ASHUGANJ POWER STATION COMPANY LTD.

TENDER DOCUMENT
FOR
CONSTRUCTION OF ASHUGANJ 100 MW HFO POWER PLANT PROJECT.

VOLUME 2 OF 2 (PART A)
TECHNICAL REQUIREMENTS

Tender Reference No. APSCL/100MWHFO/PD/IFT/2017/01

23 NOVEMBER-2017
# Technical Requirements

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Section 1
Description of the Project
Ashuganj 100 MW HFO Power Plant Project.

TECHNICAL REQUIREMENTS

DESCRIPTION OF THE PROJECT:
A Power Station with HFO based Engine Generator Sets of 100 (±10%) MW total net capacity at site conditions (35°C, 1.013 bar, 98% R.H.) is intended to be set up by Ashuganj Power Station Company Ltd. at Ashuganj, Brahmanbaria district 90 Km east from Dhaka, the capital of Bangladesh.

The proposed Plant consisting of identical units having each capacity not less than 14 (Fourteen) MW will be installed in the space, as shown at the site layout. The Project will be implemented on turnkey basis with APSCL own fund.

The Power Station will be connected with APSCL 230 kV Bus of 230 kV Grid Sub-Station through power Plant’s own switchyard to be built and other electrical equipment to be provided within this contract.

Fault Levels of existing Ashuganj Grid Sub-station’s 230 kV Bus bar are 50 kA.

Climatic Conditions: Sub-Tropical Monsoon

<table>
<thead>
<tr>
<th>To be considered in</th>
<th>Temperature</th>
<th>5°C to 45°C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plant design</td>
<td>Relative Humidity</td>
<td>36% to 100%</td>
</tr>
<tr>
<td></td>
<td>Annual Rainfall</td>
<td>120 cm to 345 cm</td>
</tr>
<tr>
<td></td>
<td>Wind Velocity</td>
<td>204 km/hr</td>
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<tr>
<td></td>
<td>Seismic Horizontal Ground Acceleration</td>
<td>0.28g</td>
</tr>
</tbody>
</table>

The project may be classified into the following broad areas. Details are however given later in the scope of work.

1. Land Survey, preparation of drawing, land development, landscaping of the proposed site.
2. The supply and construction of the Power plant equipment.
3. Equipping of 230 KV material/equipment at the HV switchyard of the power plant and 230 KV Ashuganj Grid Sub-station.
4. Supply and Construction of all civil works including control room, office building, warehouse, workshop, internal roads, boundary, temporary jetty, fuel unloading jetty, river bank protection, watch tower, plant main entrance gate with security post etc.
5. Supply and construction of entire Fuel system for the plant, fire protection system, water treatment plant, HFO treatment house etc.
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2.0.1.3 BASE FRAME INCLUDING

2.0.1.4 ELASTIC MOUNTING

2.0.1.5 COUPLING

2.0.1.6 CONNECTIONS

2.0.1.7 Flexible connections between engine and external piping

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2.0.2.5 COOLING SYSTEM following list, but not limited to:

2.0.2.6 CHARGE AIR SYSTEM including following list, but not limited to:

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2.0 **Scope of Work.**

The work stated in this specification shall cover the complete design, engineering (including supply of all calculation & settings), manufacturing, inspection, testing, supply, delivery to the site, construction, erection, installation, testing & commissioning, commercial operation and supervision of all operation & maintenance related works for the first twenty four (24) months of warranty periods after satisfactory performance tests of the Generating Units, and associated equipment at Ashuganj, Brahmanbaria, Bangladesh on full turnkey basis.

The equipment provided shall be of proven type and design, having total net output at site condition (35°C, 1.013 bar, 98 % relative humidity) of 100 (±10%) MW. Power plant consisting of identical units of engine generators heavy duty, low/medium speed (Not more than 750 rpm), 4 (four) stroke diesel cycle engine-HFO fired. The Net Power output shall be measured at HT/Secondary side of Step up Transformer excluding auxiliary consumption and transformer losses.

The work shall be carried out in accordance with the conditions of this contract, and shall include but not necessarily be limited to the following major items.

### 2.0. POWER GENERATION

#### 2.0.1 GENERATING SETS

Design, manufacture, supply, installation, testing, commissioning of stipulated number of engine generating sets complete with all auxiliary and ancillary equipment and systems (including but not limited to, heavy and light fuel handling, storage, heating and cleaning system; lubricating system; cooling system; air intake system; exhaust system; heat recovery steam generating system; water treatment system etc.). Some description of these systems is stated in the later part. These description may not be complete in all respect, so, the work have to carried out in such a way that all excluding the mentioned equipment/ system, any other equipment/ system deemed to be necessary for prudent engineering practice, those have to be incorporated.

##### 2.0.1.1 ENGINE

##### 2.0.1.2 GENERATOR

##### 2.0.1.3 BASE FRAME INCLUDING

Common base frame generator part  
Fastening equipment (set)  
Common base frame engine part

##### 2.0.1.4 ELASTIC MOUNTING

Steel springs (set)

##### 2.0.1.5 COUPLING

Flexible coupling

##### 2.0.1.6 CONNECTIONS

##### 2.0.1.7 Flexible connections between engine and external piping

- Flexible hoses and gaskets (set)  
- Cooling water bellows (set)
- Exhaust gas bellows
- Charge air bellows compensator

2.0.1.8 PLATFORMS
Engine & its auxiliaries’ maintenance platform prefabricated

2.0.2 MECHANICAL AUXILIARY SYSTEMS

2.0.2.1 AUXILIARY MODULES
Engine auxiliary module with integrated compact booster including following list, but not limited to:
- Fuel oil filter
- Fuel booster pump
- Return fuel pump
- Fuel oil cooler
- Return fuel tank
- Sludge tank
- Lubricating oil automatic filter
- Lubricating oil cooler
- Pre lubricating oil pump
- Pre heating unit
- Thermostatic valve lubricating oil back-up cooler
- Thermostatic valve high temperature water system
- Thermostatic valve low temperature water system
- Pressure increasing pump
- Steam heater
- Piping and insulation
- Valves and gauges
- Module control panel
- Exhaust gas module
  (a) Exhaust stack
  (b) Rupture disk
- Low temperature expansion tank
- Charge air silencer, 45 dB attenuation
- Exhaust gas branch pipe
- Piping and insulation
- Oil mist separator
- Pipe rack
- Auxiliary module platform
2.0.2.2 FUEL SYSTEM

2.0.2.2.1 LIGHT FUEL OIL SYSTEM including following list, but not limited to:
- Light fuel oil unloading pump unit
- Light fuel oil unloading measuring unit
- Light fuel oil storage tank
- Light fuel oil tank equipment
- Light fuel oil day tank
- Light fuel oil day tank equipment
- Light fuel oil transfer pump unit
- Light fuel oil feeder unit
- Light fuel oil feeder pump with Variable Frequency Driver (VFD) for steady supply pressure to Engine
  - Automatic filter
  - Manual by-pass filter
- Piping and valves light fuel oil system inside engine hall
- Piping and valves light fuel oil system outside engine hall

2.0.2.2.2 HEAVY FUEL OIL SYSTEM including following list, but not limited to:
Heavy fuel oil unloading pump unit
Heavy fuel oil unloading measuring unit
Heavy fuel oil storage tank
Heavy fuel oil heating equipment
Heavy fuel oil transfer pump unit
Heavy fuel oil storage tank suction header
Heavy fuel oil buffer tank
Heavy fuel oil buffer tank insulation
Heavy fuel oil buffer tank equipment
Heavy fuel oil separator unit-3 (three) nos.
  - Separator
  - Delivery pump
  - Strainer
  - Steam heater
  - Sludge tank
  - Sludge pump
  - Steel frame
  - Control panel
  - Interconnection pipes, flanges, seals and valves
Heavy fuel oil day tank
Heavy fuel oil day tank insulation
Heavy fuel oil day tank equipment
Heavy fuel oil feeder unit
- Heavy fuel oil feeder pump with Variable Frequency Driver (VFD) for steady supply pressure to Engine
- Light fuel oil feeder pump
- Automatic filter
- Manual by-pass filter
- Viscosity control system
Piping and valves heavy fuel oil system inside engine hall
Heavy fuel oil trace heating material inside engine hall
Heavy fuel oil pipe insulation inside engine hall
Piping and valves heavy fuel oil system outside engine hall
Heavy fuel oil trace heating material outside engine hall
Heavy fuel oil pipe insulation outside engine hall

2.0.2.3 LUBRICATING OIL SYSTEM including following list, but not limited to:

Lubricating oil separator unit for each engine
Oil mist separator module
- Separator
Lubricating oil separator unit
Separator cleaning device (mobile), cleaning unit & connection kit & cleaning liquid
Lubricating oil unloading pump unit: fresh oil
Lubricating oil storage tank: fresh oil
Equipment for lubricating oil storage tank: fresh oil
Lubricating oil service tank
Lubricating oil service tank equipment
Lubricating oil transfer pump unit (mobile)
Lubricating oil transfer pump unit (stationary)
Lubricating oil storage tank: used oil
Lubricating oil unloading pump unit: used oil
Equipment for lubricating oil storage tank: used oil
Piping and valves lubricating oil system inside engine hall
Lubricating oil system pipe insulation inside engine hall
Piping and valves lubricating oil system outside engine hall
Lubricating oil system pipe insulation outside engine hall
2.0.2.4 **COMPRESSED AIR SYSTEM** including following list, but not limited to:
- Starting air bottle
- Starting air compressor unit – consists of two units each two stage type
- Starting air compressor unit – consists of one units each two stage type
- Instrument air compressor unit-two sets
- Instrument air bottle
- Piping and valves compressed air system (set)

2.0.2.5 **COOLING SYSTEM** following list, but not limited to:
- Cooling radiator/ tower, Ultra low noise, with VFD
- Cooling radiator/ tower legs (set)
- Cooling radiator/ tower ladder and railings
- Maintenance water tank units (fresh water)
- Expansion tank
- Piping and valves maintenance water system (set)
- Piping and valves cooling system inside engine hall
- Piping and valves cooling system outside engine hall

2.0.2.6 **CHARGE AIR SYSTEM** including following list, but not limited to:
- Charge air filter-Wet type (Oil bath system)
- Weather hood
- Charge air silencer
- Ducting charge air system (set)

2.0.2.7 **EXHAUST SYSTEM (with stack height not less than 55m)** including following list, but not limited to:
- Exhaust gas silencer, 45 dB attenuation
- Rupture disc
- Bellows for exhaust gas silencer
- Ducting exhaust gas system (set)
- Bellows for exhaust gas ducting
- Insulation exhaust gas ducting (set)
- Exhaust gas stack pipe with drain
- Exhaust gas sampling facility

2.0.2.8 **STATION SUPPORT SYSTEM**

2.0.2.8.1 **OILY WATER SYSTEM** including following list, but not limited to:
- Oily water transfer pump units
Oily water buffer tank with heating and gravity separation compartments
Oily water feed pump unit
Automatic oily water treatment unit
Sludge tank with heating
Sludge loading pump unit
Piping and valves with heat tracing
Sludge disposal with transfer facilities

2.0.2.8.2 WATER TREATMENT SYSTEM including following list, but not limited to:
A complete modern Water treatment plant with required facilities
Treated water storage tank
Treated water storage tank equipment
Water booster unit
Piping and valves treated water system (set)

2.0.2.8.3 FIRE FIGHTING SYSTEM associated with the Engine and other systems
(as per section-13, Fire protection Facilities)
-FIRE PROTECTION SYSTEM
FIRE PROTECTION, COMMON Fire water system container
- Diesel engine driven pump unit
- Electric motor driven pump unit
- Jockey pump
- Control system
- Sprinklers (set)
- Portable fire extinguisher
- Piping (set)
Fire water tank
Fire water tank equipment
Water monitor
Outdoor hydrant
Outdoor hose cabinet
Portable fire extinguisher (dry powder type)
Piping and valves fire water system inside engine
Piping and valves fire water system inside engine hall
Underground piping and valves fire water system outside engine hall
FIRE PROTECTION, ENGINE HALL
Hydrant valve pairs
Standpipe hose cabinet
Portable fire extinguisher (dry powder type)
Mobile foam unit

FIRE PROTECTION, ELECTRICAL BUILDING
Portable fire extinguisher (C02 type)
Portable fire extinguisher (dry powder type)

FIRE PROTECTION, FUEL TREATMENT HOUSE
Portable fire extinguisher (dry powder type)
Portable fire extinguisher (dry powder type)

FIRE PROTECTION, FIRE FIGHTING PUMP HOUSE/CONTAINER
Wet pipe sprinkler system
Portable fire extinguisher (dry powder type)

FIRE PROTECTION, WORKSHOP AND WAREHOUSE
Portable fire extinguisher (C02 type)
Portable fire extinguisher (dry powder type)
Portable fire extinguisher (dry powder type)
Hose reel

FIRE PROTECTION, FUEL UNLOADING STATION
Portable fire extinguisher (dry powder type)
Portable fire extinguisher (dry powder type)

2.0.2.9 HEAT RECOVERY SYSTEM

2.0.2.9.1 STEAM GENERATION SYSTEM
STEAM GENERATION SYSTEM FOR FUEL and ENGINE HEATING including following list, but not limited to:
- Exhaust gas boiler
- Inlet and outlet hoods with inspection doors
- Modulating exhaust gas by-pass damper with actuator
- Manual steam soot blowing equipment
- Shut-off valves
- Blow-down drain
- Safety valve
- Relief valve
- Pressure switches
  Level switches
- Level control device
- Insulation and cladding
- Counter flanges, bots, nuts and gaskets
- Mounting supports
- Boiler service platform
  Bellows for exhaust gas boiler
  Heat recovery container
- Feed water tank
- Feed water pump
- Chemical dosing unit
- Blow-down tank
- Local control panel
- Light fuel oil (LFO) fired boiler for steam generation (Auxiliary Boiler)
- Oil detector
  Steam header
  Boiler washing water tank
  Boiler washing water pump
Piping, valves and insulation for steam generation system for fuel heating (set)

2.0.2.10 FUEL UNLOADING SYSTEM (HFO & LFO)
Fuel unloading system for both road & river way including the following, but not limited to:
- Fuel unloading house,
- Fuel unloading jetty/pontoon
- Fuel unloading pumps (2x100 m3 for HFO & 2x30 m3 for LFO) for each unloading point(unloading point will be two)
- Piping, valves and insulation etc

2.0.2.11 AUTOMATION SYSTEM based on complete DCS system of the plant, including following list, but not limited to:
Operator’s work station
Engineering Workstation
2.0.2.12 Other miscellaneous System/equipment/materials for mechanical auxiliary system

2.1 Emergency Diesel Generating Set

One (1) set of emergency diesel generating set complete with ancillary equipment shall be of minimum 500 KVA [pf 0.80] having diesel storage capacity for 12 hrs continuous operation for supplying power in case of grid failure to run emergency auxiliaries. EDG shall be of manual starting system and manual changeover system. Necessary interlock with 415V incoming breakers and EDG breaker shall be provided to prevent paralleling of this two systems. The starting system shall be capable of carrying out at least five (5) consecutive start without auxiliary power supply. A reliable battery charging facility with battery to be provided.

Standard protection and metering system shall have to be provided and installed.

2.2 230 KV Switchgear, Equipment and Transformers

The contractor shall furnish 04 (four) sets of 230 KV outdoor switchyard equipment which shall comply relevant IEC standard and 230 kV equipment shall be arranged in the outdoor as shown on the attached drawings or as directed by the APSCL. Two (2) 11/230 kV Power Transformers with all auxiliaries shall have to be installed by contractor.

2.2.1. 230 KV Switchgear Equipment:

The origin of the 230kV switchgear equipment must be European Union or G-8 Countries. The sub-station Basic Insulation Level (BIL) is 1050 kV. The following items shall be provided, but not limited to:

(1) 4 (four) sets of 230 kV circuit breaker [3 phase gang operated] with the following features:

<table>
<thead>
<tr>
<th>Feature</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Set</td>
<td>04 (Four)</td>
</tr>
<tr>
<td>Type</td>
<td>SF6</td>
</tr>
<tr>
<td>Rated voltage</td>
<td>230 kV</td>
</tr>
<tr>
<td>Basic Insulation Level (BIL)</td>
<td>1050 kV</td>
</tr>
<tr>
<td>Lighting impulse withstand voltage</td>
<td>1050 kV</td>
</tr>
<tr>
<td>(1.2/50 micro sec)</td>
<td></td>
</tr>
<tr>
<td>Power frequency withstand voltage</td>
<td>460 kV</td>
</tr>
<tr>
<td>(For 1 Min.)</td>
<td></td>
</tr>
<tr>
<td>Rated frequency</td>
<td>50 Hz</td>
</tr>
<tr>
<td>Rated nominal current</td>
<td>2000 A</td>
</tr>
<tr>
<td>Rated Interrupting current</td>
<td>50 kA</td>
</tr>
<tr>
<td>Operating type</td>
<td>Gang operated</td>
</tr>
<tr>
<td>Interrupting time</td>
<td>50 msec</td>
</tr>
<tr>
<td>Operating mechanism</td>
<td>Spring operated</td>
</tr>
</tbody>
</table>

(2) 4 (Four) sets of 230 kV Current Transformers having five (05) cores in which
two (02) cores for metering & others three cores for protection.

(3) 2 (Two) Sets of 230 kV Capacitive Voltage Transformers (CVT) having Sufficient Core with considering main & back up tariff meter.

(4) 4 (Four) Sets of 230 kV Lightning Arresters.

(5) 10 (Ten) sets of 230 kV Isolators (disconnecting switch).

(6) One (1) lot of Earth switch

(7) One (1) lot of steel structures for supporting the switchgear, equipment, posts and beams and gantry structures.

(8) One (1) lot of 230 kV XLPE underground cable (Single-Core, 4 cables) length approx. 9 km (2.25 km each) from Power Plant to existing APSCL 230 kV Grid Sub-station. The underground cable shall be connected at both end of 230 kV system by pot head with pilot wire cable differential protection.

XLPE Cable size: Minimum cable size 800 mm² XLPE copper conductor
Rated Voltage: 230 kV
Maximum permissible voltage: 245 kV
Short circuit Current: 98.7 kA for 1 sec.
Number of underground cable: 4 nos. (Three in use and one is spare)
Length of the Cable: Length of each underground cable approx. 2.25 km.

Bidder shall follow the clause 6.5 of volume 2 of 2 (Part-A) for underground cable detail information.

Cable should be Single point grounding at source end but provision should be made for both ends with Link Box & Protective Device (Surge Voltage Limiter) for open end.

(9) One (1) lot of suspension/post insulator string sets, tension insulator string sets and station post supporting insulator set with necessary hardware.

(10) One (1) lot of shield wire connectors and necessary hardware.

2.2.2. Step-Up Transformers and Associated Equipment:

(1) 2 (two) nos. three (03) phase step-up transformers (capacity as specified in Clause 5.2.2) and associated equipment with the following features.

<table>
<thead>
<tr>
<th>Type</th>
<th>Oil immersed, Three phase, outdoor power transformer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rating</td>
<td>To meet the requirement of the specification as stated in Clause 5.2.2</td>
</tr>
<tr>
<td>Voltage ratio of each Three (03) phase transformer at full load</td>
<td>11/230 KV</td>
</tr>
<tr>
<td>Connection [HV-LV]</td>
<td>Ynd₁</td>
</tr>
<tr>
<td>Basic insulation level</td>
<td>HV winding</td>
</tr>
<tr>
<td>Lighting impulse Withstand</td>
<td>1050 kV</td>
</tr>
</tbody>
</table>
Voltage (1.2/50 micro sec.)
Power frequency withstand Voltage (for 1 min): 460 kV 28 kV
Impedance voltage: Shall be within the range of 15% and 18%
Tap changer: On load at high tension winding 230 kV ± 8 x 1.25%.
Termination
High tension side: Outdoor bushing type (Cable Pot Head)
Low tension side: 11 kV XLPE, multiple cables

(2) One (1) lot of associated equipment.
Control and protection panel for 230 kV feeder from power plant to APSCL 230 kV grid sub-station shall be incorporated at both the ends. One (1) set at power plant control room and one (1) set at APSCL existing Network Control Room (NCR).
Energy meter or Tariff meter shall be installed at 230 kV site at APSCL existing Network Control Room (NCR).

2.3 Station Auxiliary Transformers and Associated Equipment
Two (2) sets of station auxiliary transformer and associated equipment with the following features:
Type: Oil immersed, three phase and two windings, outdoor power transformer
Rating: Capacity of each auxiliary transformer shall enable to supply 120% of the required power for the unit at 415 V system.
Rated high voltage: 11.0 kV
Rated low voltage: 415 V
Connection: Dyn11
Rated insulation: HV Winding NV Winding
Lighting impulse: 75 kV (peak) 28 kV
Withstand voltage
(1.2/50 micro sec.)
Power frequency
Withstand voltage (for 1 Min.): 28 kV 4 kV
Impedance voltage: Not less than 5 %, but not more than 7.5 %.
Tap changer: Off-Load on high tension winding ±5%
Neutral grounded: Solidly grounded
2.4 Control and Protection System

The Engine generating plant shall be normally operated and controlled from DCS and shall also be from engine individual remote control panel. In addition, there will be local control panel close to the individual Engine for operation of the plant for maintenance purpose with minimum monitoring system. This panel shall contain a selector switch having DCS, Remote and Local selection options with necessary connections.

The automatic start-up and shut down sequences shall be initiated by normally from DCS and optionally from remote control panel. Synchronisation from DCS will be fully automatic. Manual synchronization shall also be possible from remote control panel.

The following panels shall be provided in the central control room, but not limited to:

a. Engine generating unit remote control panel/ HMI [Industrial grade] including microprocessor based control system and DCS. Detail of unit control system shall have to be furnished as per designer's recommendation including data and trend logging, storage, printing facility etc.

b. 230/11 kV substation control panel based on Substation Automation System (SAS).

c. Required No. of control and protection panel for 230 KV circuits breaker (Considering both power plant end and APSCL existing Network Control Room (NCR) end)

d. One (1) 11 kV common switchgear control panel and DCS control.

e. Required Number of auxiliary Power supply control panel and DCS control.

f. One (1) synchroniser panel (Swing type) with provision of Auto and Manual Synchronization System.

2.5 Other Mechanical System

The following items shall provide, but not limited to:

a. Piping between the on-base equipment and the off-base Equipment.

b. Painting, including finished coat and special paints required for corrosion protection and high temperature resistance. Standard color code for different pipe line should be maintained with text and flow direction.

c. Design, operation and maintenance manuals, including proper and clear assembling-disassembling drawings, dimensional drawings in English in both hardcopy and softcopy form. Soft copy should be in link facilitated for easy searching of item.

d. All other work necessary for the proper operation and maintenance of the Engine generating power plant.

c. Lubricating oil for flushing and for the initial filling.

f. All lubricant and chemical additives.

g. Liquid Fuel handling facilities including metering & control.

The bidder shall mention details any other system (if required), which is not
mentioned above.

2.6 Other Electrical System

The following items shall provide, but not to be limited by any manner.

a. One (1) lot 415V power Centre.
b. One (1) lot 415 V common power Centre.
c. One (1) lot 415 V unit motor control centre for each engine gen. set.
d. One (1) Lot 11 kV XLPE power cables (copper)
e. One (1) Lot Low Voltage power cables (copper).
f. One (1) Lot Control and instrument cables (copper).
g. One (1) lot Race way materials 
h. One (1) lot Grounding system.
i. One (1) lot lighting and small power supply
j. One (1) lot Communication system including PLC, PABX, SCADA System as per requirement of PGCB.
k. One (1) lot DC power supply system including 2 (two) banks of
   110 VDC (nominal) Battery (NiCd, Alkaline) and 2(two) sets of
   battery chargers (Thyristor type) and other associated
   facilities.
l. One (1) lot UPS for unit control system in addition to Control & communication system.
m. One (1) lot CCTV coverage for all halls and plant area with control and monitoring system at control room including storage and downloading facility.

The bidder shall mention details any other system (if required), which is not mentioned above.

2.7 Maintenance Facilities

a. Two (2) Sets Electric overhead crane:
   [Two separate cranes. One is for Engine/Generator side and another one is auxiliary module site. Main hoist capacity will be sufficient enough to lift the heaviest weight of any component of an engine/generator/equipment in the engine room during maintenance and auxiliary hoist also be in enough capacity]
b. One (1) set Mobile Crane:
   Contractor shall supply a Mobile Crane (Rough Terrain Crane) of Minimum 50 ton capacity. One shall be able to reach the highest and least accessible parts of the plant and be able to handle any load from those parts.
c. Two (02) number Fork lifter of capacity one 10 ton & another 5 ton.

2.8 Fire Fighting Facilities
a. One (1) lot Foam Based Fire-fighting facilities for fuel tanks
b. One (1) lot Hydrant system including water main, hydrant stands, hydrant gun, hoses, motor driven and engine driven fire fighting pumps, jockey pump etc.
c. One (1) lot Portable fire fighting equipment.
d. Other equipment related to fire fighting system.

### 2.9 Building and Civil Works

Site survey, site development, site preparation, soil investigation, cleaning, levelling of site, reclamation; setting out of plant, design and construction of all foundations for the equipment shall be performed by the Contractor. The design shall be as per BNBC [Bangladesh National Building Code].

Contractor shall design and construct of office building, control room building, engine house, MV and LV switchgear room, rooms or buildings for Auxiliaries (Fuel treatment & Water Treatment), fuel and lube oil unloading permanent jetty, shed/room, workshop, warehouse, testing lab., guard rooms, test bench room, fencing, boundary wall, road, Transformers fire protection wall, water supply system, drainage & sewage system, River slop protection, plant main gate etc. The design and construction of all major foundations and buildings shall include piling.

- Outdoor lighting, passage ways, access ways for transporting of equipment during overhaul, and re-routing of existing passage way for the site if necessary, Access road to plant from B-type gate.

- Surface water drainage system including oil interceptors.

- Removing of debris, surplus excavated materials and rubbish, etc. resulting from the works.

- Re-instalment of any area, including existing amenities and structure affected by the contractor’s works shall have to be restored.

### 2.10 Training

#### (1) Foreign Training

The total person-months for training will be limited to 15 (fifteen) Person-Months on Engine Generating unit (HFO fired) at manufacturer’s factory in the following manner:

(a) Operation & Maintenance Training: 15 Engineers from Ashuganj Power Station Company Ltd. for 15 person months.

All living expenses, travelling expenses, daily pocket expenses (100 USD per day per Person) and lodging at actual of the trainees to and from Bangladesh to the country of Manufacturer’s factory and during the period of training including incidental expenses or medical expenses or Medical Insurance from time to time will be covered by the Contractor. The Contractor must indicate in technical offer the practical arrangements he is offering for ensuring the training, as well as the methodology used.

The Contractor will provide all maintenance and operation manual (Hard & Soft copy), drawings relating to all the equipment to each trainee on the first day of his arrival at the Manufacturer’s factory/country.

#### (2) Job Site Training
The Contractor shall also provide on-the-job training at site, at free of cost, to the suitable number of staff members of the Employer during installation, testing, commissioning and initial operation of the plant for one (1) month. During warranty period, it shall be the responsibility of the Contractor to train them adequately and properly in a planned manner so that these member of the Ashuganj Power Station Company Ltd.’s staff could take over the responsibility of operation and maintenance of the plant and equipment independently at the time of handing over of such plant and equipment as well as before issuing of FAC.

2.11 Submission of Engineering Data

Drawings and other engineering data for the specified equipment and materials are essential to the design and subsequent construction of the entire generating unit.

The contractor shall be required to submit drawings and engineering data in accordance with the Schedule and requirements specified herein to assure compliance with the overall construction and operating Schedule.

2.12 Manufacturer's Field Training Supervisor

From the date of commencement of initial operation of the major equipment, the Contractor shall dispatch manufacturer's supervisor (s) (At least one Elec. and I&C Engineer and one Mechanical Engineer) who shall be technically competent, factory trained, experienced in the operation and maintenance of the equipment to the site.

The supervisor (s) shall be responsible for providing on job training to APSCL staffs on operation and maintenance of major equipment from first starting date of commissioning to COD.

The supervisor (s) shall not be responsible for any duties required by the test and commissioning program of the equipment during training duty. The supervisor (s) must be able to fluently understand, speak, read, and write the English language.

2.13 Tests

The Contractor shall be responsible to all testing of equipment and systems supplied under this contract. The Contractor shall submit with his proposal a list of those tests, which in his opinion will satisfactorily check the operating characteristics of the equipment and determine all values necessary for evaluation of guarantees.

In the event of an award of contract, the contractor shall submit within sixty (60) days of the date of notice of award details of the proposed procedures for each test. All test procedures shall be subject to the Ashuganj Power Station Company Ltd.'s modification and approval.

2.14 Commissioning

The Contractor shall be responsible for the commissioning of all equipment in his supply, and shall provide necessary commissioning engineers to carry out all operations from first making alive of auxiliary equipment until the full commissioning has been completed.

The schedule shall cover all necessary inspections, adjustments and tests from no load to full rated capacity.

Ashuganj Power Station Company Ltd. shall provide its operating and maintenance staff to gain familiarity with the installation but the Contractor shall remain fully responsible for safe operation of all equipment in his supply during the commissioning periods, and until the completion certificate have been issued.
2.15 Supervision during Warranty Period

The Contractor shall provide three (03) competent Engineers (One mechanical Engineer, One Electrical and I&C Engineer and one operation Engineer) having at least 10 years’ experience in the required field of HFO Engine based power plant. They must be certified by the engine manufacturer or proven to be competent and acceptable to APSCL. They will be responsible to guide and supervise of all operation and maintenance of the plant. They will continuously stationed in the power plant to meet the obligations of the Contractor for the warranty services. This requirement does not limit the Contractor to supply additional qualified engineers required for the power plant to meet the obligations of the Contractor for the warranty services.

2.16 Inspection [s]/ Overhauling

The Contractor shall be responsible for execution of all inspections and overhauling of the engines during warranty period of 24 months as per Engine Manufacturer’s recommendation. For that inspections and overhauling, Contractor will arrange all spare parts and consumables at his own cost and responsibility.

2.17 Transport and Vehicle

Contractor shall supply the following items:
- **Jeep**: One brand new 2700 CC Jeep; Origin shall be Japan
- **Car**: One brand new 1500 CC car; Origin shall be Japan
- **Double Cabin Pick-up**: One (1) brand new 2700 CC Double Cabin Pick-up; Origin shall be Japan
- **Microbus**: One brand new 2700 CC, 12 seated Microbus; Origin shall be Japan

The above vehicles must be Toyota or Mitsubishi brand and Latest model (Not before 2017 model). The contractor must be handed over all vehicles to APSCL as Brand new and unused condition within 4 (four) months from the contract effective date.

2.18 Spare Parts & consumables

Spare & consumables during Warranty period

The Tenderer shall submit a list of spare parts with OEM Part No., equipment, materials and all consumables (Engine lube Oils, Fuel injector, greases, air & oil filters, Fuel oil filters, Charge air filters, ventilation filter, Breather filter, all chemicals etc.) to be necessary for day to day operation and maintenance of the generating units and other plant equipment inclusive of emergency use that takes place in the course of operation (according to the Manufacture's recommendation and guideline) during the Warranty period. The tenderer shall submit the list of spares and consumables that mentioned above with the proposal along with Manufacturer recommendation.

During the warranty period, the Contractor shall supply all (whether it is listed or not in their list) necessary equipment, spare parts, materials, consumables (Engine lube Oils, Fuel injector, greases, air & oil filters, Fuel oil filters, Charge air filters, ventilation filter, Breather filter, all chemicals etc.) to be necessary for day to day operation and maintenance of the generating units and other plant equipment inclusive of emergency use that takes place in the course of operation at his own cost and. The operation of the plant should be such that plant factor should be minimum 80%.
After completion of warranty period and before handover the plant, the contractor shall hand over all remaining spare parts, tools, equipment and consumables etc. to the APSCL.

2.19 Plant Maintenance Tools

Plant Maintenance Tools including Special Maintenance Tools & Plant Hand Tools. The contractor shall provide all special tools (For 1000 hrs to 30,000 hours maintenance works) (Not available in market and only available in manufacture of main equipment like engine, alternator, breaker etc.) and hand tools, required for maintenance of the unit and hand them over in good condition to APSCL before Provisional Acceptance Certificate (PAC). A list of all such tools shall be incorporated with tender. Contractor shall not be permitted to use any equipment/ machinery/ tools, which are to be supplied under the Contract.

2.20 Office equipment

The Contractor shall provide Five (05) Nos. of Computer (latest model), each with Laser Printer, UPS (30 Minutes at full load, Minimum), Stabiliser, Scanner, Photocopier, Racks, Standard Tables & Chairs and other office equipment.

2.21 Electrical testing equipment & tools

-A smart and modern test bench with standard testing facilities.
-CURRENT injection test set,
-Megger,
-Digital Multimeter,
-Relay testing kit,
-Process calibration,
-Pressure simulator,
-AVO insulation tester,
-Temperature simulator bath,
-Voltage detector with insulating telescope stick,
-Electric power supply test bench,
-Clamp on meter (0.600A),
-Hand tools etc. the origin of the tools must be Japan/USA/ Germany
-Temperature gun
-noise (db) measuring device
-Vibration measuring device
-oil insulation (break down voltage) tester

2.22 Workshop equipment & Tools

Contractor shall supply the equipment and tools as per the list of clause 18.4.4, volume 2 of 2 (Part-A) for maintenance & work shop activities etc.

2.23 Chemical Laboratory equipment & Tools

Chemical Laboratory equipment & Tools shall include among others all necessary equipment & Tools for oil testing, water testing and testing of chemicals & exhaust
gas used in the power plant including Spectro photo meter, Fuel oil (HFO, LFO) and Lube oil testing (Water in oil content, BN, Insoluble, AN, Density, Viscosity, Compatibility, Metal in lube oil), water (PH, Conductivity, TDS, Total Hardness, Nitrite, Total Alkalinity, Silica), Exhaust gas (SOx, NOx, CO and Particulate matter) measuring instrument etc.
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3. **Power Plant Arrangement**

3.1 **General**

The arrangement of the plant equipment shall be generally as described below:

The Power Plant (with HFO fired Engine Generating Sets) with a continuous total net generating capacity of 100 (±10%) MW shall be accommodated in the location proposed.

3.2 **Guarantee**

The net output and heat rate of the plant shall be guaranteed by the contractor at the following conditions:

a. Ambient temperature : 35°C
b. Relative humidity : 98%
c. Barometric pressure : 1.013 bar
d. Generation voltage : 11 kV
e. Power factor : 0.8 lagging at alternator terminal
f. Frequency : 50 Hz
g. Operating fuel : Heavy Fuel Oil (HFO)

The contractor shall guarantee the starting reliability of the Units including all ancillary equipment. The guaranteed reliability shall be stated in the Bid form together with the number of consecutive starts to which the Units will be subjected to demonstrate this reliability. (This is for a starting reliability of 95 %, the Units shall be subjected to 20 consecutive starts of which 19 shall be successful) the maximum speed rise after full load rejection is to be guaranteed.

3.3 **Engine Generating Set and Ancillary Equipment**

3.3.1 **Basic Equipment Requirements.**

The engine generating unit shall be of well proven design and the offered model shall have satisfactory operating experience outside manufacturer's country for at least 2 (two) years. Tenderer shall have to submit at least one certificate (must be from outside manufacturer's country) from the end users of Electricity Generating utility having the same type of engine of total minimum capacity 50 MW. This certificate must be notarized or have authentication from the Chamber of Commerce of the Tenderer's country or the Embassy/High commission of the end user's country situated in Dhaka. In absence of that in Dhaka, authentication from bidder's Embassy/High Commission.

The origin of the Engine Generating set must be European Union or G8 Countries.

The extent of supply shall include, but not be limited to, the equipment described herein. All equipment comprising the engine package shall be pre-assembled in the factory.

3.3.2 **Engine and Auxiliaries**

The engine unit shall be designed as a multi-cylinder, diesel cycle internal combustion and low or medium speed heavy-duty industrial type suitable for Heavy Oil firing for continuous operation at any load between 30% -
100% under the specified site conditions. The engine has to be of four strokes, direct injected, trunk piston, turbo-charged and intercooled design.

**Vibration Critical Speed**

The radial amplitude of vibration of any rotating shaft under steady state conditions at normal operating speed shall not exceed the value specified in API Standard 616 when measured at the shaft local to the bearing. The critical speed shall be beyond $\pm 20\%$ of the operating speed of the engine.

The engine unit shall be designed to burn Liquid fuel (Heavy Fuel Oil/Diesel). The unit shall be capable of frequent starts and stops without damage to the hot moving components and shall be able to run for base load. The Engine should have vibration measuring facilities interfaced with control system.

Main components of the engine are stated below:

**Engine block**

The engine block to be made of nodular cast iron and is of stiff and durable design to absorb internal forces. The engine block carries the underslung crankshaft. The nodular cast iron main bearing caps are fixed from below by two hydraulically tensioned studs. The caps are fixed sideways by hydraulically tensioned horizontal side studs. Together they provide a rigid crankshaft bearing. The inlet air receiver and the cooling water and lubricating oil channels are integrated into the engine block. The engine is provided with an oil sump, mounted against the engine block and sealed by an o-ring gasket.

**Crankshaft**

The crankshaft to be forged from one piece of high tensile steel. Counterweights are fitted on the crankshaft webs. The high degree of balancing results in an even and thick oil film for all bearings. The main bearings and the crankpin bearings have a steel backing and a soft running layer with excellent corrosion resistance.

**Connecting rod**

The connecting rod to be of the drop forged, totally machined type. The connecting rod is of three piece design with a horizontal split at the crankpin bearing and a flanged connection to the rod. The oil supply for the piston cooling, gudgeon pin bush and piston skirt lubrication takes place through a single drilling in the connecting rod.

**Cylinder liner**

The cylinder liner to be centrifugally cast iron with special alloy elements to create wear resistance and high strength. The liner is of stiff bore cooled collar design and supported symmetrically at the top of the engine block. It is equipped with an anti-polishing ring at the top, preventing bore polishing.

**Piston**

The piston consists of an oil cooled steel crown bolted on to a nodular cast iron skirt. The piston crown has two compression rings and one oil scraper ring. The piston skirt and cylinder liner are lubricated by a patented pressurized lubricating system utilizing lubricating nozzles in the piston skirt. This system ensures excellent running behaviour, and constant low lubrication oil consumption.

**Cylinder head**

The cylinder head to be made of nodular cast iron. Ample height and the
stiff design allowing only four hydraulically tightened studs to fix the cylinder head on to the cylinder block/liner. Each cylinder head has two inlet and two exhaust valves, all equipped with rotators. The exhaust valves are made of Nimonic and the exhaust valve seat rings are water cooled.

Camshaft and valve mechanism

The cams to be integrated in the drop forged camshaft material. The bearing journals are made of separate pieces that are fitted to the camshaft sections by means of flanged connections. This design allows lateral dismantling of the camshaft sections. The camshaft bearings are located in integrated bores in the engine block casting. The camshaft is driven from the crankshaft through a fully integrated gear train.

3.3.2.1 Starting System

The engines shall have compressed air based starting equipment capable of sustaining the complete starting cycle.

3.3.2.2 Turning Mechanism/ Gear

A motor operated turning mechanism/gear shall be provided to minimise thermal distortion of the crank shaft during a shutdown.

3.3.2.3 Accessories Drive Gear

The engine shall also be equipped with gear mechanism for machine driven accessories.

3.3.2.4 Turbocharger Wet Washing System

1. System Descriptions

For cleaning the turbochargers on and off line to remove soot a wet washing system have to be provided. The bidder shall design, manufacture and supply all the components (Viz. water tank, piping, valves, strainer, drains, manifolds, injection nozzles etc.) of the above mentioned wet washing system of suitable grade of material to handle the above wash water without any deterioration. The bidder shall clearly specify the proposed grade of materials of the above components. The bidder shall provide complete system including quality Water Plant as per manufacturer’s recommendation (from the water treatment system).

3.3.2.5 Governor System

The engine unit shall be provided with a complete governing system which shall be capable of maintaining a required constant speed under conditions of load variations, control the load, combustion oil temperatures and prevent over-speed. The characteristics of the engine generator unit and its governor shall be such that the machine operates satisfactorily in parallel with existing units in the system.

The speed governing system shall be provided with speed changing device capable of local and remote control. Provision shall be made to shut down the engine under emergency by local and remote control. The speed regulation shall be adjustable (from no load to full load) between plus and minus 5 %. The rated speed at no load condition shall be adjustable within ±0.5 % for easy synchronising.
The governing system for the unit shall also be provided with automatic over-speed trip devices adjustable up to 110% of the rated speed, and a load limiter.

The governing system shall include an adjustable load limit control, minimum fuel regulator, temperature limit control, temperature increment rate control and necessary protection equipment.

The governing system shall be suitable for parallel operation with a large power system and also for completely isolated and independent operation. In addition to the automatic speed governing system, a separate emergency over-speed trip mechanism and over combustion gas temperature trip system shall be furnished on the unit. These systems shall operate to shut the emergency fuel trip valves.

The unit shall not trip with voltage fluctuation of ±10% and frequencies variation ±4%.

Over-speed occurring under any conditions shall not have any harmful influence on the engine generating unit or on its auxiliaries. The governor shall have adjustable (±2%) droop setting.

### 3.3.2.6 Lubricating Oil System

The lubrication system of the unit shall be equipped with the gear driven main oil pump, auxiliary motor driven oil pumps, Emergency DC lube oil pump, Lube oil separator, Lube oil auto flash filter, Lube oil safety filter, delivery pipes, return pipes, reservoir, strainer, oil cooler, pressure gauges and thermometers, and all necessary oil piping for the system.

Separator will purify engine sump oil (used lube oil) by separating sludge, water and others as per requirement by the engine. Separator will have the capacity to purify whole sump oil by recirculation of the sump oil at least 4-5 times within one day.

Lubrication system will have three (3) types of tank: Fresh lube oil tank, used lube oil tank and maintenance lube oil tank. Fresh lube oil tank and used lube oil tank each having capacity 2 times the capacity of sump of one engine.

Engine lube oil sump top up/drain system will be consists of transfer pump, flow meter (for fresh oil) piping’s, valves etc.

Each oil reservoir shall be furnished complete with level glass gauge, level indicator, high and low-level alarm switches, strainer, drain valves, overflow pipe, manhole, valves, and piping.

The system shall include oil pressure and temperature alarm, and trip mechanism, each bearing shall be provided with thermocouple cell and a thermometer in pocket of oil drain.

Complete oil coolers each for 100% capacity shall be provided. The oil cooler shall be of water cooling type. The oil coolers shall be provided with water pumps.

### 3.3.2.7 Fuel system

HFO (furnace oil) will be used as fuel.
**Liquid Fuel oil system**

The unit shall be provided with liquid fuel oil system. The operating fuel would be Heavy Fuel Oil (furnace oil) and engine can run with LFO, if necessary. The liquid fuel oil system shall have fuel unloading with metering system & handling facility and storage facility for both HFO and LFO, cleaning system, heating system, fuel forwarding system, fuel injection system, oil recovery system, waste collection & treatment system, foam based fire suppression system etc.

**3.3.2.7.1 FUEL STORAGE AND HANDLING**

The fuel storage and handling system of the facility can be divided into three parts,

A. Heavy Fuel Oil System (HFO)
B. Light Fuel Oil (HSD) System
C. Fuel Transfer System

Under normal operating condition heavy fuel oil is used for the generator engines for full liquid fuel operation and light fuel oil is used for certain auxiliaries and for the generator engines in emergency and for flushing the HFO system for extended isolation.

**A. HEAVY FUEL OIL**

02 (Two) HFO storage tank of each capacity 5,000 m³ shall have to be installed as fuel storage tank of this plant. Two (02) HFO day tanks with a capacity of 1000 m³ shall have to be provided with

- A sounding pipe for manually measuring tank level,
- Remote level indication in the monitoring/control system, which shows fuel quantity by mass in the tank in percentage,
- Tank high level alarm,
- Vent with flame arrester,
- Over-flow connection to overflow tank,
- Decanting system with drain pit,
- Steam heating system, and,
- Associated valves and piping for filling, transfer and heating.
- Mass flow meter for measuring fuel inlet & outlet of the storage tank.

**HFO Bunkering/storage**

The plant has to be provided with fully equipped bunkering facility for riverside and road way bunker reception. Each bunkering unit is provided with a micro motion flow meter to constantly measure flow of fuel delivered to the storage tank.

**Light Fuel Oil**

One 1000 m³ LFO storage tank will be installed for storage and One 500 m³ LFO day tank will be installed. The necessary Design, modification and piping have to be provided by with A sounding pipe for manually measuring
tank level,
- Remote level indication in the HMI system, which shows fuel quantity by mass in the tank in percentage,
- Tank high level alarm,
- Vent with flame arrester,
- Over-flow connection to overflow tank,
- Decanting system with drain pit, and,
- Associated valves and piping for filling and transfer.

**LFO Bunkering**

The plant has to be provided with a separate fully equipped bunkering facility which is common for HFO as well as LFO. Each bunkering unit is provided with a micro motion flow meter to constantly measure flow of fuel delivered to the storage tank.

Procedure for LFO bunkering from both riverside and road way shall be same as HFO bunkering except for valve operation.

**C. FUEL TRANSFER SYSTEM**

The plant has to be equipped with a fuel transfer unit to facilitate HFO transfer in between storage tanks. Internal fuel transfer may become necessary to facilitate segregation of fuel from different supply tank.

The transfer unit consists of following components,

- Screw type transfer pumps: 2 (two) sets
- Pump suction strainer: 1 (one) each
- Transfer unit relief valve: 1 (one) on common discharge line
- Associated valves and piping

Transfer pumps takes suction from HFO storage tanks’ common outlet header and delivers into bunker filling common line.

### 3.3.2.7.2 FUEL TREATMENT

Fuel received from supplier may contain water and other solid impurities, which may have detrimental effect on combustion quality and fuel injection system components. So it is imperative that the fuel is properly treated to separate water and sludge before the fuel is fed to the engine.

HFO received from supplier goes through a two-step treatment process and finally stored in the day tank for engine consumption. The first step takes place in the fuel storage tanks, which are equipped with heating and decanting facilities. Fuel in the storage tank is heated and allowed to settle to facilitate separation by gravity where some of the water and solid impurities accumulate at the tank bottom. Time to time these accumulated water and sludge are to be drained out
from the storage tank using the drain valves provided for each fuel tank. Remaining suspended solid and water is separated by centrifuge.

All HFO storage tanks’ outlet lines connect into a common header from where the centrifugal separators take suction. Each storage tank outlet line is to be fitted with two valves in series, first one is a hand shut off valve and the second one is a pneumatic control valve, which is to be operated from the quick closing valve panel. HFO day tanks’ overflow lines are also connected with the storage tanks’ common outlet header, in another words day tank overflow goes back to separator suction. Day tank overflow lines are fitted with hand shut off valves.

3.3.2.7.3 ENGINE FUEL SUPPLY SYSTEM

Centrifuged and pre-heated fuel oil from the day tank is fed with Constant Pressure regulated by variable frequency drive operation to the individual engines by the engine fuel oil supply system have to be manufacturer specific but as a minimum should comprises of following components,

a. Two Fuel Feeder Units
b. Two Fuel Booster Units
c. Engine Wise Fuel Units
d. LFO Feeder Unit

A. Fuel Feeder Unit

The engine fuel supply system is equipped with fuel feeder units which take suction from HFO day tanks or LFO day tank as selected by the changeover valve and delivers to fuel booster unit. Feeder units are fitted with an inter-connection valve for emergency use. Each feeder unit is equipped with,

- Two feeder pumps
- Individual pump suction filter,
- Individual pump suction and delivery valves,
- Suction valve for HFO and LFO with changeover arrangement,
- Common pressure regulating valve, and,
- Discharge line common quick-closing valve.

In each feeder unit one pump remains in use while the other can be kept on standby.

Feeder unit pumps and quick closing valves are controlled from a common control panel for feeder and booster unit located near the booster unit.

Note: The feeder unit suction valves for HFO and LFO have to be equipped with a single operating lever for changing over feeder unit suction. Horizontal lever position is for HFO operation and vertical lever position is for LFO operation.

B. Fuel Booster Unit
Engine fuel supply system is equipped with identical fuel booster units, which take suction from the relevant feeder unit and deliver to engine wise fuel units. In the booster unit fuel oil is filtered and heated to attain suitable viscosity for efficient combustion before delivering to engine inlet header from where engine wise fuel unit take suction. The booster units are also interconnected by isolation valves on the supply and return line for emergency use only.

Each fuel booster unit have to be comprises of following components,

- Automatic back flushing filtration unit
- By-pass duplex filter unit
- Fuel flow meter
- Mixing column
- Two fuel booster pumps
- Two steam heaters
- Viscosity controller unit
- Fuel returns line change over arrangement.

**Fuel Oil Auto Filter**

The system is equipped with a fully automatic back flushing filter unit with a by-pass duplex filter with redundancy. Under normal operating condition the system should not be operated with the back flushing filter by passed.

**Filtration Process**

A motor driven change over unit is located at the centre of the filtration unit and surrounded by 4 filter chambers. At any given time 3 filter chambers are in use and 1 remains on standby. At a present time, interval, the filter control unit goes on flushing cycle.

Differential pressure across the filter is continuously monitored by the controller and if at any time the differential pressure reaches the set value the controller initiates a flushing cycle and activates High Filter Differential Pressure Alarm.

**Back Flushing**

At the beginning of back flushing cycle, the controller activates the changeover unit. The change over motor rotates the central change over mechanism one fourth of a turn and as a result the stand by filter goes into operation while the 3rd filter chamber goes off line and enters into back flushing cycle.

As soon as a filter goes on standby mode the control unit energizes solenoid valve-A, which allows instrument air to operate the sludge piston and opens the sludge port. Opening of the port allows the air to travel to and open valve-C of air reservoir. Air from reservoir then enters into the outlet side of the stand by filter and drives the fuel oil and accumulated dirt out of the chamber, which flows to the fuel return line to HFO day tank. Fuel from the filter main outlet enters into the stand by chamber through a control hole and gradually fills up the stand by chamber.

**By-pass Filter**
The system is equipped with a set of duplex filters with mesh size of 34 microns connected in parallel with the auto back flush filter. The by-pass filter is provided to facilitate isolation of the back-flush filter and to be only used when back flush filter maintenance is necessary while the engines are running. The by-pass filter unit comprises of:

Two filter chambers with filter elements,

One change over cock, and,

One vent line.

**Fuel Flow Meter**

Each booster unit is provided with a micro motion flow meter to constantly measure flow of fuel delivered to the engines covered by the relevant booster unit. The flow meter is located between the filter unit and the mixing column and fitted with a by-pass valve. The flow meter can register the following information:

- Cumulative mass flow in kg
- Flow rate in kg/hr or litres/hr
- Fuel pressure
- Fuel temperature

**Note:** The flow meter is capable of registering negative flow rate but the cumulative mass flow is always incremental.

If booster units are operated with the interconnection valves open and if there is any re-circulation of fuel through any of the booster units due to pressure difference then the flow meter will register incorrect (excess) cumulative mass flow readings.

A micro motion flow meter shall have to be provided in the outlet of the HFO feeder unit to measure the fuel consumption of the plant.

**Mixing Column**

Mixing column is located in between the flow meter and booster pumps. Return fuel from engines can also be directed to the mixing column. It is equipped with a float type venting arrangement to bleed of any vapour (water or fuel) and a float operated low-level alarm to ensure positive suction header for the booster pumps.

**Fuel Booster Pumps**

Each booster unit is provided with two booster pumps with individual isolation valves. The pump takes suction from the mixing column and delivers to the engines through the heater and viscosity controller unit.

**Fuel Heaters**

Each booster unit is equipped with two tube type fuel oil heater units installed in parallel. Each heater is capable of handling complete fuel heating requirement of one bank at full load. Heating steam supply valve for the heater is a pneumatic control valve controlled by either the viscosity controller or the temperature controller as selected at the booster unit control panel by the selector switch A16S2.

**Viscotherm**
The booster unit is equipped with a viscotherm unit on the fuel supply line after the heaters. It measures the process fuel viscosity and sends input for the viscosity controller unit. The viscotherm unit is fitted with isolation valves and a by-pass line with a by-pass valve to facilitate maintenance work on the unit while the booster unit is in operation.

**Return Line Change Over Arrangement**

Returned fuel from the engines can be directed either to the mixing column or back to HFO day tank. Two return lines are fitted with separate isolation valves with a single operating handle and the valves are such configured that while one valve opens the other closes. At horizontal lever position fuel return to mixing column valve remains open and at vertical lever position fuel returns to HFO day tank. In normal operating condition return fuel is directed to mixing column. Sending return fuel back to day tank should be avoided as no flow meter is available to measure the return fuel quantity.

**Temperature/Viscosity Control**

The fuel booster unit is provided with two separate controller units for temperature control and viscosity control and either one of them can be selected by the selector switch A16S2. When temperature controller is in use it maintains the fuel temperature as per set value while viscosity may vary and when viscosity controller is in use it maintains the viscosity as per the set value by controlling fuel temperature and temperature may vary. In both cases it is the steam supply to the fuel heater, which is controlled.

**C. HFO Separator Unit**

The facility is equipped with minimum three (3) HFO separation units each comprises of the following, but no limited to,

1. Separator (Westfalia/similar standard)
2. Delivery pumps
3. Strainers
4. Steam heaters
5. Sludge tanks
6. Sludge pumps
7. Steel frame
8. Control panel
9. Interconnection pipes, flanges, seals and valves

Separation will purify HFO by separating sludge, water and others as per requirement by engine. Two separation unit will purify oil required for whole plant operation and another unit will be kept for standby.

**D. Engine wise Fuel Unit**

Each engine is equipped with a fuel unit to facilitate engine wise HFO / LFO change over option, leak off fuel handling and final fuel filtration before injection.

Each fuel unit comprises of following components,
- Valve unit with solenoid controlled actuator,
- Fuel feeder pump with suction strainer,
- Duplex fuel filter,
- Pressure control valve, and
- Leak off fuel collecting tank with return pump

**Fuel unit Feeder Pump**

Each fuel unit is equipped with a fuel feeder pump with suction strainer and isolation valve. The pump is provided to facilitate boosting fuel supply pressure and re-circulate fuel through the engine when the engine is stopped and on HFO mode. The engine can operate with or without the feeder pump running depending on available fuel pressure at the supply header.

**Fuel unit Duplex Filter**

For the final filtration of fuel before it enters the engine a duplex filter is provided at the engine fuel unit. The filter is fitted with a change over cock, a differential pressure cell, heating steam line and drain and venting arrangement. Normally one filter is kept in use while the other is on standby but if required both the filters can be put into service. The DP cell monitors and indicates the pressure differential across the filter unit and activates an alarm at the fuel unit control panel (indicator H5) if it exceeds the set value.

**Leak off Tank and Return Pump**

Any leakage from individual cylinder’s fuel injection pump and fuel injection system double wall pipes are led to the clean fuel leak off tank. Each bank leak off line is equipped with a float type alarm to indicate excessive leakage. The leak off tank is fitted with a return pump with isolation valves, which operates automatically controlled by a float switch. The same activates leak off tank high-level alarm as well. The engine fuel return line passes through the leak off tank to maintain heating for leak off fuel.

**Engine Operation in LFO Mode**

Engine LFO operation facility is provided as a back up of HFO system and for flushing the fuel system before extended shutdown or to facilitate maintenance work. Engine LFO operation is possible in two different ways,

By feeder and booster units for common LFO operation, and,
By LFO feeder unit for individual engine LFO operation.

**Common LFO Operation**

This system is to be used when the common fuel supply system needs to be flushed for maintenance work or the plant has to be operated on LFO instead of HFO. Procedure for change over from HFO to LFO operation,
Engine wise LFO Operation

This system is to be used when an individual engine needs to be operated on LFO to facilitate flushing of engine fuel system for maintenance work while the remaining plant operation shall be on HFO supplied by the common fuel system. For engine wise LFO operation a separate LFO feeder unit PCA-905 is provided.

E. LFO Feeder Unit

The LFO feeder unit takes suction from the LFO day tank and delivers directly to engine fuel units with Constant Pressure regulated by variable frequency drive operation. It also supplies LFO for following auxiliaries,

- Engine driven emergency fire pump
- Black start generator
- Oil fired steam generator (if required)
- Machine shop for cleaning and testing purposes.

The LFO feeder unit is comprises of as a minimum of the following components,

- Two feeder pumps,
- Individual pump suction filter,
- Individual pump suction and delivery valves,
- Common pressure control valve, and,
- Discharge line common quick closing valve
- Variable frequency drive for pressure regulation.

Note: The LFO feeder unit is provided with a low suction pressure alarm to avoid dry running of the pump when suction filter gets clogged.

3.3.2.8 Compressed Air System

Complete compress air systems have to be provided. Compressed air is used for starting the engines and for control and instrument air.

Starting air is produced by the starting air compressor unit. Compressed air from the starting air unit is stored in starting air bottles until it is used for starting the engine. The pressure equipment is to be designed, manufactured and tested according to the European Union directive 97/23/EC "Pressure Equipment Directive" or equivalent standard.

The starting air system consists of the following main equipment:
A portable air compressor with adequate capacity duly approved by the project director shall have to be provided.
Starting air bottle
The total capacity of the starting air bottles is dimensioned to ensure a total of at least 20 engine starts. Each starting air bottle is equipped with necessary accessories.

Piping and valves compressed air system (set)
This includes pipes, valves, flanges and gaskets for the compressed air system up to the interconnection point.

Starting air compressor unit - (2x50%+1x50%)
Starting air compressor unit is used for refilling the starting air bottle(s). The following components built on a steel frame, which forms a compact skid unit have to be provided.
- Electric motor driven air compressor
- Capacity, each (for filling the bottoms within 30 minutes)
- Pressure : 30 bar
- Pressure switch for starting and stopping the electrically driven air compressor
- Alarm switch for too low starting air pressure to engine
- Oil and water separator
- Control center for manual and automatic operation
- Pressure reduction valve for control and working air
- Steel frame
- Set of interconnection pipes, flanges, seals and valves
- Maintenance crane facility

Instrument air compressor unit- (100%+100%)
The control and working air compressor unit produces control, instrument and working air. The compressed air is stored in the built-on air bottle until it is distributed to the different points. The control and working air compressor and related equipment to be built on a common frame to form a compact unit.
- Electrically driven air compressor
- Compressed air receiver
- Refrigerated air dryer with control panel Dew point
- Filter for removal of oil, water and particles
- Common control panel
- Steel frame
- Set of interconnection pipes, flanges, seals and valves
- Maintenance crane facility

Instrument air bottle
The compressed air is stored in the control air bottle until it is distributed to the different consumers.

3.3.2.9 HEAT RECOVERY STEAM GENERATION SYSTEM
(STEAM GENERATION SYSTEM FOR FUEL HEATING)
The steam generation system generates steam to be used for fuel heating in the power plant. Steam is generated by recovered waste heat from the engine exhaust gas. A standby fuel fired boiler is supplied for backup use. The system have be designed based on an minimum "N/2 (but adequate to meet the plant requirement)+1 principle" (N= No. of units) and one additional fuel fired boiler.
Steam flows from the heat recovery boilers to a steam header for distribution to the steam consumers in the plant. A non-return valve on the steam outlet of the drum prevents backflow when the boiler is not in use. Condensate is collected in the feed water tank and returned to the boilers by the feed water pumps.

A fuel fired boiler may be provided to generate steam when the engines are not running or when the exhaust gas boilers require maintenance.

**Exhaust gas boiler**

The exhaust gas boiler is to be a horizontal smoke tube type. The following is to be included:

- Inlet and outlet hoods with inspection doors
- Modulating exhaust gas by-pass damper with actuator
- Manual steam soot blowing equipment
- Shut-off valves
- Blow-down drain
- Safety valve
- Relief valve
- Pressure switches
- Level switches
- Level control device
- Insulation and cladding
- Counter flanges, bolts, nuts and gaskets
- Mounting supports
- Boiler service platform

**Bellows for exhaust gas boiler**

The expansion bellows isolate the exhaust ducting from vibrations and also allow for thermal expansion.

**Heat recovery container (preferable)**

Auxiliary equipment for the steam generation system preferably to be installed into a standard 40 feet container. All installation, piping, insulation, cabling, painting and testing of the equipment inside the container to be done at the factory where the container is assembled, thus saving installation time at site.

The following to be included:

- Feed water tank

The feed water tank is of the "hot well type" working at atmospheric pressure. It receives condensate from the steam consumers and make-up water from the water treatment system. The feed water tank is insulated and located on top of the container.

- Feed water pump (2x100%)

The feed water pump pumps feed water from the feed
water tank to the boilers at the appropriate pressure.

- Chemical dosing unit

The chemical dosing unit adds chemicals to the feed water in order to prevent corrosion and scaling in the boiler system.

- Blow-down tank

Blow down water from the boilers is lead via the blow down tank to the drain. The blow down tank can be cooled by tap water when needed. Blow down is performed at regular intervals in order to prevent the accumulation of chemical compounds in the steam system.

- Local control panel

The local control panel contains the components for controlling and operating the steam system as described above

**Light fuel oil fired boiler for steam generation (if required)**

An independent oil fired boiler is supplied for use when the exhaust gas boilers are not in use, for example during the start-up of the power plant. It is also used for heating the heavy fuel system during outages.

The auxiliary boiler unit includes:
- Evaporator section
- LFO burner
- LFO pump
- Combustion air fan
- Steam pressure gauge
- Pressure switches
- Temperature switches
- Level control device
- Main closing valve for steam
- Non-return valve at steam outlet
- Safety valves
- Local control panel
- Interconnection pipes, flanges and gaskets

**Oil detector**

The oil detector detects if the condensate return coming to the feed water tank contains oil. If oil is detected condensate will be dumped into the drain system and an alarm will be given to the control system.

**Steam header**

Steam from all the boilers is collected to the steam header and forwarded onwards to the steam consumers. Shut-off valves are installed on each incoming and outgoing line from the steam header. The steam header also functions to separate possible water droplets in the steam and drain them to the condensate return system.

**Boiler washing water tank**

Dirty washing water from the boilers is collected in the boiler washing water tank

**Boiler washing water pump**
Boiler washing water pump transfers dirty water from the boiler washing water tank to the water treatment system.

**Piping, valves and insulation for steam generation system for fuel heating (set)**

### 3.3.2.10 COOLING SYSTEM

The main task of the cooling system is to provide adequate cooling of critical engine components such as cylinder jackets, cylinder heads and turbochargers as well as to cool the lubrication oil and charge air entering the cylinders after it has been compressed by the turbocharger.

The engine cooling water cools the low temperature charge air cooler, lubricating oil cooler, high temperature charge air cooler and engine jackets in a common single-circuit radiator.

Control system with variable frequency drive will start/stop the radiator fan as per requirement by the engine.

There will be two Maintenance water tank each having capacity more than two times of total cooling water capacity of one engine.

**Contractor will design radiator arrangement for proper accessibility for maintenance considering its motor handling and transportation.**

### 3.3.2.11 CHARGE AIR SYSTEM

The charge air filter protects the engine against impurities in the inlet air and the charge air silencer reduces the air intake noise from the engine. Wet type charge air filtration system and separate silencer will be used.

### 3.3.2.12 Air Inlet System

The air filtration arrangements shall be provided for the air intake of the units to meet the manufacturer’s recommendation in this regard.

The bidder shall supply air inlet system complete in all respects including necessary supporting structures, holding frames, fasteners, pressure switches, gauges etc. whichever are necessary. The bidder shall also submit necessary design documents and drawings for this filtration system.

Each air inlet system shall be provided with silencer if required capable of keeping the sound pressure level to the prescribed limit when measured at a distance of 100 meter from the plant operating at full load as per ISO standard.

### 3.3.2.13 Exhaust System

The exhaust gas of the engine to be discharged at the required height through the exhaust gas silencer and stack pipe. The exhaust gas silencer reduces the exhaust noise from the engine.

**Exhaust gas silencer**
The exhaust gas silencer reduces the noise emission from the engine exhaust outlet.

**Bellows for exhaust gas silencer**

The expansion bellows isolate the exhaust ducting from vibrations and also allow for thermal expansion.

**Ducting exhaust gas system (set)**

This includes ducting for the exhaust gas system between the engine and the exhaust gas stack.

**Bellows for exhaust gas ducting**

The expansion bellows isolate the exhaust ducting from vibrations and also allow for thermal expansion.

**Insulation exhaust gas ducting (set)**

This includes insulation material and cladding for the exhaust gas ducts inside the building and in accessible places with a surface temperature over 60°C up to the exhaust gas stack.

**Exhaust gas stack pipe**

The exhaust gas of the engine is discharged through the exhaust gas stack.

The exhaust gas stack has the following characteristics:

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<th>Material</th>
<th>Height above ground level: No less than 50m</th>
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**Exhaust gas sampling point will be provided for SOx, NOx and particulate matter measurement as per DoE, Bangladesh requirement.**

### 3.3.2.14 Oily water treatment system

Oily water buffer/interceptor tank consists of four (04) compartments. Plant’s all dirty oil, water and sludge will be collected in the first chamber of oily water buffer compartments. By heating and gravity force, sludge, oil and emulsive oily water will be separated in the compartments. Only emulsive oily water will be accumulated in its fourth compartments. Automatic Oily water treatment unit will take its suction from fourth chamber. In the automatic oily water treatment unit (PLC controlled), the chemicals will break the emulsion, and create 3 different layers. (Sludge, disposable water and oil) during settling time. Disposable water will be disposed appropriately and sludge & oil will be send back to the first chamber of buffer tank. Separated sludge and oil from first chamber will be transferred to sludge tank.

Sludge tank and Oily water buffer/interceptor tank each having capacity considering 1% sludge of the quantity of consumed fuel for 80% plant factor for three (03) months not less than 500 m³.
3.3.2.15 Unit Enclosures

Except as otherwise specified, all equipment shall be enclosed in a minimum number of prefabricated metal enclosures. The enclosures shall be constructed in a neat and workmanlike manner and shall present an attractive appearance.

Enclosures shall be weather proofed and noise proofed and shall for wind loading of 100 miles / hour.

Enclosures shall be designed to permit easy accessibility to the equipment and to provide necessary protection for maintenance personnel. Sound absorbing insulation shall be provided on the enclosures. Enclosures shall be provided with walkways, steps, strains, and equipment doors of the locking type.

Enclosure insulation, ventilation, and cooling shall be provided to maintain temperatures suitable for personnel and for all systems whether standby or operating. Unit control rooms shall be ventilated and air-conditioned. From control room, all units will be visualized clearly.

The compartment shall be adequately ventilated utilizing forced ventilation with louvers and bug screens as required for protection of the houses equipment from outdoor environmental conditions.

Adequate interior lighting shall be provided, and emergency DC lighting shall also be provided, and those shall be energised through an automatic throw over contractor when AC source fails. Enclosure also shall be provided with day light facility to minimize power consumption.

Enclosures shall be provided with 240volt AC service outlets.

In case of installing engine generating sets within a common enclosure (engine house) above mentioned conditions and environmental limitations will also be relevant

3.3.2.16 Fire Protection Equipment

The entire enclosure including LV, MV switchgear room, all auxiliary compartment storage facilities and transformers shall be automatically protected from fire with complete fire protection system complete with fire suppression system, fire detectors, pipe works, control and safety device. Actuation of the fire protection system shall be indicated at the control compartment and by a visual and an audible alarm to warn any personnel in the compartments.

3.3.2.17 Casing Design

The casings of all the rotary parts on the main unit shall be designed in such a way, so that are suitable for easy dismantling and inspection. Lugs for lifting the upper portions shall be provided at points which will lift the casings/ heads well balanced. Complete lifting gear together with lifting drawing and instruction shall be furnished.
3.3.2.18 Insulation and Lagging

Thermal insulation shall be provided where necessary. Removable insulation blankets shall be provided in all parts where insulation must be removed for maintenance purposes.
Section 4

Generator and Ancillary Equipment
## Generator and Ancillary Equipment

### 4. Generator

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### 4.2 Exciter and Automatic Voltage Regulator

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</table>
4. Generator and Ancillary Equipment

4.1 Generator

4.1.1 General Requirements

The generator shall be designed and manufactured in accordance with International Electro-Technical Commission Publication IEC 34.

The generator shall be cooled by air. The MVAR leading capability shall not be less than 30% of the MVA rating of the generator at 0.8 leading power factor. The generator in conjunction with its exciters shall be designed to operate stably at all loads up to the maximum continuous rating.

The generator shall be capable of operating continuously under unbalance loading conditions when the negative phase sequence current component is less than 8% of the rated current.

The generator shall be so designed as to minimise the effect of torsional rotor oscillation due to system disturbances and rapid load change. The generator shall withstand continuous over-speed of 1.2 times of the rated speed without damage. The generator shall withstand 120% of rated current for more than 15 seconds.

Generator will be synchronised at 11 kV and all generator 11 kV circuit breakers will be provided with synchronising facility.

The origin of the Generator and ancillaries must be European Union or G8 Countries.

4.1.2 Generator Rating

a. Capacity at Site: To match Diesel Engines peak output at any Ambient temperature.

b. Power factor: 0.80 (lagging).

c. Frequency: 50 Hz

d. Rated rotating speed: 100-750 rpm (matching the engine speed)

e. Rated voltage: 11 kV

4.1.3 Voltage and Short Circuit Ratio

The generator shall be capable of supplying the rated output at rated speed and at rated power factor with a voltage variation between 90% and 110% of the rated voltage.

The generator shall be designed to guarantee that a nominal short circuit ratio is not less than 0.55 according to IEC 34.1.

The generator shall withstand the electromagnetic and thermal stresses causing from short circuit fault at generator terminal without damage.

4.1.4 Temperature Rise

The temperature rise of the generator under the base and peak rating operations at any ambient condition shall not exceed the values given below:
<table>
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<th>Description</th>
<th>Temperature at Base</th>
<th>Temperature at Peak</th>
</tr>
</thead>
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<tr>
<td>a.</td>
<td>Stator winding by resistance</td>
<td>95°C</td>
<td>100°C</td>
</tr>
<tr>
<td></td>
<td>Temperature detectors method</td>
<td></td>
<td></td>
</tr>
<tr>
<td>b.</td>
<td>Field winding by resistance method</td>
<td>100°C</td>
<td>105°C</td>
</tr>
<tr>
<td>c.</td>
<td>Cores and mechanical parts in contact with or adjacent to insulated winding by thermometer</td>
<td>95°C</td>
<td>100°C</td>
</tr>
<tr>
<td>d.</td>
<td>Bearing when measured on the surface</td>
<td>40°C</td>
<td>40°C</td>
</tr>
</tbody>
</table>

4.1.5 Insulation

The insulation of the armature and field windings of the generator shall satisfactorily withstand high voltage tests as specified in IEC standard. Insulation of the armature windings, field windings, and collectors shall be class F.

4.1.6 Stator

The cores shall be made up of high permeability, low loss, stampings, tightly clamped together to reduce noise and vibration to a minimum. All burrs of laminations shall be removed after punching. Sufficient ventilation ducts to ensure uniform cooling shall be provided. Clamping of the laminations and securing to the stator frame shall be done by approved methods. Attention shall be given to prevent vibration being transmitted to the generator foundations or associated equipment.

Protective covers and air shields shall be made of steel plates, welded, stiffened with suitable angles and channels, and formed in segments for case of handling. The segments shall be bolted together and to the stator frame.

The windings, terminals, and leads shall be fully insulated throughout and braced, blocked and supported against the single and three-phase short circuits fault at the generator terminals under any operating conditions.

The general construction of the stator and bracing of the winding overhand shall provide adequate cooling surface and to avoid the hot stops. The stator coils shall be either semi or completely pre-formed and shall be made up before insertion to the slots.

4.1.7 Generator Leads

The neutral and output ends of each phase windings shall be brought out to the generator terminal cubicle.

The generator neutral shall be grounded through suitable transformer with secondary resistor.

4.1.8 Bearing

Bearings shall be pressure lubricated by pressured oil from the engine lubricating oil system, and oil drain pipes shall be equipped with pockets.
for thermometer and suitable sight flow opening for observing bearing oil flow.

4.1.9 Rotor

The packing blocks used especially in the rotor winding shall be of approved material and entirely suitable for the high temperatures and mechanical forces which may cause on rotors.

The rotor slot insulation shall be mainly of epoxy resin or other approved material and particular attention shall be given to the insulating and securing of coil to coil and slip ring connections, if any, and to avoid vibration and the possible failure to either the connector or its insulation.

Adequate precautions shall be taken against local overheating of the rotor surface when neutral short circuits and single phase loading and the Contractor shall submit data showing permissible single phase and unbalanced three phase loading. The rotor shall be capable of withstanding an over-speed test of 1.2 times rated speed for two minutes.

If slip-rings are provided, a grinder for slip-ring maintenance shall be supplied by the Contractor.

4.1.10 Temperature Detectors

More than nine (9) resistance type detectors shall be provided for monitoring of generator stator winding temperatures. The detectors shall be built into the generator, fully protected from the cooling air, suitable distributed around the circumstances, and embedded in the slots in positions normally having the highest temperature in accordance with requirements of IEC standards. All detectors shall be wired out to a terminal box.

4.1.11 Insulation Against Shaft Current

One of the bearings shall be suitably insulated to prevent flow of shaft current.

4.1.12 Accessories

a. Temperature detector (Refer to Clause 4.1.10)
   - Normal use : more than 6 (six)
   - Spare : more than three (3)

b. Thermometers and thermocouples at bearing drain of generator and exciter bearings, and at any other location required for operation monitor.

c. Pressure gauge at bearing oil feed, and at any other location required for operation.

d. Alarm contacts

e. Space heater:
   The stator shall be equipped with space heater. During the generator stop, the space heater shall be in service automatically.

f. Other:
   Other instrument, terminal box, hardware buried into the generator
foundation and all other necessary accessories for generator.

4.2 Exciter and Automatic Voltage Regulator

4.2.1 Exciter

A complete voltage regulating and excitation system shall be provided. A complete and detailed description of the proposed system that meets the requirements of these specifications shall be submitted with the Tender.

A shaft mounted brushless type with static type control shall be provided.

The excitation system shall match the generator rating and shall maintain the voltage of the unit within a tolerance of plus and minus 0.5% of rated voltage regulation. The exciter shall have capacity to supply not less than 110% of the field current required by the generator at rated output, power factor, frequency and voltage.

The rated voltage of the exciter shall be 110% of the machine excitation voltage at the rated output of the machine.

The ceiling voltage of the exciter shall not be less than 140% of the matching excitation voltage. Insulation of stator and rotor winding of the exciter shall be class-F. A field breaker and discharge resistance shall be provided or alternatively special provisions must be taken to either discharge or suppress excitation following generator fault.

The excitation system shall have ample capacity to permit operation throughout its capability up to over-excitation and under-excitation limit as shown in the manufacturer's capability curves.

Over excitation limiter and under excitation limiter shall be provided.

4.2.2 Automatic Voltage Regulator (AVR)

A quick response continuously acting regulator having a negligible dead-band and characteristics enhancing the transient stability of the generator shall be provided.

The regulator shall be responsive to the generator line-to-line voltage and shall restore the exciter output voltage to range of plus / minus 2% of the nominal pre-set level in a response time of less than 50 milliseconds. The accuracy of controlling the AVR shall maintain the generator terminal voltage within plus- minus 0.5 % of the pre-set value for gradual change of output within the specified load range of the machine. It shall have the capability to adjust the generator voltage between a minimum of 80% of rated voltage (open circuit) and a maximum of 110% of rated voltage (full load).

The regulator shall be equipped with devices which will provide compensating or overriding signals to the regulator in response to the following conditions.

a. Excessive exciter output current in the event of fault in the field circuit.

b. Pole slip due to reverse induced field voltages.

c. Under excited reactive current in excess of generator capability limits

d. Voltage drop due to generator reactance.
e. Dynamic variation of generator output.

Manual control shall be provided to set the generator terminal voltage between 0% and 110% of the rated voltage.

Automatic change-over from Auto to Manual system shall be provided in case of abnormal/faulty PT Voltage.

4.3 11 kV Generator Switchgear

4.3.1 General

The generator circuit breaker shall be provided, and it shall be accommodated in metal clad switchgear cubicle arranged for local and remote control.

The origin of the 11kV switchgear equipment must be European Union or G-8 Countries.

The switchgear and the associated equipment shall be fully metal clad and shall comprise the following, but not limited to:

- Switchgear bus bar
- Voltage transformers
- Current transformers
- Surge protective equipment
- Generator circuit breaker (SF6 draw out type)
- Power fuse switch for station transformers
- Cable termination facilities for 11 KV circuit
- Secondary wiring including cable termination facilities
- Earthing facilities.
- Indication (ON, OFF) facility.
- Metering system

4.3.2 Type and Rating

1) The switchgear shall be of the metal clad type and shall comply with the standards given below and with the relevant requirements stated in this specification.

   IEC 298 AC metal-enclosed switchgear
   IEC 85 Insulating materials
   IEC 51 Electrical indicating instruments

2) The switchgear bus bar and associated connections shall have the insulation levels as given below:

   System highest voltage : 14 kV

   Withstand voltage
Lighting (impulse) : 75 KV (peak)
(11.2/50micro sec.)

Power Frequency (rms.) : 28 KV
(For 1 Min.)

3) The rated service voltage shall be of 11 KV.
4) The current rating of the main bus bars shall not be less than rated current of the related generator and rating of the associated connections shall be determined by the Contractor.
5) The short time three phase fault level rating for one second of the switchgear shall be of 80 kA (rms). The Contractor shall check the system fault current level.

4.3.3 Construction and Fittings

(1) The switchgear shall consist of rigid welded steel cubicles and shall house generator circuit breaker, bus bars, current transformers, voltage transformers, neutral grounding transformer, surge absorbing equipment etc. The generator circuit breaker and the voltage transformers shall be withdraw able type. All doors shall be padlock able and readily removable when necessary.

(2) The bus bar and its connections shall be of copper and all joint surfaces shall be silver plated.

(3) All bus bar connections shall be by bolted type. Flexible joints shall be provided wherever for thermal expansion will occur.

(4) Safety shutters actuated by inserting or withdrawing of the circuit breaker shall be provided in the circuit breaker compartment.

(5) Control circuit isolating connector shall also be provided.

(6) Clearly labelled mechanical interlocks shall be provided in each circuit breaker compartment to prevent:
- a close circuit breaker from being withdrawn from or inserted into the isolating contacts;
- A circuit breaker from being moved into any location unless it is fully withdrawn.
- a circuit breaker from being inserted into the fixed position unless the secondary isolating contacts are fitted.
- a circuit breaker from being closed except when fully inserted or fully withdrawn.
- a circuit breaker from being closed except when fully inserted or fully withdrawn.
- a circuit breaker from being closed except when fully inserted or fully withdrawn.
- a circuit breaker from being inserted against a locked safety shutter.
7) A common earth bus bar shall be provided in the switchgear. The bus bar shall consist of one copper
8) All secondary wiring shall be terminated on terminal blocks in an enclosure separate from the high voltage compartment.

4.3.4 Circuit Breaker

The 11 kV circuit breaker for transformer shall be of SF₆ gas type only and Generator breaker/bus coupler shall be SF₆/vacuum type.

The circuit breaker shall comply with the requirements of IEC 56 and the relevant requirements of these Specifications.

Rated Current: Each Generator incoming circuit breaker current rating will be at least 150% of Generator full load rated current.

- Rated Voltage : 11 kV
- Interrupting Current : 80 kA (rms) or higher

Only fully type tested circuit breakers complying with IEC 56 will be considered, and a statement as to the availability of certificates of all such type tests including impulse tests on identical or similar circuit breakers shall be submitted with Tender.

4.3.5 Current Transformer

The current transformers in the generator switchgear shall be of the epoxy resin insulated and of the bar or wound primary type. The ratio, rating, polarity and accuracy classes [tariff metering] of current transformers shall conform to IEC185.

4.3.6 Voltage Transformer

The voltage transformers shall be of the horizontally with draw-out type and shall be located on top parts of each unit switchgear. Padlocking facilities shall be provided for both the services and isolated positions. The fixed isolating contacts shall be covered by a positively driven pad lockable shutter when the voltage transformer is withdrawn.

The ratio, rating, polarity and accuracy classes [tariff metering] of voltage transformers shall conform to IEC 186. The current limiting fuses shall be provided on high tension circuit of the voltage transformer.

4.3.7 Surge Absorbing Equipment

The best quality surge arresters and capacitors for surge protection of the generator shall be provided.

4.3.8 Neutral Earthing Equipment

(1) Neutral Earthing Transformer

A single-phase, 50 Hz, dry or oil immerse type, naturally cooled neutral earthing transformer conforming to IEC 76 shall be provided for generating unit.

The voltage ratio of transformer shall be 11kV/ 240 V. The continuous rating in KVA appropriate to an earth fault duration of 30 seconds and a maximum primary earth fault current of 10A shall
be determined by the Contractor.
Insulation level of primary winding shall be of BIL 75 KV.

(2) Earthing Resistor
The resistance of secondary resistor on neutral earthing transformer shall be equal to one third of the zero sequence capacitance per phase of the generator plus the bus bar capacitors if provided. The current rating shall be suitable for a single phase to earth fault on the generator circuit for 30 seconds and a maximum primary earth fault current of 10 A.

The terminals of the resistor shall be corrosion resistance.

4.3.9 Composition of Cubicles

(1) Incoming Circuit Breaker Cubicle for each unit
- Circuit breaker : One (1) set
  Each Generator incoming circuit breaker current rating will be at least 150% of Generator full load rated current; 40KA
- Current transformer : Three (3) units
  40 VA, Cl 0.2 & 5P20
- End terminal : One (1) lot
- Ammeter with selector switch : One (1) set
- Protective relays : One (1) set
- Control switch, etc. : One (1) lot

(2) Voltage Transformer Cubicle
- Voltage transformer : One (1) three phase unit
- Under voltage relay : One (1) unit
- Voltmeter with selector switch : One (1) lot

3) Incoming Circuit Breaker Cubicles as spare
- Circuit breaker : One (1) set
- Current transformer : Three (3) units
  40 VA, Cl 0.2 & 5P20
- End terminal : One (1) lot
- Ammeter with selector switch : One (1) set
- Voltmeter with selector switch : One (1) set
- Protective relays : One (1) set
- Control switch, etc. : One (1) lot
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Transformers
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5. TRANSFORMERS

5.1 GENERAL

The transformers shall be designed and tested in accordance with IEC 76

(1) Generator Step-up Transformer

Two (2) sets, three (03) phase, oil immersed, self-cooled / forced air cooled (ONAN / ONAF), outdoor use type for stepping up the voltage from 11 KV to 230 KV with on load tap changer having uniform full insulation.

The maximum continuous rating of the transformer (at ONAN) shall meet at any tap a total output of the generator, as defined in Vol. 2 of 2 (Part-A) clause 4.1.2. Generator Rating, which is connected with the transformer shall be 120% (one hundred and twenty percent) of the corresponding MVA (pf=0.8) of the Guaranteed Net Generator output at Site condition of 35° C, 1.013 bar and 98% RH. The vector group of the Transformer shall be Ynd1. Retainer wall shall be installed between two transformers and automatic sprinkler type hydrant system shall be incorporated.

(2) Station Auxiliary Transformer

Two (2) sets, three phase, oil immersed type, self air-cooled (ONAN) for stepping down the voltage from 11 kV to 0.415 kV with off load tap changer. The vector group of transformers is Dyn11. The capacity of each auxiliary transformer shall enable to supply 120% of the required power for the unit 0.415 kV system. The capacity of auxiliary transformer shall enable to supply start-up power and common station load with redundancy.

5.1.1 REQUIREMENT FOR CHARACTERISTICS

(1) Efficiency

The transformers shall be of highest efficiency that the Contractor can attain.

(2) Temperature Rise

The temperature rise of the windings shall not exceed 55°C when measured by the resistance method, after circulating the rated current at rated frequency in the windings under test.

The temperature rise of top insulation oil shall not exceed 55°C when measured by a thermometer in an oil filled thermometer pocket on the cover or in the outlet pipe to the cooler, and the method of the test of temperature rise will be decided in accordance with IEC 76-2.

(3) Dielectric Test Voltage

The transformers shall withstand the following test voltages in accordance with IEC 76-3.

a. 230 KV CIRCUIT

- lightning impulse withstand test voltage : 1050 KV (peak)
  (1.2/ 50 micro sec.)
- Power frequency test voltage : 460 KV for one minute.

b. 11 kV circuit
- lightning impulse withstand test voltage : 75 kV (peak) 
  (1.2/ 50 micro sec.)
- Power frequency test voltage : 28 kV for one minute

c. 0.415 kV circuit
- lighting impulse withstands test voltage : Not applicable 
  (1.2 / 50 micro sec.)
- Power frequency test voltage : 4.0 KV for one minute

4) No Load Excitation Current : No load excitation current under the rated voltage and frequency shall be as small as possible.

5) Mechanical and Thermal Strength for Short Circuit
The transformers shall be designed and constructed to withstand for three seconds without damage the thermal and dynamic effects of external short circuits under the most severe conditions.

6) Tolerances
The tolerances on the guarantee values shall be in accordance with IEC 76-1.

7) Noise
Vibration and noise levels of transformers shall be in accordance with the best commercial practice.

5.1.2 REQUIREMENTS FOR CONSTRUCTION
(1) Tank and Interior Structure
a. The power transformer shall be of such structure to permit installation at the Site to be simple.
   Assembling work at the Site such as staking of core and insertion of coil shall not be allowed.

b. The tank shall be of the welded steel plate structure and shall withstand and hold continuously a vacuum of 760 mm Hg.

e. The sealed joint part of the tank shall be designed to prevent oil and gas leakage and shall be water light even after long term use, and careful attention shall be paid to fastening methods of packing of bushing, bursting tube, cooling radiator, connecting pipes and other accessories.

d. Looseness of core, yoke, coil and other parts shall not happen during transportation and long term use.
e. The transformer shall be provided with a bursting tube to discharge the pressure in case of abnormal rise of the inner pressure. The tube shall be equipped with alarm contact. The tube shall be extended up to the oil pit which will be constructed around the transformer.

f. No corona shall be discharged inside and outside of the tank under the imposed primary voltage of $230/\sqrt{3}$ kV x 130%.

g. All generated gas and oil flow under fault conditions shall be concentrated to the Buchholz or similar type relay so as to ensure the relay action.

h. The transformer shall be provided with skid type base.

i. Anti-vibration rubber or the equivalent shall be provided under the base so as to prevent propagation of transformer’s vibration to the other equipment, if installed in the powerhouse.

j. Winding of coils shall be designed so as to make the initial potential distribution caused by impulsive travelling waves as uniform as possible, to avoid potential oscillation and to withstand abnormal voltage due to switching.

k. The ground terminals of the transformer shall be copper faced steel ground pad, and shall be welded on the tank wall near the base. The ground terminal shall be of the bolt fastened type, suitable for 100-200 sq. mm hard or annealed copper stranded conductors.

l. In designing the transformers, the Contractor shall refer to the general arrangement of the transformer and shall consider the location of the lightning arrester.

(2) **Bushing and Connection**

230 kV line and neutral bushings of the generator step-up transformer shall be oil filled nitrogen sealed draw lead type with an oil level gauge, and 11 kV bushings shall be of the solid type. The glazing colour shall be of brown.

The lighting impulse (1.2/ 50 micro sec.) insulation level of bushings shall be as follows:

- 230 kV bushings : 1050 kV
- 230 kV neutral bushing : 1050 kV
- 11 kV bushings : 75 kV

The creepage distance of bushings of outdoor use transformer except neutral bushing shall not be less than 25 mm / KV of rated phase to phase voltage.

(3) **Oil Preservation System**

Oil immersed transformers shall be provided with an oil preservation system in which the insulating oil shall be
isolated from atmospheric air. The oil preservation system shall be of the diaphragm seal or air seal cell type conservator with silica-gel breather. Oil level gauge with low level alarm contact shall be mounted on the conservator.

(4) **Cooling system**

An adequate number of unit coolers shall be fixed to the tank of oil immersed transformers, and the cooling capacity shall be sufficient to operate the transformer under the rated power. The coolers shall be of such structure that will not be affected by the vibration of transformer. A valve shall be provided with each pipe connecting a unit cooler to the tank. Fixing bolts and terminals shall be such that will never get loosened after being fastened. The power source of the cooling fans shall be 415 V, 3 phase or 240 V, single phase. The fans shall normally be controlled by its own winding temperature relaying device.

(5) **Temperature Detector**

At least one (1) temperature detector shall be installed at the point where the highest temperature is anticipated.

(6) **Protective Device**

The following protection system shall be provided:

- Buchholz relay and Pressure Relieve Device (PRD) similar type for alarm and trip
- High temperature alarm and trip (winding and oil)

A Buchholz relay or oil pressure relay shall be fitted on between the conservator and the tank. A dial type thermometer with hand resetting maximum indicator shall be provided. A Pressure Relief Device (PRD) with operation indicator shall be provided.

The gas relay should be provided with double float (one operated by volume of gas flow and other operated by mass gas flow). It should have following provision:

a. Gas release valve
b. Mechanical test button
c. Provision for testing both the floats by injecting air from outside.
d. Drain cock
e. Transport graduated window
f. The relay should be mounted at such a place that can be visible from the ground without climbing on the transformer.

(7) **Wiring**

All wiring mounted on the transformer shall be drawn through conduit pipes or adequate protective tubes to the control cabinet which shall be properly located on the transformer.
The wiring shall be connected at the terminal blocks terminating the outgoing control cable. The flexible tube of the vapour tension thermometer shall be covered by a protective tube.

(8) **Insulating oil**

The insulating oil shall have a sufficient insulation strength, and shall be excellent in heat conductivity, low in viscosity and pour point, and high in flash point. The oil shall not cause any corrosion to insulating materials and structured materials of electrical equipment and shall be chemically stable for long years of use.

Delivery shall be made to Site partly contained in the transformers and partly in steel drums, according to the method of packing employed. An excess of 10% of the quantity of oil required for filling transformers shall also be supplied and its cost shall be included in the price of each transformer.

(9) **Skid Base**

The transformer shall be provided with a skid base with four (4) steel wheels and necessary jacks for setting and appropriate devices for locking in position of its foundation.

5.2 **STEP-UP TRANSFORMERS**

5.2.1 **TYPE AND RATIO**

The transformer shall be of three (03) phase, oil immersed, self cooled/forced air cooled (ONAN/ONAF) by cooling fans, outdoor use type. Ratio of delta star connection shall be 11 kV to 230 kV on full load condition.

The connection of the three phases shall be arranged in vector symbol Ynd1 according to IEC 74-4 and neutral of star connected high tension winding shall be solidly grounded.

The on load tap changer shall be provided on the high tension winding, and their ratio shall be as follows:

230 kV ±8 x 1.25%

5.2.2 **OUTPUT AND REQUIRED NUMBERS**

The maximum continuous rating of the transformer shall meet at any tap a total 120% of the generators output which are connected with the transformer.

The self cooled capacity shall not be less than 83 % of forced air cooled capacity.

Total number of step up Transformer will be 2 (two), capacity and all technical specifications should be same and identical. Two Nos transformer have to be capable to handle total output of the Generators of the power plant.

5.2.3 **IMPEDENCE VOLTAGE**

Impedance voltage (+ve seq.) shall be within the range of 15% to 18% on the forced air cooled rating on the rated tapping (11/230 kV) and shall be
guaranteed by the Contractor.

5.2.4 WINDING AND INSULATION
The full installation shall be applied on both 230 kV (phase & neutral) and 11 kV windings and neutral point of 230 kV windings shall be solidly grounded.

The winding conductors shall be of high conductivity copper.

The insulation shall be designed not merely by normal voltage per turn, but also by variation of line voltage and the operating conditions including impulse surge caused by lightning strokes on the transmission line and switching surges.

5.2.5 ON LOAD TAP CHANGER
The onload tap changer shall be provided on neutral side of 230 kV winding and shall be designed to meet the requirement of IEC 76. OLTC shall be of MR, Germany or ABB, Sweden only. Provisions shall be made for padlocking in any tap position.

5.2.6 CABLE BOX
The cable box shall be provided on each transformer so as to cover the 11 kV terminals and 11 kV power cables down to ground surface. Proper cable supports and cleats shall also be provided.

5.2.7 PHASE & NEUTRAL CIRCUIT CURRENT TRANSFORMER
Current transformer shall be provided on the high tension neutral circuit for Restricted Earth Fault & Stand by Earth Fault relays and ratio should match with phases (LV & HV) Differential protection circuit.

1) Use : Protection & Metering
2) Ratings :
   - Rated primary current : 400 - 800 A (Depends on rating of transformer)
   - Rated secondary current : 1 A (5 core)
   - Accuracy class : 5P20 (for protection) / 0.2 FS5 (for metering)
   - Rated burden : 30 VA
3) Requirements for characteristics and Construction
   The current transformer shall be designed to meet the requirements of latest IEC standard.

5.3 STATION AUXILIARY TRANSFORMER

5.3.1 TYPE AND RATIO
The transformers shall be of three (3) phase, oil immersed, self air cooled (ONAN) type. Nominal no load ratio of delta star connection shall be 11 kV to 0.415 kV.

The connection shall be arrangement in vector symbol Dyn11 according to
IEC 76-4 and neutral of star connected low tension winding shall be earthed solidly.

The off load tap changer shall be provided on the high tension winding, and their ratio shall be as follows: 11 kV ± 2 x 2.50 % / 0.415 kV Output

5.3.2 OUTPUT

Station auxiliary transformer shall enable to supply 120% of required power on units 0.415 kV for the Engine generating unit and required common power on station service.

5.3.3 IMPEDENCE VOLTAGE

The impedance voltage shall not less than 5 %, but not more than 7.5 % on the rated tapping and shall be guaranteed by the Contractor.

5.3.4 WINDING AND INSULATION

The requirements shall be in accordance with section 5.2.4 for LV side.

5.3.5 OFF LOAD TAP CHANGER

The off load tap changer shall be provided on 11 kV winding and shall be designed to meet the requirements of IEC 76. The tap changer shall be of three phase resistor equipment with rotary diverter switch, and shall be designed to provide 4 tapping steps, i.e. 5 positions as follows.

- Central tap: 11 kV
- Step voltage: 2.50%
- Upper side: 2 taps (+2.5%)
- Lower side: 2 taps (-2.5%)

All the mechanical operating parts of the gear shall be self lubricated with transformer oil, no special lubrication being necessary. The tap changer compartment oil shall be isolated from main transformer tank oil, and the compartment shall be provided with proper protection facilities and accessories.

5.3.6 CABLE BOX

The cable boxes shall be provided on both high tension and low tension terminals to terminate high and low voltage power cables. Proper cable supports and cable cleats shall also be provided.

Non segregated bus duct between low tension terminals of station auxiliary transformer and power centre terminals instead of cables may be acceptable.

5.4 ACCESSORIES

The following accessories shall be furnished for each transformer, but not to be limited:

a. Name plate
b. Valves for oil filtering and sampling
c. Air vent valve
d. Manhole and hand-hole including blind covers

e. Ladder fixed to the transformer tank for inspection of the upper part of the transformer.

f. Hanging hook

g. Grounding terminals

h. Anchor device

i. Oil preservation system including oil conservator

j. Oil level gauge

K. Dial type thermometer with hand resetting maximum indicator

l. Breather with silica-gel

m. Other necessary accessories

o. Rail track in the transformer yard.

p. Proper gravel works and water drainage system for transformer yard.

q. Fencing and locking facility for transformer yard.

5.5 **Short circuit current limiting device at low tension side of the step-up transformers**

Contractor shall supply and install short circuit current limiting device at low tension side of both step-up Transformers as per design requirement.
Section-6

230 kV outdoor Switchgear Equipment and underground cable
6. 230 kV OUTDOOR SWITCHGEAR, EQUIPMENT AND UNDERGROUND CABLE

6.1 GENERAL

6.1.1 DESIGN EQUIPMENT

6.2 230 kV SWITCHGEAR, EQUIPMENT

6.2.1 230 kV CIRCUIT BREAKERS

6.2.2 230 kV DISCONNECTING SWITCHES AND EARTH SWITCH

6.2.3 230 kV CAPACITIVE VOLTAGE TRANSFORMERS

6.2.4 230 kV CURRENT TRANSFORMERS

6.2.5 230 kV LIGHTNING ARRESTERS

6.3 STEEL STRUCTURE (Bus-bar)

6.3.1 TYPE

6.3.2 DESIGN CRITERIA

6.3.3 REQUIREMENTS FOR DESIGN AND CONSTRUCTION

6.3.4 DESIGN ITEMS

6.3.5 ACCESSORIES

6.4 INSULATORS AND WIRING MATERIALS

6.4.1 INSULATORS

6.4.2 FITTING

6.4.3 STANDARD CONDUCTORS FOR OVER HEAD LINES

6.4.4 MISCELLANEOUS MATERIALS

6.5 230 kV underground cable:
6. 230 kV OUTDOOR SWITCHGEAR, EQUIPMENT AND UNDERGROUND CABLE

6.1 GENERAL

The contractor shall furnish the 230 kV outdoor switchyard equipment which shall comply with relevant IEC as listed below and the 230 kV equipment shall be arranged in the outdoor as shown on the attached drawings or as directed by the Ashuganj Power Station Company Ltd.

The origin of the 230 kV switchgear and equipment (Circuit breaker, CT, PT, LA, DS etc.) must be European Union or G8 Countries.

6.1.1 DESIGN EQUIPMENT

(1) System Voltage

| The system shall be as follows       | : |
| Nominal system voltage             | 230 kV |
| Highest system voltage             | 245 kV |

(2) Insulation level

- Lighting impulse withstand test : 1050 kV
- Voltage (1.2 / 50 micro sec.)
  - Power frequency insulation level (for 1 Min) : 460 kV

(3) Outdoor Conductor Clearance

- Phase to phase, standard :
- Phase to phase, minimum :
- Phase to ground, Standard :
- Phase to ground, Standard :

(4) Design Conditions

Switchgear equipment shall be designed to avoid local corona formation and discharge likely to cause radio interface, and to endure short circuit current without thermal and mechanical failure for one (1) second. All cubicles and enclosures shall be vermin proof, dust resistance and weatherproof.

6.2 230 kV SWITCHGEAR, EQUIPMENT

6.2.1 230 kV CIRCUIT BREAKERS

(1) Type

Three (3) pole, three phases, porcelain type, gang operated, outdoor, trip free, spring operated, SF6 gas type complete with conduit, wiring and all other necessary accessories.
(2) Use
For switching of 230 kV step up transformer feeder circuit.

(3) Ratings
a. Rated voltage : 230 kV
b. Rated insulation level
   -Lighting impulse withstand test voltage : 1050 kV (peak)
     (1.2/50 micro sec.)
   -Power frequency withstand voltage
     (for 1 Min.) : 460 kV
c. Rated frequency : 50Hz
d. Rated nominal current : 2000A
e. Rated short circuit breaking current : 50 kA
d. Rated transient recovery voltage for terminal faults and rated characteristics for short line faults shall be in accordance with IEC 56.
g. Rated short circuit making current : 125 kA
h. Rated duration of short circuit withstand : 3 sec
i. Rated operating time : Less than 40 msec

(4) Control System
(i) For the power plant, the rated control DC supply voltages of closing and opening devices shall be 110 V DC (Nominal), and the operation of circuit breaker shall be performed safely under the following conditions:
   For tripping operation (-30% to +10%) : 88 V to 137 V DC
   For closing operation (-15% to +10%) : 106 V to 137 V DC
(ii) For existing Network Control Room (NCR) and 230 kV grid substation, the available DC control voltage is 220 V DC (Nominal). The bidder shall consider this issue for selecting equipment and switching devices in NCR and 230 kV grid substation.

(5) Requirements for Design and Construction
a. The circuit breakers shall have automatic trip free mechanism.
b. The porcelain insulator or bushings shall have sufficient strength acceptable by IEC standard to withstand stressed due to breaker operation. The glazing colour shall be of brown. The creepage distance shall not be less than 25 mm/ kV of phase to phase voltage.
c. Gas circuit breaker shall be provided with gas density detector responding to gas density and pressure. This gas density detector shall have two (2) different functions according to the gas condition: The first step gives alarm and the second step lockout the operating mechanism. Operating mechanism will be spring
operated.

d. The weather and dust proof type control box shall be furnished with the circuit breakers. The control box shall be equipped with all necessary parts to operate the circuit breaker, such as control solenoids, operating switch of remote and local control, auxiliary switch, terminal blocks, protective devices, indicating lamp sockets, and other accessories. An anti-condensation electric heater with thermostatic switch shall be provided inside the control box.

e. The circuit breakers shall be provided with an emergency push button switch. The switch shall have a protective cover to prevent inadvertent switching.

f. The circuit breakers shall be provided with an electrical anti pumping relay.

g. The supporting structure shall be free from mechanical vibration and loosening under long term use.

h. The circuit breakers shall be designed to facilitate inspection, especially for those parts which need frequent inspection.

i. The circuit breakers shall be supplied with sufficient SF₆ gas.

j. Total 02 (two) nos. SF₆ gas leak detector shall be provided.

k. Temperature limitation shall be in accordance with IEC 56.

l. The Contractor shall furnish all control cables, pipes or ducts and fittings to control box.

m. Breaker position local indication shall be provided in the local control box.

(6) Dielectric Test Voltage

a. Power frequency withstand voltage: 460 kV for one minute

b. Lighting impulse withstand voltage

   Full wave (1.2 / 50 micro sec.): 1050 kV

c. Test voltage on control cable: 2.0 kV for one minute

(7) Tools and Accessories

The following tools and accessories shall be supplied for each circuit breaker.

a. Name plate

b. Position indicating lamps (red and green) or flags.

c. Operation counter.

d. Grounding terminals

e. Gas pressure gauge

f. Safety valves, if any

g. Pressure drop protecting device

h. Manual operation device

i. Auxiliary switch
j. Control box with locking device
k. Steel supporting structure with anchor bolts and nuts
l. Operating mechanism.
m. Special tools for checking and testing
n. Power outlet, single phase, 230 V, 10 A in control box
o. Conduit pipes
p. Communication facilities between switchgear and control room
q. Necessary platform shall be provided to facilitate local control by operator
r. Other necessary accessories.

6.2.2 230 kV DISCONNECTING SWITCHES AND EARTH SWITCH

(1) Type
Outdoor, three (3) pole, single throw, Gang operated, horizontal break, rotating insulator, remote controlled motor operated type.

(2) Ratings
a. Rated voltage : 230 kV
b. Rated insulation level
   - Lighting impulse withstand test voltage : 1050 kV (peak)
   - Power frequency withstand voltage (for 1 Min.) : 460 kV
c. Rated frequency : 50Hz
d. Rated nominal current : 2000A
e. Rated duration of short circuit current : 1 sec
f. Rated short circuit withstand current : 50 kA
g. Rated short circuit making current : 125 KA

(3) Requirements for Design and Construction
a. The disconnecting switches shall be so designed and Constructed in accordance with IEC 129.
b. The contact part of the blade shall be silver electroplated.
c. The porcelain insulator shall be an outdoor and post type, and shall have creepage distance not less than 25 mm/ kV of phase to phase voltage age. The glazing colour shall be of brown.
d. An electrical interlocking shall be provided between its related circuit breaker.
e. Rotating parts shall be so designed that operation will be sure and smooth under long term use without necessity of inspection, oiling.
f. Auxiliary switches with three (3) spare “a-b” contacts, terminal blocks, indicator lamp sockets, etc. shall be accommodate in a
control box and shall be weather and dust proof type with locking device.
g. The earth switches shall be so designed and constructed in accordance with IEC standard.
h. A mechanical interlocking shall be provided between disconnecting switch and its related earth switch.

(4) **Dielectric Test Voltage**
a. Power frequency withstand voltage : 460 kV for one minute
b. Lighting impulse withstand voltage
   Full wave (1.2/ 50 micro sec.) : 1050 kV
c. Test voltage on control circuit : 2.0 kV for one min.

(5) **Accessories**
a. Nameplate
b. Control box with locking device
c. Grounding terminal
d. Auxiliary switches
e. Steel supporting structure with anchor bolts and nuts
f. Manual operation handle
g. Motor operating mechanism with manual operation interlock
h. Conduit pipes
i. Other necessary accessories.

### 6.2.3 230 kV CAPACITIVE VOLTAGE TRANSFORMERS

(1) **Type**
Outdoor, single phase Capacitive Voltage Transformers (CVT) with earthing

(2) **Use**
For metering and protection

(3) **Ratings**
a. **Rated voltages**
   - Primary : 230/√3 kV
   - Secondary : 110/√3 V, 0.2 class, 100 VA
   - Tertiary : 110/√3 V, 3P class, 100 VA
b. **Rated insulation level**
   - Lighting impulse withstand voltage : 1050 kV
     Full wave (1.2 / 50 micro sec.)
   - Power frequency withstand voltage : 460 kV
for one minute
c. Rated frequency : 50 Hz
d. **Rated burden**
   - Secondary : 100 VA
   - Tertiary : 100 VA
e. Accuracy class : 0.20 (metering) : 3P (tertiary)

(4) **Requirements for Design and Construction**

a. The Capacitive voltage transformers shall be of hermetically sealed and accessories shall be of weatherproof type. The glazing colour shall be of brown.
b. Creepage distance of bushing shall not be less than 25 mm / kV of phase to phase voltage.
c. A protection device shall be provided against short circuit of the secondary circuits of the Capacitive voltage transformers.
d. Separate junction box to be provided for metering core with locking facility.

Unless otherwise specified, the characteristic and others shall comply with the requirements of relevant IEC standard.

(5) **Dielectric Test Voltages**

a. Power frequency withstand voltage : 460 kV for one minute on primary windings
b. Lighting impulse withstand voltage
   
   (1.2 / 50 micro Sec.) : 1050 kV
c. Power frequency withstand voltage : 2.0 kV for one minute on secondary windings

(6) **Accessories**

The following accessories shall be provided for each CVT.

a. Nameplates
b. Grounding terminals
c. Lifting lugs
d. Steel supporting structure with anchor bolts and nuts
e. Junction boxes
f. Conduit pipes
g. Other necessary accessories.

### 6.2.4 230 kV CURRENT TRANSFORMERS

(1) **Type**
Outdoor, single phase, oil immersed with level indicator or gauge, N₂ gas sealed porcelain clad type, dead tank, five cores.

(2) **Use**
For metering and protection

(3) **Ratings**

a. Rated current
   - Primary : 400-800 A
   - Secondary : 1-1-1-1-1 A

b. Rated insulation level
   - Lighting impulse withstand voltage
     (1.2 / 50 micro sec.) : 1050 kV
   - Power frequency withstand voltage: 460 kV for one min.

c. Rated frequency : 50 Hz

d. Rated burden : 30 VA for protection and
   : 30 VA for measuring.

e. Rated continuous thermal current : 120%

f. Short time current ratings
   - Thermal rating (r.m.s. for one sec.) : 50 KA
   - Dynamic rating : 2.5 times the thermal ratings

g. **Accuracy classes**
   - For metering : 0.2s, n=5, 2 Core
   - For protection : 5P20, 3 Core

(4) **Requirements for Design and Construction**

a. The current transformer shall be of oil immersed hermetically sealed structure type.

b. Internal conductor shall be capable of withstanding dynamic forces caused during specified short circuit and thermal overloads.

c. The junction box with terminals shall be provided for the secondary circuit connections.

d. Each current transformer shall be equipped with terminal block of short circuiting type.

e. Creepage distance of bushing shall not less than 25 mm / kV of phase to phase voltage. The glazing colour shall be of brown.

f. Separate junction box to be provided for metering core with locking facility.

g. Unless otherwise specified, the characteristics and others shall
comply with IEC 185.

(5) **Dielectric Test Voltages**
- a) Power frequency withstand voltage: 460 kV for one minute on primary windings
- b) Lighting impulse withstand voltage: 1050 kV (1.2/ 50 micro sec.)
- c) Power frequency withstand voltage: 2.0 kV for one minute on secondary windings

(6) **Accessories**
The following accessories shall be provided for each current transformer.
- a. Nameplates
- b. Grounding terminals
- c. Lifting lugs
- d. Steel supporting structure with anchor bolts and nuts
- e. Junction boxes
- f. Conduit pipes
- g. Other necessary accessories.

### 6.2.5 230 kV LIGHTNING ARRESTERS

(1) **Type**
Outdoor, single phase, Zinc-oxide type with operation counter.

(2) **Use**
For protection of 230 kV outdoor switchyard equipment and transformer windings.

(3) **Electric system to be protected**
Three (3) phase, three (3) wire, neutral point solidly grounded system.

(4) **Ratings and Performances of Lighting arrester**
- a. Rated voltage: 216 kV
- b. Rated frequency: 50 Hz
- c. Nominal discharge current: 10 KA
- d. Type of duty: Heavy, Long duration discharge
- e. Pressure relief class: C
- f. Lighting impulse insulation level: 1050 kV (1.2 / 50 micro sec.)
(Porcelain enclosure)
Operating duty

The arrester shall successfully interrupt the follow up current at highest system voltage.

Requirements for Design and Construction

a. The series gaps shall be so designed that for practical purposes the various characteristics will not alter under the change of weather conditions
b. The various parts of the lightning arrester shall be of complete moisture proof construction so that the characteristics shall not be impaired under long term use. Sealed parts shall be so designed to prevent to ingress of moisture or water under long term use.
c. The operation counter shall be provided to record number of discharges. It shall be located at the position convenient for inspection.
d. Creepage distance of bushing shall not be less than 25 mm/ kV of phase to phase voltage. The glazing colour shall be of brown.
e. Unless otherwise specified, the characteristics and others shall comply with IEC 99-1

Dielectric Test Voltage (Porcelain enclosure)

a. Power frequency withstand voltage : 460 kV for one Minute
b. Lighting impulse withstand voltage : 1050 kV
   (1.2 / 50 micro sec.)

Accessories

The following accessories shall be provided for each lightning arrester.

a. Nameplates
b. Grounding conductor to grounding terminal
c. Operating counter
d. Grounding terminal
e. Steel supporting structure with anchor bolts and nuts
f. Other necessary accessories.

6.3 STEEL STRUCTURE (Bus-bar)

6.3.1 TYPE

The steel structure shall be lattice truss construction made of galvanised formed steel and assembled by bolts and nuts. The component members of steel structure shall have inter-changeability with other identical members. The basis framing of the steel structure shall be identical on all four (4) faces below the bend line.
6.3.2 DESIGN CRITERIA

The steel structure shall be designed in accordance with the following criteria.

(1) **Load due to the tension of conductor and wire.**
- 230 kV bus and outgoing conductor: 900 kg per conductor
- Overhead grounding wire: 450 kg per wire

(2) **Vertical loads**
The weight of the conductors, grounding wires, insulator strings and steel structures shall be taken into consideration.

(3) **Human Loads**
120 kg at the centre of the beam.

(4) **Wind loads**
Wind loads shall be calculated with wind speed of 200 km/hr, but the wind loads on unit projected area shall not be less than the followings:

- On conductors and grounding wires: 125 Kg/sq.m
- On insulators and other circular section: 130 Kg/sq.m
- On lattice structures or beam structure: 230 Kg/sq.m

Seismic Coefficient (Horizontal): 0.28 g

(5) **Working Conditions**
The normal working condition for various loads shall be deemed to work simultaneously. The wind direction shall be classified into transverse, longitudinal and oblique components to the line route and the largest load acting on the line shall be taken as the design stress of the component material.

(6) **Combination loads**
The Contractor shall calculate the maximum and minimum stresses at any combination of loading conditions. The design of each type of steel structure shall be made by the same manner of analysis. The design stresses of individual components shall be largest value of maximum stresses in the respective loading conditions.

(7) **Safety Factors**
The safety factors shall not be less than two (2) under the normal working conditions.

(8) **Minimum Thickness and Size of Steel Members**
Minimum thickness and size of steel members shall be as follows:

a. Formed steel: not less than 45 x 45 x 4 mm
b. Plate: not less than 4 mm thick.

(9) **Slenderness Ratio**
The slenderness ratio shall not exceed 120 for main members, 200 for
6.3.3 REQUIREMENTS FOR DESIGN AND CONSTRUCTION

(1) Workmanship
Workmanship shall be first class throughout. All pieces shall be straight, true to detailed drawings and free from lamination, flaws and other defects. All clippings, back nuts, grindings, bends, holes, etc. shall be true to detailed drawings and free of burrs.

(2) Galvanising
The steel structure shall be completely galvanised (Hot-Deep), except for part which shall be embedded in concrete foundation. All ferrous materials shall be galvanised to meet the requirements of IEC.

(3) Materials of Steel Structure
All materials shall be hot rolled structural steel and or high strength structural steel.

(4) Marking
All products shall be marked with systematic numbers and / or colours for convenience of assembly.

(5) Future Extension of Structure
In designing the steel structure, consideration shall be given in the design criteria to permit easy extension of steel structure in the future and same loading conditions shall be taken into account in accordance with the Specifications.

(6) Bolts and Nuts
All the members shall be connected by bolts and nuts. The diameter of the connection bolts and step bolts shall not be less than 16 mm.

6.3.4 DESIGN ITEMS
The Contractor shall submit to the Ashuganj Power Station Company Ltd. for approval design sheets and drawings including calculation of Loads, selection of constitution and members, selection of connecting bolts and calculation of reaction load against base concrete.

6.3.5 ACCESSORIES
The following accessories shall be provided, but not limited to:

a. Anchor bolts and nuts : One (1) lot
b. Gauge plate for anchor bolt : For (4) of each kind
c. U-hook bolts and nuts : one (1) lot
d. Grounding terminals : one (1) lot
e. Step-bolts : one (1) lot
f. “Roval” paint for repair : Five (5) Kg
g. Phase identification plates : one (1) lot
h. Other necessary accessories : one (1) lot
6.4 INSULATORS AND WIRING MATERIALS

6.4.1 INSULATORS

(1) Type and requirements
   a. The insulator assemblies shall consist of suspension insulator discs, hardware, strain or suspension clamps as required.
   b. The suspension insulators shall be of ball and socket type and shall conform to the requirement of IEC 120.
   c. The insulator unit shall be standard 254 mm porcelain disc type or fog type 254 mm porcelain disc type, and have a spacing of 146 mm between discs.
   d. Total creepage distance of the insulator assemblies shall not be less than 6125 mm.
   e. The insulators shall be wet-process porcelain of the highest glaze, dense and homogeneous. The glaze shall be smooth, hard, dense and uniform and shall not be effected by weather or sudden change in temperature, salty atmosphere and lighting during certain periods of the year. Colour of porcelain surface shall be brown. All ferrous metals shall be galvanised except for female thread and stainless steel. Each insulator shall bear symbols identifying the manufacturer and indicating the year of manufacturer and tension proof test load.

(2) Characteristics of Suspension Insulators
   a. Porcelain disc diameter : 254 mm
   b. Unit spacing : 146 mm
   c. Minimum electromechanical failing load : 21000 Kg
   d. Dimension of ball socket and pin : Conform to IEC

(3) Characteristic of Insulator Assemblies
   a. Nominal system voltage : 230 kV
   b. Highest system voltage : 245 kV
   c. Creepage distance not less than : 6125 mm
   d. Breaking strength of complete set : 1200 kg
   e. System insulation level
      - Basic impulse insulation level
        (1.2120 micro sec.) : 1050 kV
      - Power frequency withstands voltage
        (For 1 mm.) : 460 kV

6.4.2 FITTING

The suspension and tension clamps for bus works and outgoing feeders, tension clamps for overhead grounding wires, U-bolts, ball eyes, anchor shackles, etc. for wiring of switchyard shall be furnished by the contractor. Unless otherwise specified, all hardware fittings shall be made by malleable iron or forged steel hot dip galvanised or aluminium alloy.
All metal shall be free from rust, burrs, sharp edges, lumps and dross and shall be smooth so that interconnecting parts will fit properly and the parts may be assembled and disassembled easily. Hardware shall have ultimate strengths exceeding three (3) times tension load of bus work and overhead ground wire.

The cramps shall not be occurred in excessive heating by magnetising or other causes.

### 6.4.3 STANDARD CONDUCTORS FOR OVER HEAD LINES

1. **850 mm², hard drawn aluminium conductor**
   - The hard drawn aluminium stranded conductor of 850 mm² shall be used for 230kV bus bars and for outgoing feeder circuit. The conductors shall comply with the requirements of IEC.

2. **Galvanised Steel Wire**
   - The galvanised steel wire of 55 mm² shall be used as overhead grounding wire.

3. **Spools for Conductors**
   - The spools for conductors shall be made of steel and treated against corrosion and rust, and the following marking shall be indicated on an appropriate side of the spool.
     - Conductor number
     - Kind and cross sectional area of conductor
     - Conductor length
     - Spool weight
     - Name of manufacturer or abbreviation
     - Date of production
     - Position of beginning of conductor
     - Direction of rotation of spool
     - Indicator showing the remaining length of conductor

### 6.4.4 MISCELLANEOUS MATERIALS

All miscellaneous materials such as phase mark plates, angle steel, C-shaped steels, conduit pipes, cable cleats, bolts, nuts, and other materials for completion of the switchyard shall be provided by the Contractor.

### 6.5 230 kV underground cable:

230 kV Underground armoured and sheathed cable from power plant to existing APSCL 230 kV Grid sub-station shall have to be provided by contractor. Minimum cable size 800 mm² XLPE copper conductor. Underground cable connection at both end shall through pot head. If necessary bimetallic conductor shall be provided for connection to overhead line conductor.

Length of each underground cable approx. 2.25 km. Number of cable will be 4 (Four). Cable laying procedure will be directly buried. There is one canal of width approx. 50 meters in the cable route. Cable crossing the canal should be overhead type and contractor shall ensure enough protection by necessary support. Canal crossing should be along the adjacent bridge with identical profile but independently
supported and not attached to the bridge. Contractor should be maintained the existing navigation clearances. Dismantling of all types of obstacles in the cable rout is contractor scope. During cable laying if any existing road or structure is affected by the contractor’s works, he has to reinstall it as same as before.

Bidders are strongly advised to examine underground cable actual length and inspect underground cable route before bid submission at their own responsibility.
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Low Voltage Switchgear
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7. **LOW VOLTAGE SWITCHGEAR**

The low voltage auxiliary Power system shall consist of the following equipment, but not limited to:

- 415 V Switchgear and Motor Control Centres

The origin of all equipment of Low voltage switchgear (0.415 kV) must be European Union or G-8 Countries.

7.1 **415 V SWITCHGEAR AND MOTOR CONTROL CENTRES**

415 V switchgears and motor control centres shall be supplied to control all electric motor driven auxiliaries and supply power to the other electric load of the generating plant. If control centres or distribution panels not described in this specification be needed, they shall be supplied with each facility.

The switchgears and motor control centres are classified into the following:

- 415 V common switchgear.
- 415 V unit switchgears.
- 415 V motor control Centres.
- One spare C.B of each type and rating must be supplied with every switchgear.

7.2 **415 V SWITCHGEAR AND MOTOR CONTROL CENTRES**

7.2.1 **SWITCHGEAR (POWER CENTER)**

7.2.2 **MOTOR CONTROL CENTER**

7.2.1.1 **SWITCHGEAR (POWER CENTER)**

(a) **Type and Rating**

- Type
  
  Indoor, steel sheet formed cubicle, single bus with two bus sectionalizer and two incoming, draw out type feeder breakers.

- Rating
  
  Rated voltage : 415 V
  Rated frequency : 50 Hz
  Rated normal current incoming and bus tie circuit : 2,500 A
  Feeder circuit : 600 A
  Rated short circuit current : 40 kA (rms)
  Number of circuit : Determined by the contractor, but 2(two) spare feeders shall be provided
(b) **Kind of Unit**

Determined by the Contractor, but 2 (two) spare feeders with fully equipped (breaker, CT, Meter, Relay etc.) shall be provided on each switchgear. The switchgear shall be of 3 phase, 4 wire, neutral solidly grounded, 415 V power centre type with circuit breakers 40 kA interrupting capacity. The switchgear shall contain the following kind of circuits in general:

- Incoming and bus tie circuit
  - 40 kA, ACB
- Motor feeder circuit
  - 40 kA, ACB
- Feeder for motor control center
  - 40 kA, ACB
- Voltage transformer unit

All circuit breaker shall be able to draw out horizontally.

C. **Compartment**

Grounded metal plate shall be provided to separate between the units and circuit breaker section and bus bar section. Conductor shall be insulated.

(d) **Bus Bars**

Bus bars shall be insulated copper bars.

(e) **Cable Connection**

Power cables and control cables will be led from the terminals through rear bottom of cubicle.

(f) **Control Power**

Control power shall be 110 V DC Nominal.

7.2.2 **Motor Control Centre**

a. **Type and Rating**

- Type
  - Indoor, steel sheet formed, self-standing, dual face type motor control centre.
- Rating
  - Rated voltage : 415 V
  - Rated frequency : 50 Hz
- Rated normal current
  - Incoming : 2,500 A
  - Feeder circuit : 450, 200 or 100 A
- Rated short circuit current : 40 kA
- Number of circuit : as required including two (2) spare
feeders on each motor control centre.

b. **Kind of Unit**
   The motor control centre shall be of 3 phase, 4 wire, neutral solidly grounded, 415 V motor control centre type and shall contain the following circuits as required.
   - **Incoming**
     40 kA, moulded circuit breaker.
   - **Motor feeder circuit**
     40 kA moulded circuit breaker, contactor, and reserve units if required.
   - **Non- motor feeder circuit**
     40 kA moulded circuit breaker.

c. **Compartment**
   Grounded metal plate shall be provided to separate between the unit and CB section and bus bar section conductors shall be insulated.

d. **Draw-out system**
   Control centre unit and incoming circuit breaker shall be draw out horizontally by hand and main circuits shall be disconnected from bus bar.

e. **Motor Feeder Unit**
   Each unit shall have hinged door on which circuit breaker operating handles, indicating lamps, operating push button and miscellaneous components shall be mounted.

f. **Non-motor Feeder Unit**
   Each unit shall have hinged door on which circuit breaker operating handles and miscellaneous component shall be mounted.

g. **Cable connection**
   Power cables and control cables will be led from the terminals through front bottom of cubicle.

h. **Busbars**
   Bus bars shall be insulated copper bars.
Section 8

Control and Protection
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8. CONTROL AND PROTECTION EQUIPMENT

8.1 GENERAL REQUIREMENTS

The Contractor shall supply and install all control, protection and instrument panels with measuring instruments, relays, control switches, automatic controllers, annunciator, etc. necessary for proper operation and monitoring of the Generating units, switchyard equipment and their associated facilities. All Control & Protection System must be Micro-Processor based [Numerical] and Protective Relays shall be from ABB/ALSTOM/SIEMENS.

Country of origin of all equipment of control and protection system shall be European Union or G8 countries.

8.1.1. Control and Supervision Concept for Power Plant

The control and supervision system is designed for safe, reliable, efficient and easy operation of the generating sets, and their associated auxiliaries and electrical systems.

The control system allows centralized operation, and also from the generating set local control panel, which is placed close to the generating set.

Control modes

The following control modes are available for the generating set control.

By increasing or decreasing the engine fuel supply, the active power can be controlled in:

- **MW mode** - the generating set power is maintained at a preset value irrespective of system load or frequency. This is the typical operating mode for a base load power plant supplying an infinite grid.
- **Speed droop mode** - the generating set shares the load with the grid or other generating sets according to a speed droop curve. This is the typical operating mode for smaller grids or in island mode.

By increasing or decreasing the generator voltage, the reactive power can be controlled in:

- **Constant Power Factor control** - the generating sets power factor is maintained at a preset value irrespective of any changes are produced by the grid or other generating sets.
- **Voltage droop mode** - the generating set will share the reactive load with the grid and other generating sets equally in relation to the size of the units.

The control system will automatically switch operating mode based on the "parallel with grid" signal. In Auto mode the setting values for active and reactive power will be based on operator input in the operator interface terminal, while in Manual mode it will be based on the operator inputs selection.

**Generator control system**

All generating set control shall be made from

(1) From DCS
(2) From Gen set remote control panel
(3) From Gen set local control panel
Distributed Control System (DCS)

Distributed Control System (DCS) shall be provided to control and monitor all Generating units centrally. Sufficient number of DCS terminals shall be provided to operate the supplied number of generating units conveniently. All necessary equipment, software, hardware, hardware connection, interfacing and all other necessary accessories and equipment shall be provided for making the system satisfactorily working as per requirement of the power plant.

From Gen set remote control panel

In addition to DCS control each unit will be provided with remote control with the following panel features:

Power Monitoring Unit (PMU):
The PMU is a digital power monitoring unit where the generating sets electrical measurements can be monitored and supervised.

The PMU includes the following functions:
- Measurement of phase currents, with stored min and max
- Measurement of main and phase voltages, with stored min, max and average
- Measurement of frequency
- Calculation of Active, Reactive and Apparent power
- Calculation of Active and Reactive Energy, imported, exported and total
- Measurement of engine running hour

Generator protection relay:
The digital programmable multi-function protection relay is connected to current and voltage transformers in the generator cubicle and in the generators main terminal box.
The protection relay has the following protection functions:
- Over and under voltage protection
- Over and under frequency protection
- Reverse power protection
- Over current and short circuit protection
- Stator earth fault protection
- Loss of excitation protection
- Negative sequence (unbalance) over current protection

Programmable Logic Controller (PLC) unit for control and supervision of the generating set:

The high grade PLC integrates the control functions as required by the process and operation sequences. The PLC also handles the start/stop sequence, process measurements and alarms

The PLC includes the following units and devices:
- Power supply unit for CPU (110 VDC)
- Central Processing Unit (CPU)
- Communication cards
- Analogue Measurement Input - Output cards
- Digital Input - Output cards

Liquid Crystal Display (LCD) operator interface terminal with generating set measurement, alarm and status information.

Following features shall be incorporated:
- P1 Generating set active power (MW)
- P2 Generating set reactive power (MVAr)
- P3 Engine and turbocharger speed (rpm), with selector switch

Manual control interface unit for selection of generating set operating modes. The unit includes the following control devices:
- Generating set control mode selector switch (Auto-Manual)
- Active power control mode selector switch (Speed droop - kW control)
- Reactive power control mode selector switch (Voltage droop - p.f control)
- Engine power control switch (decrease-increase)
- Generator voltage control switch (decrease-increase)
- Synchronizing select and start of synchronization control switch
- Engine start pushbutton with engine running indication light
- Engine stop pushbutton with engine stopped indication light
- Breaker close pushbutton with breaker closed indication light
- Breaker open pushbutton with breaker open indication light
- Engine shutdown indication light with reset pushbutton
- Breaker trip indication light with reset pushbutton
- Indication lamp testing pushbutton

Set of Hardwired engine shutdown and breaker trip circuits. Safety interlocking and important protection of the generating set to be carried out by hardwired connections and the protection relay.

Emergency stop pushbutton.

From Gen set local control panel
Local control panel shall be provided with three position selector switches viz. Local, Remote and DCS. The local control panel will contain minimum control and monitoring system for local control of the Engine Generating set for maintenance and trouble shooting.

8.1.2. 230 kV SWITCHGEAR CONTROL AND PROTECTION
Substation Automation System (SAS) allows centralized operation from control room.

8.1.2.1. 230 kV SWITCHGEAR EQUIPMENT PANEL
The following panels for controlling, indicating and protecting of 230 kV switchgear equipment shall be provided in the central control room, but not limited to:

A. Two (2) nos. of step-up Transformers control and protection panel; and one (1) 230 kV line feeder control and protection panel at power plant control room.

B. One (1) 230 kV feeder control and protection panel at existing 230 kV grid substation Network Control Room (NCR)
C. All 230 kV CB’s shall be provided with synchro-check relay and all generator 11 kV circuit breakers will be provided with synchronising facility.

All front panels of the above shall be equipped with control and metering facilities, and all rear panels shall be equipped with protection relays. The relays to be provided under this Project shall be suitable for proper coordination with the existing relays of the System.

8.1.2.2. STEP UP TRANSFORMER PANEL

(1) FRONT PANEL
The front panel shall be equipped with the following items of controls and instruments, but not to be limited to:

One (1) lot 230 kV circuit breaker control switch.
One (1) lot 230 kV disconnecting switch control switch.
One (1) lot Three Ammeter for each panel
One (1) lot Synchronising key switch, removal types.
One (1) lot Ammeter (230 kV side) (0-800 A), Voltmeter & pf meter
Two (2) sets Bidirectional Digital Programable Energy/tariff meter (230 kV side) for export and import of energy and with indicating lamps for voltage failure [Cl 0.2s] with downloadable facility. One energy meter shall use as a main tariff meter and other one shall use as a backup meter. Both tariff meter shall be identical and same brand. Contractor shall be provided Optical Cable for downloading of Energy Meter Data. Energy meters brand shall be Landis+gyr, Switzerland. TTB shall be provided in front of Energy meter panel. Location of the Energy/Tarif meter shall be in existing APSCL Network Control Room, NCR.

One (1) lot Mimic bus
One (1) lot Annunciators

All Ammeter and volt meter shall be Digital.

(2) REAR PANEL
The rear panel shall be equipped with the following items of protection, but not to be limited to:

One (1) lot Overall differential relay
One (1) lot Step-up transformer primary over-current relay
One (1) lot Step-up transformer neutral over-current relay
One necessary auxiliary relays, test terminal blocks, lockout relays, etc. shall also be provided.
8.1.2.3. SYNCHRONIZING PANEL

Swing type synchronising panel shall be equipped with the following items instruments, but not be limited to:

One (1) Synchroscope
Two (2) Voltmeter (0-230 kV)
Two (2) Frequency meter (48-52 Hz)

8.1.2.4. MODIFICATION OF EXISTING CONTROL & PROTECTION PANELS AT APSCL 230/132 KV EXISTING GRID SUBSTATION (if required)

The contractor shall carry out the modification works on the panels of adjacent breakers including supply of relays, meters, auxiliary relays, signalling equipment, test terminal block etc. necessary for connections of above mentioned power plant feeders to existing APSCL 230 kV substation.

8.2 Generator 11 KV SWITCHGEAR

Generator 11kV switchgear panel shall contain the following:

One (1) lot Control switch for 11 kV circuit breaker for incoming
One (1) lot Control switch for spare 11 kV circuit breaker
One (1) lot 11 kV bus voltmeter selector switch
One (1) lot Incoming circuit ammeter selector switch
One (1) lot 11 kV bus voltmeter (0-11 kV)
One (1) lot Incoming ammeter (0-6000 A)
One (1) lot Spare breaker watt meter
One (1) lot Spare breaker Var meter
One (1) lot Spare breaker watt-hour meter with indicating lamp for voltage failure
One (1) lot Mimic bus
One (1) lot Annunciators (minimum 15 windows)
One (1) lot Test terminal blocks
One (1) lot Numerical Protection relays

8.3 HRSG CONTROL PANEL

The HRSG control panel will contain the following:

One (1) set of water/steam pressure monitors
One (1) set of water/steam temperature monitors
One (1) lot of control switches.
8.4 INSTRUMENTATION AND CONTROLS

8.4.1. DESIGN REQUIREMENTS

Control signals and instrumentation signals shall not be affected by stray AC voltage or other interface of any type normally found in a power station. The Contractor shall supply shielded cables and surge arresters where necessary.

Shock absorbing mountings shall be supplied for instrumentation equipment where required.

Each component shall be identified and tagged with a designation number. Instrument scale ranges shall be expressed in SI units or metric units.

8.4.2. MEASUREMENTS

Measurements shall be taken for plant operation and control, and for heat balance and equipment's performance & efficiency calculations including supply of software on on-line plant performance monitoring & optimisation to interface with Plant Control, Protection, Monitoring system.


(1) Pressure Measurement

Pressure shall be measured near the pump discharges, pump suctions where NPSH availability is critical, at either side of equipment where pressure drop is significant, pressure regulated process, remote end of service lines, and near flow and level measurements affected by compressibility or density changes.

Normal operating point shall be approximately 60% of the range, over-range protection of at least 1.3 times the maximum scale reading shall be furnished on all pressure instruments. Accuracy shall be plus / minus 0.5% of calibrated span for bellows or bourdon tube transmitters at the minimum.

(2) Temperature Measurement

Temperature at appropriate locations at discharge, intake, exhaust gas, rotor shaft bearings, stator windings, critical metal points, lube oil, radiators, etc. shall be measured.

In general, temperature element shall be thermocouples, resistance temperature detectors may be used as sensors for control loops. Thermocouples shall be cooper-constantan for temperatures upto 2000C iron constantan up to 7500C, and chromel alumel up to 950 0C. Cold junction compensation shall be achieved in the control room. All extension wires from thermocouples and resistance temperature detectors shall be shielded. Thermocouples shall be accurate to plus / minus 0.75 % maximum measured temperature.

Resistance temperature detectors shall have platinum resistance windings and shall be connected by the three-wire method. Resistance temperature detectors shall have an accuracy of plus / minus 20C. Local temperature gauge shall be bimetal thermometers and shall have 80
mm round dial at minimum with black and white markings.

Welded wells for temperature element shall be the same material as the associated piping systems. All screwing wells shall be stainless steel.

(3) Level measurement

Level shall be measured in all tanks and vessels. Measurement of level in large or pressurised vessels shall be by differential pressure. Local level indication of small be by gauge glass for clear liquids, and by a top mounted float or bubbler for viscous liquids. Level controllers shall be of the differential pressure, or external cage displacement type.

(4) Flow measurement

Flowmeters shall, with the exception of the area meter, operate on the relationship which exists between differential pressure and fluid velocity. Flowmeters shall have liner outputs. Accuracy for fuel flow meter shall be within 2.0% at rate of flow higher than 80%.

Flow metering of fuel shall be temperature and / or pressure compensated & with integration.

For flow-metering of oil, positive displacement meters or area meters shall be used.

8.4.3. CONTROL EQUIPMENT

(1) Transmitters

Indicating transmitters shall be provided for control loops as required. Transmitters shall be substantially unaffected by changes in temperature and in process static pressure over a range from zero to twice the normal operating pressure. Transmitter shall feature accessible zero. and span adjustment.

(2) Final Control Elements

Control valves and damper actuators shall be pneumatic, where necessary, provided with electric- to-pneumatic converters. The response of final control elements shall have minimum time lag.

a. Control Valves

Control valves rated at 2,00 kN/ sq.m (300 lbs ASA) and below shall be flanged and higher rating shall be welded. Valves shall with stand shock loads imposed by the processor. control valve actuators shall be sized to overcome packing friction and dynamic stem forces. Unbalanced force shall be kept to a minimum level consistent with efficient operation in service.

b. Damper Actuators

Damper actuators shall be fully enclosed and supplied with all accessories including special mounting brackets if required. A solenoid operated, four way pneumatic valve plus open and close limit switches shall be included.

(3) Recorders

The recording instruments shall be of the multi or single point strip chart type or microprocessor based. Circular chart recorders shall not be used. The recorder shall display the previous four hours. Roller type charts
shall have a duration of 30 days as minimum.

The whole of the recording mechanism shall be withdrawable from its case from the front for maintenance.

(4) **Positioners and E/P Converters**

Positioners shall be furnished with final control elements where:
- small change in pneumatic signal are to be amplified
- Split range control is required
- valve pressure drop is greater than 280 kN/sq.m

Positioners shall have a feedback cam to characterize relationship between input signal and final element position.

E / P converters shall be provided to convert electronic control signals to pneumatic output signals. Converter accuracy shall be plus / minus 0.5% of output span.

(5) **Solenoid Valves**

All solenoids shall have class F insulation or higher class and solenoid enclosure shall be of weatherproof construction.

Solenoid for operation on AC shall give satisfactory operation over the range of 75% to 120 % AC supply voltage.

Solenoid for operation on DC shall give satisfactory operation over the range of 85% to 115 % DC supply voltage.

8.5 **PANEL CONSTRUCTION**

All panels except local control box shall be constructed using steel plate not less than 3.2 mm thick.

(1) **Vertical Panel of Front Face**

The panel shall be fitted with indicating instruments, annunciator lamps, operating indicators, watt-hour meter and recorders (for generator's output, voltage and frequency) etc. necessary for operation.

(2) **Slant Panel**

This panel shall be fitted with control switch, indicating lamps and mimic bus, etc., necessary for operation.

(3) **Vertical Panel of Rear Face**

This panel shall be fitted with protection relays, etc.

(4) Panel Interior Space (230 kV switchgear control and protection panels only)

Sliding type doors shall be furnished on the both sides of panel for access to pace shall be provided in the middle of front and rear faces of the panel to enable a man to pass through it. Chequered plate shall be furnished at the bottom of the panel.

(5) **Type of Indicating Meters**

110 mm square with about 240° C of seal angle, flush mounting type with 1.5 class accuracy, or other approved type by the Ashuganj Power Station Company Ltd.
(6) **Testing Power source**  
Power source for protective relay, meters, etc., one set of 50 A moulded case circuit breakers of 3 phase 415 V AC and DC 110 V (Nominal) shall be provided.

(7) **Test Blocks**  
Test blocks for P.T. and C.T. circuits, shall be provided on the panel as required. The test block shall be of the back-connected plug or stud type with removal covers. All test blocks shall be provided with suitable circuit identification and shall be arranged to isolate completely the instrument from the instrument transformers and other external circuits so that no other device will be affected, and means shall be provided for testing either from an external source of energy or from the instrument transformers.

The test blocks shall be arranged so that the current transformer secondary circuits cannot be open circuited if any position while the test plugs are in place, being inserted, or being removed. Three test plugs for each type of block furnished shall be furnished.

(8) **Control Switch**  
The handles of control switches for circuit breakers, disconnecting switches and auxiliary equipment shall be of the stick type, the handles of the control switches for adjustment shall be of the oval type, and the handles of the selector switches shall be of the flower type. Every switch shall have engraved identification number on the knob in white.

(9) **Internal wiring**  
**a. Wire**  
The internal wiring shall be made with PVC wire of 2.5 sq. mm copper stranded or larger, and solder-less terminals shall be used for connection. AT high temperature area heat resistant cables or wires shall be used.

The secondary circuit of C.T. and PT shall be wired with PVC wire 4.0 sq. mm (minimum) copper stranded.

**b. Colour Coding**  
The colour-coding shall be made as follows:

- Secondary circuit of potential transformer: Red
- Secondary circuit of current transformer: Black
- DC control circuit: Blue
- AC control circuit: Yellow
- Main circuit: Yellow
- Earthing circuit: Green

**c. Terminal blocks**  
Terminal blocks to be connected with internal wiring and external wiring shall have the cover (s) and identification numbers.

(10) The secondary circuit of P.T. for metering shall be provided with fuse. C.T. and P.T.’s are to connected through test block. A handset of flush type for paging system shall be installed on the slant part of remote unit panel. Switches such as circuit breaker controlling switch, annunciator test switch,
emergency stop switch, etc., which may be unwillingly operated by accident due to mechanical or human contact, shall be protected by transparent plastic switch cover.

(11) **Name Plate**

Switchgear, panels, equipment and power and control circuits shall be provided with an engraved name plate or with other suitable means of identification approved by the Ashuganj Power Station Company Ltd. The nameplates shall be made of nickel frosted sheet plastic or of anodised aluminium approximately 2 mm thick engraved with black letters on a white background. Nameplates of all panels, switches, etc. shall be written in English.
Section 9
Cabling and Grounding
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9. POWER CABLE, CONTROL CABLE AND GROUNDING

9.1 GENERAL

(1) **Scope**

The Contractor shall design, supply, install, terminate and commission all the cables for the plant.

(2) **Voltage Drop**

Except for measuring circuit the maximum possible voltage drop shall be such that 2.5% under normal running condition and 10% under motor starting.

(3) **Armouring**

All control and instrument cables shall be provided with galvanised steel wire or steel tape armour and PVC cover sheath.

9.2 CABLE TYPES

9.9.1. 11 kV XLPE POWER CABLE & BUS.

(1) **The cable shall be stranded annealed copper conductor.**

The construction of the conductor shall be the compacted circular single core type. The size of the conductor shall be capable to carry the rated capacity of each feeder and at specified site conditions without exceeding its maximum temperature i.e. 90°C. The minimum size of 11 kV cable shall not be less than 100 sq. mm. The copper conductor shall comply with latest IEC Standard.

(2) **Insulation**

The insulation material shall be extruded vertically cross-linked polyethylene of low dielectric loss, high dielectric strength, low thermal resistivity and long term stability. It shall be free from contamination by oil, chemical and moisture. The extrusion process shall ensure that the insulation is homogenous and the single core 11 kV XLPE Copper conductor power cable and other necessary items for the completion of the cable system.

The power cable and accessories shall be designed and constructed in accordance with the requirements of latest IEC Standard. High Voltage Cross linked Polyethylene Insulated cable" and the most up-to-date experience for a system of this voltage level and shall incorporate the latest improvements of design and manufacture for the type of cables and accessories required.

Free from voids and impurities. The process shall be dry method. The average thickness of insulation measured at section shall not be less than the value specified in the standard.

(3) **Terminations**

The end terminating materials shall be supplied for the termination of 11 KV cables.

(4) The cable shall be flame retardant.

The 11 kV Bus shall have the capability to carry the total load to
the primary side of the relevant step-up transformer.

9.9.2. **415 V Power Cables**

The cables shall be rated 415 volts for installation in cable trays, conduits and cable ducts.

All auxiliary power cable with a nominal conductor area of 60 sq. mm and above shall be stranded annealed copper conductor, XLPE insulated with galvanised steel wire or steel tape armour and PVC sheathed. All other auxiliary power cables shall be stranded annealed copper conductor, PVC insulated with galvanised steel wire or steel tape armour and PVC sheathed. All auxiliary power cables shall be designed, fabricated and tested in accordance with the latest IEC Standard.

The cables shall have copper conductor and shall be selected with due consideration to load requirements of each feeder and short circuit current capacity of the cable in order to prevent premature insulation failure. The conductor insulation shall be numbered or colour coded.

For motor circuit, the cables shall have a current carrying capacity of at least equal to 115% of the full load current rating of the motor after application of the appropriate derating factors.

Cable supports shall be provided for the cables and shall be at least one cable support bracket per vertical section for interconnection between adjacent sections. The minimum size of power cable shall be of 10 sq.mm. The cable shall be flame retardant.

9.9.3. **CONTROL AND INSTRUMENT CABLES**

Control and Instrument Cable shall be provided with galvanised steel wire or steel tape armour and PVC cover sheath.

In general, control and instrument cables shall be rated 415 volt and shall have copper conductor with either PVC overall jacket, unless specified otherwise. All control and instrument cables shall be designed, fabricated, and tested in accordance with the latest IEC Standards.

All cables shall be of oil-resisting, heat-resisting and flame-retardant type (armoured) and shall be stranded copper conductor. The minimum size of control cables shall be as follows:

- For CT circuit - 4.0 sq. mm
- For PT circuit - 4.0 sq. mm
- Other circuit - 2.5 sq. mm

Wiring for circuits such as the circuits to be connected to electronic circuit, telephone circuit, etc. adversely influenced by stray electric field shall be provided with suitable shielding.

- PVC Insulated and Jacket Cables

PVC insulated control cables shall be used in the area of installation where the ambient temperature is normally lower than 400C.

- Cross linked polyethylene Insulated Cables.

Cross linked Polyethylene insulated control cables shall be used in the area
of installation where the ambient temperature is normally between 400°C and 550°C.

-Mineral Insulated (MI) Cables.

Mineral insulated control cables shall be used in the area of installation where ambient temperature is normally above 550°C. Where instrument junction boxes such as for limit switches, pressure switches, transmitters, resistance temperature detectors etc. are at high ambient temperature, they shall be wired with MI cables up to a junction box.

(1) **Insulation requirements**

All control cables, with the exception of equipment internal wiring and panel wiring, shall be installed in conduits, cable ducts or cable trays.

Cables contained in cable trays, conduit or cable ducts shall be continuous with no splices permitted between loads and supply location. Methods for installation of cables shall be such that there will be no cuts or abrasions in the insulation or sheath or break in the conductor. Conductors used for AC and DC circuits shall not be mixed in the same multi-conductor cable.

In general, conductors and cables shall be supported and terminated so that no strain is imposed on the terminations. Insulated clamped jugs shall be used for all control cable terminals.

**9.9.4. 230 kV XLPE POWER CABLE**

Bidder shall follow the clause 6.5 of volume 2 of 2 (Part-A) for details of 230 kV underground cable. The following matters shall also follow:

(1) **The cable shall be stranded annealed copper conductor.**

The construction of the conductor shall be the compacted circular single core type. The size of the conductor shall be capable to carry the rated capacity of each feeder and at specified site conditions without exceeding its maximum temperature i.e. 90°C. The minimum size of 230 kV cable shall not be less than 1000 sq. mm. The copper conductor shall comply with latest IEC Standard.

(2) **Insulation**

The insulation material shall be extruded cross linked polyethylene of low dielectric loss, high dielectric strength, low thermal resistivity and long term stability. It shall be free from contamination by oil, chemical and moisture. The extrusion process shall ensure that the insulation is homogenous and the single core 230 kV XLPE Copper conductor power cable and other necessary items for the completion of the cable system.

The power cable and accessories shall be designed and constructed in accordance with the requirements of latest IEC
Standard. High Voltage Cross linked Polyethylene Insulated cable" and the most up-to-date experience for a system of this voltage level and shall incorporate the latest improvements of design and manufacture for the type of cables and accessories required.

Free from voids and impurities. The process shall be dry method. The average thickness of insulation measured at section shall not be less than the value specified in the standard.

(3) Terminations
The end terminating materials shall be supplied for the termination of 230 kV cables.

(4) Laying
Under-Ground Cable from power plant to existing APSCL 230 kV grid Sub-station bay shall be buried at minimum 1.5 meters depth and provided with RCC slab over 30cm of sand back filling for cable mechanical protection.

9.3 RACEWAY

9.3.1. RACEWAY
Raceway shall be provided for all cables, and these shall be rigid conduit metal type cable trays.

9.3.2. RACEWAY FITTINGS AND SUPPORTS
Raceway shall include all fittings, junction boxes, flexible attachments, raceway support hardware, etc.

9.4 CABLE ERECTION
Concrete lined cable trenches shall be provided within the power station. All such trenches shall be provided with covers to form a flush finish with the finished floor level. Cables shall be secured by non-corrodible cleats supporting steelwork, or on trays. Wooden cleats shall not be used. Cables shall not be clipped or cleated directly to masonry. All cable supporting steelwork racks cleats trays and fixings in trenches or elsewhere shall be supplied under this contract.

Where the cables are to be installed on racks, these racks shall be of galvanised steel angles or aluminium and designed such that the spacing and type of supporting cleat ensure that no undue pressure is exerted on the sheath or armour of any cable.

Cables tray shall be of the first grade perforated galvanised steel with folded side members and supported on steel work or masonry is required. Segregation of the various services shall be achieved by use of separate trays for each voltage grade of cable used. The design of the cable tray system shall make due allowance for the future installation of at least 10 percent spare cables and also for the installation of cables supplied by others.

All cables in vertical runs shall be supported to ensure that no strain due to the weight of the cable is taken by any terminating box. Each cable when erected shall have permanently attached to it at each end, non-corrodible metal markers showing the cable identification number, voltage, rating, size and make up.

Single core cables shall be laid up in close trefoil 3-phase groups and erected in separate non-magnetic clamps to the approval of the Ashuganj Power Station
Where cables are erected on outdoor steelwork supporters, sun shades of approved design and materials shall be included and erected as necessary to protect the cables.

### 9.5 GROUNDING

The Contractor shall provide all grounding cable, equipment, and materials required for a complete installation including the direct buried ground mat for the power station. This shall include, but not be limited to, all facilities for grounding of panel boards, control panels, transformers, switches, lighting poles, lighting standards, and all electrical equipment enclosures. Two point grounding for each equipment, panel board and steel structure shall be provided.

1. **Grounding wire for ground grid**
   
   Hard drawn copper stranded wire in accordance with latest IEC Hard Drawn Copper wire for electrical purposes.
   
   Nominal cross-sectional area: 200-sq. mm.

2. **Grounding wire of the equipment to be connected with grounding grid.**
   
   Annealed copper standard wire in accordance with latest IEC Annealed copper stranded wire for electrical purposes.
   
   Nominal cross-sectional area: 100 sq. mm.

Ground grid shall be laid so that the completed earthing system shall have a maximum earth resistance value of less than 0.5 ohms, at any point on the system. The contact voltage at any point inside the power station at the incidence of an earth fault shall not exceed the standard safe limit. The power station grounding shall be embedded to a minimum depth of 800 cm. The grounding rods addition to the above grid shall be provided, if required. The minimum outer diameter of grounding rod shall not be less than 15 mm.
Section 10
DC Power Supply System
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10.3 DC DISTRIBUTION BOARD .............................................................110
10. DC POWER SUPPLY SYSTEM

10.1 BATTERIES

(1) Scope of work

The Contractor shall design, manufacture, delivery to the site and install two (2) sets of 110 V DC (nominal), Ni-Cd, Alkaline storage batteries, complete with all accessories, as specified, hereunder for the plant.

The Contractor shall provide two (2) sets of 110 V DC (nominal), Ni-Cd, Alkaline storage batteries, complete with stands, inter-cell connections, battery moulded circuit breakers and maintenance equipment. For design purposes the ambient temperature in the battery room shall be taken to range from 10°C to 45°C. Each battery shall be associated with battery charger(s) and DC distribution board(s). The rated voltage at the batteries shall be 110 V DC (nominal). The Contractor shall furnish characteristics and performance curves of both for batteries and chargers. Sufficient ventilation shall have to be provided.

(2) Description of the Equipment

Two (2) sets of 110 V DC (nominal) battery for Engine generating units with stands and internal connections.

Two (2) sets of accessories comprising:

Two (2) Hydrometers

Two (2) cell voltmeters, plus / minus 3 V, portable type, accuracy Class 1.0 complete with leads and probes.

Two (2) - Alcohol - in - glass thermometers to cover the range 0°C to 55°C

One (1) Supply of battery record log books for at least 15 separate recordings for each battery

One (1) Plastic case to contain the above accessories.

Three (3) Connector bolt wrenches.

One (1) set of electrolyte filling tools.

(3) Technical description

a. The batteries shall be of the Ni-Cd, Alkaline. The cell containers shall be of the fully enclosed vented type made of transparent plastic material with clearly visible high and low electrolyte limits indelibly marked on the container. Each cell shall have a large electrolyte reserve capacity above the plates to allow for minimum maintenance, The Contractor shall provide 5 (five) hours rated batteries and shall make capacity test at commissioning period.

But the capacity of the batteries shall not be less than followings.

- 110 V battery : 200 AH, 5 hours

Number of cells of each battery set shall be as follows:

- for 200 AH battery set: As required + 4 batteries per set as spare.

Cells shall be numbered consecutively and terminal cells marked to indicate polarity.

b. These batteries shall be used for supplying power for DC controls,
alarms indication and for emergency lighting and power equipment to be installed within the power station.

c. Each cell shall be assembled in heat-resistant, shock absorbing clear plastic containers with covers cemented in place to form a leak proof container. Vent plug and filler cap shall be provided in the cover.

d. Separators between plates shall permit free flow of electrolyte.

e. The weight of the battery elements shall be supported from ledges moulded in the jar walls or from the cover.

f. Cell posts shall be sealed against electrolyte creepage.

g. Cell terminal posts shall provide with connector clamps, bolts and nuts.

h. Sufficient sediment space shall be provided so that the cells will not have to be cleaned out during normal life.

i. Electrolyte level limits shall be marked on the cell container.

j. The battery shall be shipped uncharged with the electrolyte shipped in separate containers.

k. The battery shall be furnished complete with cell inter-connectors and a two-step steel rack.

l. The battery shall be suitable for operating satisfactorily in an ambient of 45°C.

m. Each set of Battery shall be capable to withstand/able to continuous supply of power for a minimum period of 5 (five) hours during the failure of AC supply.

10.2 BATTERY CHARGER

(1) Scope of works

The Contractor shall design, manufacture, deliver and install the battery chargers (Thyristor type), complete with all accessories, as specified, hereunder for the plant.

The Contractor shall provide two (2) sets 110 V DC (nominal) chargers, in the auxiliary room of the control building to be used for automatic charging of 110 V. The electrical connections between the batteries, the DC distribution boards and the chargers shall be made as per requirement. Only charger with fully proven design shall be provided. The charger shall be capable of performing continuously at float charge as well as boost charge (with timer).

(2) Description of the Equipment

Two (2) sets 110 V DC (Nominal) output, 415 V AC, three phase input, battery chargers with automatic regulator and filters to maintain the performance. One (1) set for one (1) battery set and other set as standby. The continuous current rating of the battery chargers shall be determined by the Contractor so as to meet the capacity of related battery.

But the continuous current rating of the chargers shall not be less than the following:

-110V Charger output : 180A

(3) Performance
a. **Constant Voltage Characteristic**

The chargers shall normally have a constant voltage characteristic and shall be designed to carry the load current while the battery floats and to replenish the battery after intermittent discharge. The set voltage shall be adjustable between 1.20 V/cell and 1.70 V/cell by means of a potentiometer located inside the cubicle.

The DC voltage shall be maintained within plus / minus 1 percent of the set voltage for all loads from zero to rated output for any variation of between plus / minus 10 percent of the nominal AC input voltage or between 48 and 52 Hz in frequency.

The proper voltage adjusting means such as silicon dropper shall be provided to keep the DC terminal voltage within a permissible range.

Constant voltage charging shall recommence automatically when the battery voltage reaches the pre-set value.

The current limit setting shall be adjustable down to 80 percent rated output.

b. **Control**

The chargers shall be provided with an automatic IU control system.

c. **Ripple Voltage Limits**

With the battery connected and with any non-destructive load between zero and rated the peak value of the ripple voltage (unweighted) measured across the output terminals shall not exceed the followings:

- Charger nominal : 110 V
- DC voltage
- Ripple voltage : 2.0 V peak to peak limit

### 10.3 DC DISTRIBUTION BOARD

The Contractor shall provide the DC distribution board in the Engine unit control package and in the auxiliary room of the control building. The Contractor shall determine the continuous current rating of the distribution boards.

Number of the feeders and current rating of feeders shall be determined by the Contractor. Five (5) spare feeders on each distribution board shall be provided.
Section 11
Lighting and Small Power Supply System
## 11. LIGHTING AND SMALL POWER SUPPLY SYSTEM

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11. LIGHTING AND SMALL POWER SUPPLY SYSTEM

11.1 GENERAL

(1) **Scope of Works**

The Contractor shall design, manufacture, deliver and install power station lighting and small power supply complete with all the accessories at the site as specified hereinafter.

(2) **Details**

Detail description and drawings of all lighting fittings, distribution boards, switches, DC equipment, socket outlets, poles, glands, etc., comprising the offer shall be submitted with Tender.

(3) **Electricity Supply**

Supplies for lighting distribution boards of 415 Volts 3 phase 4 wire 50 Hz shall be taken from the station auxiliary switchboard.

The 125 volt DC supply required for emergency lighting services shall be obtained from the batteries supplied under the Section 10. Under AC failure conditions for the DC, emergency lighting to be installed shall be automatically switched on.

11.2 DISTRIBUTION BOARDS

The distribution boards and all component parts shall be manufactured and tested in accordance with the latest IEC standard. Distribution boards shall have dust proof sheet steel, galvanised, weatherproof cases. The metal casing is to be provided with knockouts or other approved form of cable entries, corresponding to the circuit capacity, together with a suitably screened brass earthing stud.

The distribution boards shall be either double pole and neutral types as required and shall be equipped with means to provide over load protection to each circuit. This protection shall comprise moulded case circuit breaker.

11.3 CABLES

All cabling associated with the lighting and small power socket outlets services shall be stranded annealed copper conductor, PVC insulated galvanised steel wire or steel tape armoured and PVC sheathed as appropriate or mineral insulated copper sheathed cable depending upon the service required.

The Contractor shall select conductor sizes for the respective circuits to meet the following conditions:

a. Minimum conductor sizes for lighting circuits shall be 2.0 sq. mm and for socket outlets 3.5 sq. mm.

b. The size shall be adequate for the current to be carried.

c. The size shall be adequate to limit the voltage drop in phase and neutral conductor to the farthest lighting or power point under normal full load conditions to within 2.5%.

11.4 LIGHTING AND SMALL POWER

The following lighting and small power arrangements shall be provided as a minimum by the Contractor.
<table>
<thead>
<tr>
<th>Location</th>
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<td>Power Generating Area</td>
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<td>Inside of engine house except control package</td>
<td>100</td>
<td>Fluorescent lamp or incandescent lamp with reflector and guard if necessary explosion proof type shall be used.</td>
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</tr>
<tr>
<td>Office</td>
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(a) **Plug Sockets**

Plug sockets shall be located so that any point inside the engine house, inside a building or outside in the high voltage areas can be reached within the following distances from a plug socket.

(i) Single phase plug socket

Indoor - : 10.0 m
Outdoor- :20.0 m

(ii) Three phase plug socket
Outdoor- :45.0 m

At least two plug sockets shall be installed within the vicinity of an indoor control board and no plug socket shall be installed within the battery room.

11.5 EMERGENCY LIGHTING

The Contractor shall design DC emergency lighting and power supply system for the power station, and illumination level of DC emergency lighting shall be as follows.

The lighting shall consist of 125 V DC operated incandescent luminaries.

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<tr>
<th>Location</th>
<th>Illumination Level (Lux)</th>
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<tbody>
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<td>Control room and inside of control package</td>
<td>15</td>
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<tr>
<td>Inside of other package</td>
<td>1</td>
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<tr>
<td>The other area surrounding the plant</td>
<td>0.5</td>
</tr>
</tbody>
</table>

Additional emergency lighting arrangement, independent emergency light units operated from built in charger and batteries charged by 230 V AC shall also be provided strategically. Total ten units shall be included in the Tender.

11.6 MISCELLANEOUS MATERIALS

(1) Lighting Poles

Lighting poles shall comprise tubular or octagonal metal or reinforced concrete construction with a base of sufficient section to house an inspection trap, lockable door, cable entry and terminations suitable for the incoming cables and the secondary cables feeding the light sources, all of which shall be supplied with the pole. All poles shall be suitable for burying to a depth of 1.5 m and have an adequate concrete foundation.

Metal poles shall be either hot dip galvanised or covered with a bituminous base protective area with the fitting erected and a safety factor of 2.5 allowed.

(2) Conduits Pipes

The rigid steel conduit pipes shall be galvanised and have a minimum thickness of 2.3 mm and minimum inside diameter of 16 mm.

(3) Outlet Switches, Junction Boxes and Fittings

The boxes to be concealed in the concrete shall be of galvanised sheet steel and shall be fitted with appropriate covers so as to be flush with the finished surface of the concrete structure. The boxes in the exposed work shall be
of galvanised steel or alloy fitted with appropriate covers.

(4) **Tumbler Switches**

The wall switches shall be of the enclose flush or surface mounting tumbler type, single pole, 250 V, 10A and fully installed in the boxes fitted with suitable plates for covering them.

(5) **Miscellaneous**

All apparatus, accessories and materials which have not been specifically mentioned but which are necessary for the completion of the work shall be provided by the Contractor.
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Fuel Handling Facilities
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12. FUEL OIL SYSTEM AND HANDLING FACILITIES

12.1 Fuel system

HFO (furnace oil) will be used as fuel.

12.1.1 Liquid Fuel oil system

The unit shall be provided with liquid fuel oil system. The operating fuel would be Heavy Fuel Oil (furnace oil) and engine can run with LFO, if necessary. The liquid fuel oil system shall have fuel unloading with metering system & handling facility and storage facility for both HFO and LFO, cleaning system, heating system, fuel forwarding system, fuel injection system, oil recovery system, waste collection & treatment system, foam based fire suppression system etc.

12.2 FUEL STORAGE AND HANDLING

The fuel storage and handling system of the facility can be divided into three parts,

A. Heavy Fuel Oil System (HFO)
B. Light Fuel Oil (HSD) System
C. Fuel Transfer System

Under normal operating condition heavy fuel oil is used for the generator engines for full liquid fuel operation and light fuel oil is used for certain auxiliaries and for the generator engines in emergency and for flushing the HFO system for extended isolation.

A. Heavy Fuel Oil

02 (Two) HFO storage tank of each capacity 5,000 m³ shall have to be installed as fuel storage tank of this plant. One (1) buffer tank capacity as requirement. Two (2) HFO day tanks with a capacity of 1000 m³ shall have to be provided with the following, but not limited to:

- A sounding pipe for manually measuring tank level,
- Remote level indication in the monitoring/control system, which shows fuel quantity by mass in the tank in percentage,
- Tank high and Low level alarm,
- Vent with flame arrester,
- Over-flow connection to overflow tank,
- Decanting system with drain pit,
- Steam heating system, and,
- Associated valves and piping for filling, transfer and heating.
- Mass flow meter for measuring fuel inlet & outlet of the storage tank.

HFO Bunkering/storage

The plant has to be provided with fully equipped bunkering facility for riverside and road way bunker reception. Each bunkering unit is provided with a micro motion flow meter to constantly measure flow of fuel delivered to the storage tank.

B. Light Fuel Oil
One 1000 m³ LFO storage tank will be installed for storage and One 500 m³ LFO day tank will be installed. The necessary Design, modification and piping have to be provided by with a sounding pipe for manually measuring tank level,

- Remote level indication in the HMI system, which shows fuel quantity by mass in the tank in percentage,
- Tank high level alarm,
- Vent with flame arrester,
- Over-flow connection to overflow tank,
- Decanting system with drain pit, and,
- Associated valves and piping for filling and transfer.

**LFO Bunkering**

The plant has to be provided with a separate fully equipped bunkering facility which is common for HFO as well as LFO. Each bunkering unit is provided with a micro motion flow meter to constantly measure flow of fuel delivered to the storage tank.

Procedure for LFO bunkering from both riverside and road way shall be same as HFO bunkering except for valve operation.

**C. FUEL TRANSFER SYSTEM**

The plant has to be is equipped with a fuel transfer unit to facilitate HFO transfer in between storage tanks. Internal fuel transfer may become necessary to facilitate segregation of fuel from different supply tank.

The transfer unit consists of following components,

- Screw type transfer pumps 2 (two) sets
- Pump suction strainer 1 (one) each
- Transfer unit relief valve 1 (one) on common discharge line
- Associated valves and piping

Transfer pumps takes suction from HFO storage tanks’ common outlet header and delivers into bunker filling common line.

**12.3 FUEL TREATMENT**

Fuel received from supplier may contain water and other solid impurities, which may have detrimental effect on combustion quality and fuel injection system components. So it is imperative that the fuel is properly treated to separate water and sludge before the fuel is fed to the engine.

HFO received from supplier goes through a two-step treatment process and finally stored in the day tank for engine consumption. The first step takes place in the fuel storage tanks, which are equipped with heating and decanting facilities. Fuel in the storage tank is heated and allowed to settle to facilitate separation by gravity where some of the water and solid impurities accumulate at the tank bottom. Time to time these accumulated water and sludge are to be drained out from the storage tank using the drain valves provided for each fuel tank. Remaining suspended solid and water is separated by centrifuge.

All HFO storage tanks’ outlet lines connect into a common header from where the buffer tank suction by screw type transfer pump after that centrifugal separators take suction from buffer tank. Separator outlet connected with day tank. Each
storage tank outlet line is to be fitted with two valves in series, first one is a hand shut off valve and the second one is a pneumatic control valve, which is to be operated from the quick closing valve panel. HFO day tanks’ overflow lines are also connected with the buffer tank. Day tank overflow lines are fitted with hand shut off valves.

**HFO Separators**

The facility is equipped with two HFO separation units each comprises of two separator units, one Sludge tank and one sludge transfer pump. Separation will purify HFO by separating sludge, water and others as per requirement by engine. One separation unit (Consists of two separators) will purify oil required for whole plant operation and another unit will be kept for standby. Each separator unit comprises of following components.

### 12.4 ENGINE FUEL SUPPLY SYSTEM

Centrifuged and pre-heated fuel oil from the day tank is fed with Constant Pressure regulated by variable frequency drive operation to the individual engines by the engine fuel oil supply system have to be manufacturer specific but as a minimum should comprises of following components,

- Two Fuel Feeder Units
- Two Fuel Booster Units
- Engine Wise Fuel Units
- LFO Feeder Unit

#### a. Fuel Feeder Unit

The engine fuel supply system is equipped with fuel feeder units which take suction from HFO day tanks or LFO day tank as selected by the changeover valve and delivers to fuel booster unit. Feeder units are fitted with an inter-connection valve for emergency use. Each feeder unit is equipped with,

- Two feeder pumps
- Individual pump suction filter,
- Individual pump suction and delivery valves,
- Suction valve for HFO and LFO with changeover arrangement,
- Common pressure regulating valve, and,
- Discharge line common quick-closing valve.

In each feeder unit one pump remains in use while the other can be kept on standby.

Feeder unit pumps and quick closing valves are controlled from a common control panel for feeder and booster unit located near the booster unit.

**Note:** The feeder unit suction valves for HFO and LFO have to be equipped with a single operating lever for changing over feeder unit suction. Horizontal lever position is for HFO operation and vertical lever position is for LFO operation.

#### b. Fuel Booster Unit

Engine fuel supply system is equipped with identical fuel booster units, which take suction from the relevant feeder unit and deliver to engine wise fuel units. In the booster unit fuel oil is filtered and heated to attain suitable
viscosity for efficient combustion before delivering to engine inlet header from where engine wise fuel unit take suction. The booster units are also interconnected by isolation valves on the supply and return line for emergency use only.

Each fuel booster unit have to be comprises of following components,

- Automatic back flushing filtration unit
- By-pass duplex filter unit
- Fuel flow meter
- Mixing column
- Two fuel booster pumps
- Two steam heaters
- Viscosity controller unit
- Fuel returns line change over arrangement.

**Fuel Oil Auto Filter**

The system is equipped with a fully automatic back flushing filter unit with a by-pass duplex filter with redundancy. Under normal operating condition the system should not be operated with the back flushing filter by passed.

**Filtration Process**

A motor driven change over unit is located at the centre of the filtration unit and surrounded by 4 filter chambers. At any given time 3 filter chambers are in use and 1 remains on standby. At a present time, interval, the filter control unit goes on flushing cycle.

Differential pressure across the filter is continuously monitored by the controller and if at any time the differential pressure reaches the set value the controller initiates a flushing cycle and activates High Filter Differential Pressure Alarm.

**Back Flushing**

At the beginning of back flushing cycle, the controller activates the changeover unit. The change over motor rotates the central change over mechanism one fourth of a turn and as a result the stand by filter goes into operation while the 3rd filter chamber goes off line and enters into back flushing cycle.

As soon as a filter goes on standby mode the control unit energizes solenoid valve-A, which allows instrument air to operate the sludge piston and opens the sludge port. Opening of the port allows the air to travel to and open valve-C of air reservoir. Air from reservoir then enters into the outlet side of the stand by filter and drives the fuel oil and accumulated dirt out of the chamber, which flows to the fuel return line to HFO day tank. Fuel from the filter main outlet enters into the stand by chamber through a control hole and gradually fills up the stand by chamber.

**By-pass Filter**

The system is equipped with a set of duplex filters with mesh size of 34 microns connected in parallel with the auto back flush filter. The by-pass filter is provided to facilitate isolation of the back-flush filter and to be only used when back flush filter maintenance is necessary while the engines are
running. The by-pass filter unit comprises of,
Two filter chambers with filter elements,
One change over cock, and,
One vent line.

**Fuel Flow Meter**

Each booster unit is provided with a micro motion flow meter to constantly measure flow of fuel delivered to the engines covered by the relevant booster unit. The flow meter is located between the filter unit and the mixing column and fitted with a by-pass valve. The flow meter can register the following information,

- Cumulative mass flow in kg
- Flow rate in kg/hr or litres/hr
- Fuel pressure
- Fuel temperature

**Note:** The flow meter is capable of registering negative flow rate but the cumulative mass flow is always incremental.

If booster units are operated with the inter connection valves open and if there is any re-circulation of fuel through any of the booster units due to pressure difference then the flow meter will register incorrect (excess) cumulative mass flow readings.

A micro motion flow meter shall have to be provided in the outlet of the HFO feeder unit to measure the fuel consumption of the plant.

**Mixing Column**

Mixing column is located in between the flow meter and booster pumps. Return fuel from engines can also be directed to the mixing column. It is equipped with a float type venting arrangement to bleed off any vapour (water or fuel) and a float operated low-level alarm to ensure positive suction header for the booster pumps.

**Fuel Booster Pumps**

Each booster unit is provided with two booster pumps with individual isolation valves. The pump takes suction from the mixing column and delivers to the engines through the heater and viscosity controller unit.

**Fuel Heaters**

Each booster unit is equipped with two tube type fuel oil heater units installed in parallel. Each heater is capable of handling complete fuel heating requirement of one bank at full load. Heating steam supply valve for the heater is a pneumatic control valve controlled by either the viscosity controller or the temperature controller as selected at the booster unit control panel by the selector switch A16S2.

**Viscotherm**

The booster unit is equipped with a viscotherm unit on the fuel supply line after the heaters. It measures the process fuel viscosity and sends input for the viscosity controller unit. The viscotherm unit is fitted with isolation valves and a by-pass line with a by-pass valve to facilitate maintenance work on the unit while the booster unit is in operation.

**Return Line Change Over Arrangement**
Returned fuel from the engines can be directed either to the mixing column or back to HFO day tank. Two return lines are fitted with separate isolation valves with a single operating handle and the valves are such configured that while one valve opens the other closes. At horizontal lever position fuel return to mixing column valve remains open and at vertical lever position fuel returns to HFO day tank. In normal operating condition return fuel is directed to mixing column. Sending return fuel back to day tank should be avoided as no flow meter is available to measure the return fuel quantity.

**Temperature/Viscosity Control**

The fuel booster unit is provided with two separate controller units for temperature control and viscosity control and either one of them can be selected by the selector switch A16S2. When temperature controller is in use it maintains the fuel temperature as per set value while viscosity may vary and when viscosity controller is in use it maintains the viscosity as per the set value by controlling fuel temperature and temperature may vary. In both cases it is the steam supply to the fuel heater, which is controlled.

**C. ENGINE WISE FUEL UNIT**

Each engine is equipped with a fuel unit to facilitate engine wise HFO / LFO change over option, leak off fuel handling and final fuel filtration before injection.

Each fuel unit comprises of following components,

- Valve unit with solenoid controlled actuator,
- Fuel feeder pump with suction strainer,
- Duplex fuel filter,
- Pressure control valve, and
- Leak off fuel collecting tank with return pump

**Fuel unit Feeder Pump**

Each fuel unit is equipped with a fuel feeder pump with suction strainer and isolation valve. The pump is provided to facilitate boosting fuel supply pressure and re-circulate fuel through the engine when the engine is stopped and on HFO mode. The engine can operate with or without the feeder pump running depending on available fuel pressure at the supply header.

**Fuel unit Duplex Filter**

For the final filtration of fuel before it enters the engine a duplex filter is provided at the engine fuel unit. The filter is fitted with a change over cock, a differential pressure cell, heating steam line and drain and venting arrangement. Normally one filter is kept in use while the other is on stand-by but if required both the filters can be put into service. The DP cell monitors and indicates the pressure differential across the filter unit and activates an alarm at the fuel unit control panel (indicator H5) if it exceeds the set value.

**Leak off Tank and Return Pump**

Any leakage from individual cylinder’s fuel injection pump and fuel injection system double wall pipes are led to the clean fuel leak off tank. Each bank leak off line is equipped with a float type alarm to indicate excessive leakage. The leak off tank is fitted with a return pump with isolation valves, which
operates automatically controlled by a float switch. The same activates leak off tank high-level alarm as well. The engine fuel return line passes through the leak off tank to maintain heating for leak off fuel.

**Engine Operation in LFO Mode**

Engine LFO operation facility is provided as a back up of HFO system and for flushing the fuel system before extended shutdown or to facilitate maintenance work. Engine LFO operation is possible in two different ways,

By feeder and booster units for common LFO operation, and,

By LFO feeder unit for individual engine LFO operation.

**Common LFO Operation**

This system is to be used when the common fuel supply system needs to be flushed for maintenance work or the plant has to be operated on LFO instead of HFO. Procedure for change over from HFO to LFO operation,

**Engine wise LFO Operation**

This system is to be used when an individual engine needs to be operated on LFO to facilitate flushing of engine fuel system for maintenance work while the remaining plant operation shall be on HFO supplied by the common fuel system. For engine wise LFO operation a separate LFO feeder unit PCA-905 is provided.

D. **LFO FEEDER UNIT**

The LFO feeder unit takes suction from the LFO day tank and delivers directly to engine fuel units with Constant Pressure regulated by variable frequency drive operation. It also supplies LFO for following auxiliaries,

- Engine driven emergency fire pump
- Black start generator
- Oil fired steam generator (if required)
- Machine shop for cleaning and testing purposes.

The LFO feeder unit is comprises of as a minimum of the following components,

- Two feeder pumps,
- Individual pump suction filter,
- Individual pump suction and delivery valves,
- Common pressure control valve, and,
- Discharge line common quick closing valve
- Variable frequency drive for pressure regulation.

**Note** The LFO feeder unit is provided with a low suction pressure alarm to avoid dry running of the pump when suction filter gets clogged.
Section 13

Fire Protection Facilities
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13. FIRE PROTECTION FACILITIES

13.1 GENERAL

The Contractor shall design, manufacture, deliver to the Site, install, test and commission the fire fighting and fire detection equipment to protect the Diesel Engine generating unit and all associated equipment. In particular, the following shall be included:

- CO₂ Gas fire protection system for the packaged units (LV, MV etc).
- Water hydrant system including motor & diesel engine driven pumps, jockey pumps etc.
- Portable fire fighting equipment
- Foam based fire suppression equipment for fuel tanks
- Automatic Sprinkler type hydrant system

13.2 DESIGN REQUIREMENTS

The general design of the fire protection facilities shall take into account that the basic operating policy for the power station will have the minimum of personnel supervision for the Engine.

Where automatic systems are provided, alternative manual initiation facilities shall also be provided.

All fire protection installations shall comply with the requirements of the codes of practice of the National Fire Protection Association (NFPA), Boston, Massachusetts, U.S.A., as appropriate for the respective systems, to the approval of the Ashuganj Power Station Company Ltd. The codes and practice of the Japanese Fire Protection may also be considered.

13.3 CO₂ /INERT GAS FIRE PROTECTION SYSTEM

An automatic Carbon Dioxide (CO₂)/inert gas fire protection system shall be provided in all enclosures except in the unit local control package. The fire protection system shall comply with the requirements of National Fire Code No. 12A published by the National Fire Protection Association, Boston, Massachusetts, U.S.A. or equivalent.

The equipment shall consist essentially of fire detectors distributed strategically within the enclosures which, on sensing a dangerous condition at any location, will initiate audible and visual alarms, trip all running plant including ventilation equipment, and release CO₂ /inert gas into the affected enclosure. Actuation of the fire protection system shall also trip generating unit and immediately shut off the fuel supplies to the unit at a point external to the enclosures. There will be time lag of 30 seconds between the ringing of an alarm and discharge of gas, so that the personnel working in the package could leave safely.

Facilities for alternative manual actuation of the fire protection system shall also be provided such that, when the manual mode has been selected the protection sequence will not proceed beyond the alarm stage without manual action by an operator.

System of lock off to (but not exit from) the enclosure affected shall also be provided.

The fire protection system shall be segregated into separate zones so that at least the protection for any one compartment can be selected to the manual
mode whilst, at the same time, retaining the automatic mode for the remaining enclosures.

Lock-off boxes shall be provided at all entries to enclosures, with switches whereby an operator may inhibit automatic release of extinguishant. These boxes shall be provided with status indicators signifying 'Auto on' 'Auto-off' and 'Extinguishing Released' and a red lamp shall also be illuminated at the box in the event of extinguishing release. The status shall be indicated at the control panel of the control building also.

Fire detection shall be by means of ultra violet flame detectors with a backup system utilising rate-of-rise temperature detectors. The use of smoke detectors shall be subject to specific approval by the Ashuganj Power Station Company Ltd. as regards their type and location.

Audible and visual fire alarms shall be provided in all machinery enclosures, the local control cabs and in the control room of the control building. Additional audible alarms shall also be provided external to the engine generator enclosures. Particular areas of high fire risk such as confined spaces where lubricating oil could possibly come into contact with high temperature, surfaces shall receive special consideration. Such areas shall be treated as separate fire protection zones with detection and gas injection facilities operating independently of the system provided for the machinery enclosure concerned.

The fire protection equipment shall be complete in all respects including pipework, valves, fire detectors, nozzles, control equipment, fully charged CO₂ gas cylinders and cylinder racks.

13.4 HYDRANT SYSTEM

Fire hydrant of water type shall be provided in the power station as per USA standard (NFPA).

13.4.1 HYDRANT

Hydrants shall be installed at required places around the generating unit, electrical building, step-up transformers, station auxiliary transformers and 230 kV switchyard. Automatic Sprinkler Hydrants system shall be provided for step-up transformers, station auxiliary transformers. Each hydrant stand shall be fitted with an isolating valve and approved type of instantaneous hose complying 30-m hose with combined jet/water-fog nozzle shall be provided in the cabinet adjacent to each hydrant. Gun type Hydrants shall be installed at some distance of the fuel storage area to protect from oil fire by foam.

13.4.2 PIPING

The fire fighting water mains shall consist of buried piping of at least 120 mm diameter. The underground pipe work shall be provided with an approved protective coating unless the pipe is manufactured from an approved non-corrosive material. To avoid corrosion, cathodic protection will be installed.

13.5 PORTABLE EQUIPMENT

The following portable fire fighting equipment or equivalent shall be provided:

(1) SCBA-self contain breathing apparatus- two sets
(2) Twelve (12) 30 Kg CO₂ with trolley
(3) Eight (08) 20 Kg Dry chemical trolley
(4) Eight (08) 20 Kg Foam trolley
(5) Fifty (50) 10 Kg CO₂ (Carbon Dioxide)
(6) Fifty (50) 10 Kg DCP (Dry Chemical Powder)
(7) Twenty five (25) 10 Kg Foam

The portable equipment offered shall be of a type for which replacement cartridges and dry powder refills shall be readily available locally.

13.6 FOAM BASED FIRE SUPPRESSION FACILITIES FOR FUEL TANK.

Foam based fire suppression facilities and equipment shall be installed as an appropriate manner to protect the Fuel Tanks.
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Communication Facilities
COMMUNICATION FACILITIES

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14. COMMUNICATION FACILITIES

14.1 GENERAL

The Contractor shall design, manufacture, deliver to the Site and install the following communication facilities:

a. Internal telephone system
b. Paging system

14.2 INTERNAL TELEPHONE SYSTEM

14.2.1 PRIVATE AUTOMATIC BRANCH EXCHANGE

The exchange shall be of a PABX type approved by the Ministry of Communications for connection to the public telephone network and installed with in the central control room of the power station.

The initial installed capacity shall be 10 exchange lines and 50 extension lines. The exchange shall be capable of expansion to a capacity of more than 20 exchange lines and 100 extension lines. A single operator's position shall be provided.

All internal telephone connections within the power station boundary shall be the responsibility of the Contractor including all facilities for the connection of this service within the building.

(1) Functions

The PABX system shall be provided with the following functions:

a. Extension to extension calls shall be made by direct dialling.

  Extension to exchange lines and PLC lines for dialling a single access digit shall make outgoing calls.

  Operator access from extension by dialling a single digit shall be required.

  Trunk barring on outgoing calls shall be provided as required on selected extensions.

  Provision for limited barring on outgoing calls from selected extensions shall be provided.

  Operator recall from an extension engaged with an incoming or outgoing call shall be effected by operation of a recall button followed by dialling the operator access digit.

  Call transfer between extensions on incoming and outgoing public ex-change calls shall be provided.

  Operator intrusion into an established call in order to offer an exchange call or urgent message shall be provided. An intrusion tone shall be introduced.

  i. Exchange alarms shall be extended to the operator's console or switchboard.

  ii. Six (6) extensions shall have a priority facility to intrude into extension to extension calls. An intrusion tones shall be introduced.
(2) Equipment to be provided shall include, but not to be limited:

a. A main distribution frame of sufficient size to accommodate the future expansion.

b. Automatic switching equipment.

c. Manual switchboard or console.

d. A necessary inters unit cabling and cables supports.

e. Concealed wiring to each office, workshop, administration building, etc. to accommodate a single instrument at each point.

f. 50 telephone instruments complete which will be connected at telephone points to be advised by the Ashuganj Power Station Company Ltd.

14.2.2 TELEPHONE FACILITIES

PABX telephones should be located as follows:

a. Control room (2)

b. Control package of Diesel Engine unit

c. Telephone cubicle (1)

d. Auxiliary room (1)

e. Office, Managers room, Workshop, etc. (Total 10)

f. Administration building, guard houses and other buildings (Total 25)

g. Spare Total: 50 Numbers

Land phone must be provided in Administration Building.

14.3 PAGING SYSTEM

14.3.1 GENERAL

The paging system, which shall consist of amplifiers, control equipment, handsets and speakers, shall be provided.

The system shall be provided with one channel.

14.3.2 FUNCTION

(1) Commanding Communication

Commanding and paging shall be made from any handsets through the local speaker sets.

(2) General Communication

When the other party answers the paging, general communication is established by releasing the page button. Simultaneous two-way conversations shall be possible on one same channel.

(3) Emergency Alarm

1,000 Hz alarm note shall be sound from all speakers by pushing the button located on the control panel and desk in the central control
14.3.3 EQUIPMENT

(1) Handset
Flush type : 5 sets
Indoor wall type : 12 sets
Outdoor wall type : 7 sets
Handsets installed indoors shall be of noise-proof type.

(2) Speaker Set
15 W outdoor type : 10 sets
5 - 10 W indoor type : 13 sets
All speaker shall be able to adjust their output.

(3) Amplifier Cubicle
All Silicon transistor amplifiers shall be mounted in the amplifier cubicle. The amplifiers shall be suitable for the driving of the above speakers all together and shall be divided into adequate capacity.

One set spare amplifier shall be furnished and it shall be put into operation automatically when the normal use amplifier fails.

(4) Control Panel
a. Relay Panel
Relays shall be provided for the starting and stopping amplifier and to establish the commanding talk from the handsets. The talking shall be indicated with a lamp on all handsets. The relays shall be of semiconductor static type or wire spring relay with sulphuric acid proof type.

b. Change-over Panel
When one set amplifier fails, the failed amplifier's circuit shall be transferred to the spare amplifier's circuit with relays. Manual change-over switch shall also be provided.

c. Amplifier Protection
Protection for the amplifier shall be provided according to the manufacturer's standard.

d. Test device
Ammeter for measuring the emitter current of each transistor and changeover switch and power source voltmeter shall be provided on the front of the panel. Red lamps for the indication of operation and orange lamps for the warming shall be provided on the front panel.

e. Terminal block
Terminal block shall be provided in order to connect the incoming cables from handsets and speakers.
14.3.4 LOCATIONS OF HANDSETS AND SPEAKER

The location of handsets and speakers will be advised by the Ashuganj Power Station Company Ltd. after award of the Contract.

14.4 COAXIAL CABLE

Coaxial cables shall be of stranded copper conductor (7/0.4 mm), solid dielectric coaxial type with polyethylene insulated, annealed copper wire braided and with PVC sheathed.

The electric characteristics at 20 deg. C shall be as follows:

- Dielectric strength (for 1 minute) : 6KV AC
- Insulation resistance : More than 10 M ohms / km
- Attenuation : 3.2dB/km at 300 kHz
- Impedance (nominal) : 77ohms at 300 kHz

Sufficient length of the coaxial cables and cords with all the necessary cable connectors shall be supplied to each station for making connections between the coupling capacitors and the coupling filters, the coupling filters and the line protective devices, and the line protective devices and the PLC telephone terminals.

14.5 POWER SUPPLY

The communication facilities to be furnished shall be operated by a 240 V, 50 Hz single phase AC (with UPS) and/or DC 50 V. These power supply facilities shall be provided by the Contractor.

DC 50 V system shall be designed and provided based on the following requirements:

(1) Battery

- Type of battery : Ni-Cd Alkaline.
- Capacity : Capable of loads continuously for five(S) hours without voltage dropping 90% of nominal voltage, but not less than 50 AH (5 hr rate).
- Number of cells : 48 cells.

(2) Battery Charger

- Type : Thyristor type with automatic voltage regulator, 240V single phase input.
- Capacity : 120% current of battery 5 hour rate charging current at minimum.
- Performance : Performance shall be same as these shown on Section 10.2 (3).
- Required Number : 1 set.

14.6 PLC System

The PLC System to be provided [extension from existing system] shall include all necessary equipment (such as PLC exchange, telephone sets, line extension etc.) and have to be matched with the system exists in the grid sub-station. The
existing PLC [Power Line Carrier] equipment shall be from ABB and PLC exchange of Siemens.

14.7 Electrical Protection, Communication and Instrumentation System

Separate Marshalling Kiosk shall be provided for Tele-metering terminal for future connection with SCADA. Communication, control, monitoring and voice channels shall be provided between the power station and PGCB’s National Control Centre in consultation with PGCB. Contractor shall collect information, design drawings and requirement from PGCB and install necessary system/equipment to meet National Load dispatch centre, PGCB requirements.

SCADA, communication, telemetry, fibre optical terminal and Tele-protection equipment to be supplied and installed by the contractor shall be compatible with National Load Dispatch Centre (NLDC) equipment and system of PGCB.

The contractor shall provide the following Tele-control facilities required at NLDC.

a. Control of the 230 kV CB, DS and reset for trip.
b. Indication of 230 kV switches position and trip relays activated.
c. Measurement of 230 kV MW, MVar and Voltage.
d. Alarm facilities in the event of any 230 kV tripping and protection.
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Maintenance Facilities
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15. MAINTENANCE FACILITIES

15.1 Overhead Electric Crane

15.1.1 SCOPE

The Contractor shall provide and install Overhead cranes for the power station requirement (where needed, such as in the engine room, maintenance hut or any other places), complete in all respects including longitudinal gantry structure, gantry rails, conductors, power supply, weather protection shed etc.

15.1.2 EXTENT OF SUPPLY

The equipment to be supplied by the Contractor under this specification shall include, but shall not be limited to, the following:

a. Capacity of the engine room main crane shall be sufficient enough to lift the weight of heaviest part/equipment during assembly or maintenance. Another auxiliary hoist of minimum capacity 10 ton shall be incorporated with main crane.

b. Sufficient sets of steel wire hoisting ropes

c. All integral electric cabling and wiring

d. All limit switches

e. One (1) set of gantry structure, gantry rails, girders, holding down bolts, securing plates, abutments, and weather protection shed.

f. One (1) set of power supply cables and trolley conductors complete with supporting brackets and one (1) set of power supply indication lamp.

g. One (1) alarm bell

h. All lifting eyes, rings and bolts to facilitate erection and maintenance

i. All catwalks, ladders, platforms and handrails to provide safe access to items requiring regular maintenance

j. Special tools required for the maintenance of the crane

k. All other equipment required for the safe and efficient operation of the crane

15.1.3 TYPE OF CRANE

The crane shall be of the semi-indoor and low speed overhead electric," travelling type equipped with single trolley, one (1) main and one (1) auxiliary hoist.

15.1.4 RATING

The rating of the crane shall be as follows:

(1) Hoisting capacity : Determined by the contractor as per the requirement of the plant

(2) Span :

(3) Lift :
(4) Speed
   a. Hoisting speed
      Main hoist : 
      Auxiliary hoist : 
   b. Trolley travel : 
   c. Bridge travel : 

(5) Operating power source
   and terminal voltage : 3 phase, 4 wire, 415 V AC, 50 Hz 

(6) Bridge travelling rail : 37 kg/m 

(7) Space limit of the crane : Determined by the requirement of the plant. 

15.1.5 REQUIREMENT FOR CHARACTERISTICS
   (1) The brake for hoisting shall be capable of stopping and holding 120% of the rated capacity. 
   (2) Deflection of bridge girder under load on main hook at the centre of the bridge girder shall not more than 1/500 of the span. 
   (3) The crane shall be capable of raising, lowering, holding and transporting the rated load without damage to, or excessive deflection of any crane parts. 
   (4) Operation of Hoists 
      Each hoist shall be controlled individually by the relevant controller equipped in the operator’s cab. 

15.1.6 REQUIREMENTS FOR MATERIALS
   (1) All materials used for the crane shall be new and conform to the latest revision of ISO or approved equivalent standards. 
   (2) Safety factors shall not be less than the following: 
      - Shaft and axles : 5.0 
      - Gears and pinions : 5.0 
      - Wire rope : 6.0 
      - Steel structure : 3.0 

15.1.7 STRUCTURAL DESIGN
   (1) Bridge and End Truck Frames 
      The bridge structures shall be of welded construction, but with all field connections designed for high-strength bolting. The various parts of the main structure of the crane shall be sub-assembled and the field connections reamed. 
      The end truck frames shall be either one-piece steel castings or built-up structural steel members. 
   (2) Trolley Frame 
      The trolley frame shall be fabricated from steel sections or cast steels and shall be designed to support the hoisting machinery.
(3) **Walkway and Ladders**

Steel safety tread walkways and ladders shall be provided to allow access to all parts of the crane for inspection, repairs and maintenance. Where required, cross walkways shall be provided, connecting walkways on opposite sides of the crane.

Walkways shall be at least 0.70 m wide and provided with a substantial toe-guard at least 0.10 m high and hand-railing not less than 1 m high over the entire length and ends. Ladders shall be provided where required for access between the walkways and operator's cab. The Contractor shall prepare access from the floor to the operator’s cab.

(4) **Operator's cab**

An operator’s cab shall be located on each crane and in such a manner as to allow maximum travel of the hooks and maximum visibility for the operator. The cab frame shall be fabricated from steel. All the enclosed walls of the cab shall be of transparent material.

The following controls shall be located inside of cab:

a. Manually operated controllers and master switches
b. Main air circuit breaker
c. Push - button switch for main contactor
d. Individual switches for lighting, warning signal, etc.
e. Volt meter for power source

15.1.8 **ELECTRICAL DESIGN**

The Contractor shall furnish and install all electrical equipment on the crane including all motors, electrically operated brakes, air circuit breakers, switches, contractors, controllers, resistors, control panels, relays, limit switches, trolley travel conductors, current collectors, transformers, complete lighting system, receptacles, conduit, wiring, cabling, insulators, anchors and other electrical equipment necessary for the safe and proper operation and control of the crane.

The Contractor shall also supply the main runway conductors, insulators, brackets and associated accessories.

The main power supply shall have a short circuit capability of 50 kA.

All electrical equipment shall conform to the appropriate IEC.

All motors, controllers, auxiliary apparatus and conduit shall be substantially grounded to the structural parts of the crane.

(1) **Motors**

All electric motors shall be of the wound rotor, drip-proof, protected type and tropicalized. They shall be in accordance with the latest edition of IEC Standard for crane motors.

(2) **Controller**

The controllers shall be readily accessible for maintenance and inspection purposes. The nominal 415 volts, three phase, 50 Hz power supply from the main collectors shall be controlled by
means of a suitable manually operated main air circuit breaker located in the operator's cab.

The main power supply breaker shall be identified by a nameplate instructing the operator to open the breaker when leaving the cab upon completion of work.

a. **Bridge and Trolley Travelling**

The travel motion of the bridge and trolley shall be controlled by the normal methods of acceleration, reversing and plugging the motor. Multi-pole contactors may be used.

Within limits of each required speed, the drive shall be controlled to provide substantially uniform speed regardless of load. The control shall include all necessary relays, timers, and limit switches required, for smooth and safe operation.

b. **Hoisting and Lowering Control**

The hoist drive shall be controlled to provide substantially uniform speed on each master switch step regardless of load.

(3) **Main Circuit Contactor**

A main circuit contactor shall be provided in common for main power supply circuit of main and auxiliary hoists, and for bridge and trolley travel.

The main circuit contactor shall be controlled manually by a push-button switch located in the operator's cab and it's control circuit shall have necessary interlocking circuit as follows, but not limited to these.

(4) **Master Switch**

The master switches for the main hoist, auxiliary hoist, trolley travel, and bridge travel shall be on the cam operated type, with a contact operating mechanism to ensure, positive operation of the contacts in both directions. Contacts shall be double break, spring-operated, readily renewable without disturbing the wiring and with automatically adjusting fingers to reduce wear.

(5) **Limit Switch**

Automatic reset, totally enclosed, heavy duty, adjustable limit switches shall be provided to limit the travel of the trolley and the bridge. The switches shall disconnect power supply to the motor when either the bridge or the trolley has travelled to within braking distance of its respective stop at either end of the travel. A warning signal, preferably a buzzer installed in the cab, shall alert the crane operator when the trolley approaches its stops. The signal shall be activated ahead of the trolley's limit switch.

(6) **Protective Panel**

All power circuits to motors and all secondary circuits such as lighting shall be placed in the panel. The panel shall also include all overload relays, low voltage control, and all other necessary equipment recommended by the Contractor.

(7) **Runway Conductors and Trolley Conductor**
The Contractor shall furnish the main runway conductors, insulators, support brackets, and all other necessary equipment required for installation. The Contractor shall also furnish and install the trolley conductors, insulators and accessories required for the complete operating system. The insulators shall be brown glazed porcelain insulators. The size of conductor shall not be less than 125 sq. mm solid copper.

(8) **Cabling**

All cabling, collector gear and power supply conductors required for the operation of the crane shall be supplied by the Contractor. The crane shall be capable of travelling the full length of the engine house area/equipment bay.

Support brackets, suitably insulated, shall be supplied by the Contractor for power supply conductors. Power cables and isolation switch for the supply to the power supply conductors shall also be supplied by the Contractor.

15.1.9 **GANTRY STRUCTURE, RAILS AND GIRDER**

The Contractor shall supply a set of gantry structure complete with weather protection shed, rails and girders holding down bolts and abutment plates located at the ends of each rail. Gantry rails and girders shall run over the full length of the engine house area/equipment bay and adequate allowance for thermal expansion shall be provided in the design. The structural steel shall be designed and fabricated conform to the Section 18.5.1.

The weather protection shed shall be provided to cover the working area of the crane. The material of the shed shall be corrugated asbestos cement sheet. The thickness of asbestos cement sheet shall not be less than 5 mm.

15.1.10 **SITE TESTS**

(1) **Control and protective equipment**

Static tests of all automatic sequences.

(2) **Running tests**

The assembled crane shall be load tested including overload test with a load equal to 125% full lifting capacity after erection by the Contractor and all tests shall be in accordance with the relevant IEC Standard.

The Engineer and the Ashuganj Power Station Company Ltd. shall witness these tests.

The Contractor shall supply all equipment including weights for the above tests. The Contractor shall also be responsible for the disposal of the materials used for the test load.
15.2 Mobile Crane

15.2.1 GENERAL

15.2.2 Types & Rating
Contractor shall supply a Mobile Crane (Rough Terrain Crane) of Minimum 50 ton capacity. One shall be able to reach the highest and least accessible parts of the plant and be able to handle any load from those parts. Another auxiliary hoist of capacity minimum 5 ton shall be incorporate with main hoist.

15.3 Tools

15.3.1 General
Special tools and equipment shall be supplied under this Contract and the Tenderer is required to give a full list with details in the Schedule of Tools and Appliances when submitting his Tender.

Each set of tools and appliances shall be provided with conveniently sized, robust, lockable boxes suitably inscribed with the name of the Plant for which they are to be used.

The tools and appliances with the boxes shall be handed over to the APSCL at the time of issue of the Taking Over Certificate.

15.3.2 SPECIAL TOOLS
Special tools means that type of tool which is fabricated/manufactured by the engine/generation/motor/breaker on its plant manufactures for its maintenance purposes which is not available in common market and which is dedicated for the said plant. The contractor will supply all the special tools required for the plant.

One set of special tools, gauges and equipment required for the normal maintenance of the whole of the Plant shall be provided by the Contractor.

One set of special lifting and handling appliances required for the normal maintenance of the whole Plant and equipment shall be provided by the Contractor.

Special tool list with unit price shall be submitted with offer.

15.4 HOIST/EOT
The hoist shall be of chain- block type and the capacity shall be selected taking into consideration of weight of object. The hoist shall be provided with the monorail, supporting materials for rail and anchor bolts. The hoists shall be installed in the following area, but not be limited to, for the convenience of maintenance [EDG etc.].

- Auxiliary compartment

15.5 Fork Lift
Contractor shall provide Two number of brand new Fork lifter of capacity one 10 ton & another 5 ton.
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16. TESTS AND INSPECTIONS

16.1 GENERAL

The Contractor shall perform all tests and inspections necessary to ensure that the material and workmanship conform to the Contract and design drawings. Those tests and inspections shall demonstrate that the equipment will comply with the requirements of this Specification and meet the specified guarantees.

The Ashuganj Power Station Company Ltd. and the Engineer shall have a right to access the Contractor or sub-Contractor's works to determine or assess compliance with the provisions of this Specification or to witness the Contractor's inspections or tests.

The contractor shall supply to the Ashuganj Power Station Company Ltd. as soon as practicable which shall contain details of each test performed and shall be prepared as required by the Ashuganj Power Station Company Ltd., records, results and calculation of all electrical tests shall be provided.

16.2 WORKSHOP TEST

(1) All plant shall be subjected to type, sample and routine tests at the manufacturer's factory in accordance with these clauses and conditions of the Contract.

(2) Type, sample and routine tests shall be to the relevant ISO and IEC Standards or other approved international standards for equipment where the test requirements are not specified in these clauses.

(3) The Contractor may offer type test results for identical equipment in lieu of the type tests specified, in which case the Ashuganj Power Station Company Ltd. may waive the specified type tests. If type test results for identical equipment are offered in lieu of the specified type tests, the Contractor shall also provide evidence as to the similarity of the equipment tested and the Contract equipment.

(4) The Contractor shall submit evidence to the Ashuganj Power Station Company Ltd. & Engineer that the instruments used for the testing shall have been calibrated at an approved testing laboratory within a period of up to six months for a portable instrument and twelve months for a fixed instrument.

16.2.1 Engine Generating Sets

The engine generating sets shall be assembled as a complete unit and run under simulated operating conditions at the manufacturer's works. The units shall be tested to ensure smooth running and satisfactory operation of the accessories. Necessary tests shall also be performed for EDG as per relevant standard.

The Contractor shall state in his proposal the performance and reliability tests to be carried out in the works. The Contractor shall give the Ashuganj Power Station Company Ltd. & Engineer notice of the tests at least six (6) weeks in advance. The tests to be carried out shall include, but not to be limited, the following:

a. Dynamic balancing together with over-speed tests

b. Bench testing of all accessories

c. No load operation of the assembled units to test the followings among others:
- Vibration
- Lubrication system
- Fuel system
- Jacket temperature
- Exhaust temperature
- Governor system
- Temperature control system
- Air system
- Over-speed trip
- Water system
- Individual accessories

**16.2.2 GENERATOR**

Each generator shall be operated at no-load on the factory test floor with the following observations and respective data so reported and reference to IEC Standard shall be made:

b. Mechanical inspection and balance.
c. No-load field current at rated voltages and frequency.
d. Voltage phase balance and phase sequence.
e. Dielectric tests.
f. Insulation resistance of field and armature.
g. Standard no-load and short circuit tests.
h. Characteristic "V" curve test and efficiency tests.
i. Generator fixed losses.
j. Generator variable losses (at loads available with driving motor).
k. Measurement of vibration
l. Temperature rise test

**16.2.3 EXCITER**

Each exciter shall be operated at no-loads on the factory test floor with the following observations and respective data so reported and reference to IEC Standard should be made:

a. Saturation run.
b. Mechanical balance.
c. Resistance.
d. Dielectric tests.
e. Insulation resistance of windings.
f. Exciter characteristics tests
16.2.4 STEP-UP TRANSFORMERS

The transformers shall be completely assembled at the factory and shall be subjected to the following tests by the Contractor, in accordance with the latest revisions of IEC 76 "Power transformers" and 551 "Measurement of transformer and reactor sound levels".

a. General inspection
b. Measurements of Winding resistance
c. Voltage ratio measurement and check of polarity
d. Measurement of impedance voltages
C. Measurement of load loss
f. Measurement of no-load loss and current
g. Test of temperature rise
h. Induced over-voltage withstand test
i. Separate-source voltage-withstand test
J. Insulation resistance measurement (megger)
k. Results of shop tests to be submitted.
   - Results of type tests of lightning impulse-voltage withstand test
   - Test of protective relays
   - Characteristic test of bushing type current transformers

16.2.5 230 kV SWITCHGEAR EQUIPMENT

(1) Circuit Breakers

The tests shall be performed in accordance with the latest revisions of IEC 56-4 'High-voltage alternating-current circuit breakers, Part 4: Type tests and routine tests'.

- General inspection
- Insulation resistance measurement
- Dielectric withstand voltage test
- Operation test

In accordance with the requirements of IEC 56, details of the transient recovery voltage to which the circuit breaker will be subjected during short circuit testing shall be submitted to the Ashuganj Power Station Company Ltd. for approval.

The Ashuganj Power Station Company Ltd. may require in addition any of the following tests to be carried out, the details of which will be agreed between the Ashuganj Power Station Company Ltd. and the Contractor:

- Earth fault interruption tests
- Out of phase switching tests according to IEC 267
- Capacitance switching tests
- Small inductive breaking current switching tests
- Tests under environmental conditions
- Voltage withstand test after breaking capacity tests
(2) **Isolators (Disconnecting Switch) and Earthing Switch**

The tests shall be performed in accordance with the latest revisions of IEC 129 "Alternating current disconnectors (isolators) and earthing switches".

- General inspection
- Insulation resistance measurement
- Dielectric withstand voltage test
- Operation test

(3) **Current Transformers**

The test shall be performed in accordance with the latest revisions of IEC 185 "Current transformers".

- General inspection
- Polarity test
- Insulation resistance measurement
- Dielectric withstand voltage test
- Characteristic test

(4) **Voltage Transformers**

The test shall be performed in accordance with the latest revisions of IEC 186 "Voltage transformers"

- General inspection
- Polarity test
- Insulation resistance measurement
- Dielectric withstand voltage test
- Characteristic test

(5) **Lightning Arresters**

The test shall be performed in accordance with the latest revisions of IEC 99-1 "Lightning arresters, Part 1: Non-linear resistor type arresters for AC system".

- General inspection
- Power frequency spark-over voltage test
- Lightning impulse spark-over voltage test
- Measurement of leakage current and insulation resistance

(6) **Steel Structures**

General inspection

Material quality and quantity check

(7) **Bus Support, Insulators and Wiring Materials**

The following shop tests shall be performed by sampling inspection method and number of samples for the test shall be decided after award of the Contract.

a. **Bus Supports**
- General inspection
- Dielectric test of power frequency
- Tension proof test

b. **Insulator Assemblies and Grounding Wire Attachment**
- General inspection
- Dielectric test of power frequency
- Breakdown test of insulator
- Dimension measurement of hardware
- Tension proof test

c. **Stranded Conductors for Overhead Line and Grounding System**
- General inspection
- Tensile strength test

d. **Other Materials**
- General inspection

16.2.6 **CONTROL AND PROTECTION SYSTEM**
The following tests for the control and protection system shall be performed at the workshop.
- General inspection
- Measurement of insulation resistance
- Dielectric withstands voltage test
- Performance test of relay Error test of meter
- Sequential operation test of Control & Protection System.

16.2.7 **OTHER MATERIALS AND EQUIPMENT**
All other materials and equipment shall be tested at the Contractor's workshops in accordance with latest IEC, ISO, other approved international Standard and/or the request of the Ashuganj Power Station Company Ltd.

16.3 **TESTS AT SITE**

(1) **Responsibility for Tests**

a. The Contractor shall conduct the tests at the Site in accordance with these clauses and the conditions of the Contract.

b. The Contractor shall provide all equipment and personnel required to carry out the tests, including the provision, installation and removal of all test instruments, the connection and disconnection of plant items and obtaining of all records. The Ashuganj Power Station Company Ltd. will provide electricity, fuel and water required for the tests on completion without charge to the Contractor.

c. The Contractor shall prepare and submit to the Ashuganj Power Station Company Ltd. at least three months prior to the commencement of testing, schedules in approved format for each test together with a program
provided by all Contractors. Contractor shall ensure safety control of tests. The Ashuganj Power Station Company Ltd. & the Engineer shall coordinate for the tests.

d. The Contractor shall submit one copy of the results of each of the tests at the Site to the Project Director within one week of the tests being carried out. Four copies of the certificates shall be provided to the Ashuganj Power Station Company Ltd. within one month of the tests being carried out.

e. The APSCL’s staff will observe and participate in the tests on completion.

f. The Contractor shall submit evidence to the Ashuganj Power Station Company Ltd. that the instruments used for the tests have been calibrated at an approved testing laboratory within a period of up to six months.

(2) Scope of Tests

The tests to be carried out and passed before taking over of the works by the Ashuganj Power Station Company Ltd. shall be deemed to comprise two main stages of testing as follows:

a. Preliminary tests which are tests performed prior to rotation or energising at normal voltage or admission of normal water or air pressure to the main or auxiliary plant under test.

b. Tests on completion which are tests to progressively prove the correct operation of complete auxiliary systems and of the main plant items. These tests shall be carried out in accordance with the conditions of the Contract.

(3) Reliability Test Period

a. The tests on completion shall include a reliability test period for all generating units and auxiliaries, which shall commence when the Contractor has notified the Ashuganj Power Station Company Ltd. that the plant is ready for commercial operation. During this period, the plant and auxiliaries will be required to operate under the working conditions of the station, within their operating limits, continuously as required by the operation of the station, without failure or interruption of any kind for a period of one hundred sixty eight (168) hours. The units will be operated by the Contractor’s Engineer/Staff. The Contractor may make minor adjustments to the units, provided that such adjustments do not in any way interfere with or prevent the commercial use of the units by the Ashuganj Power Station Company Ltd. or result in reducing the output or efficiency.

b. Should any failure or interruption occur in the operation of the units due to faulty design, materials or workmanship under the Contract but not otherwise, sufficient to interrupt the commercial operation of the units, the reliability test period of one hundred sixty eight (168) hours shall recommence after the Contractor has remedied the cause of the defect.

16.3.1 TESTS ON COMPLETION

(1) The Contractor shall give to the Ashuganj Power Station Company Ltd. in writing twenty one (21) days' notice of the date after which he will be ready to make the tests on completion. Unless otherwise agreed, the tests shall take place within ten (10) days after the said date, on such day or days as the Ashuganj Power Station Company Ltd. shall in writing notify the Contractor.

(2) If, in the opinion of the Ashuganj Power Station Company Ltd., the tests
are being unduly delayed he may by notice in writing call upon, the Contractor to make such tests within ten (10) days from the receipt of the said notice and the Contractor shall make the said tests on such day within the said ten (10) days as the Contractor may fix and of which he shall give notice to the Ashuganj Power Station Company Ltd.. If the Contractor fails to make such tests within the time aforesaid the Ashuganj Power Station Company Ltd. may himself proceed to make the tests. All tests so made by the Ashuganj Power Station Company Ltd. & the Engineer shall be at the risk and expense of the Contractor unless the Contractor shall establish that the tests were not being unduly delayed in which case tests so made shall be at the risk and expense of the Ashuganj Power Station Company Ltd.

(3) The Ashuganj Power Station Company Ltd. except where otherwise specified, shall provide free of charge, such as fuel, water, as may be requisite and as may be reasonably demanded to carry out such tests efficiently. However all the calibration devices, standard or sub-standard special test instruments, stores, apparatus etc., required to conduct all the tests would be provided, arranged and installed by the Contractor at his own cost and expenses. The Contractor will pay all expenses including the custom duties etc. on the import or export of all such instruments etc.

(4) If any portion of the works fail to pass the tests, tests of the said portion shall, if required by the Ashuganj Power Station Company Ltd. or by the Contractor, be repeated within a reasonable time upon the same terms and conditions save that all reasonable expenses to which the Ashuganj Power Station Company Ltd. may be put by the repetition of the tests shall be deducted from the Contract price.

16.3.2 FIELD INSPECTIONS AND TESTS ON ENGINE GENERATING UNITS

The following field inspections and tests will be carried out in the sequence detailed below, and the successful performance and completion of all the tests taken together shall constitute the APSCL's acceptance tests:-

(1) Inspection and Checking of Units

After completion of erection and/or installation, and before put into operation, each unit and all its appurtenances (engines, generators, motors, pumps, heaters, fans, piping, valves and all other mechanical and electrical equipment and material) shall be thoroughly cleaned and then inspected under the supervision of the Engineer and in presence of the APSCL's Engineer for correctness and completeness of installation and acceptability for placing in operation. Contractor shall ensure APSCL’s Engineer signature on inspection sheet as a witness. The time consumed in the inspection and checking of the units shall be considered as a part of the erection and installation period.

(2) Start-up and Trial Operation

Following the satisfactory completion of the inspections and checking of Diesel Engine units, the same will be placed in trial operation during which all necessary adjustments, repairs etc. shall be made as required, then the unit being shut down as required. When the
equipment is operating properly its characteristics shall be recorded on the start-up report sheets. Start-up reports for all the equipment must be completed before the start of the initial commercial operation period.

The time consumed in start-up and trial operation shall be considered as a part of the erection and installation period.

The following test shall be carried out.

- Start-up mechanical running test, adjustment of engine air intake/fuel injection valves control and interlocking, etc. The measured data such as pressure, temperature, vibration, adjustable speed range etc. shall be observed and recorded.
- Checking of cooling system and lube oil system.
- Checking of over-speed tripping devices, protection and interlocking system, start-up and shut-down sequence of auxiliary system.
- Noise, NOₓ, SOₓ and vibration level measurement.
- Manual and automatic synchronization.
- Generator Protection relay testing.
- Checking of base load and peak load capability.
- Load rejection and governor tests.
- Testing of start-up times.

On the completion of Start-up and Trial operation Ashuganj Power Station Company Ltd. & Engineer will instruct cycling operation, shutdown and start-up during the next few days. After satisfactory completion of these observations, plant shall be considered to have been put on Performance Test.

3 Performance Tests

Performance tests shall be run to determine whether the equipment complies with the guarantee provided that unit is made ready for performance test by the Contractor and certified by Ashuganj Power Station Company Ltd. & Engineer. The tests shall be conducted in accordance with the latest ISO or ASME Performance Test Codes applicable for Engine Generating Sets (HFO fired) using previously approved correction curves and complying with the following special conditions unless otherwise specified. The chemical analysis and lower heating values of the fuels shall be determined from two laboratories to be chosen respectively, one by the APSCL, the other by the Contractor.

The APSCL shall provide without charge such as fuel and water as may be reasonably required to conduct the performance and acceptance tests. The gross station efficiencies under different load conditions established during an eight (08) hours continuous test shall be calculated in a manner as approved by the APSCL. Power measurements at HT/Secondary side of the step up transformer and at the incoming circuit of unit motor control centre shall be made with totalising meters.

Generator power output shall be held as constant as possible during
the performance test.
The Engine generator shall run at 25%, 50%, 75% and 100% of base rating and peak load prior to placing the unit into commercial operation and to prove that sudden load rejections from loads up to maximum capability can be accommodated by the engine without the speed rise being sufficient to cause the over-speed trip to initiate.

The output and heat rate tests will be carried out on each unit in the following manner:

i) 1/2 hour at 1/4 load
ii) 1/2 hour at 1/2 load
iii) 1 hour at 3/4 load
iv) 6 hours at full load

Full load at the generator terminal for the purpose of the test will be calculated from the guaranteed output according to the site ambient installation conditions.

Correction factors for variations of test conditions from the specified design conditions shall be stated in the Tender.

Performance Test should be done before Reliability Run Test.

(4) Reliability Run Test and Acceptance

The Contractor shall be responsible for running on Reliability Run Test period at the Site, including all auxiliaries and controls for the Plant. The Contractor shall operate the units at various loads as specified by the Ashuganj Power Station Company Ltd. after synchronising the system.

The Reliability Run Test shall start on the specified date and shall last for one hundred sixty eight (168) hours during which time the plant and auxiliaries will operate continuously, uninterrupted without adjustment or repair to the satisfaction of the Ashuganj Power Station Company Ltd. & Engineer at all loads up to and including the maximum loads.

During Reliability Run Test BPDB Dependable Capacity Test Witness Committee will witness the plant reliability test for at least six (6) hours at any time during 168 hours test period. After successful completion of Dependable Capacity Test as well as the Reliability Run Test BPDB will declare COD of the plant.

The plant will be accepted by APSCL after successful completion of both performance & Reliability Run Test. After submission and acceptance of test reports by APSCL test witness committee, PAC will be issued.

(Note: 75% and 50% load of the plant means aggregate of 75% and 50% load of individual Engines.)

(5) Test Reports

The Contractor shall submit to the Ashuganj Power Station Company Ltd. within three (3) months after the signing of the Contract, the detailed procedure for the conductance of the performance and acceptance tests for approval.
The procedure shall include the following for such test or group of tests:

a. The time duration of each test at each load.
b. The number of test runs at each load.
c. The sequence of the tests to be conducted.
d. A list of instruments that will be used for each test.
   The list shall designate which instruments are:
   i) Special test instruments
   ii) Certified
   iii) To be calibrated before and after each test
   iv) Check instruments
   v) Station supply instruments.
   Schematic diagrams showing all test points and cross references to the instrument list shall also be included.
e. All formulas, calculations, conversion factors, curves, correction curves, etc., to be used in the conductance of the tests and the calculations of the test results.
f. Sample test reports or data sheets and all specific result sheet forms that will be used for the test.
g. Written procedure and description of conducting the test.
h. All test data to be recorded by the Contractor and the Ashuganj Power Station Company Ltd. & Engineer.

Necessary tests shall also be performed for EDG as per relevant standard.

16.3.3 FIELD INSPECTIONS AND TESTS ON SWITCHGEAR EQUIPMENT

The following site tests shall be performed by the Contractor.

(1) Protection, Control, Alarm, Measurement and Indication Equipment

a. Wiring

Insulation resistance test using 500 V Megger shall be carried out on all AC and DC protection, control, and alarm and indication circuit.

The insulation of all circuits shall be checked before proceeding with other tests and it is also essential that all AC wiring is correctly connected relay contacts, auxiliary contacts, etc., being closed, as necessary, to verify this. Checks shall be made on cable glands, cable jointing, fuse or circuit breaker and small panel items, such as indicating lamps. Static equipment which may be damaged by the application of test voltage shall have the appropriate terminals short circuited. Inter relay, inter unit and cubicle wiring carried out at the Site shall be checked to the appropriate circuit and/or wiring diagram.
Where, it is found necessary during pre-commissioning work to effect site modifications to the secondary wiring, site copies of the appropriate schematic and wiring diagrams shall be suitably marked as agreed with the Ashuganj Power Station Company Ltd. before the circuit is commissioned.

Loop resistance measurements shall be made on all current transformer circuits. Separate values are required for current transformer circuits.

b. Mechanical Check

All relays shall be examined to ensure that they are in proper working condition and correctly adjusted, correctly labelled, and the relay case, cover, glass and gaskets are in good order and properly fitting.

c. Secondary Injection

Secondary injection shall be carried out on all AC instruments and relays, using voltage and current of sinusoidal waveform and rated power frequency.

(2) Current Transformer Magnetising Tests

The magnetisation characteristic of all current transformers shall be checked at the minimum of two points to identify the current transformers with reference to the manufacturer's estimated design curve, and to determine the suitability of the current transformer for its intended duty. It may be noted that it is not normally necessary to check the characteristic up to the knee-point for this purpose. Special measures may have to be taken to ensure that the core is fully de-magnetised before commencing the test.

a. Primary Injection

Primary current injection tests shall be carried out by the Contractor. The primary injection methods employed for a particular installation shall therefore be agreed with the Ashuganj Power Station Company Ltd.

Tests shall be carried out as follows:

- Local primary injection to establish the ratio and polarity of current transformers of similar ratio.
- Overall primary injection to prove correct inter-connections between current transformer groups and associated relays.
- Fault setting tests to establish, where practicable, the value of current necessary to produce operation of the relays. If not practicable, these tests are to be carried out by secondary injection applied at the wiring close to the current transformer.

(3) DC Operations

Tests shall be carried out to prove the correctness of all DC polarities, the operating levels of DC relays and the correct functioning of DC relay schemes, selection and control switching, indicating and alarms.
(4) **On Load Tests**

In view of the hazards inherent in these tests, they shall be carried out under the direct supervision of the Ashuganj Power Station Company Ltd. & Engineer.

An operation and stability test shall be carried out for on load commissioning of unit type protection.

Test for restraint shall be carried out to prove the characteristics of protective systems with directional/differential characteristics.

On load checks shall be made after the protection gear has been placed in service to ensure that all connections and test links have been replaced and test leads removed, as well as to confirm the integrity of the current transformer circuits. Where necessary voltage readings shall be taken at the terminals on each relay & meters to ensure that loop connections between the relays & meters are complete. Special attention shall be paid to broken delta voltages and residual current circuits where zero voltage or current respectively may not be proof of the completeness of the circuit.

(5) **Step-up Transformers**

a. General mechanical checks.

b. Core and winding insulation tests.

c. Ratio and HV magnetizing current tests.

d. Vector group check.

e. Motors overload protection tests.

f. Buchholz device tests.

g. Temperature instrument calibration and tests.

h. Operational tests on tap change equipment.

i. Dielectric strength tests of insulation oil.

The above tests shall be recorded on approved test sheets, two signed copies of which shall be forwarded to the Ashuganj Power Station Company Ltd. immediately after a test or series of tests has been completed.

The Ashuganj Power Station Company Ltd. & Engineer shall countersign the test sheets if found to be satisfactory and retain one copy. The Contractor shall provide to the Ashuganj Power Station Company Ltd. six bound copies of all site test sheet as final records.

(6) **230 kV Switchgear**

a. **General Check**

A general check of all the main switchgear and ancillary equipment shall be made and shall include a check of the completeness, correctness and condition of earth connections, arcing ring and horn gaps, painted surfaces, cables, wiring, pipework, valves, blanking plates and all other auxiliary and ancillary items. Checks shall be made for oil and
gas leaks and that insulators are clean and free from external damage. A check shall be made that loose items which are to be handed over the ASHUGANJ POWER STATION COMPANY LTD., e.g. blanking plates, tools, spares, are in order and are correctly stored or handed over.

b. Circuit Breakers

Following completion of erection of circuit breakers and all high voltage circuits, power frequency withstand voltage test at a level to be agreed shall be applied.

Local air components associated with pneumatic operation, including air compressors, shall be tested and air loss measurements and pressure and alarm settings checked. Tests shall be made also on mechanical and hydraulic operating systems.

Contact resistance tests shall be carried out with not less than 15 amperes passing through the contacts. In the case of multi-interrupter circuit-breakers, resistance tests will be required at each interrupter or pair of interrupters as well as through the series of interrupters on each pole.

Operational tests will include local and remote trip/closed. SF6 gas type circuit-breakers testing shall be required on the gas system to prove the gas quantity, its dryness and its dielectric strength. The gas leakage shall also be measured.

c. Isolators (Disconnecting switch) and Earthing Switches

Manually operated equipment shall be subject to operational tests to confirm contact pressures, contact resistance, synchronism of operation of all phases and the ease of operation.

Checks shall be made of the local and remote indications and operation of auxiliary contacts.

Motorised equipment shall be tested to prove the motor operation, including local and remote operation. Timing tests shall also be carried out.

Earth switches and maintenance earthing devices shall be tested to confirm the opening and closing sequences and checks shall be made on the earth mat, indications and manual locking devices.

d. Capacitive Voltage Transformers

All Capacitive voltage transformers shall be checked for polarity phasing, accuracy class and for secondary output.

e. Current Transformers

All current transformers shall be checked for polarity phasing, accuracy class and for secondary output.

f. Lightning Arresters

General inspection shall be carried out to verify the condition and satisfactory mounting of the arrester and its earth
connections and electrodes.

(7) **Interlocking**

All interlocking arrangements both electrical and mechanical shall be fully checked and tested.

(8) **Earthing System**

Tests shall be made on the effectiveness of the bonding and earthing which will include conductivity tests on selected joints, on the main earthing system, and at the connections to equipment and structures. Checks shall also be made on precautions taken to avoid corrosion attack on the earthing system.

(9) **Others**

All other equipment and/or systems shall be tested in accordance with the instruction by the Ashuganj Power Station Company Ltd.

16.4 **ACCEPTANCE AND INTERIM OPERATION**

(1) After the performance tests, if the equipment supplied by the Contractor is found to meet the guarantees and any other specified requirement, and if all other work called for hereunder has been completed, the APSCL’s acceptance will be forthcoming. This acceptance shall, however, not relieve the Contractor of his responsibility for first inspection.

Should the equipment furnished by the Contractor fail to operate as required, or in case of failure to meet any of its guarantees, the APSCL shall have the right to operate the equipment, using the Contractor’s supervisory operating personnel, until such defects have been remedied and guarantees met with. In the event that defects necessitate to the rejection of the equipment or any part thereof, the Ashuganj Power Station Company Ltd. shall have the right to operate the equipment until such time as new equipment is provided to replace the rejected equipment. Such operation shall not be deemed an acceptance of any equipment.

16.5 **FIRST INSPECTION**

16.5.1 **RESPONSIBILITY DURING GUARANTEE PERIOD**

The Contractor shall be responsible for operation during the period commencing with initial start-up and extending through trial operation and all performance tests. The Contractor shall also be solely responsible for two (2) years operation and maintenance of the plant after satisfactory performance test by providing sufficient number of supervisory Engineers/staff. During the trial operation period, the Contractor will furnish the supervisory operating personnel; In addition, any calibration device, special test instruments, etc., required preparing for and conducting the performance tests.

The training programme of APSCL's personnel shall be conducted to meet the satisfaction of the APSCL & Engineer. The Contractor shall provide the service of competent personnel knowing English language to assist/ train-up the APSCL’s Engineers and staff.

16.5.2 **FIRST INSPECTION/ OVERHAULING**

The first Inspections/Overhauling after the completion of recommended
hours of operation shall be undertaken by the Contractor and the charges on this account including all corrections, repairs and replacements made by him shall be entirely at his own cost.

For the first inspection/Overhauling the Contractor will provide the supervisors with special tools and the Ashuganj Power Station Company Ltd. will provide ordinary labour, normal tools, mobile crane with driver under the responsibility of the Contractor. Fuel, lubricants and wages for the local staff for crane will be paid by the Contractor.

First inspection/ Overhauling will in any case be carried out before expiry of the warranty period of twenty four (24) months, according to a programme to be mutually agreed between the Contractor and the Ashuganj Power Station Company Ltd. The scope of first inspection will include, but will not be limited to, the item listed. The cost of this inspection/overhauling will be included on the cost of spares and services of warrantee period.
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17. **CIVIL WORKS**

17.1 **GENERAL**

The General Conditions, Tender Drawings and Schedules shall be read in conjunction with this Specification. Matters described in one are not necessarily repeated in the others.

17.1.1 **GENERAL REQUIREMENTS**

The Tenderer's proposal shall cover all requirements of the Tender Documents and any other items not specifically mentioned but which are deemed to be necessary for the satisfactory design, supply of materials, construction, and supervision of the civil works on the basis of a turnkey contract.

The Contractor shall upon examining the design of the foundations and major structures, develop and prepare the detailed design and the construction drawings of all civil structures for the approval of the Ashuganj Power Station Company Ltd. which shall meet the equipment and structures specification, to be supplied by the Contractor for the Project.

The Ashuganj Power Station Company Ltd. shall reserve the right to examine the Contractor's design and to instruct a change or modification by the Contractor.

These modifications shall be carried out by the Contractor without additional cost as a result of any claims made by the Contractor on the Ashuganj Power Station Company Ltd.

Approval of the design by the Ashuganj Power Station Company Ltd. shall not relieve the Contractor of liability for the construction works.

The Tenderer shall familiarise himself with the site levels, subsoil and other data necessary to enable him to estimate the bearing capacity and foundation requirements, for use in the preparation of his tender.

It is the Contractor's entire responsibility to search for filling material for land reclamation work and to make all arrangements necessary for the satisfactory completion of the land reclamation work within the Project. His tender shall include for all local eventualities.

The Tenderer shall quote firm prices which shall remain valid throughout the Contract Period on all items in the Price Schedule unless other-wise stipulated.

17.1.2 **TOPOGRAPHIC SURVEYS**

The Contractor shall carry out surveys as are necessary for the proper design and execution of the Works. The results of such additional surveys together with the survey drawings shall be submitted to the Ashuganj Power Station Company Ltd. for approval.

17.1.3 **SITE INVESTIGATION**

The Contractor may conduct soil investigation if deemed necessary at his own cost before submission of the bid. However, after signing of contract, a detailed soil investigation, and analysis to determine the soil liquefaction potential of the power plant site, shall be carried out by the Contractor. The underlying sub-soil of the power plant site shall not be susceptible to liquefaction under earthquake conditions following treatment, if required,
after detailed soil investigation remedial measure have to be carried out by the Contractor.

The scope of the Contractor’s geotechnical investigation programme shall comprise machine drilled boreholes supplemented with Cone Penetration Tests (CPT) to sufficient depth to determine overall ground conditions and founding depths for piled foundations. The number and extent of boreholes and CPTs’ shall be sufficient to accurately determine ground conditions across the site, and under all major structures (including the retaining wall along the river edge). Standard Penetration Tests (SPT) shall be performed in all boreholes, and piezometers shall be installed in sufficient boreholes to assess groundwater levels, and their seasonal variations.

It is anticipated that the following will be the minimum geotechnical investigation program by the Contractor:

- Boreholes, a minimum of 40 m deep
- Geophysical tests in the above boreholes
- Piezometers
- Cone Penetration Tests to refusal
- Standard Penetration Tests in all boreholes

Laboratory testing consisting of at least; classification tests, particle size distribution (grading curves), moisture contents, densities, Atterberg Limits, consolidation tests, triaxial compression tests, compaction tests, mica content, groundwater chemistry, soil electrical resistivity, and soil chemistry.

The laboratory testing shall also be sufficient to determine all of the parameters needed for the design of foundations, and the assessment of settlements, stability, soil liquefaction and lateral spread potential, vibration effects on adjacent facilities, etc.

The data, results, and conclusions from this geotechnical investigation programme shall be collated in a “Geotechnical Factual Report” for review by the Employer. The report shall also include recommendations on foundation types and foundation design parameters, assessment of short and long term settlements, and an assessment of the potential of the soils to liquefy under a range of earthquake accelerations, or vibration from the plants rotating machinery.

**17.1.4 SITE LABORATORY**

The Contractor shall provide a site laboratory with a concrete floor space of not less than 4m x 10m adequately equipped to carry out quality control tests of material and workmanship in accordance with the procedures and tests as described in the relevant ASTM Standard or other approved Standard. He may as an alternative to the provision of laboratory equipment, make arrangement for all necessary tests to be carried out by personnel with relevant experience from an approved laboratory.

**17.1.5 RECORDS AND DRAWINGS**

The Contractor shall keep at the Site accurate and up-to-date records and drawings of the Works, and shall submit these records to the Ashuganj Power Station Company Ltd. at the end of every week. Such record shall include the amount of labour, plant and materials employed upon the Site during that week.
17.1.6 SAMPLES, TESTING AND INSPECTION

The Ashuganj Power Station Company Ltd. may request at any time to test or inspect sample of material and workmanship proposed and the Contractor shall furnish these immediately. When the Ashuganj Power Station Company Ltd. & Engineer has approved the samples, material, and workmanship not corresponding in quality and character with the samples approved shall be rejected. The costs of all sampling and testing to be conducted either on the Site or in an approved laboratory shall be borne by the Contractor.

17.1.7 STANDARDS AND CODES OF PRACTICE

The Civil Works shall be designed and constructed in accordance with the Specifications, relevant Standards and Codes of Practice of Bangladesh National Building Code. The Contractor shall submit together with his bid a schedule of standards and codes of practice to be followed in the design and construction of the Works. Copies of these codes and standards shall be made available to the Ashuganj Power Station Company Ltd. & Engineer during the design and construction period. In the case of the Standards and Codes not published in English, the Contractor shall obtain English translations when required and send them to the Ashuganj Power Station Company Ltd..

The Contractor shall be responsible for the establishment of design parameters to satisfy the requirement of the project.

Basic design conditions shall be as follows:

a. For Seismic horizontal ground acceleration: 0.28g
b. Design Storm: Based on frequency-intensity Duration curves prepared for 6h
c. Wind velocity: 204 km/hr
d. Design load for road: H-20 (AASHTO)
e. Standards and codes of practice: ASTM, ACI, and inter-national codes of practice and other Standards to be approved by the APSCL.

17.1.8 PREPARATION OF DESIGN AND DRAWINGS

The Contractor shall prepare all designs and detailed working drawings as deemed necessary for the execution and completion of the Works.

The Contractor shall be responsible for ensuring that the design satisfies the requirements of all local and national authorities. Design calculations shall be in accordance with an approved method and should take into account the most critical combination of dead load, wind load, and seismic load. Design calculations and detailed drawings shall be submitted to the Ashuganj Power Station Company Ltd. for approval. The Contractor may commence construction on the Site only after drawings are approved by the Ashuganj Power Station Company Ltd. & Engineer.

17.2 SCOPE OF CIVIL WORKS

The civil works shall include collection of site data, detailed design, production of working drawings, provision of labour, supply of construction plant and materials,
construction and rectification of defects during the Warranty Period of the Works.

The Scope of Work shall include, but not be necessarily limited to, the following:

a) Site Works: Site clearance, excavation and filling of the Site to formation level (Site development up to same level of existing power plant) including running surplus excavated materials to disposal area, sheet piling work, site roads and surfacing, water supply, sewage treatment cable ducting, pipe ducting, drainage, landscaping, fencing, boundary wall and gates. The elevation of the finished ground level (FGL) shall not be less than 8.90 m PWD. The elevation of finished floors, concrete slabs and foundations shall be minimum 0.2 m above the finished ground level

d) Slope and Streambed Protection:

The contractor shall provide necessary river bank protection for the project area. This work shall consist of the provision and installation of protection for stream banks, riverbanks, embankment slopes, cut slopes and other surfaces composed of erodible materials where protection is desired. Generally, protection to slopes will form an impervious layer constructed in or on designated surfaces and shall have at its bottom and ends anti-scour devices, such as cut-off walls or toe walls. Protection to the riverbanks shall form a graded aggregate scour protection

Riprap Protection to Slopes: Stone for riprap shall consist of stone boulders of suitable size and shape. The stone shall be dense, resistant to the action of air and water, and suitable in all other respects for the purpose intended. Alternatively concrete blocks manufactured from stone chips maybe used, the minimum thickness of stone shall be 100 mm (measured perpendicular to face of riprap). No face dimension shall be less than the thickness of the stone. Unless otherwise specified, the stones shall weigh not less than 10 kilograms each. The minimum thickness of the concrete block shall be 600 mm with a weight not less than 20 kg, with the concrete being Class B manufactured in accordance with Section 17 of the Specification

Protection to River Bank:

The following materials shall be used:

- Coarse gravel with sizes ranging from 5 - 40 mm and of approved grading.
- Cobblestones with sizes ranging from 50 - 100 mm and of approved grading.
- Boulders with sizes ranging from 100 - 200 mm.

The soundness of gravel and stones shall be approved by the Engineer.

The boulders shall be dense, resistant to the action of air and water and suitable in all other respects for the purpose intended

The Contractor shall be responsible to complete all the protection works as directed by the Ashuganj Power Station Company Ltd

c) Foundation: For all plants and structures supplied under this Contract. Suitable foundations shall be provided for the engine generating unit(s), 230 kV switchgears, transformers, elevated water tank, overhead travelling crane, buildings, Oil storage Tanks, Fuel oil Handling System, emergency diesel Generator (EDG), and all other equipment, buildings and structures.

d) Temporary works as necessary to construct the permanent works. Provision of site office for the Engineer and the Project Director including all services, furnishings, and attendance for the period required by the Engineer but not
17.3 EARTHWORKS

17.3.1 GENERAL
The Contractor shall prepare the drawing necessary for his construction purpose based on drawings and the specification, and submit them to the Ashuganj Power Station Company Ltd. for approval. The Contractor shall be responsible for and shall complete all the earthworks as shown on the approved drawings or as directed by the Ashuganj Power Station Company Ltd.

17.3.2 EXCAVATION
Before commencing any excavation on the Site, the Contractor shall notify the Ashuganj Power Station Company Ltd. at least 48 hours before starting any additional surveys. He shall carry out, where directed by the Ashuganj Power Station Company Ltd. extra surveys required resolving any doubts which may arise as to correctness of any surveys or record. Thereafter the decision of the Ashuganj Power Station Company Ltd. & Engineer regarding what shall be recorded as the correct survey shall be final.

Excavations shall be carried out to the width, lengths and depths shown on the approved drawings. The Contractor may excavate by any method he considers suitable, subject to the approval of the Ashuganj Power Station Company Ltd.

Selected granular materials from the excavation as approved by the Ashuganj Power Station Company Ltd. shall be used in the embankment construction and filling.

Unsuitable materials shall be removed from the Site to disposal areas.

Cut and fill slopes shall be designed for to be thorough stability. Unless otherwise indicated On the Drawing the exposed surfaces of all cuttings and embankments shall be soiled and turfed to the satisfaction of the Ashuganj Power Station Company Ltd.

The Contractor shall take particular care during the excavation of the foundation to avoid deterioration of the ground due to exposure to the weather. The final 120 mm of excavation above formation level shall be carried out by hand immediately before the next stage of construction is to start. A similar method shall be adopted in the ease of the sides of excavation against which the structure is to bear. If the contractor finds any obstacle during the excavation it have to be removed by the contractor at his own cost.

The Contractor shall provide all strutting and shoring necessary for the safe execution of the Works and shall provide the necessary pumps, de-watering facilities, and temporary drains to ensure that all excavation shall be carried out in the dry.

The rates for excavation and filling shall be deemed to have included for the full cost of excavation and filling of the materials including site clearing, stripping of top soil, all pumping and temporary works necessary to keep the excavation and filling free from water, temporary shoring and timbering, trimming to line and level, stock-piling, handling, compaction, cutting, slope protection, river bank protection, removing surplus excavated material to spoil tips, together with all other costs incurred in
complying with the contract requirements.

17.3.3 FILLING

The area to be filled shall be cleared of vegetation and the top soil shall be stripped and stockpiled. All soft yielding material shall be removed and replaced with granular selected material. Where fill has to be deposited against the hill slope, the Contractor shall take all necessary precautions to ensure that a good bond is achieved between the fill and the original ground.

No fill shall be deposited in the area to be filled until the Ashuganj Power Station Company Ltd. & Engineer has inspected and given approval. Filling to the formation level shall be brought up from the bottom in uniform compacted layers. Excavated material obtained from the Site may be used for embankment construction and filling if the soil is suitable and APSCL agree.

Filling, levelling and compaction on the Site shall be carried out in layers not exceeding 300 mm thickness. The Contractor shall carry out all necessary quality control works including in-situ soil density tests, moisture content and other laboratory testing to ensure that all materials used in the embankment or filling elsewhere are compacted in accordance with the specified requirements.

The maximum dry density (MDD) for the purpose of this specification shall be determined by the following procedures or equivalent.

a. Selected materials used in the embankment other than below buildings shall be compacted to a density not less than 95% MDD.

b. Sub-grade for road below formation level to a depth 650mm shall be compacted to a density not less than 95% MDD or as approved by the Ashuganj Power Station Company Ltd..

c. Location of buildings and equipment foundations shall be compacted to a density not less than 95% MDD or as approved by the Ashuganj Power Station Company Ltd..

The following standards tests (any one) shall be conducted for determination of MDD.

(1) Standard Proctor Method
(2) Modified AASHTO Test

17.3.4 BACKFILLING

This section shall apply to the performance of all work in connection with the required backfill for the permanent works.

(1) Material

Material for backfill shall be obtained from excavated soil or other sources approved by the Ashuganj Power Station Company Ltd.

(2) Workmanship

Backfill to all foundations trenches, pits, etc., shall not be placed until the work has been inspected and approved Backfill around sewers, water mains and other utility lines shall be carefully placed so that the piping will not be displaced or damaged. Fill in contact with pipes shall
be entirely free of rocks. Backfill around service pipe shall be of sandy material. The backfill shall be compacted at optimum moisture content in layers not exceeding 15cm to 92% of the maximum dry density. Compaction shall be carried out by vibratory plate compactor.

17.3.5 MEASUREMENT AND PAYMENT

(1) Land reclamation works
Measurement by volume, for the payment of filling for the land reclamation works shall be made on the basis of the original ground surface and the site formation levels shown on the approved drawings. The quantity of filling given in the Schedule was estimated for tendering purposes. If the final quantity of the filling work varies beyond 10 (ten) percent, the Contractor shall notify the Ashuganj Power Station Company Ltd. for approval regarding the re-measurement and subsequent a variation the contract amount will be adjusted. Payment for the filling of the land reclamation works shall be made based on the unit price fixed by the Tenderer.

(2) Foundations and Ducts etc.
All expenses required for excavation and back filing of foundations, ducts, trenches, roads and all other structures shall be included in the lump sum price bid for the respective work item in the Schedule. The lump sum price bid shall not be modified or subject to adjustment for any design variation due to a change of geological or other conditions.

17.4 FOUNDATION

17.4.1 GENERAL
The Contractor shall take full responsibility for the suitability of the type of foundations he proposes to use and shall guarantee the performance of the foundations.

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.

All structures shall be supported on piled foundations unless the Contractor can clearly demonstrate by calculation that structural strength, stability, and settlement limits, under all loading conditions, can be achieved with an alternative foundation type for certain foundations. Foundations supporting operating plant and equipment will be designed for both static and dynamic loads based on equipment Contractor’s operational loading information and design criteria.

Seismic design best practice requires that all foundation elements within a structure are rigidly interconnected at or near ground level using either tie beams, or the intrinsic strength and stiffness of any ground floor slabs

All foundation shall be designed in accordance with the requirement as laid down in CP2004: 1972 Foundation or other approved Standards and Codes of Practice/BNBC.

17.4.2 PILING
Pile foundations shall be designed and applied to buildings, equipment, and structure where required based on available information obtained
from the subsoil investigation to be carried out at the Project Site by the Contractor.

In the event that piled foundations are proposed, the Contractor shall submit a detailed design for piled foundations to the Ashuganj Power Station Company Ltd. for approval. The Contractor can apply any type of pile design to satisfy the soil condition. The bid price for piling shall be lump sum and shall remain firm irrespective of the type of design.

(1) General

The Contractor shall supply, install and test at least one of the types of pile specified herein, or in accordance with the approved design and the drawing showing the piling arrangement. Each pile shall be suit existing the sub-strata at the Site. The Ashuganj Power Station Company Ltd. reserves the right to order additional test piles at no extra cost if the type of pile or the sub-strata differs from the one originally driven and tested.

The Contractor shall take full responsibility for the suitability of the type of piles he proposes to use and shall guarantee that each pile will carry a test load equal to twice the working load in accordance with this specification.

The standard of workmanship shall be as laid down in CP.2004; 1972 "Foundations" or other approved standard/BNBC.

(2) Pre-cast Piles

The Contractor’s arrangements for the provision of piles shall be to the approval of the Ashuganj Power Station Company Ltd. The Contractor shall submit full details of the manufacture including details of formwork, placing of concrete, vibrators, curing, handling, storage, and transport.

All concrete, reinforcement and other materials used for the manufacturing of piles shall comply with the requirements of the relevant sections of the Specification. Concrete may need to be made from sulphate resisting cement where necessary.

The reinforcement for a pile shall be fabricated to form a rigid cage. The main longitudinal reinforcement shall be in one continuous length except where otherwise approved and shall be finished level and cut square at the head of the pile, and shall bear against pile shoe. The minimum cover to the main reinforcement shall be 65mm. The spacer blocks shall be made of concrete of the same grade as that used in piles. Cast-in threaded inserts or metal tubes of an approved type shall be used to form holes in the piles where required.

Pile shoes shall be firmly fixed during concreting to prevent any displacement. The whole of the concrete in any pile shall be poured continuously. After a pile has been cast, the date of casting and reference number shall be clearly inscribed near the pile head.

The maximum variations permitted on the specified cross section dimensions shall be -3mm to +6mm. The maximum departure from alignment on the face of the pile shall not exceed +6mm over a 3-metre length and 12 mm over the total length of the pile.

Piles shall not be lifted without permission of the Ashuganj Power Station Company Ltd. and such permission will not normally be given.
until the concrete in the pile has attained a strength of 175kg/cm². During lifting, adequate precautions shall be taken not to cause undue stress to the piles. Piles shall be stored on adequate supports correctly located and spaced to avoid undue bending in the piles. Due consideration shall be given to future handling, curing and withdrawal of older piles without disturbing newer piles.

All piles shall be kept continuously wet for a minimum 7 days from the date of casting, or as directed by the Ashuganj Power Station Company Ltd..

No pile shall be driven until the concrete has reached the strength specified on the drawings or as otherwise described.

(3) Driving Piles

The Contractor shall submit with his tender full details of the performance, size and type of his driving plant together with information on the type of hammer and the number of rigs he proposes to employ on the works.

The driving rig shall be approved by the Ashuganj Power Station Company Ltd.

Piles shall be adequately guided whilst being driven and the guides shall be held rigidly in position down to the lowest level reached by the hammer.

The maximum departure of any pile head at cut-off level from the position indicated on the drawings shall not exceed 75mm. The maximum departure from the vertical or the correct angle of rake shall not exceed 1 in 50.

The Contractor shall provide to the Ashuganj Power Station Company Ltd. with three copies of the driving record for each pile, these records shall reach the APSCL’s Representative not later than the day following the driving of the relevant pile and shall contain details of the following:

(a) Location
(b) Pile details such as reference number, date of casting, length, and dimensions.
(c) Date and time of driving
(d) Type, weight and drop-of hammer or equivalent information if other type of equipment is used.
(e) Information on number and thickness of packing used during the driving of the pile and their condition after removal from the pile head.
(f) Number of blows per 300mm over the last 3 meters of penetration.
(g) Number of blows per 50 mm over the last 300 mm of penetration.
(h) Toe level of pile.

(i) Other relevant information as may be required by the Ashuganj Power Station Company Ltd.

If any pile is in any way considered unsatisfactory by the Ashuganj Power Station Company Ltd., he reserves the right to order the
Contractor to remove the pile and/or to install replacement piles at positions selected by the Ashuganj Power Station Company Ltd., all at the cost of the Contractor.

(4) In-Situ Piles

Before commencing the piling, the Contractor shall submit details of the type and number of rigs to be used for in-situ piles.

Jetting shall be permitted only with the approval of the Ashuganj Power Station Company Ltd.

The spoil from the pile holes and material remaining from the cutting of piles shall be removed by the Contractor to a tip to be provided by him.

Before pouring concrete into the core, the reinforcement for each pile shall be made up to form a rigid cage and lowered into the core. Arrangements are to be made to ensure that the minimum cover to the main reinforcement is 75 mm. The main longitudinal reinforcement shall be in one continuous length except where otherwise approved and the main bars shall extend at least 1 metre above cut-off level.

The concrete for the pile cores shall comply with the concrete specification. Concrete may need to be made from sulphate resisting cement where necessary. Concreting of the core shall not commence until the Ashuganj Power Station Company Ltd. has inspected.

The concrete shall be transported and placed in such a way that it is homogeneous with a high density, and care shall be taken to avoid segregation. The method of placing and compacting the concrete shall be to the complete satisfaction of the Ashuganj Power Station Company Ltd. Care shall be taken that harmful materials do not fall into the pile hole during concreting.

Curing of pile-heads exposed to the atmosphere below cut-off level shall comply with the concrete specification where practicable.

The concrete shall be finished 40 mm above cut-off level. Concrete shall not normally be placed in or through water. In particular circumstances only, the Ashuganj Power Station Company Ltd. may allow the Contractor at his own expense to place concrete (using suitable mix) through water by means of a termite pipe. If the Contractor’s piling system does not normally exclude water during concreting, he should allow in his tender for the use of compressed air or other method to keep the pile hole free of water whilst the concrete is being placed.

(5) Steel Piles

The Contractor shall take all necessary precautions to prevent damage to steel piles and fittings when handling, pitching and driving piles. Adequate bearers shall be provided under stacks of piles at positions to prevent distortion of the piles. Any piles which are permanently deformed will be rejected.

Details and jointing lengths of piles will only be permitted with the Ashuganj Power Station Company Ltd.’s approval. The type of joint and weld details shall be in accordance with the pile manufactures recommendations.

Where the completed pile will be subjected to long term corrosion adequate measures shall be taken to protect the surface of the exposed
pile by casing in concrete or such other means satisfactory to the Ashuganj Power Station Company Ltd..

(6) **Miscellaneous Piling Systems and Subsoil Improvement Method**

The Contractor can propose any system of piling or subsoil improvement method not covered by the foregoing specification and shall submit his proposal thereon to the Ashuganj Power Station Company Ltd. for approval in sufficient time to allow the suitability of the system in the ground conditions prevailing on this Site to be investigated fully.

(7) **Testing**

The Contractor shall install at least two piles solely for testing purposes and shall submit a detailed driving record and other data as directed by the Ashuganj Power Station Company Ltd. for the purpose of proving the proposed pile design. If this pile test does not satisfy the specified settlement, further piles shall be installed and tested. At least one test pile have to be installed for the Engine hall foundation. Pile shall be tested as per:

- ASTM D 1143 (Compression Load)
- ASTM D 3689 (Uplift Load)
- ASTM D 3966 (Lateral Load)

The Contractor shall provide all the equipment required for carrying out load tests on piles together with the apparatus for measuring shall be to the satisfaction of the APSCL.

Measurement of pile movement during testing shall be by a means capable of reading to 0.1 mm. This shall be related to a benchmark situated at a sufficient distance from the pile to ensure a permanent datum.

The loading system shall incorporate a proving ring, load cell or other apparatus capable of measuring the load to an accuracy with 2%.

(8) **Test Pile Load**

The test pile load shall be twice the specified working load and shall be applied in steps not exceeding 10 tons. Displacement readings shall be taken every 5 minutes after application of the load increment until two consecutive readings show that the displacement has ceased. When the test load reaches the specified working load, the displacement readings shall continue until it is established that no further displacement has occurred over a 15 minute period.

The working load shall be then maintained for a further 24 hours, displacement readings taken every 2 hours.

When no further displacement is apparent on completion of the 24 hour period or when approved by the Ashuganj Power Station Company Ltd., the load shall be removed in one stage and the recovery readings taken every 15 minutes until recovery has ceased.

The pile shall then be reloaded in one stage to the specified working load, readings being taken every 15 minutes until displacement has again ceased.
The load shall be then increased in equal increments up to twice the specified working load, the same procedure being followed as stipulated for the beginning of the test. The maximum load shall be maintained for 24 hours or as directed by the Ashuganj Power Station Company Ltd. after all displacement has ceased, and readings shall be taken every 2 hours during this period.

On completion of this period or when approved by the Ashuganj Power Station Company Ltd., all loads shall be removed and the displacement on recovery noted.

**9) Settlement Under Test Loads**

The settlement of the pile head under test load shall not exceed the following figures under the loads stated:

- Under 120% working load, settlement of 8mm.
- Under 200% working load, settlement of 25mm.

After removal of test load immediate residual settlement of 3mm for 120% working load and 15mm for 200% working load.

On completion of each pile test the Contractor shall supply the Ashuganj Power Station Company Ltd. with two copies of a complete report which shall include graphs of load-settlement, load-time-settlement and recovery of the pile as the load is removed.

**10) Rejection of Piles**

If any pile is found unsatisfactory to the Ashuganj Power Station Company Ltd. he reserves the right to order the Contractor to install replacement piles at the locations selected by the Ashuganj Power Station Company Ltd. at no extra cost.

**17.4.3 FOUNDATION of Engine Generators, Engine house, Fuel Oil Tanks Transformers, Switchgears etc.**

Appropriate foundations shall be provided for the Engine generating units, Engine house, Fuel oil tanks, Transformers, Switchgears etc. The Engine generating units, Engine house, Fuel oil tanks, Transformers, Switchgears etc shall be supported by the reinforced block foundation.

The Tenderer shall together with his Bid provide adequate information and data required for the design of the Engine generating units, Engine house, Fuel oil tanks, Transformers, Switchgears etc foundation.

The design drawings and calculation sheets shall be submitted to the Ashuganj Power Station Company Ltd. for approval prior to commence the construction.

**1) Design load and Combination**

The following loads and external forces shall be considered for structural analysis of the Engine generating unit Engine house, Fuel oil tanks, Transformers, Switchgears etc, foundations.

a. Concrete weight
b. Machine weight
C. Dynamic load (vertical direction)
d. Dynamic load (horizontal direction)
e. Short circuit force of generator
f. Seismic horizontal ground acceleration: 0.28g

In following load cases, the worst case shall be selected for the design of the Engine generating unit, Engine house, Fuel oil tanks, Transformers, Switchgears etc. foundation.

Long term
\[ a+b+c \text{ or } a+b+d \]

- short term
\[ a-b+e \text{ or } a+b+c+f \text{ or } a+b+d+f \]

17.4.4 FOUNDATION FOR BUILDING AND OTHER EQUIPMENT
Suitable foundations shall be provided for the elevated water tank, switchyard equipment, radiators, overhead travelling crane, buildings, transformers equipment, and miscellaneous structures.

17.4.5 HARDCORE
The Contractor shall place where required hardcore under the foundations of the equipment. The material shall be crushed rock or natural rubble stone not larger than 15 cm in size containing suitable quantities of fines to a grading and quality approved by the APSCL.

17.4.6 REPLACEMENT OF UNSUITABLE MATERIAL
In a case where the in-situ soils are found unsuitable for proper construction of the foundations, such materials shall be excavated and replaced with sand or other suitable granular material to be approved by the Ashuganj Power Station Company Ltd. The Contractor shall submit materials samples, laboratory test results and the proposed method of compaction and construction to the Ashuganj Power Station Company Ltd. for approval prior to commence the construction.

17.5 Deleted

17.6 CONCRETE WORKS

17.6.1 GENERAL
Standards of design, materials, and workmanship shall be in conformity with this Specification, ACI Standard or other internationally accepted Standards approved by the Ashuganj Power Station Company Ltd.

For the purpose of the Contract, this Specification shall be applicable to all concrete works to be included in the civil engineering and building works.

17.6.2 COMPOSITION
The Contractor shall make trial mixes using samples of aggregates and cements typical of those to be used at least four weeks before commencing any concreting in the Works. The strength requirements for each grade of concrete proposed in the design shall be determined by the Contractor by means of trial mixes to satisfy the conditions specified in Table 17.1. The cylinder/cube test samples have to be tested in BUET.
Table 17.1

<table>
<thead>
<tr>
<th>Class</th>
<th>A</th>
<th>B</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum size of aggregate (mm)</td>
<td>20</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>Water-cement ratio</td>
<td>Less than 0.45</td>
<td>Less than 0.50</td>
<td>Less than 0.55</td>
</tr>
<tr>
<td>Maximum slump (In cm)</td>
<td>7 - 10 (15 cm or more where concrete is to be placed by tremie under water or drilling mud or by pumping)</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>Compressive strength at 28th day (kgf/sq. cm)</td>
<td>306</td>
<td>255</td>
<td>160</td>
</tr>
<tr>
<td>Approximate Percentage of air content</td>
<td>2 ± 1</td>
<td>2 ± 1</td>
<td>2 ± 1</td>
</tr>
<tr>
<td>Fineness Modulus of fine aggregate</td>
<td>2.3 - 2.4</td>
<td>2.3-2.4</td>
<td>1.8</td>
</tr>
<tr>
<td>Applicable to Foundation, Column, slab, beam, wall pile, road, pavement</td>
<td>Trenches, drain-channel, corner stone, ducts, river bank protection</td>
<td>Levelling</td>
<td></td>
</tr>
</tbody>
</table>

17.6.3 TESTS

In order to control the quality of concrete to be placed, samples of concrete for testing shall be taken and cubes made as and when directed by the Ashuganj Power Station Company Ltd. Tests shall be done in accordance with this Specification or equivalent Standards approved by the Ashuganj Power Station Company Ltd.

a. Slump test
b. Compression test
C. Air test

For each grade of concrete, six test cylinders conforming to ACI or equivalent shall be prepared for each 30 cubic meters of concrete in each day's work. Three cylinders shall be tested on the 7th day and the remaining three on the 28th day. The slump and compression tests shall be carried out and the results shall submitted to the Ashuganj Power Station Company Ltd. in written form.

The cost of preparing, storing and transporting test specimens to the place of testing and testing shall be borne by the Contractor.
17.6.4 CEMENT

All cement shall be of normal Portland cement complying with BSTI or other approved standard. When required by the Ashuganj Power Station Company Ltd., the Contractor shall obtain for him the manufacturer’s test certificate prior to any delivery. All cement shall be stored dry in a well-ventilated and weatherproof building. The cement shall be furnished either in bulk or in bags from the cement factory approved by the Ashuganj Power Station Company Ltd..

17.6.5 ADMIXTURE

The Contractor may use water-reducing and set-retarding agents, but the use of admixture must have the prior approval of the Ashuganj Power Station Company Ltd..

17.6.6 WATER

The water used for making concrete, mortar and grout shall be clean, fresh and free from injurious amounts of oil, organic matter or any other deleterious substance.

17.6.7 AGGREGATE

The fine and coarse aggregates shall be durable, non-reactive hard materials complying with internationally accepted standards approved by the Ashuganj Power Station Company Ltd.. All aggregates shall be washed prior to use in order to remove clay, silt, dust and adherent materials.

The aggregates shall be stored on drained concrete paved areas in such a manner that intermingling of different sizes and types of aggregates is prevented. The stock piles of the aggregates shall be protected from rubbish or wind blown dust.

Coarse and fine aggregates shall be well graded within the standard limits specified as follows.

17.6.8 STANDARD GRADING

a. Standard Parameter of Materials Coarse aggregate (20 – 5 mm)

1) The Flakiness Index for all coarse aggregate test fractions as determined shall be less than 30%.
2) The Elongation Index for all coarse aggregate test fractions as determined shall be less than 30%.
3) The aggregate crushing value shall be less than 30% and the ten percent fines value shall be greater than 150 KN. Alternately the aggregate shall have Los Angeles abrasion loss as determined by AASHTO T-96 not more than 32%.
4) The weighted percentage loss of aggregate by use of 5 cycles of sodium sulphate test (AASHTO T104) shall be less than 10% by mass.
5) Water absorption as determined by AASHTO T-85 shall not be more than 2%.

<table>
<thead>
<tr>
<th>Sieve size (mm)</th>
<th>50.8</th>
<th>38.1</th>
<th>31.7</th>
<th>25.4</th>
<th>19.1</th>
<th>12.5</th>
<th>9.52</th>
<th>4.72</th>
<th>2.38</th>
</tr>
</thead>
</table>

NOT FOR SUBMISSION
### b. Fine aggregate

1) Water absorption as determined by AASHTO T-84 shall not be more than 2.5%

#### Standard Grading

<table>
<thead>
<tr>
<th>Sieve size (mm)</th>
<th>9.52</th>
<th>4.76</th>
<th>2.38</th>
<th>1.19</th>
<th>0.595</th>
<th>0.297</th>
<th>0.149</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percentage passing by weight</td>
<td>100</td>
<td>90-100</td>
<td>80-100</td>
<td>50-90</td>
<td>25-65</td>
<td>10-35</td>
<td>2-20</td>
</tr>
</tbody>
</table>

### c. Limits of injurious material content

<table>
<thead>
<tr>
<th>Maximum percent by weight</th>
<th>Silt / clay</th>
<th>Volume lost by washing test</th>
<th>Less than specific gravity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coarse aggregate</td>
<td>0.25</td>
<td>1.5</td>
<td>1.0</td>
</tr>
<tr>
<td>Fine aggregate</td>
<td>1.0</td>
<td>7.0</td>
<td>1.0</td>
</tr>
</tbody>
</table>

#### 17.6.9 CONCRETE MIXING

All concrete except where specifically approved by the Ashuganj Power Station Company Ltd. shall be mixed in weigh batch mixing machines. The machine shall have a Water storage tank with a gauge so that a predetermined quantity of water can be injected direct into the mixer drum. If concrete is to be mixed by hand, it shall be approved by the Ashuganj Power Station Company Ltd. The Contractor shall take all precautions to protect the concrete from the effects of injurious materials.

#### 17.6.10 PLACING

The concrete shall be placed in the positions and sequences indicated on the approved drawings immediately after mixing under the supervision of the Ashuganj Power Station Company Ltd. or his representative.

Prior to placing the concrete all deleterious substance such as organic matter, standing water, flowing water, wood fragments shall be removed from the surface against which the concrete is to be placed. When concrete is to be placed against a construction joint or adjacent to a set surface the whole surface shall be thoroughly roughened. It shall be cleared of all loose and foreign matter and washed with water immediately before fresh concrete is placed.

The concrete shall be fully compacted throughout the layer and it shall be thoroughly worked against the formwork and round the reinforcement without displacing them Unless otherwise directed by the Ashuganj Power Station Company Ltd., approved power driven vibrators of the immersion type shall be used. Vibrators shall penetrate to the full depth of the concrete layer and shall re-vibrate that layer to ensure that the successive layers are well knitted together. The placing of concrete shall not be
permitted under the following conditions unless specifically approved by the Ashuganj Power Station Company Ltd.

- If it rains
- If it is poorly illuminated during night work
- If ordered to stop by the Ashuganj Power Station Company Ltd. or his representative.

17.6.11 TRANSPORTATION

Ready mixed concrete shall be transported speedily to the point of placing by a means that shall be approved by the Ashuganj Power Station Company Ltd. and which shall give little chance for segregation of materials. Generally, the transportation of ready mixed concrete shall be limited to within one hour. Concrete delivered in excess of the time limit shall be rejected. When concrete is observed to have segregated or started solidifying at the transportation of placing, it shall be rejected and replaced.

17.6.12 CURING

Concrete shall be protected during the first stage of hardening from the harmful effects of sunshine, drying winds, hot weather and rain or running water. The concrete shall generally be wet-cured for at least 7 days. The curing method for concrete shall be submitted to the Ashuganj Power Station Company Ltd. for approval.

17.6.13 FORMWORK AND TIMBERING

Formwork and timbering shall be so designed and constructed that the required finishes in concrete works are achieved. Formworks shall be constructed accurately to the required shape, position and level and shall have sufficient strength to withstand the compaction pressure. The materials to be used for formwork, shall be approved by the Ashuganj Power Station Company Ltd.

Forms shall be removed without damage to the concrete. The use of form oil or other release agents shall be approved by the Ashuganj Power Station Company Ltd.

The removal time of formwork and timbering shall be as follows:

- Walls, beams, column: 3 days
- Beam soffits (props left under): 7 days
- Slab soffits (props left under): 21 days

17.6.14 WATER STOPS AND EXPANSION JOINTS

The Contractor shall place water stops, waterproofing membranes and expansion joints at locations as are necessary for the proper construction of the concrete structure. The materials to be used shall be submitted in advance to the Ashuganj Power Station Company Ltd. for approval.

17.6.15 FINISH AND REPAIR OF CONCRETE

(1) General
The classes of finishes and the requirement for finishing concrete surfaces shall be as specified in this clause or as shown on the approved drawings. Surface irregularities in finishes shall be distinguished from construction tolerances, which are allowable deviations from established lines, grades and dimensions, as described herein.

Surface irregularities are designated "abrupt" and "gradual" for purposes of classifying finishes. Offsets resulting from displaced, misplaced, or mismatched forms or by loose knots in forms, or other similar forms of defects shall be considered "abrupt" irregularities and will be checked by direct measurement. All other surface irregularities shall be considered "gradual" irregularities and will be measured as a departure from the testing edge of three meter template.

Finishing of concrete surfaces shall be performed only by skilled workmen.

Concrete surfaces shall be free from imperfections such as honeycombs and cracks. The Contractor shall at his own expense repair honeycombs, cracks, and irregularities promptly as directed by the Ashuganj Power Station Company Ltd.

(2) Concrete Construction Tolerances

Variations in alignment, grade and dimensions of the structures from the established alignment, grade and dimensions shown on the approved drawings shall be within the tolerances specified in the following tables. Concrete work that exceeds the tolerance limits specified herein may be required by the Ashuganj Power Station Company Ltd. to be remedied or removed and replaced by the Contractor.

Construction Tolerances for Concrete

a. Variation from vertical:
   - In the lines & surfaces of columns, walls and towers:
     - In 3 m: 5 mm
     - In 6 m: 10 mm
     - In 12 m or more: 20 mm
   - For exposed columns, joint grooves and other Conspicuous lines:
     - In 6 m max.: 10 mm
     - In 12 m or more: 15 mm

b. Variation from the level or from the grades indicated on the approved drawings:
   - In 3 m: 5 mm
   - In any bay or 6 m max.: 15 mm

   - In floors, inverts:
     - In 12 m or more: 20 mm

c. Variation of the linear structure lines from established position in plan and related position of walls:
   - In any bay or 6 m max.: 20 mm
   - In 12 m or more: 30 mm

d. Variation in locations of sleeves and sizes and locations of floor openings and wall openings: 10 mm

e. Variation in cross-section @1 minus
   - Dimensions or columns: 10 mm
   - Plus: 15 mm
beams and in the thickness of slabs and walls

<table>
<thead>
<tr>
<th>Variation in steps:</th>
<th>Rise</th>
<th>3 mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>In a flight of stairs</td>
<td>Tread</td>
<td>5 mm</td>
</tr>
<tr>
<td>In consecutive steps</td>
<td>Rise</td>
<td>2 mm</td>
</tr>
<tr>
<td></td>
<td>Tread</td>
<td>3 mm</td>
</tr>
</tbody>
</table>

| Variation in other structure            | 30 mm |

<table>
<thead>
<tr>
<th>Construction Tolerance for Placing Reinforcing Steel</th>
<th>50 mm cover or less</th>
<th>10 mm</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>more than 50 mm</td>
<td>15 mm</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Variation of protective Covering</th>
<th>50 mm cover or less</th>
<th>10 mm</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>more than 50 mm</td>
<td>15 mm</td>
</tr>
</tbody>
</table>

| Variation from indicated spacing (any one bar)    | 25 mm |

(3) Repair of concrete

The Contractor shall repair at his own expense the imperfections of concrete surfaces and the irregularities which do not meet the allowance specified in the preceding item. Repairing works shall be performed and completed within 24 hours after the removal of forms, in accordance with the direction of the Ashuganj Power Station Company Ltd..

17.6.16 REINFORCEMENT BAR

The reinforcement bars for the Diesel Engine generating units foundation blocks shall be deformed steel bars. Dimension, shapes, tensile strength, yield point and other mechanical properties of the reinforcement bars shall comply with relevant approved standards. All reinforcement must be free from oil, grease, paint, dirt, loose scale or rust at the time of concreting.

The physical properties of the reinforcement bar shall have the following values:

- **Yield point**: more than 4180 kg/cm²
- **Ultimate tensile strength**: more than 7138 kg/cm²

Reinforcement bars shall be stacked of the ground on sufficient supports to prevent distortion of the bars. Prior to fabricating and placing the reinforcement, the Contractor shall prepare a bar bending schedule, and drawings for submission to the Ashuganj Power Station Company Ltd. for approval. Reinforcement shall generally be bent cold by an approved means to the dimensions shown on the approved bar bending schedule and shall be rigidly fixed in the positions shown on the approved reinforcement drawings using annealed soft black iron binding wire to prevent movement during concreting. The Ashuganj Power Station Company Ltd. shall have the right to select at any time samples of reinforcement bar for testing for compliance with the Specifications. The spacer blocks, prior to using, shall be submitted to the Ashuganj Power Station Company Ltd. for approval.

17.6.17 PAYMENT

All costs associated with concrete work and reinforcing bar for equipment foundations, ducts, roads, buildings, drainage system and all other
structures shall be deemed to include in the lump sum price bid for the respective work item in the Schedule. The lump sum price bid shall not be modified or subject to any adjustment for design variations due to changes of geological and other conditions.

17.7 ROADS AND SURFACINGS

The Contractor shall furnish all designs and construct the roads, yards, paths, surfacing as necessary for the proper functioning of the power station.

The roads and yards as indicated in the Drawings or directed by the Ashuganj Power Station Company Ltd. shall be generally designed with raised kerb, in compliance with the approved Standard and to satisfy the following basic design requirement:

- **Maximum grade**: 7%
- **Pavement width**: as directed by Ashuganj Power Station Company Ltd.
- **Turning radius**: more than 10 mm.

17.7.1 CONCRETE PAVEMENT

The roads and yards shall be paved with reinforced cement concrete and shall be designed in accordance with the procedures as outlined in the AASHTO Standard or any other acceptable international standard or Design of Pavement Structures or other internationally accepted methods approved by the Ashuganj Power Station Company Ltd. Basic design conditions are as follows:

- **Design load**: Minimum 20 ton axle weight
- **Minimum thickness of concrete pavement**: 20cm

17.7.1.1 Sub-grade Preparation and Test

The aggregate sub-base for the concrete pavement shall be prepared by bringing the sub-grade to a firm and unyielding surface by rolling the entire area with an approved roller weighing not less than ten (10) tons. The sub-grade shall be sprinkled with water, if necessary, to attain satisfactory compaction. All soft, yielding material which will not compact readily when rolled shall be removed as directed. All holes or depressions shall be filled with suitable material and the whole surface compacted uniformly. In cut, sections, the ground below the surface of the sub-grade, shall not be ploughed or disturbed, except as otherwise directed by the Ashuganj Power Station Company Ltd. When necessary, additional approved material shall be added to bring the sub-grade to the desired elevations and cross section, and the whole shall be rolled until compacted thoroughly.

The Contractor shall perform a bearing test by a method to be instructed by the Ashuganj Power Station Company Ltd. on the surface of the sub-grade and he shall examine the thickness of sub-base.

The Ashuganj Power Station Company Ltd. may instruct a modification to the design of pavement, if required based on test results without any claim on the Ashuganj Power Station.
17.7.1.2 Aggregate Sub-base Materials for Concrete Pavement

Aggregate sub-base material for concrete pavement (roadways, parking areas, etc.) and roadway shoulder shall consist of hard, durable fragments of crushed gravel and stone or other similar materials, including additional selected filler for blending under the direction of the Ashuganj Power Station Company Ltd. The maximum dimension of any particle shall not be greater than two-thirds of the required thickness in which it is to be placed. Oversized material, if present, shall be removed at the quarry by screens, grizzlies, or by hand. When necessary to obtain proper uniformity, additional filler shall be blended by mixing on the roadway. The faction of the aggregate sub-base material, including any additional filler passing the No.200 sieve shall not be more than of that passing the No.40 sieve. The fraction of the material passing No.40 sieve shall have a liquid limit not greater than 25 and a plasticity index of not more than 6.

The following gradation requirements shall apply to the sub-base for concrete pavement and the thickness of sub-base shall be not less than 20 cm after it is compacted or as otherwise agreed with the Ashuganj Power Station Company Ltd.

<table>
<thead>
<tr>
<th>Sieve designation (Square Mesh Sieves)</th>
<th>Percentage by Weight</th>
<th>Passing</th>
</tr>
</thead>
<tbody>
<tr>
<td>38.1 mm (1 1/2&quot;)</td>
<td>95</td>
<td>100</td>
</tr>
<tr>
<td>19.1 mm (3/4&quot;)</td>
<td>60</td>
<td>90</td>
</tr>
<tr>
<td>2.5mm (No.8)</td>
<td>20</td>
<td>50</td>
</tr>
<tr>
<td>0.074 mm (No.200)</td>
<td>2</td>
<td>10</td>
</tr>
</tbody>
</table>

17.7.1.3 Construction of Aggregate Sub-base for Concrete Pavement

The aggregate sub-base material shall be placed on the prepared and approved sub-grade. The deposition and spreading of the material shall be as directed by the Ashuganj Power Station Company Ltd. It shall start at the point farthest from the point of loading, and shall progress continuously without breaks. The materials shall be deposited and spread in a uniform layer and without segregation of size, to such a loose depth of not more than 15 cm each layer, making allowance for any filler to be blended on the road, that when compacted, the layer shall have the required thickness. Spreading shall be from spreader boxes or from moving vehicles, or by placing in a windrow followed by spreading to required depth and width by means of a blade grader. After the sub-base material has been spread, it shall be bladed to a smooth surface conforming
to the cross section.

The Contractor shall schedule his operations so as to assure completion of spreading within 48 hours after processing. Immediately following the final spreading and smoothing, all materials placed shall be compacted to the full width by rolling with a power roller weighing not less than 10 tons. The rolling shall start longitudinally at the sides and shall progress toward the centre, overlapping on successive trips by at least one-half of the width of the roller unit. In confined areas the direction of rolling shall be as ordered by the Ashuganj Power Station Company Ltd.. Alternate trips of the roller shall be slightly different in length. The rollers, unless directed otherwise, shall operate at a speed between 3 to 5 kilometres per hour. Rolling shall be accompanied by watering if necessary and as directed by the Ashuganj Power Station Company Ltd..

17.7.1.4 Concrete Pavement

(1) Materials

i. Cement and reinforcing steel will be furnished by the Contractor. The concrete to be used for concrete pavement shall be not less than 240kg/sq.cm in the strength at 28 days. The concrete pavement shall be 20cm in thickness or as designed.

ii. Fine and coarse aggregates, and water shall conform to the applicable Section of the Specification.

iii. Preformed Expansion Joint Filler Ashuganj Power Station Company Ltd. - The preformed expansion joint filler for the concrete pavement shall be 19mm (3/4") in thickness, non-extruding type, shall conform to the requirements of ASTM D1752-67, "Specifications for Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction, Non-extruding and Resilient Non-bituminous Types", Type II.

iv. Dowel bars All dowel bars except at the expansion joints, shall be deformed steel bars and shall conform to ASTM A6 15 Grade 60.

v. Joint Sealer Concrete joint bituminous sealer for all joints shall conform to ASTM D1850-67, "Specifications for Concrete Joint Sealer, Cold-Application Type".

vi. Slab reinforcement The slab reinforcement shall be made of steel bars of 10 mm conforming to ASTM A615 Grade 60. The longitudinal and transverse spacing shall be 15cm respectively or as design each intersection shall be firmly bound by binding wires or fixed by an adequate method approved by the Ashuganj Power Station Company Ltd.. It shall be embedded in the concrete at 6cm below the surface.

(2) Construction Method

i. Formwork
The concrete pavement shall be constructed one lane at a time. The side forms for the concrete pavement shall be made of shaped steel sections which shall have sufficient strength when staked down to resist the pressure of the concrete mixer and finishing machine, or finishing tools, without springing. They shall be straight and of a depth equal to the thickness of the pavement at the edge and free from warps or bends at all times. Flexible or curved forms of proper radius shall be used for curves 30 metres radius or less. The form base shall not be less than twenty (20) centimetres wide for forms twenty (20) centimetres or more in height. Flange braces shall extend outward on the base not less than two-thirds \((2/3)\) of the height of the form. The use of wooden side forms may be permitted.

Timber formwork shall be oiled or greased at all times to prevent warping or cracking.

When placing the forms, they must be seated firmly and in contact with the sub-base surface for their entire length, exactly on the desired line and grade.

Before the mixing of concrete, forms shall have already been set for a sufficient length well in advance of the forward end point where the concrete is to be placed, but in no case less than the length between expansion joints, except for closures which may require a shorter length. Sufficient forms shall be provided so that it will not be necessary to move those in place within twenty four (24) or more hours after the concrete has been poured. All forms shall be cleaned and oiled each time they are used.

In the pouring of sections, construction joints shall be located at expansion joints. Should it be necessary to make construction joints beyond the expansion joint, such construction joints shall be made at the location of contraction joints.

\(\text{ii. Joints}\)

(a) Longitudinal Joint: The longitudinal joint running at the centre line of the pavement shall be formed in accordance with the section and dimension shown on the approved drawings. Before concreting the next lane, the longitudinal joint shall be painted with two (2) coats of liquid asphalt applied at a temperature of 65\(^\circ\) to 135\(^\circ\) Fahrenheit. The asphalt should be completely dry before commencing pour to the next lane.

(b) Transverse Joints: The transverse joints consist of the expansion joints and contraction joints. The expansion joint shall in principle be formed at every 40m and the contraction joint shall be formed at an interval of every 8m between the expansion joints. In the expansion joints, 19 mm (3/4\(^\)”) preformed expansion moulding strip shall be placed and bituminous Dealer shall be poured after removing the strip and before opening the
Dowels: In all longitudinal joints, 75cm long tie dowel bars of 3/4" diameter shall be used for concrete pavements. In all contraction joints, 75cm long slip dowel bars of 3/4" diameter shall be embedded in the concrete. All dowel bars shall be placed at an interval of 75 cm. The remaining half of the dowel bars for the transverse joints shall be painted, greased, and wrapped with wax paper before concreting the next slab. The slip dowel bars in the expansion joints shall provide a cap having adequate size and type at the end of the bars.

iii. Mixing

Hand mixing of concrete will not be permitted. Machine mixers, if used, shall have a standard mixer of an approved type with a capacity of at least 0.76cu.m. (1 cubic yard). Truck mixers, if used, shall be of the revolving drum type, water-tight, and so constructed that the concrete can be mixed to ensure uniform distribution of material throughout the mass. The procedures of concrete mixing shall be in accordance with the Specification for Concrete Work Section.

iv. Placing

Concrete shall be placed only on aggregate sub-base that has been prepared as previously prescribed and approved by the Ashuganj Power Station Company Ltd. The concrete shall be deposited in such a manner as to require as little handling as possible, and shall immediately be distributed or spread by shovelling or by other approved methods, to such depth, and grade, that when compacted, the finished grade of the pavement will be attained correctly. Vibrators of approved type and capacity for the purpose intended shall be used to sufficiently compact the concrete.

v. Finishing

After the concrete has been deposited, distributed and vibrated, the concrete shall be struck off and screeded by mechanical means approved by the Ashuganj Power Station Company Ltd. The finishing machine shall be of the screeding and trowelling type designed and operated both to strike off and to compact. Hand finishing may be employed in limited areas where finishing machines cannot be operated. Finishing of concrete shall be done, as directed to the satisfaction of the Ashuganj Power Station Company Ltd. All finished surfaces shall be tested with a 3-meter straight edge and it shall not vary more than 1cm in 3m from the designed surface. Any variation of the surface from the desired crown or cross-section shall be properly corrected.

vi. Removal of Formwork and Repair
All forms for concrete shall remain in place undisturbed for not less than twenty-four (24) hours after the concrete is placed, after which the forms may be removed. In the removal of formwork, care should be taken so as not to break the edges of the pavement. In case portions of the concrete are spalled, they shall be immediately repaired, at the expense of the Contractor, with fresh mortar mixed in the proportion of one (1) part cement to two (2) parts clean sand. Major honeycombed area will be considered as defective work and shall be removed and replaced at the expense of the Contractor. Any area or section removed shall not be less than 3 meters in length nor less than the full width of the lane involved.

The Contractor shall repair at his own expense all imperfections, or irregularities of the concrete pavement in accordance with the direction of the Ashuganj Power Station Company Ltd.

vii. Curing

As soon as the concrete has sufficiently set, and to prevent the marring of the surface, the pavement shall be covered with burlap or canvas, which shall be kept wet with clean water for a period of not less than twenty-four (24) hours.

After removing the burlap, the pavement shall be covered immediately with either a layer of earth or sand four (4) centimetres in thickness and shall be kept wet for a period of not less than fourteen (14) days. Ponding of the surface of the pavement may also be adopted for curing the concrete, in which case, the pavement shall be kept under water during the same length of time.

viii. Opening to Traffic

From the start of curing, the pavement shall be closed entirely to traffic until twenty-eight (28) days have elapsed after the concrete was poured.

ix. Cleaning and Sealing Joints

After completion of the required curing and before opening the pavement to traffic, all Joints shall be thoroughly cleaned of all concrete or aggregate fragments, earth or other foreign material. Longitudinal, expansion and contraction Joints shall be poured with bituminous sealant to the depth of 40mm from the top concrete surface. Only after the joint sealant has thoroughly hardened shall the pavement be opened to traffic.

x. Protection of Adjacent Construction

Any adjacent construction such as concrete pavement, curb and gutter, stone masonry and handrails shall be protected by shields, covers or other means. If concrete is applied to adjacent construction either by accident or
because of inadequate protection, the Contractor shall remove such material as directed and at his expense.

xi. Maintenance

The Contractor shall be responsible for the maintenance of the surface for a period of twenty eight (28) days or until such time as the Ashuganj Power Station Company Ltd. may direct, after which the work shall be accepted in writing by the Ashuganj Power Station Company Ltd.

No extra compensation will be made to Contractor for any maintenance work required as specified. All costs attendant thereto shall be included in the lump sum price bid for Road and Parking Area in the Schedule.

17.7.2 Gravel Surfacing

The Contractor shall supply and place a layer of gravel not less than 10cm in areas other than the paved and lawned areas in the power station as shown on the Drawing or as directed by the Ashuganj Power Station Company Ltd.. Materials for graveling shall be 3 to 7cm in size conforming to the grading requirement of the Specification.

17.7.3 Landscaping and Turfing

Areas around the power house building, administration building shall he turfed as shown on the Drawings or as directed by the Ashuganj Power Station Company Ltd..

Turf shall be freshly cut approved carpet grass free from thorns and weeds. The area to be turfed shall be provided with a layer of 20cm top soil suitable for the growth of the lawn. The Contractor shall maintain and replace all dead turf at his own expense until the end of maintenance period.

The Contractor shall submit a detailed proposal on landscaping for the Site. Trees, flowers and other plants adaptable to the climate and soil conditions of the Site shall be planted in the open spaces provided adjacent to the control and administration building area and along the perimeter of the boundaries to form a green belt around the power station. A proposal which shall include a landscape drawing with a schedule showing types of trees, planting positions and other details shall be submitted to the Ashuganj Power Station Company Ltd. for approval.

17.8 Drainage System

17.8.1 Design Conditions

The design of the storm water drainage system comprising the interceptor, roadside and perimeter drains for buildings, powerhouse, and switchyard shall be submitted to the Ashuganj Power Station Company Ltd. for approval.

The Contractor shall carry out detailed designs of the storm water drains using the rational method or other approved procedures. The work shall be carried out in accordance with the rules and regulations of the local and other authorities.

Design conditions for drainage system shall be as follows:
Rainfall intensity : 100 mm/hr
Run-off coefficient : 0.6
Manning's roughness coefficient : 0.013

for concrete lined channel

All drains or channels shall be concrete lined. Concrete sumps, silt traps, screens and drain covers shall be steel grating incorporated in the design where it is appropriate.

17.8.2 Drain Laying

All trenches and drains are to be set out accurately to line and fall as specified. Trenching for pipes shall be excavated with sufficient width to allow adequate working space for pipe jointing. Backfilling of trenches to a height 300 mm above the top of the pipes using selected materials shall be hand packed and well rammed against the side of the pipes.

The laying of each length of drain is to be commenced at the lower end and socketed pipes shall be laid with their sockets at the higher end each pipe is to be accurately levelled and securely held in position before the joint is made.

All surface water channels shall be made from concrete grade B as described in Section 17.6.

The Contractor shall keep sumps, drains, trenches and ditches free from water at all times until, in the opinion of the Ashuganj Power Station Company Ltd., the concrete works has hardened.

Man-holes, inspection chambers and catch-pits shall be constructed.

17.9 Sewage Works

17.9.1 General

As there is no existing government central sewage treatment system operating in the vicinity of the Site, individual septic tanks shall be provided in the Site.

17.9.2 Sewer, Manholes and Septic Tanks

Pipes proposed for use in the sewer shall be approved by the Ashuganj Power Station Company Ltd., cast iron pipes and fittings complying in all respects with B.S.78 and/or B.S.437 shall be used. Manholes or inspection chambers with covers shall be provided at every change in direction or gradient to satisfy the requirement of the Local Authority.

The sewer shall be laid accurately to the design levels and gradient. Each length of sewer shall be carefully water tested to the satisfaction of the Ashuganj Power Station Company Ltd. before the concrete haunching is placed and before the trench is back filled. Septic tanks shall be constructed in accordance with the details shown on the approved drawings.
17.10 Water Reticulation System

17.10.1 Internal Water Reticulation System

The water supply system shall be designed to serve a dual purpose of providing potable water for domestic consumption, fire-fighting and plant.

17.10.2 Water Requirement

The system shall be designed to meet the project requirement as follows:

1. Plumbing

The facilities for general plumbing comprises two (2) deep wells not less than 120 m in depth with pump and G.I pipes of appropriate sizes connecting the supply to the internal plumbing facilities provided for electrical building connection with existing water supply system at a suitable point. The supply system shall be extended with sufficient number of taps to provide water for lawns.

17.10.3 Design Parameters And Standard

The water reticulation system shall be designed and installed in compliance with the requirement of the local and other authorities. The parameters and criteria to be adopted for design are:

a. Design population : 100 persons
b. Storage requirement for plumbing system
   : 3 times the average daily demand
c. Minimum fire flow : 2.5 m3/min
d. Minimum diameter of fire-fighting main (steel)
   : 120 mm
e. Pressure in pipe : 7 bar
f. Maximum spacing of fire hydrant : 60 mm

17.10.4 Materials and Workmanship

All pipes, fittings, jointing materials and valves which are necessary for the complete installation of the system shall be supplied and installed in compliance with the approved standards and workmanship.

The Contractor shall supply all pipe, special fittings, valves, joints, jointing materials and other necessary materials for the complete installation of the system as shown on the approved drawings.

The installed system shall be tested to the satisfaction of the Ashuganj Power Station Company Ltd.
17.10.5 Deep-well And Deep--well Pump

17.10.5.1 General

(1) Scope of Work

In accordance with the Specification and as shown on the bid drawings or as directed by the Ashuganj Power Station Company Ltd., the scope of this work shall cover the supply, fabrication, construction, installation, erection and all the necessary materials, labour, tools and equipment for the complete and satisfactory operation of the domestic water supply system from deep-well [2X100% capacity] to storage tank. Water quality for Plant/ Fire Extinguisher shall be as per Plant/Equipment manufacturer's requirement. Water for drinking purpose shall be as per WHO's standard. Contractor shall design the reservoir/ storage tank as per requirement of the Tender.

All materials, equipment and accessories shall be new and unused, free from defects and imperfections and best suited for the purpose intended. Materials used in the manufacture and installation of all equipment to be furnished shall be of the required quality used in commercial products of reputable manufacturers. All equipment or substitute materials and equipment to be used shall conform to the latest specifications and provisions of approved Standards of the Engineering Institutes or other equivalent standards approved by the Ashuganj Power Station Company Ltd.

One deep-well pump shall be installed for each well.

(2) Instruction Book

The Contractor shall submit ten (10) copies of instruction books on the operation and maintenance of equipment furnished and installed by him under this clause two (2) months before he starts on the installation work.

(3) Painting

All metal, wooden and textile surfaces of materials furnished and installed by the Contractor under this Section shall be painted in accordance with Section 18.6, except as listed below. Performance of painting work shall be as specified in the Section 18.6 of the Specifications.

a) Portions to be embedded in concrete or in the soil
b) Plated surfaces other than zinc plating
c) Concealed zinc plated portions
d) Surfaces treated with special decorative finishes
e) Surfaces where so indicated by the Ashuganj Power Station Company Ltd.

Colour of paint shall be as directed by the Ashuganj
Power Station Company Ltd..

(4) Concrete, Plastering and Earth Work

Concrete, reinforcing, plastering and earth work to be executed under this clause shall be performed according to the applicable provisions of the relevant clauses of the Specifications.

17.10.5.2 Drilling, Developing And Testing The Deep-well

(1) General

The Contractor shall provide plant, labour, material, equipment and perform all operations in connection with the drilling, developing, placing of casings and well screens, and pumping tests for the deep-well which shall be drilled to a depth as indicated below.

(2) Drilling

Drilling of the deep-well shall be carried out by an appropriate method most suited to the conditions of the deep-well site to be drilled. When necessary, temporary casings shall be used in sections of the hole through overburden or unstable material to prevent the caving-in of the well. The location of the well drilling site shall be as shown on the bid drawings or as directed by the Ashuganj Power Station Company Ltd.

(3) Well Log

A written record of the drilling information which is called a Well Log shall be kept by the drillers and shall be available for examination by the Ashuganj Power Station Company Ltd. at any time during the work and a complete typewritten copy of the well log shall be submitted to the Ashuganj Power Station Company Ltd. within ten (10) days after completion of the work. The well log shall show amongst other things the type of materials encountered, colour of the return water, depth at which circulation as lost, manner of drilling, length of casings installed, and other pertinent drilling data.

(4) Well Completion and Development

The Contractor shall undertake all operations pertaining to the completion and development of the well which shall consist of the installation of casings, installing well screen within a sand and gravel formation, developing the water-bearing formation, grout filling of the upper section of the well casing (from collar to at least 6m deep), surging and back-washing.

The well casings to be installed shall be carbon steel, ASTM A-53, seamless, Grade B or equivalent. Openings of the well screens shall be so designated to prevent clogging and shall be free from jagged edges and irregularities so as to avoid clogging and corrosion.
(5) Pumping Test for Yield and Draw-down

Pumping tests shall be performed to determine the deep-well capacity and other hydraulic characteristics of the water-bearing strata.

The Contractor shall furnish and operate a pump for this purpose that is capable of continuous operation at a sustained delivery of 380 lit/mm or more in a duration of at least five (5) hours of pumping test operation. Measurements of the volume of water pumped per minute, the depth of static water level before pumping started, the depth of the pumping level at one or more constant rates of pumpage, the rate of recovery of the water level after pumping test stopped and the length of pumping time of each pumping rate shall be made by the Contractor in the presence of the Ashuganj Power Station Company Ltd. & Engineer. The Contractor shall construct any other structures necessary to conduct water away from the deep-well.

For a comprehensive test of the well, the pump shall be operated continuously at about 1/3 of its capacity until pumping level is attained. After making the necessary measurements, the pump rate is adjusted to about 2/3 of the pump capacity and measurements are repeated when the pumping level becomes constant. By increasing the rate of pumpage to produce maximum draw-down; or increasing it to the full capacity of the pump and making measurements a third time when the pumping level becomes stable.

All the necessary equipment the measuring devices for testing the deep-well shall be calibrated and provided by the Contractor at his own expense.

After developing and testing operations are completed to the satisfaction of the Ashuganj Power Station Company Ltd., the Contractor shall measure the depth of the well and record the total open depth of the casing. Sterilisation of the well is done by pouring a solution of 450 grams of high test Calcium Hypochlorite (HTH) in 45 litters of water.

Upon completion of the drilling, the Contractor shall submit to the Ashuganj Power Station Company Ltd. the complete well-draw-down test results for check and determination of the actual head and setting of the deep well pump.

(6) Data to be Submitted with Bids

A complete list and description of equipment, plant and tools for executing the work in accordance with these Specifications and their location at the time of opening of bids in order that they may be inspected by the Ashuganj Power Station Company Ltd..
17.10.5.3 Deep-well Pump

(1) General
The Contractor shall furnish, deliver, install and test a motor-driven pumps (2X100 % capacity) complete with accessories and housing at the top of the well in accordance with these Specification.

(2) Type and Description
The deep-well pump shall be a submersible type with a cast iron body, bronze impeller, high-grade steel discharge column and stainless steel shaft. The discharge pipe column and drive shaft of ample size shall be supplied with interchangeable sections of not greater than 3.0 m in length.

This pump shall be operated in conjunction with the float switch to be installed in both the elevated water tank and fire fighting storage tank.

All water passages of the pump shall be smooth and long term corrosion-resistance of dependable operation.

(3) Rated Capacity
The deep-well pump shall be rated to a discharge capacity of approximately, 600 lit/m against a total dynamic head of the system as determined. The total head of each pump may vary and it is required that the pump be capable of satisfactory operation within fluctuations of head.

The pump shall be guaranteed to circulate not less than the specified quantity of water when pumping and without producing excessive vibration and noise. The efficiency of the unit shall be as high as good engineering practice will permit.

(4) Electrical Works
a) Pump Motor
The motor shall be submersible type, full voltage starting and with torque-locked rotor current and slip characteristics conforming to standard equivalent to those of the IEC Standard.

It shall be of the continuous duty type for operation on 415 volt, 3-phase, 50-flz. Motors shall be capable of operating continuously at rated output plus or minus 5% of the rated frequency and at any voltage within plus or minus 10% of the rated value.

b) Control Equipment
The control equipment shall be of the float-switch actuated control type installed in the water storage tanks and shall be of suitable switch for draw-down in the deep-well. One of the two deep-well pumps shall start operation alternately when the water level
in the water storage tank goes down to the designated level.

When the water level of the deep-well goes down to the designated level, the deep-well pump shall be stopped immediately, and the other deep-well pump shall be started automatically. Breakdown of deep-well pumps shall be connected to an alarmed on the control board in the control room.

c) Control Board

The control board shall be installed in the fire pump-house.

A boxed knife switch shall be provided in the fire pump-house for each pump.

d) Signal Indicators

i) All indicator lights shall be of AC type with coloured glass or plastic lens and shall be so constructed that the lamp can be readily fitted and removed and the lens changed from the front of the boards.

ii) Ammeters shall be capable of accepting the starting current characteristics of the corresponding motor and shall be suitably calibrated to indicate the full load running current at three quarter full scale deflection.

e) Conduit Piping and Wiring

Conduit piping and wiring for the work shall comply with the applicable provisions of the Specification.

(5) Installation

The Contractor shall construct a concrete base foundation for accurate mounting of the pumping unit and shall provide foundation bolts for anchoring the pump, which shall be carefully levelled and grouted in place.

The pumping unit and control equipment shall be housed for all weather protection.

(6) Accessories

The following accessories shall be equipped for each pump:

Sluice valve : 1 Pc
Check valve : 1 Pc
Air release valve : 1 Pc
Pressure gauge with cock : 1 Pc
Water pipe : Required Length
Well cover : 1 Pc
Submersible cable : Required Length
Flanges : 1 Set  
Foundation bolts : 1 Set  
Other necessary accessories

(7) Data to be submitted with Bids

Complete specifications of the supply including the physical dimensions and materials used for the principal parts of the supply.

Pump discharge capacities, efficiencies, horsepower input and performance characteristic curves at various heads on pump settings.

Guaranteed brochures, catalogues and other related technical data concerning the operation of the supply.

(8) Piping

Materials and Performance of piping for the work shall be in accordance with the applicable provisions of the Specification.

17.11 Ducts

The concrete ducts to install cables and pipes shall be provided. The ducts shall be covered with concrete or steel checkered plate, both having enough strength, and shall be provided with the necessary number of racks for cable and pipes.

The thickness of the concrete ducts shall be not less than 18cm, width and depth of ducts shall be more than 40 cm respectively and an appropriate drainage system shall be designed within the duct.

The Contractor shall submit design drawing to the Ashuganj Power Station Company Ltd. for approval.

17.12 FENCING, GATES, FLAG POLES, SITE BOUNDARY WALL AND ACCESS ROAD TO PLANT

17.12.1 Fencing

Chain link fencing shall be installed as directed by the Ashuganj Power Station Company Ltd. The chain link fencing shall be 2.4 m high with 3 strands of barbed wire at the top, generally complying with B.S. 1722 or other approved Standards.

Posts and struts shall be fabricated from 100 mm x 100 mm x 6.5 mm thick angles and set in concrete. The struts shall be fitted to all end and corner posts at changes in direction or acute variations in levels and at intervals not exceeding 9 meters in straight lengths of fence. All posts shall be hot dip galvanised.

Prior to the supply and installation, the Contractor shall submit samples of fencing materials, structures and colour to be adopted to the Ashuganj Power Station Company Ltd. for approval.

17.12.2 Gates

Sliding metal gates of 2.4 meter high and pedestrian swing gates of 2.0 meter height shall be constructed at suitable locations as directed by the APSCL. The gate should also have pocket gate.
Decorative brick walls to be incorporated in the work next to the pedestrian gate at the power station shall have the following dimensions:

- Height: 2.4 metres
- Length: 5.0 metres
- Thickness: 0.25 metre

The Contractor shall submit design drawings showing details of the gates for approval of the Ashuganj Power Station Company Ltd.

17.12.3 Flag Poles

Three (3) flag poles shall be erected at locations as directed by the Ashuganj Power Station Company Ltd.

The poles shall be of tapered steel pipe, about 15 m in height with a diameter of 20 cm at the bottom. The pole shall be firmly held to a concrete foundation.

It shall be equipped with a brass pulley near the top and nylon rope for hoisting the flag.

The pole shall be painted in accordance with the specification for painting to the satisfaction of the APSCL.

17.12.4 Site Boundary Wall

The site boundary wall shall be installed around the power station as directed by the APSCL. The site boundary wall shall be of brick wall with RCC frame in accordance with KPI Standard and 2.40 m high and 0.25 m thickness.

The contractor have to build a double layer boundary wall with insulation in between the layers at the APSCL existing residential side only of the project area. Height of that wall will be at least 20 feet from the GL. So that the noise limit should not exceed 40 dB at night and 50 dB at day at the adjacent residential area. If any additional majeure needed to maintain this noise level it have to be borne by the contractor.

17.12.5 Access road to Power Plant

Contractor shall have to construct an access road from B-type gate to the power plant site. The road shall be minimum length of 700 meters, width of 5 meters and depth of 300 mm RCC made. Road ISG 300 mm, sub base 300 mm and base course of 300 mm shall be ensured by the contractor. Contractor shall follow the specification for road according to Roads and highways division of Bangladesh.
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18. Building Works

18.1 General

The General Conditions, Tender Drawings, relevant Specifications On materials and workmanship described elsewhere in this Documents, Schedules shall be read in conjunction with this Specification.

The Contractor shall design and construct all the buildings for this power generation facility. Building architecture shall follow the local design style and practice for similar industrial type buildings and subject to Employer’s approval.

All buildings shall comply with the Bangladesh National Building Code-2006 for selection of non-combustible construction materials, requirements for fire protection and separation, lighting and lightning protection, building ventilation and air conditioning of control and electronic equipment areas, office areas etc. as required for such facilities.

All buildings shall be provided with suitably sized rainwater collection gutters and downpipes, routed to the storm water drainage system. They shall be designed for the rainfall intensity. Personnel access ways to and from buildings shall be provided with canopies or substantial overhangs to protect personnel from rainfall while entering and leaving the buildings.

Major equipment access doors shall be rolling steel doors. They shall be motor operated with manual override.

All double and single vertical hinged doors shall be steel doors with door closer. Double doors are provided where required for both equipment removal and access. Doors for building entries and exits, control rooms, hallways, offices, laboratories, and other high traffic areas, shall be fitted with glazed viewing windows.

Where fire doors are required, the doors, door frames, and door hardware shall have appropriate industry certification of the required fire rating.

Windows and louvers shall be manufacturer-standard aluminium, factory tinted, used in commercial or industrial applications, as appropriate.

Steel-trowelled, surface-hardened concrete shall be used in unfinished concrete floor areas. The floors for chemical contaminated areas shall be concrete construction with a chemical resistant coating. Floors for offices and control and electronic rooms shall have terrazzo tiles. For high moisture areas, such as showers and locker rooms, ceilings shall have moisture resistant, lay-in terrazzo tiles. Unglazed ceramic tiles shall be used on floors in high moisture areas, such as locker rooms, showers, and toilets.

Suspended lay-in acoustical tile ceilings and recessed fluorescent lighting shall be provided in control rooms, electronics rooms, offices, conference rooms, toilets and lunch rooms.

All masonry wall plastered surfaces, ceilings, doors and door frames shall be painted.

Building finishes, materials selection, paints selection, colour schemes, etc. will be selected by Employer from samples and manufacturers’ catalogues submitted by the Contractor.

Glaazed ceramic tiles shall be used on toilet/shower room and chemical lab wall till 2m height.
18.1.1 Contractor's Responsibilities

This is a turnkey contract which includes all building works and services. The Tender shall cover all requirements of the Tender Documents and any other items not specifically mentioned but which are deemed to be necessary for the complete execution of the Works to the entire satisfaction of the Ashuganj Power Station Company Ltd. No additional cost will be considered for any item which the Contractor has over looked but are essential for the full completion of the Project in every respect.

The Tender shall include the building works proposal complete without-line drawings indicating any variation or improvement which he deems technically or financially justified for the works mentioned in the Tender Document, schedule of materials and finishes on which the tender has been based. The Building shall generally conform to the sizes shown below & as per approval of the Ashuganj Power Station Company Ltd.

The Contractor shall be responsible for all performance in the detailed design, supply of material, labour, plants and equipment, construction and relevant works incidental to the completion of the Building Works.

The Contractor shall perform the Works thoroughly in accordance with the agreed construction schedule and direction to be made by the Ashuganj Power Station Company Ltd. during the Contract Period.

18.1.2 Building Sub-Contractor

The Contractor may employ a building subcontractor for building works. If the Contractor intends to subcontract the building works design and/or construction, his tender shall include full details of comparable works carried out elsewhere by the subcontractor, together with details of the financial stability and general efficiency of the proposed subcontractor.

18.1.3 Construction Schedule

A preliminary building construction schedule showing the completion time for the building works shall be submitted by the Tenderer based on the overall project implementation schedule. The Contractor shall prepare and submit to the Ashuganj Power Station Company Ltd. for approval a detailed construction schedule for the building works developed from the preliminary building construction schedule before commencement of the Work on the Site. The approved construction schedule shall not be altered without the written consent of the Ashuganj Power Station Company Ltd..

18.1.4 Records

The Contractor shall keep accurate and up-to-date records and drawings of the Works at the Site and shall provide the Ashuganj Power Station Company Ltd. with copies of these records. The Contractor shall submit to the Ashuganj Power Station Company Ltd. weekly reports of labour, plant and materials employed on the Site.

18.1.5 Samples Testing And Inspection

The Contractor shall perform testing and inspection of materials and shall submit sample materials, test certificates and workmanship details to the Ashuganj Power Station Company Ltd. for approval. The costs of all samples and testing shall be borne by the Contractor.
18.1.6 Temporary Services

The Contractor shall be responsible for arranging the provision of electricity, water, drainage, etc. necessary for the proper execution of the Works. All costs for these services shall be borne by the Contractor.

18.2 Scope of The Works

The building works shall include collection of the Site information, detailed design, production of working drawings, provision of labour, plant and materials, tests/inspection, construction and remedy of defects during the Warranty Period. The Building shall generally con-form to the sizes as mentioned below.

a. Control building, Engine house, Fire Fighting pump house, Emergency Diesel Generator house, Guard house, water supply house, fencing, boundary wall, road etc. shall be constructed by the Contractor within the Site area.

b. Dimensions and number of rooms of the Buildings mentioned shall be to the standard practice based on the size and number of Equipment and acceptable to Ashuganj Power Station Company Ltd.

   However, dimension of

   1) control building [two storied, all air-conditioned rooms including control room, battery room, auxiliary room] shall not be less than 13 Metres x 24 Metres;

   2) Two storied administration building each floor minimum 360 Sq. meters area. Dimensions not less than 12 Metres x 30 Metres.

   3) Three storied warehouse each floor minimum 300 Sq. meters storage area (including overhead crane and hoist crane etc.). Dimensions not less than 15 Metres x 20 Metres.

   4) Two storied workshop building with Maintenance people sitting facility. Each floor having minimum 500 Sq. meters area (including overhead crane and hoist crane etc.). Dimensions not less than 20 Metres x 25 Metres.

18.3 Design of The Works

18.3.1 Designs and Drawings

The Contractor shall design in accordance with this Specification and prepare complete working drawings as necessary for the construction of the Works. All drawings shall be submitted for the approval of the Ashuganj Power Station Company Ltd.

18.3.2 Standards and Codes Of Practice And Other Design Conditions

Design and construction of building works shall conform to recognise authoritative intentional or national standards and codes of practice [BNBC]. The adopted standards or codes shall be consistent throughout any section of the works unless otherwise specified. The Contractor shall have full responsibility to investigate the existence of any decrees and local bylaws governing the proposed works and to fully comply with such requirements which are effective when the date of tender submission.

As described elsewhere in the documents the Contractor shall indicate in his tender standards and codes to be conformed in design and construction of the Works. Copies of these codes and standards shall be made available to the Ashuganj Power Station Company Ltd. during the design and
construction period.

a. **Basic design conditions for buildings are outlined as follows:**

   - **Design wind speed**: 100 miles/hr.
   - **Seismic horizontal ground acceleration**: 0.05g
   - **Ditto - (vertical)**: Nil

b. **Live load of each floor shall be more than as follows:**

   - **Auxiliary room**: 500 kg/sq.m
   - **Cable spreading room**: ditto

### 18.3.3 Submission of Designs and Drawings

The Contractor shall be required to produce full design calculations for the foundations, building structures, and detailed working drawings and reinforcement bar bending schedule etc. Design calculations shall be prepared in accordance with an approved method of computation based on the most unfavourable combination of dead load, live load or crane load and wind load. The Contractor shall be responsible for the detailed design, strength and safety of the structures, and ensuring that the design satisfies the requirements of all authorised local and international bodies.

Design calculations and detailed drawings shall be submitted to the Ashuganj Power Station Company Ltd. for approval in accordance with the requirement set out in Section 18.3.1 of the Tender Documents. Construction on the Site shall only commence after drawings are finally approved.

Notwithstanding the Ashuganj Power Station Company Ltd.'s approval, the Contractor shall be held responsible for the accuracy of his submitted information, designs and drawings.

### 18.4 Building and Services

#### 18.4.1 Control Room Building

The structure shall be reinforced concrete load bearing frames, floors, and roof slabs, with plastered brick masonry infill panels and internal partitions. The building shall all be air conditioned. All floor slabs shall be designed for a minimum live load of 10 kN/m2. The control room shall be design such way that all engines shall be visible from control room.

Control building [two storied, all air-conditioned rooms including control room, battery room, and auxiliary room] shall not be less than 13 Metres × 24 Metres.

#### 18.4.2 Administration Building

The structure shall be reinforced concrete load bearing frames, floors, and roof slabs, with plastered brick masonry infill panels and internal partitions. The building shall all be air conditioned. All floor slabs shall be designed for a minimum live load of 10 kN/m2.

Two storied administration building each floor 360 Sq. meters area.
18.4.3 Warehouse Building

The structure shall be reinforced concrete load bearing frames, floors, and roof slab, with plastered brick masonry infill panels and any internal partitions. The ground floor slab shall be designed for a minimum live load of 15 kN/m².

The warehouse shall be furnished with sufficient robust shelving to store all mandatory and recommended spare parts, consumables, specialised tooling, and machine tools for machines in the workshop, raw materials, steel racking, fasteners and general engineering equipment for a minimum of two years operation.

Desks and chairs shall be provided for a minimum of four work locations in the warehouse for store men, engineering and purchasing personnel, each equipped with a PC for inventory control purposes.

Three storied warehouse each floor 300 Sq. meters storage area (including overhead crane and hoist crane etc.).

18.4.4 Workshop Building

The structure shall be reinforced concrete load bearing frames, floors, and roof slab, with plastered brick masonry infill panels and any internal partitions. The workshop will have an overhead crane able to access the full workshop floor and its lifting capacity will match the heaviest maintenance lifting load. The ground floor slab shall be designed for a minimum live load of 15 kN/m².

The external shell for this building will be a structural steel frame with sheet metal cladding on the walls and roof. Its structure shall be designed for all the loads and load combinations specified earlier.

All floor gratings shall be hot dip galvanised construction suitable for the floor loading. FRP grating shall be used where chemical spillage is expected.

Two storied workshop building having floor 500 Sq. meters storage area (including overhead crane and hoist crane etc.).

In workshop building, The Contractor shall install, testing and commissioning by providing the equipment and tools but are not limited to the followings:

**List of Equipment and Tools:**

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Description of Equipment and Tools</th>
<th>Q'ty</th>
</tr>
</thead>
</table>
| 1      | Precision Small type Lathe Machine (Type: KD 50  
|        | Bed Length: 400 mm  
|        | High of center:50 mm  
|        | Distance between center:180 mm  
|        | Spindle bore: 8mm  
|        | Longitudinal movement of the compound rest:75mm  
|        | Transverse movement: 65mm  
|        | Maxim turning diameter over Lathe bed:100 mm  
<p>|        | Main Spindle Speed:280 rpm to 2900 rpm)                                                         | 1    |
| 2      | Bed type universal milling machine                                                                | 1    |
| 3      | Heavy duty Vertical Drilling Machine (Size: 0-25 mm, 25-50 mm, 50-75 mm)                          | 1    |
| 4      | Spindle vertical drill machine (Size: up to 50 mm)                                                | 1    |</p>
<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Description of Equipment and Tools</th>
<th>Q'ty</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>Heavy duty power hacksaw (Type: Sawing range 250mm (square and round).</td>
<td>1</td>
</tr>
<tr>
<td>6</td>
<td>Precision bench type grinding machine</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Over all height: 3.5 feet</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Maximum grinding area: diameter up to 10 inch</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Rectangular 4 inch to 16 inch</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Vertical grinding Machine (Size: 100, 115, 180, 210 mm)</td>
<td>2</td>
</tr>
<tr>
<td>8</td>
<td>Thread cutting Machine (Model: K75 Hand operated)</td>
<td>1</td>
</tr>
<tr>
<td>9</td>
<td>Thread cutting Machine (Model: K75 Motor operated)</td>
<td>1</td>
</tr>
<tr>
<td>10</td>
<td>Hydraulic pipe bender (Size: 0.5 inch to 4 inch)</td>
<td>2</td>
</tr>
<tr>
<td>11</td>
<td>Magnetic drill machine (Size: 2mm to 25 mm)</td>
<td>1</td>
</tr>
<tr>
<td>12</td>
<td>Piston ring removal and installing tools set</td>
<td>2</td>
</tr>
<tr>
<td>13</td>
<td>Motor operated Valve seat grinding machine (Size: Standard)</td>
<td>1</td>
</tr>
<tr>
<td>14</td>
<td>Valve spindle machine</td>
<td>1</td>
</tr>
<tr>
<td>15</td>
<td>Magnetic Grinding Machine (Size: Standard)</td>
<td>1</td>
</tr>
<tr>
<td>16</td>
<td>Vice Table (Size: Standard)</td>
<td>1</td>
</tr>
<tr>
<td>17</td>
<td>Heavy Vice (Foundation Bolt) (Size: Standard)</td>
<td>1</td>
</tr>
<tr>
<td>18</td>
<td>Smith working table (Size: Standard)</td>
<td>1</td>
</tr>
<tr>
<td>19</td>
<td>Anvil (Size: Standard)</td>
<td>1</td>
</tr>
<tr>
<td>20</td>
<td>Gas welding set (Size: Standard)</td>
<td>1</td>
</tr>
<tr>
<td>21</td>
<td>Arc welding set (Capacity: 500 amp)</td>
<td>1</td>
</tr>
<tr>
<td>22</td>
<td>Argon welding set (Capacity: 500 amp)</td>
<td>1</td>
</tr>
<tr>
<td>23</td>
<td>Hydraulic Ladder (For Light maintenance) (Capacity: Up to 50 meter)</td>
<td>1</td>
</tr>
<tr>
<td>24</td>
<td>Hand Liner honing machine</td>
<td>1</td>
</tr>
<tr>
<td>25</td>
<td>Motor operated vertical honing machine</td>
<td>1</td>
</tr>
<tr>
<td>26</td>
<td>Valve seat removal and fixing machine</td>
<td>1</td>
</tr>
<tr>
<td>27</td>
<td>Valve guide removal and fixing machine</td>
<td>1</td>
</tr>
<tr>
<td>28</td>
<td>Deep Freezer (-150 deg. C)</td>
<td>1</td>
</tr>
<tr>
<td>29</td>
<td>Cylinder head cleaning machine</td>
<td>1</td>
</tr>
<tr>
<td>30</td>
<td>Seat cutting machine</td>
<td>1</td>
</tr>
<tr>
<td>31</td>
<td>Portable vacuum cleaner</td>
<td>2</td>
</tr>
<tr>
<td>32</td>
<td>Cylinder head pressure testing machine</td>
<td>1</td>
</tr>
<tr>
<td>33</td>
<td>Seat ring grinding machine</td>
<td>1</td>
</tr>
<tr>
<td>34</td>
<td>Injector testing machine</td>
<td>1</td>
</tr>
</tbody>
</table>

18.4.5 **Miscellaneous Buildings**

Miscellaneous buildings including but not limited to Reception cum Security Building. The Contractor shall provide any other buildings, structures or facilities if they are required to meet noise emission requirements or for other reasons, as determined by the Contractor.

Construction all Buildings

**1) Main construction materials**

Frame: Reinforced concrete

Roof: Reinforced concrete roof with lime concrete waterproofing.
Exterior wall: Reinforced concrete and/or brick.
Partition wall: Brick
Floor: Concrete with plastic tile, ordinary tile, trowelled mortar finish, etc
Foundation: The Contractor shall examine subsoil condition for design of foundation. Proper foundation shall be designed by the Contractor in accordance with the Specifications

(2) Windows:
Aluminium sash shall be provided. Window area shall be generally more than 1/10 of the room floor area unless otherwise indicated. All windows except toilet, store, and cable spread mg room windows shall be fitted with sun blinds of approved made. The glasses should be gas filled tempered glass.

(3) Machines and utilities:
Air conditioning system, ventilation system, water supply system, power supply system, drainage system, sanitary system and lighting system shall be provided.

(4) Finishes and room sizes:
The Contractor may submit the layout to suit any particular requirement subject to the approval of the APSCL.

(5) Other Requirement:
a. Control room: Noise level shall be kept to a value less than 45 db (A).

b. Toilets: Toilets shall be provided with sanitary fittings as required for plant operation and maintenance team sufficiently. Provide adequate sanitation facilities as outlined in the EIA. Toilets and bathrooms must be properly equipped including hand washing facilities with hot water and with separate facilities for men and women. The fittings should be submitted to APSCL for approval.

c. Ventilation and air conditioning
All rooms shall be provided proper ventilation system. The control room, relay room, electronics spares store, shall be provided air conditioning system.

18.4.6 AIR CONDITIONING SYSTEM
The detail design of air conditioning system for control building shall be based on the following criteria:
Outside temperature: 36 °C
Inside temperature: 20 °C
Relative humidity: 60%
Type of system: Package air conditioning units
Design calculations and drawings shall be submitted to the APSCL for approval prior to commencement of the work. Details of the equipment proposed shall be submitted with the Tender.

18.4.7 Ventilation System

All rooms in the control building, guard house etc. shall be designed and furnished proper ventilation system in principle.

Unless otherwise specified, natural ventilation will be acceptable for the minor buildings. All toilets, battery room and shall have exhaust fans of approved made.

All fans shall be statically and dynamically balanced to avoid vibration and shall have blades to secure quiet efficient operation.

18.4.8 Plumbing and Sanitary Installation

The whole of the plumbing works in the buildings shall be provided in accordance with the relevant bylaws and to the complete satisfaction of the APSCL. Pipes shall be connected to each point where water is required, with a minimum head of 2 metres at all outlets.

All cast iron pipe works and fittings as are necessary for the complete installation of the sanitary system shall be supplied and installed in accordance with the requirement of the local authorities and other standards approved by the APSCL.

18.4.9 Lighting

The whole of the power supply and lighting system for the buildings shall be designed and installed in accordance with the Section 11 of volume 2 of 2 (Part A).

18.5 Materials and Workmanship

18.5.1 Structural Steel

(1) General

Structural steel, bolts and nuts shall comply with the requirement of an approved standard and this Specification in all respects and those shall be fabricated from hot rolled sections unless otherwise specified or agreed in writing by the Ashuganj Power Station Company Ltd.

(2) Materials

The materials to be used shall be free from harmful defects and rust. Samples of materials shall be tested, and copies of the test reports giving physical and chemical properties shall be submitted to the Ashuganj Power Station Company Ltd. for approval. The Contractor shall carry out all necessary tests, at his own expenses, to prove that the materials offered for the intended purpose are in compliance with the approved Standard.

In lieu of these tests, mill sheets issued by the authorised manufacturers will be acceptable. The characteristic strength of the structural steel shall have the following values regardless of the standard and code used: -

a. Yield Point : not less than 4180 kg/sq.cm
b. Tensile Strength : not less than 7138 kg/sq.cm

c. Elongation : not less than 20%

(3) Bolt and Shear Connector

High strength bolts, anchor bolts, ordinary bolts and shear connectors to be supplied for the erection of structures shall conform to the Standard approved by the Ashuganj Power Station Company Ltd. and shall be of an approved manufacturer. Specially devised high strength bolts, if used, shall tightened in accordance with the manufacturer's instructions. Any bolt that has been fully, tightened and then untightened shall not be used in the permanent Works.

(4) Fabrication

Fabrication and erection drawings shall be submitted to the Ashuganj Power Station Company Ltd. for approval prior to commencement of any fabrication and erection work. Steelwork shall be fabricated to the required details in a manner approved by the Ashuganj Power Station Company Ltd.. The Contractor shall provide adequate facilities for the Ashuganj Power Station Company Ltd. to inspect materials and fabrication works in the shop and at the Site when required.

(5) Welding

Welding of structural steel shall be performed to the required type and size by an electric arc process by qualified welders under approved conditions. The plant, equipment and the adopted testing and inspection method shall conform generally with the relevant approved standard and other details in this Specification and shall all be to the satisfaction of the Ashuganj Power Station Company Ltd.

Welding shall not be performed when the ambient temperature is less than 0 deg C; when surfaces are wet or exposed to rain, or strong wind; or when welders are exposed to inclement weather conditions.

Surfaces to be welded shall be free from loose or thick scale, slag, rust, moisture, grease and other foreign material that will prevent proper welding or produce objectionable fumes. Welding shall be principally carried out in workshops. Where necessary the Ashuganj Power Station Company Ltd. may approve site welding, subject to the satisfactory provision of effective protection and safeguards for welding works by the Contractor.

(6) Welding Procedure

Details of the proposed welding procedure, manufacturer, classification on, code type and size of electrodes to be used shall be submitted to the Ashuganj Power Station Company Ltd. for approval. When necessary, welding tests shall include specimen weld details representative of the actual construction which shall be welded in a manner simulating to most unfavourable conditions liable to occur in the particular application. All costs of the tests shall be borne by the Contractor. All welds shall be finished full and made with correct number of runs. Slag and other inclusions shall be cleaned from all welds.

Notwithstanding the approval of welding schedule and procedure by the Ashuganj Power Station Company Ltd., the Contractor shall bear full responsibility for correct welding and for minimising the distortion
in the finished structure.

a. Preparation of Base Metal

Surface and edges to be welded shall be smooth, uniform, and free from fins, tears, cracks, and other discontinuities, which will adversely affect the quality or strength of the weld. In the preparation of the fusion faces, shearing shall be limited to metal thickness not greater than 8 mm. All fusion faces shall be prepared by machining shall be limited to metal shall be prepared by machining or flame cutting, or where approved, by special oxygen cutting apparatus. Fusion faces, angle of level, root radius, and the like shall be properly prepared to give the approved weld forms. The parts to be joined by fillet welds shall be brought into contact as close as practicable. The gap between parts shall normally not exceed 4.8 mm (3/16 in.). A butting parts to be joined by butt welds shall be carefully aligned and the correct gap and alignment maintained during the welding operation.

b. Butt Welded Joint

Ends of the welds shall have full throat thickness by means of run off tab. Additional metal remaining after the removal of the tab shall be removed by machining, or by other approved means. Ends and surfaces of the welds shall be smoothly finished. All main butt welds shall have complete penetration and, except on tubes or partial penetration Joint, shall be welded from both sides. The back of the first run shall be suitably gouged out.

c. Intermittent Welds

Intermittent welds shall not be permitted without the approval of the Ashuganj Power Station Company Ltd.

(7) Paint

Prior to delivery after shop inspection, the whole of the steelwork shall be prepared for painting by an approved blast cleaning method. All rust, grease, mill scale and harmful matter shall be removed. The surface shall be blast cleaned to:-

a. Swedish Standard Sa 2 1/2 SIS OS 5900 1967

b. British Standard 4232 Second Quality

U.S.A. Standard commercial blast finishSSPC-SP-6-63

The first coat of primer of recommended by the manufacturer as suitable for use under the prevailing condition at the application site shall be applied immediately after blast cleaning (or within two hours).

No paint shall be applied to the surfaces to be embedded in concrete, to contact surfaces for joints using high strength friction bolts and to surfaces within 50 mm either side of joints to be welded.

Painting shall be carried out in a clean, dry building where air temperature shall not be allowed to drop below 5 deg.C. No paint shall be applied on the steelwork with condensation. Painting shall not be carried out when the relative humidity is over 90%, or if in the open, during rain, fog or mist. The welded areas and the edges of site
joints shall be cleaned down, primed and painted all in accordance with the standards specified, after erection.

Each coat of the paint will be applied in different colour. When paintwork is damaged it shall be cleaned and re-painted following the procedures as approved by the Ashuganj Power Station Company Ltd. The manufacturer's instructions regarding inter-coat intervals shall be strictly observed.

(8) Transportation and Storage of Steelwork

The whole of the steelwork shall be handled in such a manner that the shape and surfaces of the section shall not be damaged during lifting and transportation. The Contractor shall take all necessary measures, to ensure that steelwork members shall be handled, stored and erected without their being subject to stresses in excess of those for which they were designed. Chains and hooks will not be used in contact with the steel work and lifting slings shall be of nylon rope. Steel work shall be stored in clean, dry conditions off the ground. Separate pieces of steelwork shall have spacer blocks between them.

(9) Erection

The Contractor shall ensure the correctness of alignment, plumbing and stability of the various frames and members. He shall also take all necessary measures, by adequate resistance to wind and stability against collapse, during construction.

No permanent bolting and site welding shall be carried out until proper alignment has been obtained.

18.5.2 Concrete

The specifications for concrete works under Section 17 are applicable to building works.

18.5.3 Grouting of Structural Steel work

(1) Materials for Grouting

The aggregate for grouting shall consist of hard siliceous sand, and grained chips, gravel or crushed stone, or other approved inert materials with similar characteristics. The materials shall be clean, free from lumps, soft or flaky particles, shale, crusher dust, silt, alkali, loam, organic matter or other deleterious substances. The aggregate shall be of uniform grading and shall be of such a size that 100% will pass through a 10 mm mesh and not more than 10% will pass through a 120 micron mesh. A pre-mixed non-shrink resin grout may be used. The manufacturer's instructions on mixing and the placing of the grout shall be observed.

(2) Admixtures

An admixture which acts as a non-shrinking agent shall be added to the grout only with the Ashuganj Power Station Company Ltd.'s approval. All proprietary admixtures shall be added and mixed strictly in accordance with the manufacturer's instructions.

(3) Surface Treatment

Concrete surface which is to be grouted shall be thoroughly cleaned.
and all laitance removed from the surface by means of a hammer and chisel. A power hammer shall not be used.

(4) **Mixing**

The Contractor shall submit to the Ashuganj Power Station Company Ltd. for approval details of the mix and the methods he intends to use, prior to the commencement of the grouting.

(5) **Placing**

For cement based grouts the concrete surface to be grouted shall be thoroughly saturated with water at least two times before the commencement of grouting.

### 18.5.4 Roofing and Brickwork

#### (1) Roofing

Roofing material for administration building shall be reinforcement cement concrete, warehouse and workshop building shall be of corrugated sheet metal cladding. The Contractor shall submit samples and technical details of the roofing material for approval of the Ashuganj Power Station Company Ltd.

An insulation layer of glass fibre or rock wool board of minimum 25 mm thick shall be incorporated in the roofing system. The thermal conductance of the composite roof cladding shall be less than 1.10 kcal/sq.m hr-deg C at 250C.

All accessories and the method of fixing shall be strictly in accordance with the manufacturer’s instructions and to the satisfaction of the Ashuganj Power Station Company Ltd.

#### (2) Waterproofing

Waterproofing for reinforced concrete flat roofs shall be of lime concrete. The minimum thickness of lime concrete shall be 10 cm.

#### (3) Eaves Gutters and Down Pipes

Eaves gutters shall be of PVC or galvanised steel sheet coated with bitumastic painting to be approved by the Ashuganj Power Station Company Ltd.. Where large section is required, steel sheet is preferable for strength. Down pipes shall be of PVC pipe, galvanised steel pipe or cast iron pipe to be approved by the Ashuganj Power Station Company Ltd.

#### (4) Brick Walls

Bricks to be used for walls shall be Bangladesh made. Unless otherwise specified or as shown in drawing, the thickness of brick-wall shall be more than 15 cm.

Mortar for use with brickwork shall be mixed in the proportions of 1:3 cement, sand or 1:2:5 cement, lime and sand by volume. Mortar may be mixed by hand or machine. Hand mixing shall be carried out on a clean, watertight platform. Cement shall be of a quality as described in the Section 17 for concrete. Sand shall be well-graded (2.5 mm down) hard and free from deleterious substances. Lime for mortar shall be pure calcium carbonate properly burned, then hydrated, and
finely ground. All joints shall be completely filled with mortar. The thickness of the horizontal mortar joints shall not exceed 40 mm to every four joints. The mortar shall be used within 2 hours of mixing with water and any mortar not used then shall be discarded.

All brick-walls are to be reinforced with approved reinforcing material at every fourth course.

The damp proof course shall be provided at joint and intersections laid on a bed of cement sand (1:1), bedded in and coated on the upper surface with liquid bitumen.

External fair faced wall shall be weather struck; faces or wall which are to be plastered or rendered shall have their joints raked out to form key.

(5) Calking

The Contractor shall calk the joints to ensure water tightness of the building structures. Prior to calking materials and working method shall be approved by the Ashuganj Power Station Company Ltd.

18.5.5 Carpentry and Joinery

(1) Timber

All timber shall be of best quality, perfectly dry and well seasoned, sawn die square, free from sap, shakes, wanly edges, large loose or dead knots and all other defects and shall be to the approval of the Ashuganj Power Station Company Ltd.

(2) Preservative

Timber to be used in shower rooms or in contact with the ground floor, shall be treated with an approved preservative against rot or termite attack. The backs or frames to be fixed to walls and all other bedding surfaces shall be painted with two coats of preservative before fixing. All fixing blocks, pallets, and other hidden timber shall be so treated prior to fixing.

(3) Joinery Fittings

All timber for Joinery fitting shall be of selected type properly seasoned and dry to a agreed moisture content not exceeding 18%. The Ashuganj Power Station Company Ltd. shall have the right to check all timbering used and to reject any timber found to have a moisture content exceeding 18%.

Joinery fittings and built-in cabinet are to be constructed exactly as shown on the approved drawings.

All work must be carried out by experienced cabinetmakers in a sound and workmanlike manner with properly fabricated joints, dovetailed, mitred or mortised and with concealed pins and screws. All joints shall be glued before pinning or screwing.

(4) Faults

Any defect in the wood works such as shrinks splits, fractures, etc shall be removed and replaced to the satisfaction of the Ashuganj Power Station Company Ltd.
18.5.6 Doors and Windows

All double and single vertical hinged doors shall be steel doors with door closer. Double doors are provided where required for both equipment removal and access. Doors for building entries and exits, control rooms, hallways, offices, laboratories, and other high traffic areas, shall be fitted with glazed viewing windows.

Where fire doors are required, the doors, door frames, and door hardware shall have appropriate industry certification of the required fire rating. All the doors should have handles.

Windows and louvres shall be manufacturer-standard aluminium, factory tinted, used in commercial or industrial applications, as appropriate.

Prior to furnishing and installing, the Contractor shall submit the shop drawings indicating shape, dimensions, material including hardwares and locking method of doors and windows for all buildings for the approval of the Ashuganj Power Station Company Ltd..

The standard requirements of doors and windows are as follows:

a. Steel doors
   Frame and Stile Plates : more than 2.3 mm thick
   Stile and Panel : more than 1.6mm thick
   Thickness : 80 mm
   Size : double door 2.0 x 2.0 m  single door 1.0 x 2.0 m or other sizes as shown on the approved drawing

b. Wooden doors
   Plywood for panel : more than 5 mm thick
   Thickness : 40 mm
   Size : 0.9x2.0 m or other sized as shown on the approved drawing

Hollow flush door shall be painted 2 coats of rust resistant paint and finish coat. Hollow flush door shall be of the waterproof type.

c. Aluminium window
   Thickness : 70mm
   Finishing : Alumite
   Size : double window 0.9 x 1.8 m e single window 0.9 x 0.9 m or other sizes as per approved drawing
   Glass (tinted) : 6mm

d. Aluminium swing doors
   Frame and stile plate : More than 2.3 mm thick
   Thickness : More than 45 mm
   Size : As directed by the APSCL

All other type of doors, windows, which are not specifically mentioned, shall
be provided to the satisfaction of the Ashuganj Power Station Company Ltd..

18.5.7 Glazing Works

(1) Materials

Sheet glass shall be of good quality, free flow unevenness and strain of bubbles. All the glass used on the ground floor shall be tinted glass (salon-radiation absorbing glass), and all the glass used on the first floor and control room shall be clear glass. Where so required figured glass shall be used. Minimum thickness of tinted glass and clear glass shall be 6 mm. Glazing beads, sealant, putty, clips and setting block shall be of good quality and those recommended by the glass manufacturer. All the glass used in the following rooms shall be tinted wire glass.

Auxiliary room and cable spreading room Warehouse and workshops Stores

(2) All glass shall be installed tightly in accordance with the instructions of the glass manufacturer.

Upon completion of the works, glass shall be wiped clean and shall be inspected by the Ashuganj Power Station Company Ltd.

18.5.8 Metal Works

(1) General

The metal works will include handrails, drain pipes, steel ladders, step ladders, cable duct hatch cover plate, removable hatch cover plate, rain water leader, air duct, louver and others. Prior to fabrication work drawings and quality of materials shall be submitted to the Ashuganj Power Station Company Ltd. for approval.

(2) Materials

The materials to be used in the Works shall be free from defects and conform to JIS Standard or relevant Standards approved by the Ashuganj Power Station Company Ltd.

(3) Workmanship

All plates and sections shall be true to form, free from twist and straightened before any fabrication work is started on them. The works of cutting, fabrication, welding, installation and painting shall be done in accordance with this Specification and relevant Standard. If difference quality metals are in contact with each other, these contact surfaces shall be separated by means of bituminous paint, felt strip, rubber sheet and other material to be approved by the Ashuganj Power Station Company Ltd.

18.5.9 Floor-laying

(1) PVC Flooring

PVC flooring shall be heat resisting vinyl tiles obtained from an approved manufacturer. The tiles shall be not less than 2.4 mm thick and laid by an specialist to a jointing layout approved by the Ashuganj Power Station Company Ltd. A matching PVC cove-type skirting is to
be used in conjunction with the floor tiles. The tiles and skirting shall be laid on a flat, clean concrete floor, in strict accordance with the manufacturer's instructions, using the recommended adhesive.

(2) **Unglazed Vitreous Ceramic Tiles**

The tiles shall be plain and of manufacture and colour approved by the Ashuganj Power Station Company Ltd. The tiles shall be laid by experienced craftsmen on a concrete slab accurately formed with a true, smooth surface. Joints shall be accurately aligned in both directions and matching covered skirtings. Expansion Joints shall be the same width as tile Joints, approximately 5 mm, and filled with approved filling material. The surface of the base shall be cleaned of all dirt, grease, grit, etc. and the tiles shall be dry and clean.

(3) **In-situ Terrazzo**

In-situ terrazzo paving is to consist of 2 1/2 parts 6.5 mm - 9.5 mm approved marble chippings, clean and free from dust, mixed with one part of "concrete" or "snowcrete" or approved equivalent according to the background required. The terrazzo shall be laid by a specialist. The terrazzo is to be trowelled to a dense even surface, rubbed down and polished to approval. Where surface are required to be left rough finish the finishing coat shall be brushed with wire brush while still green to expose the aggregates.

Brass dividing strips 25 mm x 3.2 mm shall be provided at junctions of different floor finishes, finishing flush with flooring non-slip nosing tiles of approved manufacture and colour shall be provided in finishing works for steps and stair.

(4) **Damp-Proof Membrane**

An approved bitumen/PVC water-proof membrane shall be placed on the blinding concrete under concrete slabs, to exclude rising moisture.

18.5.10 **Wall and Ceiling Finishes**

(1) **Materials**

Cement, sand, hydrated lime, gypsum plaster, expanded metal lathing, flat headed galvanised nails, galvanised staples and wire shall all comply with approved standards. Materials shall be carefully stored in a dry weatherproof store until required for use.

(2) **Preparation of Backgrounds**

Backgrounds for plaster work shall be carefully brushed out and removed dust and other deleterious matter likely to impair the bond of the undercoat with the structure. When the background surface is dry and undue suction occurs, this shall be sprinkled with water to prevent drying the applied plaster.

(3) **Plasterwork**

Undercoat shall consist of Portland Cement, hydrated lime and sand gauged in the proportions 1:1:6. The undercoat shall be keyed to take the finishing coat and allowed to dry out completely before the latter is applied.
Finishing coats shall be applied in accordance with the recommendations of the manufacturer of the particular brand to be used. The total thickness of the two coats shall not be less than 15 mm thick.

(4) **External Rendering**

External rendering shall be applied in two coats, with an approved waterproof agent added to the mixes. The walls shall be wetted before the application of the first coat, which shall be finished flat and vertical by straight edge, and scored to form a key. The second coat shall not be applied until the first coat has dried out completely. Immediately before application of the second coat, the surface of the first coat shall be wetted, and the second coat shall be applied by machine, to give a “Tyrolean” finish of uniform thickness and texture.

An approved plasticizer may be used in both coats. All external rendering shall be protected from rain and direct sunlight for period of 7 days.

(5) **Glazed Ceramic Tiling**

Glazed export quality ceramic wall tiles shall be of minimum nominal size 200 mm x 200 mm x 10 mm for wall, colour to be selected. Fittings shall be obtained from a supplier approved by the Employer. The ceramic tile fixing and grouting materials shall be obtained from the same source. Floor tiles shall be of minimum 600mm x 600mm x10mm.

The Contractor shall ensure that the rendering is accurately formed and has a true plumb surface which is free from all high spots and depressions.

The rendered backing for tiling shall be cleaned and will be wetted (just enough to prevent it from absorbing water from the fixing bed) immediately prior to tiling. All tiles shall be dipped in water to ensure that they are completely clean prior to fixing. All tiles shall be immersed in water in clean containers for at least half an hour before use. Tiles shall then be stacked lightly together on a clean surfaces to drain with the end tiles, turned glaze outwards. They shall be fixed as soon as all surfaces water has evaporated they must not be allowed to dry out more than this.

Approximately two days after the fixing of the tiles, all joints shall be pointed with neat white grouting cement; the finish shall be flushed and free from all voids and irregularities.

All wall faces shall be finished plumb and flush throughout free from unevenness and irregularities of plain; all angles shall be straight and true. The finished work shall be left clean and free from all materials, which will scratch or in any way impair the finished work. Final polishing shall be done with a dry cloth. The Contractor shall be responsible for the adequate protection of the tiling from all damage until the handling over. Any damage which does occur shall be made good by the Contractor at his own expense. The whole of the work shall be left in a state satisfactory to the Ashuganj Power Station Company Ltd..

(6) **Suspended Ceiling**
Materials, samples and drawings showing details of construction of all types of ceiling required shall be submitted to the Ashuganj Power Station Company Ltd. for approval.

Appropriate size of aluminium tees shall be grided to the module of standard panels to accommodate acoustic boards, or approved equivalent, the odd size panels at perimeter shall then be arranged to equal dimension.

Fixing of hanger to beams, floor slab and soffits must be capable of carrying the load of ceiling boards and ventilation grill should be supported from the strengthened aluminium tee grids.

(7) **Gypsum Board Partitions**

Gypsum panels shall be 1000 mm wide by 12 mm thick obtained from an approved manufacturer.

The stud partition shall be extended from floor to ceiling with variation in heights to suit. Stud shall be formed of approximately 0.03 gauge cold rolled steel with prepunched holes in the web 120 mm on centre to allow horizontal passage of utility lines. Studs shall be spaced 1000 mm on centre with horizontal spacer channels and framing materials.

Glass panel framing shall be anodised aluminium with glazing recess. Glazing shall be 6 mm clear sheet glass fitted with neoprene or vinyl gaskets.

The Contractor shall submit samples of metal and drawings showing details of constructions for approval of the Ashuganj Power Station Company Ltd..

18.6 **Painting**

18.6.1 **Materials**

All paint distempers and other materials shall be of an approved brand or brands and shall comply with JIS Standard or other, equivalent standard to be approved by the Ashuganj Power Station Company Ltd.. Paint for use on concrete or brickwork shall be of a type specially prepared for this purpose. Each coat shall be of a distinct colour from the preceding one and all colours shall be approved by the Ashuganj Power Station Company Ltd.. Mixed paint and synthetic resin emulsion paint shall be applied based on the following method:

<table>
<thead>
<tr>
<th></th>
<th>Metal (unit: kg/sq.m)</th>
<th>Mixed paint Wood</th>
<th>Synthetic resin emulsion Concrete Brick</th>
</tr>
</thead>
<tbody>
<tr>
<td>First paint</td>
<td>0.14</td>
<td>0.09</td>
<td>0.13</td>
</tr>
<tr>
<td>(Rust inhibitive paint)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Second paint</td>
<td>0.08</td>
<td>0.11</td>
<td>0.13</td>
</tr>
<tr>
<td>Finishing paint</td>
<td>0.04</td>
<td>0.09</td>
<td>0.13</td>
</tr>
</tbody>
</table>

**Note:** Rust inhibitive paint shall be either red lead or zinc rich lead type.
For painting of structural steelwork, see Section of 18.5.1(7).

18.6.2 Surface Preparation

Prior to painting, the dust, grease, injurious adherent substance, rust shall be removed from the surface to be painted. The planed grain, interlocked grain, fluff in wood shall be ridded with sandpaper and all cracks, manholes open; duct and other imperfection shall be made good with hard stoppings consisting of paste white lead and gold size stiffened with whiting. Cracks and holes on the concrete surface shall be flattened with cement paste, mortar, or cement filler.

18.6.3 Workmanship

All painting and decoration shall be carried out by skilled workmen according to the best current practice in accordance with manufacturer's instructions.

All materials shall be applied by brush unless otherwise specified or approved.

18.6.4 Priming

All joinery, metal works to be painted shall be primed using appropriate and approved primer before delivery assembly or fixing. No primer is required on surfaces to be distempered or emulsion painted unless otherwise specified.

18.6.5 Number of Coats

Unless otherwise specified, the required finishes shall consist of the following treatments, in addition to preparation, priming etc: -

a. Distempering Two coats

b. Emulsion painting Two coats

c. Oil painting Three coats on woodwork
   Two coats on elsewhere

18.6.6 Major Construction Materials

The Contractor shall maximise the use of locally available materials for construction of the civil, structural, and architectural work, provided the local construction materials comply with the codes and standards specified in Section 3.2. The following are the minimum requirements when applying those codes and standards:

- All concrete for structures and foundations shall have a minimum compression strength of 30 MPa in 28 days
- All structural concrete shall use Type 1 cement as per ASTM C150, unless the soil chemistry of the site requires a sulphate and/or chloride resistant cement suitable for the soil chemistry of this site. An alternative is to use Type 1 cement plus approved admixtures that will provide the required sulphate and/or chloride resistance
- All concrete shall use crushed stone coarse aggregate, and natural sand fine aggregate, as per ASTM C33
- Concrete mixing water shall be potable quality water only
- All concrete admixtures shall comply with the Bangladesh National Building Code-2006
All concrete mix designs, including concrete admixtures, shall be subject to Employer’s review and prior approval

All reinforcement for concrete construction shall be deformed reinforcing bars with a yield stress exceeding 410 N/mm², as per ASTM 615

All structural steel material shall be minimum ASTM Grade A36 for rolled steel shapes, angles, tees, plates, etc. having a minimum yield stress of 250 N/mm²

All handrails and posts shall be prefabricated, double rail type, hot dip galvanised steel pipe, with minimum 38 mm diameter and 4 mm wall thickness, as per ASTM A53

All floor gratings shall be a minimum 32 mm deep and hot dip galvanised, except that the turbine building operating floor grating shall be heavy duty suitable for the floor live load

All field connection bolts for structural steel shall conform to ASTM A325 and/or ASTM A490

All shop and field welding electrodes, welding procedures, inspection and testing of welding for structural steel work, etc., shall comply with applicable AWS Standards

The metal siding and roofing materials for the warehouse and workshop building shall be industrial grade, with factory applied protective coatings on the exterior surfaces consisting of high performance Kynar 500 colour coating, or approved equal

18.6.7 Unloading Facilities

It is Contractor’s responsibility to transport plant and equipment from manufacturer’s premises to the project Site at Ashuganj. The Contractor shall assess the inland transportation system in Bangladesh from the major sea ports to the project Site. Whether the Contractor uses the road facility or river facility for transportation of major plant and equipment, the Contractor shall develop appropriate unloading facilities at Site and the river side.

Bidders are advised to examine the condition of existing power plant area as a route to transport equipment to Site from the barge at Meghna River. Based on the results of their investigation, the Bidder may decide to include in their scope construction of a temporary jetty at the river bank and improvement of condition of the road(s) to be used for transportation of heavy equipment and materials. The temporary unloading facility will be approx. 0.7 km away from the project site.

After completion of transportation of all materials and equipment to the site, the temporary jetty must be demolished and removed from the river bank site.

18.6.8 Storage

The Contractor shall furnish an exclusive place for storing the combustible paints. The place for storage shall be fully ventilated. Adequate measures shall be taken against the ingress of dust and direct rays of the sun.
Section 19
Spare Parts
19. SPARE PARTS

19.1 GENERAL

The Contractor shall provide Mandatory/safety spare parts list for the life time (20 years) of the Plant and guarantee that the spare parts shall be available during the life time (20 years) of the plant.

Spares & consumables during Warrantee period

The Tenderer shall submit a list of spare parts with OEM Part No., equipment, materials and all consumables (Engine lube Oils, Fuel injector, greases, air & oil filters, Fuel oil filters, Charge air filters, ventilation filter, Breather filter, all chemicals etc.) to be necessary for day to day operation and maintenance of the generating units and other plant equipment inclusive of emergency use that takes place in the course of operation (according to the Manufacture's recommendation and guideline) during the Warranty period. The tenderer shall submit the list of spares and consumables that mentioned above with the proposal along with Manufacturer recommendation.

During the warranty period, the Contractor shall supply all (whether it is listed or not in their list) necessary equipment, spare parts, materials, consumables (Engine lube Oils, Fuel injector, greases, air & oil filters, Fuel oil filters, Charge air filters, ventilation filter, Breather filter, all chemicals etc.) to be necessary for day to day operation and maintenance of the generating units and other plant equipment inclusive of emergency use that takes place in the course of operation at his own cost and. The operation of the plant should be such that plant factor should be minimum 80%.

After completion of warranty period and before handover the plant, the contractor shall hand over all remaining spare parts, tools, equipment and consumables etc. to the APSCL.
Ashuganj 100 MW Power Plant

Mandatory Spare Parts of the Generating Sets (Engine & Generator) for Two (02) years after warranty period.

<table>
<thead>
<tr>
<th>SL No.</th>
<th>Description</th>
<th>Quantity</th>
<th>Price</th>
</tr>
</thead>
<tbody>
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20.2 Grid Networks

Location of Proposed Power Plant

Ashuganj 230/132 kV Grid S/S
20.3 Sub-station Single Line Diagram

Conceptual Single Line Diagram of Ashuganj 100 MW HFO Power Plant
# 20.4 Fuel Analysis

**SPECIFICATION OF HIGH SPEEED DIESEL (HSD)**

<table>
<thead>
<tr>
<th>SI NO</th>
<th>Characteristics</th>
<th>Requirements</th>
<th>Test Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Density at 15°C, Kg/L</td>
<td>0.820-0.870</td>
<td>ASTM D1298/ ASTM D 4052</td>
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<tr>
<td>2</td>
<td>Color ASTM, Max.</td>
<td>3.0</td>
<td>ASTM D 1500</td>
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<tr>
<td>3</td>
<td>Acidity, inorganic</td>
<td>Nil</td>
<td>ASTM D 664/ ASTM D 974</td>
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<tr>
<td>4</td>
<td>Acidity, total, mg of KOH/g, Max</td>
<td>0.20</td>
<td>ASTM D 664/ ASTM D 974</td>
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<tr>
<td>5</td>
<td>Ash, percent by mass, Max</td>
<td>0.01</td>
<td>ASTM D 482</td>
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<tr>
<td>6</td>
<td>Carbon residue on Conrad son on 10 percent residue, percent by mass, Max</td>
<td>0.20</td>
<td>ASTM D 189</td>
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<tr>
<td>7</td>
<td>Cetane Number, Min</td>
<td>48</td>
<td>ASTM D 613</td>
</tr>
<tr>
<td>8</td>
<td>Cetane index (calculated), Min</td>
<td>46</td>
<td>ASTM D 4737</td>
</tr>
<tr>
<td>9</td>
<td>Pour point, Max</td>
<td>a) Winter 6°C, b) Summer 9°C</td>
<td>ASTM D 97</td>
</tr>
<tr>
<td>10</td>
<td>Copper strip corrosion for 3 hour at 100°C</td>
<td>Not worse Than No.1</td>
<td>ASTM D 130</td>
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<tr>
<td>11</td>
<td>Distillation: 90% vol. recovery, °C, Max</td>
<td>375</td>
<td>ASTM D 86</td>
</tr>
<tr>
<td>12</td>
<td>Flash point, Pensky Martens closed cup/ Abell, °C Min</td>
<td>55</td>
<td>ASTM D 93/IP 170</td>
</tr>
<tr>
<td>13</td>
<td>Kinematic viscosity, centistokes at 38°C, Max</td>
<td>6</td>
<td>ASTM D 445</td>
</tr>
<tr>
<td>14</td>
<td>Sediment, percent by mass, Max</td>
<td>0.01</td>
<td>ASTM D 473</td>
</tr>
<tr>
<td>15</td>
<td>Sulphur, parts per million (ppm), Max</td>
<td>500</td>
<td>ASTM D 4294/ D 5453/D 2622</td>
</tr>
<tr>
<td>16</td>
<td>Water content, Percent by volume, Max</td>
<td>0.05</td>
<td>ASTM D 6304, D 95</td>
</tr>
<tr>
<td>17</td>
<td>Oxidation stability, g/m³, Max</td>
<td>25</td>
<td>ASTM D 2274</td>
</tr>
</tbody>
</table>

*Winter shall be period from November to February (both Months inclusive) and rest of the months of the year shall be called as summer.*
### HIGH SULPHUR FURNACE OIL (HSFO 180CST) SPECIFICATION

<table>
<thead>
<tr>
<th>SI NO</th>
<th>Characteristics</th>
<th>Requirement</th>
<th>Test Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Density at 15°C, kg/L</td>
<td>0.890-0.960</td>
<td>ASTM D 1298/ ASTM D 4052</td>
</tr>
<tr>
<td>2</td>
<td>Flash point, Pensky Martens closed cup 6°C, Min</td>
<td>66</td>
<td>ASTM D 93</td>
</tr>
<tr>
<td>3</td>
<td>Sediment, percent by mass Max,</td>
<td>0.25</td>
<td>ASTM D 473</td>
</tr>
<tr>
<td>4</td>
<td>Kinematic viscosity in centistokes at 50°C Max.</td>
<td>100-180</td>
<td>ASTM D 445</td>
</tr>
<tr>
<td>5</td>
<td>Water content, Percent by volume, Max</td>
<td>0.5</td>
<td>ASTM D 6304, D95</td>
</tr>
<tr>
<td>6</td>
<td>Pour point, °C Max</td>
<td>30</td>
<td>ASTM D 97</td>
</tr>
<tr>
<td>7</td>
<td>Sulphur, percent by mass, Max.</td>
<td>3.5</td>
<td>ASTM D 4294/ D 1552/D 2785/D 5453</td>
</tr>
<tr>
<td>8</td>
<td>Carbon residue, Conrad son, percent by mass, Max.</td>
<td>10</td>
<td>ASTM D 189</td>
</tr>
<tr>
<td>9</td>
<td>Gross Calorific value, kcal/kg, Min.</td>
<td>10250</td>
<td>ASTM D 240</td>
</tr>
<tr>
<td>10</td>
<td>Ash, percent by mass, Max.</td>
<td>0.1</td>
<td>ASTM D 482</td>
</tr>
<tr>
<td>11</td>
<td>Acidity, Inorganic, mg KOH/g</td>
<td>Nil</td>
<td>ASTM D 664</td>
</tr>
</tbody>
</table>
20.5 Seismic Zone Map of Bangladesh
20.6 Environmental Standards

20.6.1 General Introduction

The EPC contractor shall follow the Environmental Conservation Act, 1995 and the Environmental Conservation Rules (ECR), 1997 of Department of Environment (DoE) Bangladesh as well as World Bank Guidelines for environmental issues and ADB Environmental Safeguard Policy 2009 for environmental issues. The EPC contractor is responsible to prepare and submit Environmental Monitoring Report to Employer as per Environmental Monitoring Plan of EIA report during the construction period. The EPC contractor shall comply the Environmental Management Plan (EMP) of Environmental Impact Assessment (EIA) report.

The key design criteria shall be used in the development of the Ashuganj 100 MW HFO based Power Plant Project are summarized below.

20.6.2 Information

The Section provides excerpts from key environmental documents for information and reference only. The final environmental requirements shall be the most stringent of the limits indicated in all applicable environmental standards to the Ashuganj 100 MW HFO based Power Plant Project, and as indicated below and finalized in the project’s final Environmental Impact Assessment (EIA) and approved permit.

The Ashuganj 100 MW HFO based Power Plant Project shall comply with both the national environmental standards, as well as, the standards established by the ADB Safeguard Policy and World Bank.

For complete sets of the above referenced standards, refer to the following publications:


The EPC contractor is responsible for ensuring the design(s) complies with all the applicable standards.

20.6.3 General Environmental Requirements and Permit Compliance

The Ashuganj 100 MW HFO based Power Plant Project shall be designed by the EPC contractor and constructed to comply with all requirements of the DoE, Bangladesh and the WB Guidelines, the Environmental Conservation Act, 1995 and the Environmental Conservation Rules, 1997 and its amendment.

In Bangladesh, the Department of Environment (DoE) is the government agency responsible for environmental planning, management, and monitoring according to the Environmental Conservation Rules (ECR), 1997 issued under the Ministry of Environment and Forest (MoEF). According to the ECR, the Project falls under the Red Category classification. Obtaining Environmental Clearance Certificate from the DoE for projects in the Red Category involves three steps. The first step is to obtain a Local/Site Clearance Certificate if required and the second step is to submit the Environmental Impact Assessment (EIA) report, along with the Layout Plan, Time Schedule and a detailed design of the effluent treatment plant (ETP) and obtain approval of DoE. After EIA approval from DoE has been received, the project proponent may undertake activities for land development and infrastructural development of the project and may open L/C (Letter of Credit) for importing machineries for the project including machineries relating to waste treatment plant and other pollution control devices. Without obtaining Environmental Clearance Certificate (ECC) the proponent shall not start operation of the project.

20.6.4 Environmental Limits and Permit Compliance

The EPC contractor shall comply all environmental regulations of DoE, Bangladesh, ADB Safeguard Policy and WB Group as well as APSCL’s HSE and Lender’s requirements (if any) during the construction phase of project. The EPC contractor shall comply the final Environmental Management and Monitoring Plan that prescribed in the EIA report.

20.6.4.1 Gaseous Emissions

The air emissions from the Ashuganj 100 MW HFO based Power Plant Project are the gaseous products of combustion of liquid fuel. The pollutant of concern with firing HFO is sulfur-oxides (SOx), nitrogen-oxide and
Particulate Matter (PM). The composition of fuel contains Sulphur and produces sulfur-oxides (SOx). To control of sulfur-oxides (SOx) emission, the EPC contractor shall provide flue gas desulfurization (FGD) and to control of NOx emission the EPC contractor shall provide water injection facilities or Selective Catalytic Reduction System (SCR) for reciprocating engines.

The EPC contractor shall provide appropriate technology (Electrostatic Precipitator-ESP) for control of Particulate Matter (PM) of reciprocating engines.

The Ashuganj 100 MW HFO based Power Plant Project is to comply with stack emissions standards and ambient air quality guidelines of the Environmental Conservation Rules, 1997 and appropriate DOE, Bangladesh schedules and World Bank Guidelines.

The WB Guidelines limit for NOx are 1460 mg/Nm³ (bore size diameter <400 mm), 1850 mg/Nm³ (bore size diameter ≥400 mm), PM limits are 50 mg/Nm³ and SOx 1170 mg/Nm³ at 15% dry oxygen content. The EPC contractor will follow the guidelines described in following table 1.

<table>
<thead>
<tr>
<th>Smoke Type</th>
<th>Emission Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>NOx</td>
<td></td>
</tr>
<tr>
<td>If bore size diameter (mm) &lt; 400: 1460 mg/Nm³</td>
<td></td>
</tr>
<tr>
<td>If bore size diameter (mm) ≥ 400: 1850 mg/Nm³</td>
<td></td>
</tr>
<tr>
<td>SOx</td>
<td>1170 mg/Nm³</td>
</tr>
<tr>
<td>Particulate Matter</td>
<td>50 mg/Nm³</td>
</tr>
</tbody>
</table>


NDA: Non Degraded Air shed (No or few pollution existing)

DA: Degraded Air shed (Significant pollution already existing at site)

20.6.4.2 Ambient Air Quality

The EPC contractor shall perform to monitor ambient air quality during the project construction period and until handover period to APSCL. The EPC contractor is responsible for ensuring the compliance with all the applicable standards.

Table 2 provides the ambient air quality standards applicable to the Ashuganj 100 MW HFO based Power Plant Project.
Table 2: Applicable Ambient Air Quality Standards

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Bangladesh Standard</th>
<th>World Bank Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Standard</td>
<td>Average time</td>
</tr>
<tr>
<td>Carbon Monoxide (mg/m³)</td>
<td>10</td>
<td>8 hour</td>
</tr>
<tr>
<td></td>
<td>40</td>
<td>1 hour</td>
</tr>
<tr>
<td>SPM (µg/m³)</td>
<td>200</td>
<td>8 hour</td>
</tr>
<tr>
<td>PM 10 (µg/m³)</td>
<td>50</td>
<td>Annual</td>
</tr>
<tr>
<td></td>
<td>150</td>
<td>24 hour</td>
</tr>
<tr>
<td>PM2.5 (µg/m³)</td>
<td>15</td>
<td>Annual</td>
</tr>
<tr>
<td></td>
<td>65</td>
<td>24 hour</td>
</tr>
<tr>
<td>NOx (µg/m³)</td>
<td>100</td>
<td>Annual</td>
</tr>
<tr>
<td>Ozone (µg/m³)</td>
<td>235</td>
<td>1 hour</td>
</tr>
<tr>
<td></td>
<td>157</td>
<td>8 hour</td>
</tr>
<tr>
<td>SOx (µg/m³)</td>
<td>80</td>
<td>Annual</td>
</tr>
<tr>
<td></td>
<td>365</td>
<td>24 hour</td>
</tr>
</tbody>
</table>


20.6.4.3 Noise Level

The EPC contractor is responsible for comply the current DoE, Bangladesh noise category for the site and determining the appropriate design criteria to meet the controlling standards. Permissible noise levels at Project boundaries (all sides surrounding the project) as per WB and DoE, Bangladesh ECR guidelines are indicated in Table 3.

Table 3: Permissible Noise Levels

<table>
<thead>
<tr>
<th>Area</th>
<th>WB Sound Level Limits, dB(A) (hourly Leq)</th>
<th>DOE Sound Level Limits, dB(A) (hourly Leq)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Day Time 7am-10pm</td>
<td>Night Time 10pm-7am</td>
</tr>
<tr>
<td>Sensitive Areas (e.g. schools)</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Residential Areas</td>
<td>55</td>
<td>45</td>
</tr>
<tr>
<td>Mixed-Use Areas (predominantly residential areas mixed with commercial and industrial)</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Area</td>
<td>WB Sound Level Limits, dB(A) (hourly Leq)</td>
<td>DOE Sound Level Limits, dB(A) (hourly Leq)</td>
</tr>
<tr>
<td>---------------------</td>
<td>------------------------------------------</td>
<td>--------------------------------------------</td>
</tr>
<tr>
<td></td>
<td>Day Time 6am-9pm</td>
<td>Night Time 9pm-6am</td>
</tr>
<tr>
<td>Commercial Areas</td>
<td>70</td>
<td>70</td>
</tr>
<tr>
<td>Industrial Areas</td>
<td>70</td>
<td>70</td>
</tr>
</tbody>
</table>

The EPC contractor has to be aware that mitigation measures are to be incorporated in the design. The contractor will consider the following options for prevention and control of sources of noise emissions during plant design:

I. Selecting equipment with lower sound power level.
II. Installing silencers for fans.
III. Installing suitable mufflers on engine exhausts and compressor components.
IV. Installing acoustic enclosures for equipment casing radiating noise.
V. Use of sound insulation to improve acoustic performance during buildings & control room construction.
VI. Installing acoustic barriers without gaps and with a continuous minimum surface density of 10 kg/m² in order to minimize the transmission of sound through the barrier. Barriers should be located as close to the source or to the receptor location to be effective.
VII. Installing vibration isolation for mechanical equipment.
VIII. Locating noise sources to less sensitive areas to take advantage of distance and shielding.
IX. Siting permanent facilities away from community areas if possible.
X. Taking advantage of the natural topography as a noise buffer during facility design.
XI. Will mark the noisy areas as large size as possible that is clear to all with decibel level by permanent color.

During construction phase the contractor will comply the following points for reduction and prevention of noise pollution:

I. Will use fine-tuned, low noise generating construction equipments (Crane, fork lift, drilling rig, piling hammer, roof hoist etc.) and will submit
the fitness test certificate of these done by reliable company to HS&E division of APSCL & project authority.

II. Will establish batching plant in remote & isolated area.

III. Limiting the hours of operation for specific pieces of equipment or operations, especially mobile sources operating through community areas.

IV. Reducing project traffic routing through community areas wherever possible.

V. Speed limit of vehicles at the project site will be 10 km/hr.

VI. Use of any faulty equipment like crane, fork lift, roof hoist, drilling rig, piling hammer etc. that creates black smoke and high noise are strictly prohibited.

VII. Noisy activities during night time is prohibited.

VIII. Transportation of heavy equipment and vehicle will be done at night as much as possible with limited speed.

20.6.4.4 Effluent Discharge

Effluent discharges shall not exceed the discharge limits for industrial/power plant effluents specified by Bangladesh or the World Bank guidelines. The Bangladesh guidelines for wastewater are provided in the Environment Conservation Rule 1997. The effluent discharge quality requirements are summarized in following Table 4 as per WB & DoE, Bangladesh guideline:

Table 4: The Effluent Discharge Limits for Power Plant

<table>
<thead>
<tr>
<th>No</th>
<th>Item</th>
<th>Unit</th>
<th>Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Nitrogen including ammonia (N molecule)</td>
<td>Mg/l</td>
<td>50</td>
</tr>
<tr>
<td>2</td>
<td>Ammonia (Free ammonia)</td>
<td>Mg/l</td>
<td>5</td>
</tr>
<tr>
<td>3</td>
<td>Arsenic (As)</td>
<td>Mg/l</td>
<td>0.2</td>
</tr>
<tr>
<td>4</td>
<td>BGD$^{20}$ C</td>
<td>Mg/l</td>
<td>50</td>
</tr>
<tr>
<td>5</td>
<td>Boron</td>
<td>Mg/l</td>
<td>2</td>
</tr>
<tr>
<td>6</td>
<td>Cadmium (Cd)</td>
<td>Mg/l</td>
<td>0.05</td>
</tr>
<tr>
<td>7</td>
<td>Chloride</td>
<td>Mg/l</td>
<td>600</td>
</tr>
<tr>
<td>8</td>
<td>Chromium (Total Cr)</td>
<td>Mg/l</td>
<td>0.5</td>
</tr>
<tr>
<td>9</td>
<td>COD</td>
<td>Mg/l</td>
<td>200</td>
</tr>
<tr>
<td>10</td>
<td>Chromium (Hexavalent chromium)</td>
<td>Mg/l</td>
<td>0.1</td>
</tr>
<tr>
<td>11</td>
<td>Copper (Cu)</td>
<td>Mg/l</td>
<td>0.5</td>
</tr>
<tr>
<td>12</td>
<td>Dissolve Oxygen (DO)</td>
<td>Mg/l</td>
<td>4.5-8</td>
</tr>
<tr>
<td>No</td>
<td>Item</td>
<td>Unit</td>
<td>Standard</td>
</tr>
<tr>
<td>----</td>
<td>-------------------------------------</td>
<td>---------------</td>
<td>----------</td>
</tr>
<tr>
<td>13</td>
<td>Conductance</td>
<td>Micro mho/cm</td>
<td>1.200</td>
</tr>
<tr>
<td>14</td>
<td>Total soluble matters</td>
<td>Mg/l</td>
<td>2.100</td>
</tr>
<tr>
<td>15</td>
<td>Fluoride (F)</td>
<td>Mg/l</td>
<td>2</td>
</tr>
<tr>
<td>16</td>
<td>Sulphide (S)</td>
<td>Mg/l</td>
<td>1</td>
</tr>
<tr>
<td>17</td>
<td>Iron(Fe)</td>
<td>Mg/l</td>
<td>1</td>
</tr>
<tr>
<td>18</td>
<td>Total Kjeldahi nitrogen (N)</td>
<td>Mg/l</td>
<td>100</td>
</tr>
<tr>
<td>19</td>
<td>Lead (Pb)</td>
<td>Mg/l</td>
<td>0.1</td>
</tr>
<tr>
<td>20</td>
<td>Manganese (Mn)</td>
<td>Mg/l</td>
<td>5</td>
</tr>
<tr>
<td>21</td>
<td>Mercury (Hg)</td>
<td>Mg/l</td>
<td>0.005</td>
</tr>
<tr>
<td>22</td>
<td>Nickel (Ni)</td>
<td>Mg/l</td>
<td>1.0</td>
</tr>
<tr>
<td>23</td>
<td>Nitrate (N molecule)</td>
<td>Mg/l</td>
<td>10.0</td>
</tr>
<tr>
<td>24</td>
<td>Grease</td>
<td>Mg/l</td>
<td>10</td>
</tr>
<tr>
<td>25</td>
<td>Phenol compound (C₆H₅OH)</td>
<td>Mg/l</td>
<td>1.0</td>
</tr>
<tr>
<td>26</td>
<td>Dissolve phosphorus (P)</td>
<td>Mg/l</td>
<td>8</td>
</tr>
<tr>
<td>27</td>
<td>Radio active substance : Defined by Bangladesh nuclear Committee</td>
<td></td>
<td></td>
</tr>
<tr>
<td>28</td>
<td>pH</td>
<td>Mg/l</td>
<td>6-9</td>
</tr>
<tr>
<td>29</td>
<td>Selenium</td>
<td>Mg/l</td>
<td>0.05</td>
</tr>
<tr>
<td>30</td>
<td>Zinc(Zn)</td>
<td>Mg/l</td>
<td>1.0</td>
</tr>
<tr>
<td>31</td>
<td>Total dissolve evaporation residue</td>
<td>Mg/l</td>
<td>2.100</td>
</tr>
<tr>
<td>32</td>
<td>Temperature</td>
<td>Celsius</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Summer</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Winter</td>
<td></td>
<td></td>
</tr>
<tr>
<td>33</td>
<td>Suspended solid (55)</td>
<td>Mg/l</td>
<td>50</td>
</tr>
<tr>
<td>34</td>
<td>Cyanide (CN)</td>
<td>Mg/l</td>
<td>0.1</td>
</tr>
</tbody>
</table>

**Table 5: Indicative Values for Treated Sanitary Sewage Discharges**

<table>
<thead>
<tr>
<th>Pollutants</th>
<th>Units</th>
<th>WB Guideline Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td></td>
<td>6-9</td>
</tr>
<tr>
<td>BOD</td>
<td>mg/l</td>
<td>30</td>
</tr>
<tr>
<td>COD</td>
<td>mg/l</td>
<td>125</td>
</tr>
<tr>
<td>Total Nitrogen</td>
<td>mg/l</td>
<td>10</td>
</tr>
<tr>
<td>Total Phosphorus</td>
<td>mg/l</td>
<td>2</td>
</tr>
<tr>
<td>Oil and Grease</td>
<td>mg/l</td>
<td>10</td>
</tr>
<tr>
<td>Total Suspended Solids</td>
<td>mg/l</td>
<td>50</td>
</tr>
<tr>
<td>Total Coliform Bacteria</td>
<td>MPN/100 ml</td>
<td>400</td>
</tr>
</tbody>
</table>

NOT FOR SUBMISSION
1. **MPN = Most Probable Number**


### 20.6.4.5 Sanitary - Domestic Wastewater

Plant Sanitary wastewater from the anticipated approx. 100 plant member staff shall be collected and treated within a septic tank on the project site and shall comply with the DoE, Bangladesh & WB standards for effluent water. The EPC contractor shall ensure that the discharge treated domestic wastewater is compliant with current DoE, Bangladesh and WB standards. The treated sewage water or sanitary waste water will be finally released to another ground septic tank and soak well. Release of treated sewage water to neighboring river, canal, any surface water body & irrigation field is strictly prohibited. Treatment of all wastewater must be consistent with the standards and measures in the EHS guidelines of WB on wastewater and ambient water quality. Septic systems should only be used for treatment of sanitary sewage and are unsuitable for process wastewater treatment. During design the septic system the following issues will be considered:

I. Properly designed and installed in accordance with local regulations and guidance to prevent any hazard to public health or contamination of land, surface or ground water.

II. Well maintained to allow effective operation.

III. Install in areas with sufficient soil percolation for the design waste water loading rate.

IV. Install in areas of stable soils that are nearly level, well drained and permeable with enough separation between the drain field and the groundwater table or other receiving waters.

### 20.6.4.6 Plant Waste water

The EPC contractor shall provide treatment facilities of all plant liquid wastes and oil water separator, grease trap in compliance with the DoE, Bangladesh and WB Group environmental standards requirements, prior to discharge. Such plant liquid wastes shall include, but not limited to the following:

1. Demineralizer waste

2. Oily water and chemical area drains
3. Sanitary waste water

4. Miscellaneous waste water from laboratories, water softening etc.

The EPC contractor shall provide adequate sanitary facilities during the Project construction and operations. The oily waste stream from the Ashuganj 100 MW HFO based Power Plant Project shall be kept to a reasonable minimum and should be removed by oil water separator and grease trap from the collection of rainwater or drain water from areas that are not at risk of contamination by oil & grease.

All plant process wastewater and all industrial wastewater effluents (including waste water from utility operations, engine or equipment washing facilities, runoff from process and materials staging areas, equipment maintenance shop & laboratories water) shall be collected and treated by chemical neutralization, physical, chemical and biological treatment methods to comply with the effluent discharge limit criteria set forth in the DoE, Bangladesh Environmental Conservation Rules, 1997 and appropriate DoE schedules and will also conform to the requirements of the General EHS Guidelines for environmental waste water treatment of WB Group. The EPC contractor shall formulate and provide as part of the plant’s quality assurance (QA) program, a system to monitor the quantity and quality of the treated plant wastewater. The program shall provide for the submission of monthly reports summarizing the previous month’s results of the plant wastewater treatment program to Manager (Health, Safety & Environment) of APSCL.

If EIA report recommends for Effluent Treatment Plant (ETP), then the EPC contractor shall be bound to establish ETP.

20.6.4.7 Storm Water

Storm water includes any surface runoff and flows resulting from precipitation, drainage or other sources. Typically storm water runoff contains suspended sediments, metals, petroleum hydrocarbons, polycyclic aromatic hydrocarbons (PAHs), coliform etc. Rapid runoff even of uncontaminated storm water, also degrades the quality of the receiving water by eroding stream beds and banks. In order to reduce the need for storm water treatment, the EPC contractor will apply the following principles:
I. Storm water will be separated from process and sanitary waste water streams in order to reduce the volume of waste water to be treated prior to discharge.

II. Surface runoff from process areas or potential sources of contamination should be prevented.

III. Where this approach is not practical, runoff from process and storage areas should be segregated from potentially less contaminated runoff.

IV. Runoff areas without potential sources of contamination should be minimized (e.g. by minimizing the area of impermeable surfaces) and the peak discharge rate should be reduced by using vegetated swales.

V. Siltation trap will be used to prevent sediment load in surface runoff water.

VI. Where storm water treatment is deemed necessary to protect the quality of receiving water bodies, priority should be given to managing and treating the first flush of storm water runoff where the majority of potential contaminants tend to be present.

VII. The segregated scrap yard or waste dumping site should be made with tin shed to be safe from precipitation and cemented floor to prevent soil contamination and as well as to prevent surface water runoff pollution.

VIII. Oil water separator and grease traps should be installed and maintained as appropriate at refueling facilities, workshops, parking areas, fuel storage and containment areas.

20.6.4.8 Solid Wastes
The proposed Ashuganj 100 MW HFO based Power Plant Project may generate small quantities of solids and unit process wastes during the construction of the plant and its operational phases. The staff working at the plant and the plant’s water/wastewater treatment processes will produce some solid wastes such as paper, packing materials, food wastes and process sludge from the water treatment facilities etc. All such solid waste would be non-toxic in nature and may not require any special disposal requirements. The EPC contractor has to provide all supporting facilities like designated dustbin, trolley, manpower for handling and management of these materials and they should be transported to a designated off-site landfill or waste management area for final disposal in an environmentally sound manner during plant construction and commissioning. It is strictly forbidden for
EPC contractor to release any kind of trash to neighboring river, canal, any surface water bodies and irrigation fields or bare fields. If any project related waste is found to neighboring water bodies and surrounding land areas by HS&E division of APSCL, EPC contractor will clean it immediately and will manage properly. The landfill methods shall comply with the DoE, Bangladesh Environmental Conservation Rules, 1997 and will also conform to the requirements of the General EHS Guidelines of WB Group.

The EPC contractor shall provide the disposal method for the recovered oil from the plant equipment that will be captured and sent to a recycler for reprocessing (DoE approved vendor) or to a processor for fuel application in a brick kiln.

20.6.4.8.1 Medical Wastes
The EPC contractor will properly manage & incinerate the medical waste generated from its site medical center. It is strictly prohibited to discard this pathogenic and hazardous waste to any surface water body and surrounding lands.

20.6.4.9 River Water Temperature
The EPC contractor is allowed to discharge treated process waste water (only blow down water, open cycle cooling water, water from laboratories and water softening) to the river if required with an increase within 3°C of the ambient temperature at the edge of a scientifically & environmentally established mixing zone from the plant’s outfall discharge as per WB Guidelines.

20.6.5 Environmental Monitoring
The EPC contractor will monitor all the applicable parameters during construction phase and will provide facilities for operational phase. The following environmental issues should be monitored, according to EMP:

1. SOx, NOx, CO₂ & CO in ambient air during project construction period for using of heavy construction equipments like crane, fork lift, drilling rig, batching plant, roof hoist etc.
2. SOx, NOx, CO₂, CO, O₂ & SPM emissions from each stack during operation.
2. PM (SPM, PM2.5, PM10) in ambient air during construction & operation.
4. Surface water, ground water & drinking water quality during construction & operation.
5. Plant treated wastewaters during operation.
6. Discharge water quality (pH, Temperature, EC, TDS, Oil & Grease).
7. The EPC contractor shall also provide an online continuous emission monitoring system (CEMS) for SOx, NOx, O2, CO & CO2 measurements of flue gas which can also be monitored by DCAS in control room.
8. The EPC contractor shall provide portable device for exhaust measurement of stack emissions, ambient air quality monitoring and noise monitoring.
9. The EPC contractor shall also setup an Environmental Laboratory for operational period to monitor all marked parameters of water, waste water, air quality monitoring etc., equipped with Thermometer, EC meter, pH meter, Oil & Grease test meter, TDS Meter, TSS Meter, Lux Meter, BUMP Test Meter, Noise meter, Hygro meter (for control room, laboratories, store & large indoor work station) and other applicable parameters. All equipments will be robust with calibration certificate and country of origin will be USA or Europe based. Training will be provided by contractor to respective HS&E personnel and others of APSCL to operate these equipment properly.

Monitoring of all the marked parameters can be carried out by the EPC contractor or experienced 3rd party engaged by EPC contractor and approved by HS&E division of APSCL. The EPC contractor shall monitor and ensure ground level concentrations of SOx, NOx & PM (SPM, PM2.5 & PM10) in consideration of proposed stack height (stack height will be finalized as per recommendation of Feasibility Study, stack height determination report and EIA report) as baseline survey and to keep the concentrations within the acceptable limit. This situation is considered as potential environmental problem and the EPC contractor may use these values for design; however it is required and the responsibility of the EPC contractor to ensure that the Project is properly designed and is compliant with WB Standards and DoE, Bangladesh Standards.

20.6.6 Environmental Management Plan

20.6.6.1 General Introduction

Power plant project has the potential of creating environmental and occupational health & safety impacts during both construction and operation, particularly in terms of air emissions, noise pollution, water and sanitation, discharge of liquid wastes, solid wastes, employee’s health and safety. Energy projects can also have some positive effects, particularly in terms of socio-
economic benefits. The Environmental Management Plan (EMP) is related to the implementation of the measures prescribed in the EIA to reduce the adverse impacts to acceptable levels and to enhance the beneficial effects. The objectives of the EIA cannot be achieved unless taking the mitigation and benefit enhancement measures, identified in the EIA, are observed properly. For the Ashuganj 100 MW HFO based Power Plant Project, all the measures will be said to be successful if they comply with the Environmental Quality Standards (EQS) as specified in the Bangladesh-DoE Environmental Conservation Rules of 1997. The general objectives of the EMP for this project are as follows:

1. Implementation of the mitigation measures to reduce or eliminate negative impacts
2. Implementation of enhancement activities in order to maximize positive impacts
3. Identifying monitoring requirements and monitoring indicators
4. The site EMP will be used to demonstrate that the Ashuganj 100 MW HFO based Power Plant Project is operated with the minimum impact. The EMP presents the project information and examines the following:
   I. Work plans and schedules
   II. Resources necessary for implementation
   III. Emergency procedures
   IV. Training requirements
   V. The EPC contractor has to follow strictly the EMP suggested in EIA and Lender’s requirements (if there is any) both for construction and operational phase. The plant designs have to comply all the environmental requirements.

20.6.6.2 Air Quality Management
During plant construction, dust is generated from construction activities and the movement of transport vehicles. Construction Management shall attempt to minimize dust generation during the construction works; water shall be sprayed on exposed surfaces regularly during the dry season as required to keep the soil wet, thereby minimizing dust generation. Materials Stock pile will be covered suppression of dust to prevent dust pollution. Transportation of all construction materials (brick, sand and other dust containing material etc.) by
vehicle will must be covered with tarpaulin or polythene to the project site from the source to prevent dust emission at the site and road network.

Guaranteed emission levels for the plant at full-load capacity will be used in the design to predict the expected atmospheric emissions from the power plant, once it is operating. These levels are based on the temperature and excess oxygen concentrations prevalent within the combustion chamber.

Emission monitoring will form part of the plant operation procedure. During operation, stack emissions will be continuously monitored using fully automated continuous emission monitoring station (CEMS) for SOx, NOx, CO2, CO, O2 & SPM. The EPC contractor will provide proper emission monitoring on behalf of the Employer.

20.6.6.3 Water Quality Management
Make up water will be withdrawn from the Meghna River (if required) during the entire period of project life and discharge back to the river with consideration to minimize wastage. The volume of wastewater discharged from the power plant will consist of boiler wash water, boiler blow down, jacket water and other occasional releases. It will be passed to a treatment facility for treatment prior to river discharge to maintain DoE, Bangladesh and WB standard effluent quality.

The discharge of oily water shall be prevented by the plant’s treatment system, oil water separator & grease trap, through which all the process wastewater discharge will be conveyed, treated, and tested before release to the Meghna River if required. Any oil leakage from the tanks shall be transferred to the waste oil tanks. Oily surface water runoff shall be collected by the site drainage system and passed into the oily water treatment system before discharge to the river. Correct labeling & covering of drains, operator training, and monitoring of effluent shall also be maintained. To minimize waste, treated and cleaned water can be reused & recycled as much as possible within the power plant.

The effluent discharged from the neutralizing tank shall be continuously analyzed before release to confirm that it complies with World Bank and DoE, Bangladesh standard regarding discharge limits.
Ground water samples, surface water samples and drinking water samples from existing drinking water system of Ashuganj 100 MW HFO based Power Plant and Jar/bottled mineral water if it is used shall be collected for routine analysis on a monthly and quarterly basis as determined by the HS&E Manager. If any incident occur, additional monitoring shall be conducted immediately following an incident such as a spillage in order to document that there has been no contamination of the ground water & surface water by accidental spillages, leakages, or as a result of surface-water run-off from the plant site.

20.6.6.4 Solid Waste Management
There shall be a plant solid waste management system in place to handle plant solid wastes and recovered solids from wastewater treatment. Solid wastes, insulation materials, oily rags, used fuel and lube oil filters shall be collected in leak-proof and fire-proof containers that shall be taken off the site for proper disposal. Sufficient number of labeled dustbin (for paper, plastic, glass, food/organic waste, toxic, hazardous waste etc.) of different color codes to segregate waste and spittoon shall be kept at various & applicable locations of the plant site according to guideline of HS&E division of APSCL. The solid waste, oily rags and filters shall be collected in a designated place and handled in a safe and sanitary disposal manner in an off-site landfill, or if deemed appropriate for recycling (DoE approved vendor), incinerated in a brick kilns. Contractor will provide some trolleys for waste and material handling.

20.6.6.5 Fuel Management
The Ashuganj 100 MW HFO based Power Plant Project will fired on liquid fuel (HFO). There is to need comprehensive fuel management plan and Risk assessment plan for heavy fuel oil.

20.6.6.6 Lubricating Materials and Chemicals Management
Lube oil shall be brought in barrels and supplied to the system. A portion of the lube oil system will be cleaned by means of oil purifier/recycling and will be returned back into system. The dirty oil from the system shall be collected in drums and sold to approved oil recyclers for further cleaning and recycling, or to brick kiln operators for final destruction as a kiln fuel.

20.6.6.7 Overfill Protection
Overfill from vessels and tanks should be prevented as they are among the most common causes of spills resulting in
soil and water contamination. The EPC contractor will provide the following recommended overfill protection measures:

I. Will provide written procedures (SOPs) for transfer operations that includes a checklist of measures to follow during filling operations of hazardous materials, in spill prevention and response and the use of filling operators trained in these procedures. Will provide material safety data sheet (MSDS) for all kinds of solid and liquid hazardous chemicals, fuel oil & lubricating oil etc.

II. SOPs for management of secondary containment structures, specially the removal of any accumulated fluid, such as rainfall, to ensure that the intent of the system is not accidentally or willfully defeated.

III. Installation of gauges on tanks to measure volume inside.

IV. Use of dripless hose connections for vehicle tank and fixed connections with storage tanks.

V. Provision of automatic fill shutoff valves on storage tanks to prevent overfilling.

VI. Use of catch basin around the fill pipe to collect spills.

VII. Use of piping connections with automatic overfill protection (float valve).

VIII. Pumping less volume than available capacity into the tank or vessel by ordering less material than its available capacity.

IX. Provision of overfill or over pressure vents that allow controlled release to a capture point.

X. Provision of secondary containment for components (tanks, pipes) of the hazardous material storage system, to the extent feasible with 110% capacity of the largest tank or 25% of the combined tank volume and will be made of impervious, chemically resistant material.

XI. Will provide training of operators on release prevention, including drills specific to hazardous materials as part of emergency preparedness response training.

XII. Will provide training on inspection programs to maintain the mechanical integrity and operability of pressure vessels, tanks, piping systems, relief and vent valve systems, controls and pumps and associated process equipment.

XIII. Identification of locations of hazardous materials and associated activities on an emergency plan site map.

XIV. Facility evacuation routes.
XV. Will provide training to the employees on post event activities such as clean-up and disposal, incident investigation, employee re-entry and restoration of spill response equipment.

20.6.6.8 Storage Tank and Piping Leak Detection
The EPC contractor shall provide leak detection system that may be used in conjunction with secondary containment, particularly in high risk locations. Leak detection is especially important in situations where secondary containment is not feasible or practicable such as in long pipe runs. The contractor shall provide:

I. Automatic pressure loss detectors on pressurized or long distance piping.
II. Approved or certified integrity testing methods on piping or tank systems to conduct test at regular intervals.

20.6.6.9 Health and Safety Management
Construction and operational activities shall be carried out in accordance with relevant health and safety procedures. The procedures of the World Bank Health and Safety Guidelines will be followed in this regard. These are briefly described below:

20.6.6.10 Workplace Air Quality
The workplace air quality shall follow the World Bank’s General Guidelines for Environmental, Health and Safety. Protective respiratory equipment shall be used in areas where employees are exposed to welding fumes, solvents, and other material present that exceed accepted standards or the World Bank threshold limits. In the control room there should be a system to monitor daily temperature and humidity and for this calibrated hygrometer will be installed by contractor. The store or warehouse will be dust free system and temperature and humidity will be controlled. Air-conditioning system will be must where needed. Smoke detector and proper Firefghting system (sprinkler, portable fire extinguishers, fire blanket & hydrant point with hose reel) with emergency evacuation plan will be also present in the control room, engine room, store, workshop and all other applicable areas. The safe walkway also should be marked with color in the store and engine hall. Sufficient number of safe emergency assembly points will be marked clearly with direction from different locations, office/plant inside and outside areas.
20.6.6.11 Workplace Noise
To keep noise levels within the allowable H&S Guideline limits, sound-insulated equipment and control room, workstation shall be employed in normal work areas. Plant equipment shall be well maintained to minimize noise levels; canopy system and turbine inlet silencers shall be used to reduce plant noise.

20.6.6.12 Integrity of Workplace structure
The EPC contractor will ensure permanent and recurrent places of work that will be designed and equipped to protect OHS:

I. Surfaces, structures and installations will be easy to clean and maintain, and not allow for accumulation of hazardous compounds.

II. Buildings will be structurally safe, provide appropriate protection against the climate, and have acceptable light and noise conditions.

III. Fire resistant, noise-absorbing materials should, to the extent feasible, be used for cladding on ceilings and walls.

IV. Floors will be level, even, and non-skid.

V. Heavy oscillating, rotating or alternating equipment should be located in dedicated buildings or structurally isolated sections.

VI. All the structures will have lightning arrester as safety manner.

VII. Workplace structures will be designed and constructed to withstand the expected elements for the region and have an area designated for safe refuge.

VIII. SOP will be provided for project or process shut-down, including an evacuation plan.

20.6.6.13 Workspace and Exit
I. The space for each worker and in total will be adequate for safe execution of all activities, including transport and interim storage of materials and products.

II. Passages to emergency exits will be unobstructed at all times. Exits will be clearly marked by LED light to be visible in total darkness. The number and capacity of emergency exits will be sufficient for safe and orderly evacuation of the greatest number of people present at any time, and there should be a minimum two exits from any work area.
20.6.6.14 Electrocution Avoidance

To reduce the risk of electrocution, a formal work permit to work system shall be operated during both construction and operational phases. Strict procedures shall be followed for de-energizing and checking-securing electrical equipment with appropriate Lock-out, Tag-out (LOTO) and lagging before maintenance work commences. Strict safety procedures must be implemented in the case of energized equipment, including constant supervision. Full training shall be provided on the respiratory revival techniques for electrocution of personnel. Contractor will must do the following:

I. Will mark all energized electrical devices and lines with warning signs.

II. Locking out and tagging out devices during service or maintenance.

III. Checking all electrical cords, cables, and hand power tools for frayed or exposed cords and following manufacturer recommendations for maximum permitted operating voltage of the portable hand tools.

IV. Double insulating/grounding all electrical equipment, transformers, electric & light pole, fencing etc. used in environments that are or may become wet; using equipment with ground fault interrupter (GFI) protected circuits.

V. Protecting power cords and extension cords against damage from traffic by shielding or suspending above traffic areas.

VI. Appropriate labelling of service rooms housing high voltage equipment ('Electrical Hazard') and where entry is restricted or prohibited.

VII. Establishing ‘No Approach’ zones around or under high voltage power lines in conformance with horizontal and vertical distance according to electricity rule.

VIII. Rubber tired construction or other vehicles that come into direct contact with or arcing between high voltage wires may need to be taken out of service for periods of 48 hours and have the tires replaced to prevent catastrophic tire and wheel assembly failure, potentially causing serious injury or death.

IX. Conduct detailed identification and marking of all buried electrical wiring prior to any excavation work.

X. Provide warning signage for all hazardous electrical points.
20.6.6.15 Work in Confined Spaces

Confined spaces such as tanks, sumps, sewers, and excavations areas shall be tested for the presence of toxic, flammable, and/or explosive gases or vapors and for the lack of oxygen before entry during both construction & operational phases. Contractor will must maintain proper work permit for confined space with Bump test measurement for toxic gases. Employees shall use approved full-face mask, air-supplied respirators in areas that may be contaminated or are potentially deficient in oxygen during any period of time they are in a confined area. Furthermore, adequate ventilation shall be provided before entry and during occupancy of confined spaces. For operational phase contractor will also provide sufficient number of portable ventilation system with ventilation hose and dragger machine for bump test to the employer. Proper safety & warning signage will be installed or displayed clearly in large and sufficient number.

The EPC contractor shall submit health records relating to the hazardous substances in accordance with GoB rules and guidelines including international regulations as and when applicable.

The EPC contractor shall provide all necessary health and safety protective equipment and devices (having international standards) to all supervisors, inspectors and related personnel who will work in confined spaces.

Areas where people may be exposed to excessive noise shall be sign posted as "Hearing Protection Areas" and their boundaries shall be defined with red lines. No person will be allowed to enter this area unless wearing personal hearing protectors.

The confined work spaces shall be provided with sufficient air to avoid any health risk. Where there is a risk of poisonous or asphyxiating gases being present, these shall be tested for and confirmed to be at safe levels before entry takes place. Adequate care shall be taken to minimize stress and ergonomic design shall be implemented to minimize occupational health hazards. Emergency contact numbers shall be posted to the project sites for any emergency.

First aid facilities shall be kept in readiness and evacuation plans for emergency situations shall be facilitated with adequate drills, instructions and signs. Adequate firefighting arrangements shall be installed and maintained.
in good working condition. In case of any emergency, firefighters from the local fire service station shall be called upon.

### 20.6.7 Health and Safety

#### 20.6.7.1 General Requirements

The EPC contractor shall develop an appropriate safety management plan and take all necessary safety and other precautions to protect property and persons from damage, injury or illness arising out of the performance of the work. The EPC contractor shall have own HS&E team with HS&E officer with sufficient number of supervisors and staff and will submit their details to HS&E division of APSCL and project authority. The sub-contractors will also have their own HS&E team with supervisor & staffs to execute HS&E plan properly during construction phase until handed over to employer. The EPC contractor will be responsible for continuous HS&E monitoring of all project activities, sub-contractors and will finally submit monitoring reports to HS&E division of APSCL and project authority. Prior to commencement of project work, EPC contractor will submit its own HS&E Plan, health & safety insurance policy for permanent employees & part time workers to HS&E division of APSCL and project authority to justify its treatment & compensation policy for any accident or incident of employees or workers. EPC contractor will also engage sub-contractor if needed which has self-health & safety insurance policy for their employees and part time workers. Otherwise EPC contractor will provide all treatment cost and compensation according to Bangladesh Labor Law and international standards for any kind of accident, incident or injury of any employee, worker of its own and sub-contractors. Child labor is strictly prohibited in project activities.

The EPC contractor shall be responsible for providing its employees, Sub-contractors, agents and sub-agencies with a safe working environment. The EPC contractor shall inspect the working environments where its employees, Sub-contractors, agents or sub-agencies are or may be present on the site and shall promptly take action to correct conditions which cause or may be responsible to cause such working environments to become an unsafe place of employment.

The EPC contractor shall have policies and rules of personal safety accountability. Use of all kinds of respective quality
full personal protective equipment (PPE) like safety shoe with socks, safety jacket, safety belt, full body safety harness, shock absorber, safety goggle, ear muff, ear plug, welding helmet, welding hand shield, grinding helmet, leather hand gloves, dotted fabric hand gloves, high voltage resistant hand gloves, acid resistant hand gloves, leather welding legging, leather welding apron, chemical suit, safety helmet, gas mask, dust mask etc. are mandatory for all employees and workers of both contractor, sub-contractors & visitors. The EPC contractor will be responsible to provide & ensure all of these. Daily inspection of all safety materials before work starts will be mandatorily done by project HS&E officer, supervisor of contractor and sub-contractor. Such rules shall apply to anyone working on site. As a minimum requirement, these policies and rules shall cover the following:

I. Head, hand, ear, body and foot protection
II. Eye protection
III. Substance abuse
IV. Prohibiting of any kind of weapons
V. Reporting of unsafe conditions
VI. Use of power tools, safety net etc.
VII. Scaffolding (Bamboo scaffolding is strictly prohibited. Quality full metal scaffolding with safe and strong coupling is mandatory for project work).
VIII. Other general rules of behavior at a construction site.

Prior to starting any field work on each job, the EPC contractor shall conduct an initial safety meeting or daily toolbox meeting with an authorized representative of his sub-contractors and the Employer. The EPC contractor shall have a written safety work procedure and/or standards to cover the following types of activities as well as a plan (like training sessions, weekly training sessions, mock drill etc.) to communicate all site safety and loss prevention requirements to its employees and sub-contractors’ employees.

As a minimum such procedures and/or standards shall cover the following activities:

I. Excavation
II. Use of ladders and platforms
III. Work requiring protective clothing, safety jacket, safety shoe and equipment including safety belt, full body safety harness & shock absorber etc.

IV. Maintaining work permits strictly for hot work, cold work, works in height and confined space etc.

V. Working at heights.

VI. Burning and welding operations

VII. Cleaning and working at confined spaces

VIII. Cleaning; tagging and working on equipment that has been energized

IX. Use of motor vehicle on site

X. Radiographic test (RT)

XI. Electrical works on or near energized circuits

XII. Safe handling and storing of pressurized circuits

XIII. Emergency management plan/Emergency response plan

XIV. Reporting of injuries and other safety and loss prevention incidents.

For mitigation of noise impacts the EPC contractor shall put up temporary noise barriers during the construction phase and provide special noise protection devices (to international standards) to all persons on and around the project site.

Precaution shall be taken by the EPC contractor to ensure the health and safety of his staff and labor including all Employer's personnel. The EPC contractor shall also establish a site Medical Center. A medical officer (Minimum qualification: MBBS) with skilled nurse, medical staff shall be appointed for the Medical Center and the medical center shall be well equipped with all kinds of medicines, first aid facilities, sick bed, and ambulance services available at site for all times. The EPC contractor shall maintain records of all incident and accident, treatment provided and reports concerning health and safety due to implementation of the project. EPC contractor will submit monthly HS&E report complying all identified issues along with safe man hour to HS&E division of APSCL.

20.6.7.2 Health and Safety Management at Site
The EPC contractor shall appoint a qualified HS&E officer with supervisor and staffs at site to be responsible for
maintaining the safety and protection against accidents of personnel on the site. The HS&E team members shall be qualified and experienced with proven track record and shall have the authority to issue instructions and take protective measures to prevent accidents. The EPC contractor shall provide all required facilities in case of any accident immediately after the occurrence and pay appropriate compensation including all treatment costs & hospital bills. The selection of hospitals shall be approved by the HS&E division of APSCL & Employer/project authority.

20.6.7.3 20.7.6.3 Staff and Labor Records
The EPC contractor shall keep and maintain records of all staff and labors engaged on the project during the contract period and submit updated records each month to the Employer.

20.6.7.4 20.6.7.4 Health and Safety Equipment and Protective Devices
The EPC contractor shall provide all necessary safety protective equipment and devices for his staff and laborers including Employer’s staff at site. Contractor will also provide sufficient number of all kinds of safety materials for employee of operational period. Equipment and devices shall be of international standard and approved by the HS&E division of APSCL & Employer.

The EPC contractor shall provide the following safety equipment (all kinds of safety materials mentioned previously) during construction phase but not limited to the given list:

I. Head protection equipment (Helmet)
II. Hand protection equipment (Gloves)
III. Ear protection equipment (Ear plug)
IV. Foot protection equipment (Safety shoes)
V. Eye protection equipment (Goggles)
VI. Harness
VII. First aid facilities
VIII. Sick bed
IX. All kinds of primary medicine
X. BP machine and
XI. Ambulance services

20.6.7.5 Health and Safety Related Signs, Cordons and Training

The EPC contractor shall hang and maintain health and safety related warning signs, cordon off dangerous areas and deploy security personnel for protecting dangerous and hazardous areas in compliance with international codes and also organize training for all staff, labors and Employer personnel at site. In addition, the EPC contractor shall submit training reports and a training manual to the Employer (HS&E division of APSCL & project authority). The contractor will hang sufficient numbers of all respective warning signage, color printed emergency evacuation plan in large frame, speed limit in large size in all hazardous and working points with pictorial diagram in both Bengali and English language as per guidance of HS&E division of APSCL. Hazardous areas (electrical rooms, compressor rooms, etc), installations, materials, safety measures, and emergency exits, etc. should be marked appropriately. Signage should be in accordance with international standards and be well known to, and easily understood by workers, visitors and the general public as appropriate. Contractor will mark all the building and facilities structures by smooth & quality name plate in large size as per guidance of HS&E division of APSCL. All equipment, tanks, conduits etc. will be marked clearly with color seal and arrow mark for easy identification & operation.

All vessels that may contain substances that are hazardous as a result of chemical or toxicological properties, or temperature or pressure, should be labeled as to the contents and hazard, or appropriately color coded. Contractor will also mark the safe work area inside the machine hall and store. If there is any drain any machine hall, it will be covered with grating.

Similarly, piping systems that contain hazardous substances should be labeled with the direction of flow and contents of the pipe, or color coded whenever the pipe passing through a wall or floor is interrupted by a valve or junction device.

Contractor will mark the building structure with necessary name plate and post in the road network. Sufficient number of ‘Emergency Assembly Point’ will be established with arrow marked direction from all nearby points for easy identification and to reach. Contractor will provide large LED sign in all doors for entry & exit, emergency exits and
arrow marked LED sign for emergency exit from engine hall and work places. Contractor will make safe smoking zone for both construction and operational periods and smoking everywhere in project site is strictly prohibited. The contractor will set large safety instruction & warning boards for plant operational areas, visitor safety instruction board at main gate and a LED based Accident free record board with time, date, number etc. as per guidance of HS&E division of APSCL.

20.6.7.6 Health and Safety Responsibility
The EPC contractor shall be responsible for any damage to the health of his staff, laborers and also Employer personnel or any project persons engaged on the project site and shall pay compensation to international level and be acceptable to the Employer.

20.6.7.7 Storage Facilities for Chemicals, Fuel, Oil and Grease
The EPC contractor shall follow Government of Bangladesh rules and guidelines including international regulations as and when applicable for storage of chemicals, fuels, oil and greases. Will provide all MSDS and warning signage in large size and in sufficient numbers both in Bengali and English language in all respective points as per guidance of HS&E division of APSCL.

20.6.7.8 General Fire Protection Requirements
All plant and buildings shall be designed and arranged to minimize the possibility of fire hazards originating from them or spreading to them from a fire in the vicinity. Plant and cables shall be segregated to reduce fire risk, damage and multiple shutdowns.

Electrical requirement located in hazardous area shall be explosion proof, flame proof, intrinsically safe or otherwise designed to be suitable for the location zone.

All equipment installed shall comply with NFPA rules and recommendations and also with Government of Bangladesh rules and guidelines and international regulations where applicable. The EPC contractor shall provide certification of compliance with the NFPA regulations and also Government of Bangladesh agency/agencies as and when required. Local regulations must be adhered to and the EPC contractor must obtain system approval from the local fire authority. The work place will be designed to prevent the start of fires through
the implementation of fire codes applicable to industrial settings. Other essential measures will be:

I. Equipping facilities with fire detectors, alarm systems, automated sprinkler and firefighting equipment. The equipment will be in good working order and be readily accessible. It will be adequate for the dimensions and use of the premises, equipment installed, physical and chemical properties of substances present and the maximum number of people present.

II. Provision of manual firefighting equipment that is easily accessible and simple to use.

III. Fire and emergency systems that are both audible and visible.

IV. All the hydrant point will be of coupling system for hose reel and valve attachment.

V. All the hose cabinets (both indoor & out door) will be of one sided door lock system with push-pull button and will be opened by one master key. The contractor will provided sufficient numbers of key set to the fire control room of this plant.

VI. Portable fire extinguishers will be mounted by safe clip on wall at height of 30-36 inches from ground for easy operation and area will be marked by color code.

VII. Operating system will be displayed beside all fire hydrant points, extinguishers for ease of operation of these.

VIII. Contractor will provide necessary trainings to relevant employees of fire division of this plant and other employees on alarm system and complete firefighting system of this plant for operational period.

20.6.7.9 **Lavatories and Showers**

Adequate lavatory facilities (toilets and washing areas) will be provided for the number of people expected to work in the facility and allowances made for segregated facilities, or for indicating whether the toilet facility is “In Use” or “Vacant”. Toilet facilities should also be provided with adequate supplies of running water, soap, and hand drying devices. Where workers may be exposed to substances poisonous by ingestion and skin contamination may occur, facilities for showering and changing into and out of street and work clothes should be provided. Emergency eye wash and body shower will be in suitable position for easy access and will have containment to prevent environmental pollution.
20.6.7.10 **Potable Water Supply**
Adequate supplies of potable drinking water will be provided with water purifier (RO system) and hot & cold-water dispenser from supplied water source to all indoor and outdoor working stations.

20.6.7.11 **Clean Eating Area**
Where there is potential for exposure to substances poisonous by ingestion, suitable arrangements are to be made for provision of clean eating areas where workers are not exposed to the hazardous or noxious substances. Contractor shall make a furnished pantry with crockeries, microwave woven, electric kettle, freeze and water purifier with hot and cold water dispenser which will be easy to access from control room and other working stations for employees for operational period.

20.6.7.12 **Lighting**
Workplaces should, to the degree feasible, receive natural light and be supplemented with sufficient artificial illumination to promote workers’ safety and health, and enable safe equipment operation. Supplemental ‘task lighting’ may be required where specific visual acuity requirements should be met.

Emergency lighting of adequate intensity will be installed and automatically activated upon failure of the principal artificial light source to ensure safe shut-down, evacuation, etc.

20.6.7.13 **Safe Access**
Passageways for pedestrians and vehicles within and outside buildings will be segregated and provide for easy, safe, and appropriate access. Equipment and installations requiring servicing, inspection, and/or cleaning should have unobstructed, unrestricted, and ready access. Hand, knee and foot railings should be installed on stairs, fixed ladders, platforms, permanent and interim floor openings, loading bays, ramps, etc. Openings will be sealed by gates or removable chains Covers should, if feasible, be installed to protect against falling items. Measures to prevent unauthorized access to dangerous areas should be in place.

20.6.7.14 **First Aid**
The contractor will ensure that qualified first-aid is provided at all times. Appropriately equipped first-aid stations will be easily accessible throughout the place of work both for construction and operational period.
Eye-wash stations and/or emergency showers will be provided close to all workstations where immediate flushing with water is the recommended first-aid response.

Where the scale of work or the type of activity being carried out so requires, dedicated and appropriately equipped first-aid room(s) will be provided. First aid stations and rooms should be equipped with gloves, gowns, and masks for protection against direct contact with blood and other body fluids.

Remote sites should have written emergency procedures in place for dealing with cases of trauma or serious illness up to the point at which patient care can be transferred to an appropriate medical facility.

20.6.7.15 Air Supply
Sufficient fresh air will be supplied for indoor and confined work spaces. Factors to be considered in ventilation design include physical activity, substances in use, and process-related emissions. Air distribution systems should be designed so as not to expose workers to draughts.

Mechanical ventilation systems should be maintained in good working order. Point-source exhaust systems required for maintaining a safe ambient environment should have local indicators of correct functioning.

Re-circulation of contaminated air is not acceptable. Air inlet filters should be kept clean and free of dust and microorganisms. Heating, ventilation and air conditioning (HVAC) and industrial evaporative cooling systems should be equipped, maintained and operated so as to prevent growth and spreading of disease agents (e.g. Legionella pneumophila) or breeding of vectors (e.g. mosquitoes and flies) of public health concern.

20.6.7.16 Work Environment Temperature
The temperature in work, rest room and other welfare facilities should, during service hours, be maintained at a level appropriate for the purpose of the facility. The contractor will ensure it during design & equipment installation.

20.6.7.17 Communicate Hazard Codes
Copies of the hazard coding system will be posted outside the facility at emergency entrance doors and fire emergency connection systems where they are likely to come to the attention of emergency services personnel.
Information regarding the types of hazardous materials stored, handled or used at the facility, including typical maximum inventories and storage locations, will be shared proactively with emergency services and security personnel to expedite emergency response when needed. Representatives of local emergency and security services should be invited to participate in periodic orientation tours and site inspections to ensure familiarity with potential hazards present. The EPC contractor will establish and all of these.

20.6.7.18 Emergency Response Plan
The EPC contractor shall prepare a detailed emergency response plan (ERP) particularly on activities which may cause significant environmental safety concerns and submit this to the HS&E division of APSCL for approval. After approval, the EPC contractor shall execute the approved ERP for emergencies arising from activities carried out within the limits of the project site.

20.6.7.19 Risk Assessment and Management
The EPC contractor shall identify potential risks of this project and prepare a risk management plan to handle those risks and shall submit a report to the HS&E division of APSCL & project authority during the initial stage of project implementation. The EPC contractor shall arrange proper training of all of his staff and also the Employer's staff during all phases of the project (within the contract period) regarding implementation of the risk handling plan and also report to the HS&E division of APSCL & project authority regularly.

20.6.7.20 Record Keeping
Record will be maintained of significant environmental matters, including monitoring data, accidents, training, daily toolbox meeting or safety instruction meeting with project workers with relevant photographs, employees' health checkup and occupational illnesses, spills, fires, traffic movement and other emergencies. The information will be reviewed and evaluated to improve the effectiveness of the environmental, health and safety programme. Safe work permit and ID card of project related all employees and workers of EPC contractor will be provided by EPC contractor with the permission of Security & Discipline division of APSCL and APSCL authority. EPC contractor will also manage the safe work permit and ID card for workers of Sub-contractor by themselves or own responsibility with
the permission of Security & Discipline division of APSCL. During construction period, a standard temporary medical center will be established for providing first aid and necessary treatment to project employees and all workers in the project site. EPC contractor shall keep record of injury, or accident according to guideline of HS&E division of APSCL. Sufficient number of good sanitary toilets (at least 1 toilet for 15 workers) with proper washing facilities will be made at construction site for the use of workers during construction period. Sufficient number of good sanitary toilets (at least 1 toilet for 15 employees/workers) with proper washing facilities will also be made for operational phase. The toilets made for construction phase which will not be used during operational phase will be demolished by contractor finally and will make the site clean, safe and beautiful. Training is essential to maintain the employees' health and safety. Both theoretical and practical training will be conducted for the employees on the hazards, precautions and procedures for the safe storage, material handling and use of all potentially harmful materials. Training procedures will incorporate information from the Material Safety Data Sheets (MSDS) for potentially harmful materials. Training will include instruction on the following:

I. Use of personal protective equipment and first aid tools.
II. Prevention of accident
III. Emergency preparedness for fire, earthquake etc.
IV. Safe chemical handling practices, waste minimization and safe disposal.
V. Safety awareness for no smoking in plant area and sensitive locations.
VI. Location and proper use of emergency equipment, fire extinguishers etc.
VII. Procedures for raising the alarm and notifying emergency response teams
VIII. Proper response actions for each foreseeable emergency situation
IX. Proper usage of lock-out and safety tagging before work orders are issued.
X. Use of safe drinking water and sanitary toilets for safety and hygiene.
XI. Emergency response spill plan and train personnel in its use.
20.7 Manufacturer List
Annexure A:

General Layout (Ashuganj 100 MW HFO Power Plant Project)