drying of the concrete surface.

All foundations, footings and slabs in contact with ground shall also receive a bituminous coating.

The R.C.C. structure of the Cooling Tower shall be painted on the exterior surface with three coats of waterproof cement paint.

### 3.4.4 PAVING

Paving shall be provided for a minimum clear width of 2.0 m from the outer face of the HW pipes all around the cooling tower basin. Paving shall also be provided in between the hot water pipes and space available between HW pipes and CT basin wall spray catcher.

### 3.4.5 WATER PROOFING AND CONSTRUCTION /EXPANSION JOINTS

For water proofing of underground structures including basin slab and hot water distribution channel, water proofing cum plasticizer compound shall be mixed with the concrete. PVC sealing strips shall be used for all expansion joints where water is retained. At expansion joints, joints filler material (preformed bitumen impregnated fibre board) with sealing compound on both sides shall be provided throughout the length of the joint.

The number of construction joints shall be kept as low as possible consistent with reasonable precautions against shrinkage. Concreting shall be carried out continuously up to construction joints.

ANNEXURE-2

FORMAT FOR NO DEVIATION CERTIFICATE
(To be submitted in the bidder's letter head)

BHARAT HEAVY ELECTRICALS LIMITED,
Power Sector - Eastern Region,
Plot no 9/1, DJ Block, Sector – II, Salt Lake City,
Kolkata – 700 091

| | | |
|---|---|---|
| Sub | No Deviation Certificate. | |
| Job | Package-11: Civil, Structural & Architectural works (except pile, pile cap, pedestal and associated works) for Non Plant Buildings including Green Building for 2x660 MW Maitree STPP Rampal, Bangladesh. | |
| Ref | 1.0 | Tender no PSER:SCT:KLN-C1911:18. |
| | 2.0 | BHEL's NIT, vide reference no PSER:SCT:KLN-C1911:6940 Date: 05-07-2018. |
| | 3.0 | BHEL's TCN-01, vide reference no PSER:SCT:KLN-C1911:TCN-01, Date: 17-07-2018. |
| | 4.0 | All other pertinent issues till date. |

Dear Sirs,

With reference to above, this is to confirm that as per tender conditions, we have visited site before submission of our offer and noted the job content & site conditions etc. We also confirm that we have not changed/ modified the tender documents as appeared in the website/ issued by you and in case of such observance at any stage, it shall be treated as null and void.

We hereby confirm that we have not taken any deviation from tender clauses together with other references as enumerated in the above referred NIT. We hereby confirm our unqualified acceptance to all terms & conditions, unqualified compliance to technical specification, integrity pact (if applicable) and acceptance to reverse auctioning process.

In the event of observance of any deviation in any part of our offer at a later date whether implicit or explicit, the deviations shall stand null & void.

We confirm to have submitted/uploaded offer/documents in accordance with tender instructions with acceptance of the terms & conditions of the tender by us and as per aforesaid references.

Thanking you,

Yours faithfully,

(Signature, date & seal of authorized representative of the bidder)