4 x 150 MW CHANDGANA TAL
THERMAL POWER PLANT PROJECT

OWNER'S TECHNICAL SPECIFICATION & REQUIREMENTS
(OTSR)

OWNER
Prophecy Power Generation LLC

Amended items to OTSR issued for 4x150MW for Phase 1 of 2x150 MW only
April 11, 2013

Table of Contents-Amended items

Following are the effected items of the OTSR supplied earlier for submitting proposal for phase1 and phase 2. Amendment to these effected items are detailed below for submit revised price bid for phase 1 of 2x150 MW only.

Owner is considering to place contract for phase 1 of 2x150MW only and EPC contractor is requested to update their price submitted for phase 1 of 2x150MW with following changes to the OTSR given to them earlier for phase1and 2.

Chapter 1- General Description and Scope of Works

1.3.1: Coal Supply and Fuel Oil Supply:

Coal Handling System : the coal storage yard shall have capacity for phase 1only. The coal conveying system capacity of structure and belts shall be designed for four units but the coal handling system length in the main building shall be to serve two units only.

Fuel Oil (Distillate Fuel Oil): Only one tank of 1000 ton capacity shall be constructed and space left for the second tank.

1.3.2 Ash Pond: Ash pond and civil work for only 2x150MW shall be constructed.

1.3.3 Lime Stone Building: The civil work of lime stone building and handling system will be constructed for 4x150MW units but equipment for lime stone handling system will be installed for 2x150MW units.

1.3.4 Raw Water and Potable Water Supply System: storage capacity for raw water reservoir, service, firefighting water and potable water sufficient to support phase 1only shall be built and open space left for phase 2.

1.3.5 Effluents and Rain Water Discharge System: Wastewater treatment system and equipment shall be constructed for phase 1 only.

1.3.6 **220 KV Electrical Interconnection and Switch Yard**: Contractor must provide outgoing gantry suitable to accommodate two outgoing feeders and station busbar to accommodate in the future two additional outgoing and three additional incoming isolators. Switchyard building shall have space to expand for future connection of two generator transformer and one station transformer and associated isolators connection to the station side of busbar and two outgoing feeders. The enclosed switchyard building size shall be constructed to accommodate equipment for both phase 1 and 2 but only equipment for phase1 shall be installed. See figure1 for switchyard layout.

1.3.10 Construction Water: Mine Pit water shall be treated and used for construction instead of ground water as indicated before. Ground water will be used for drinking purpose. Owner has obtained the permit for use of ground water for drinking and will also obtain the permit for use of Mine Pit water for construction.

1.3.11 Construction Power: Owner can supply maximum of 2.3 MW temporary supply for construction of 2x150MW phase1. Contractor shall arrange diesel generator set for any extra electric supply. **Contractor shall indicate separately cost of fuel used for extra electric supply above 2.3 MW he require during phase 1 construction until the backup power is available**. Backup power will be available six months before COD of unit 1.

1.**4.1 Civil, Building and Structure and 9.1 Building and Structures:** Size of following buildings is to be reduced as follow:

- Admin Building: 2400 sq. meter with adjacent space left to expand to 3400 sq. Meter
- Canteen Building: 500 Sq. meter
- Workshops building: 1000 Sq. meter with adjacent space left to expand to 1500 Sq. meter
- Store/ware house: 1500 Sq. meter with adjacent space left to expand to 2300 Sq. meter.
- Dormitory/Hostel: 20 rooms and no change in other details.

COMMERCIAL SCHEDULES:

SCHEDULE 1: SEE ATTACHED

SCHEDULE04: SCHEDULE OF PERFORMANCE LIQUIDATED DAMAGES (L/D) & BOUNS FOR EARLY COMPLETION-SAFETY RECORD PENALTYAND BONUS.

A) Liquidated Damages:

4) Delay in construction after agreed Commercial Operation date US$85,000.00/day/unit

B) Bonus for early completion:
Owner will pay US$17,500/day for every day of early completion from agreed Commercial Operation Date up to maximum of US$0.5 million.

"SCOPE OF WORK FOR PHASE 2 IF PROJECT IS DONE IN TWO PHASES:

Contractor shall complete all work for phase 2, 2x150 MW units and common plant items and auxiliary buildings of phase two as per OTSR of 4x150MW. Any item of scope of work mentioned in OTSR for 4x150 MW and not completed in phase 1 shall also be completed in phase 2. As for other aspects involved in Phase 2, Contractor shall strictly follow the Conditions of Contract."

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August 2012

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Chapter 1 – General Description and Scope of Works

1.1 General

The Owner's Technical Specification & Requirements (OTSR) specifies the minimum requirement for a 4x150MW (nominal) coal fired thermal power project (referred later on in this OTSR as Power Plant or Plant) being developed, constructed, commissioned and operated by the Owner at a Site 300km east of Ulaanbaatar, capital city of Mongolia. The overall area for the Power Plant is estimated to be 1,500m x 1,500m (225ha), including the coal yard and ash disposal area. A paved road, Route A051, connecting Ulaanbaatar and Undurkhaan, is about 7km north of the Site. The nearest railway station is Baganuur, 180km west of the Site.

The design of the Plant must be based on CFB technology, suitable to burn a wide range of coal (with high moisture content and low calorific value) from a nearby coal mine. The schedule for completing the first unit must not be more than 33 months including site leveling and formation from the date of Notice to Proceed (NTP) of the Project, with subsequent units completed every 4 months interval.

Where applicable, the proposed equipment must be based on the Contractor's standard modular design modified to meet also the requirements as set out in this document. The region of the site is in severe shortage of skill workers and general labors, hence, the design and supply of the Plant must be based on the maximum degree of modularization and shop assemblies so as to minimize the required construction time.

In response to this OTSR, the Contractor must provide all Plant and services associated with the design, fabrication, installation, construction, training, start-up, testing, documentation, performance determination and quality assurance of a complete coal fired power station, operating as a complete Plant, under the specified conditions and achieve the guaranteed performance parameters.

The main power block of the Facility must consist of four identical power generating Units. The turbine hall must be based on a totally enclosed structure and the boiler must be of fully enclosed type. FGD and SCR are not required for flue gas scrubbing. The Plant must deliver electric

power to the grid through a 220 kV SF6 gas insulated switchyard (GIS). Start-up power shall also be obtained through the back-feed from the same GIS.

Make-up water for the steam generator and various plant services will be obtained from the Mine Pit water and delivered by Owner to a flange located 1m from Site boundary. However the Mine Water needs to be treated for use as make up water and other plant services and cooling. Contractor shall design and install suitable water treatment facilities to use Mine Water for make up as well as plant cooling. Coal from nearby coal mine will be delivered by Owner to the first junction house within the Plant. Ash will be trucked to an ash disposal site.

1.2 Site Meteorology and Geology

The following meteorological data are anticipated for the Site. The Plant must be designed to operate safely within the limits of these conditions.

Ambient temperature range	-46ºC to + 39ºC
Average wind speed	5.0 m/s
Maximum wind speed	40 m/s
Yearly average rainfall	203 mm
Atmospheric Pressure	89.26 kPa(a)
Relative Humidity	40 - 94%

The Plant must be designed to a seismic condition of PGA = 0.16g (peak ground acceleration), to MSK 64 Intensity -VIII as detailed in Seismic Hazard Assessment of Chandgana Site Report by RCAG. The Plant must also be designed for the existence of permafrost soil with thawing prevention measures (if required). In addition, a wind loading of 40m/s shall be used for the design.

The information as given above is for reference only. The Contractor must make all additional measurements and site investigations, as deemed necessary, to determine the required design of the Plant.

1.3 Terminal Points

The Contractor must provide the scope of Works within the Site boundary up to the terminal points as defined below:

1.3.1 Coal Supply and Fuel Oil Supply

The contractor shall provide 2 KM conveyor from coal mine area to first junction tower at the coal yard storage area. Coal will be delivered by the mine by mine conveyor to receiving hopper at the mine end of 2 Km conveyor. The Contractor must build a receiving hopper to receive the coal run off from the belt conveyor of the mine. Coal from first junction tower at the storage yard can be directly sent to coal bunkers or coal yard for storage. Coal sampling and metering facility must be installed at this first junction tower transfer point so that the quality and quantity of coal received can be gauged. The Contractor shall also provide an extra 1km portable conveyor to be installed by the Owner.

Fuel Oil (Distillate Fuel Oil) of specification given in ATTACHMNET- D will be delivered by tankers to site (by Owner). The Contractor must build a suitable unloading facility, 2x1000 ton fuel oil storage tanks, complete with heating facility if required, pumping and metering facility.

1.3.2 Fly Ash and Bottom Ash and Ash Pond

Fly ash shall be transferred to the Ash Pond by pneumatic control. The bottom ash will be dumped to the Ash Pond site by trucks. The Contractor must provide unloading stations for the bottom ash suitable for the dump trucks to drive through. Sprinkler water facility shall be provided for the fly ash at its discharging point. The Ash Pond for ten years of ash storage capacity for worst coal is required to be constructed by the Contractor at the Plant site within the Power Plant boundary

1.3.3 Limestone and Sand

The Contractor must provide unloading stations or space suitable for the lime trucks to unload the material. The lime supplied will be in the form of about 100 mm size and not powder, which requires further handling and grinding. The expected specification of lime stone are attached in Appendix A. First fill of sand for the CFB boiler will be supplied by the Owner. The Contractor shall indicate the quantity of sand required

1.3.4 Raw Water and Potable Water

Raw water will be pumped / piped for the station's usage from Mine Pit by Owner. The raw water will be delivered to a flange at 1m away from the station boundary. The Contractor must install metering equipment to register the total consumption. Potable and fire water must be derived from raw water after appropriate treatment and stored separately. Mine Pit water analysis is given in Appendix B and for the purpose of designing the Plant the Contractor shall design the water treatment plant to purify Mine Pit water for use as make up water as well as for cooling of various equipment and heat exchangers.

1.3.5 Effluents and Rain Water Discharge

The site has no discharge points for effluents and rainwater. The Contractor must collect and treat all sewage, effluents and rainwater to meet the Mongolian discharge criteria and then re-use the water to the maximum extent possible, including for the use of landscaping. Depending on the water balance calculation, it may be necessary to build an evaporation pond to store the excess waters.

1.3.6 220kV Electrical Interconnection

The Contractor must provide an outgoing gantry suitable to accommodate 3 outgoing feeders with a space for the fourth one, complete with insulation discs on both sides of the gantry. Overhead conductors on the outgoing side of the gantry will be provided by others. For the 220kV GIS, at least one spare bay (without CB) must be provided. All equipment for protection, telemetry and control interface must be agreed with the dispatch control center and provided.

1.3.7 Access Roads and Entrances

Access roads leading to the Site will be provided by others. The Contractor must provide the roads within the station boundary fence to terminal points 1m away from the site entrances. Two separate entrances with all the necessary facilities (gate house and electronic personnel access /

clocking system for one main gate) must be provided. One weight bridge must be provided at the secondary entrances which the ash and limestone trucks will use.

1.3.8 Site Fencing

2-meter high wall-type site fencing must be provided. In addition, the Contractor must also provide suitable security guard house and watch towers around the perimeters.

1.3.9 Telecommunication

Telephones lines to site for external use will be arranged by Owner. The Contractor must provide suitable telephone exchange facility to receive the lines. It is acceptable for the Contractor to pass through the telephone exchange facility to the Plant for permanent use at handover, subject to Owner's inspection.

1.3.10 Construction Water

Ground water (analysis attached in APPENDIX C)can be used for construction. Owner will complete the study for using ground water and obtain necessary approval from the authority. Contractor shall drill necessary bore holes and install equipment and pumps to use the ground water. Contractor shall also install necessary water treatment plant to make the ground water suitable for civil construction and drinking for site workers.

1.3.11 Construction Power

One single electric feeder of 1.45 MVA at 6 kv will be provided by the Owner leading to a single terminal point within the Site boundary. The Contractor must pick up from the defined terminal point and provide the necessary transformer and circuit breaker to receive and distribute the power for construction usages. In addition, the Contractor must pay the cost of electrical power for the construction usage. It is advisable for the Contractor to provide two diesel generators (2MW each) as back up supply for construction as the local grid is not reliable. The Contractor can pass the two diesel generators to the Plant (as EPC scope) for permanent use at handover, after major overhaul and subject to Owner's inspection.

1.3.12 Laydown Area and Contractor's Colony

The Contractor must indicate additional area required for the temporary storage of equipment and the Contractor's colony. The Owner believes the site has vast nearby areas to serve this purpose.

1.3.13 Landscaping

In designing the site layout, the Contractor must reserve sufficient areas for landscaping. The plantation (trees and grasses) will be carried out by Owner.

1.4 Scope of Works

The Contractor must provide a complete and fully operational Plant. All equipment and services not explicitly specified in the OTSR, but necessary for the complete and proper installation and required operations of the plant must be deemed to be included.

The Contractor must design the Plant in accordance with the acceptance international standards and codes. In addition, design must also meet the local standards and regulations. When required, the Contractor must submit the relevant design calculations and studies to the Owner for review. The general scope of supply must include, but not be limited to, the following:

1.4.1 Civil, Buildings and Structures

The plant is situated in cold zone for almost six months of the year and the effective anti-freezing measures shall be taken such as

a) Suitable underground water pond with cover shall be designed with adequate buried depth for foundation and the pond.

b) Freezing resistance concrete suitable for the cold weather conditions at site shall be used where ever required and wherever concrete is in permanent contact with water. Freezing soil depth of 2.6 meter can be assumed.

c) External enclosure walls shall be of suitable thickness with insulation for the cold weather conditions. All doors of building exposed to outdoor cold conditions shall be of double door type and all windows of double glazing glass with single frame type.

Contractor shall Design, construction and obtain government licenses of all necessary buildings, foundations and superstructure for the complete Power Plant which must include, but not be limited, to the following:-

1) Detailed geological calculation confirming the seismic class;

2) Site leveling and formation, including clearance of debris from Site;

3) Piling and foundation treatment (if necessary, depending on Contractor's design);

4) One common reinforced concrete chimney of 215m height with twin steel stacks, each to connect to the flue ducts of two units; or two reinforced concrete chimneys of 215 m height with one steel stack in each for two units; one lift for each chimney;

5) Two (primary and secondary) access entrance gates with guard houses and watch towers;

6) Site fencing of 2-m high wall type;

7) One road weight bridge for ash / limestone transportation and records at the secondary entrance;

8) Coal yard of storage sufficient for 14 days' consumption by 4 Units at 100% TMCR;

9) Main steam boiler structures and foundations, including coal bunker bay and cyclones;

10) Main steam turbine building including deaerator bay;

11) Foundation and buildings for electrical equipment including gantry, buried cable, and switchyard

12) Fire station building and equipped with one fire engine and other mobile fire-fighting equipment;

13) Medical clinic (including portable medical facilities and one ambulance);

14) Fully covered coal conveyor structures and foundations, coal yard for 14 days' operation of Worst Coal, coal water settling pond, crusher house, coal conveying gantry.

15) Foundations & structures for fuel oil tanks and bund walls, including pump shed;

16) Transformer compound partitioning, three-sided anti-fire walls (for main transformer only), soak pits & associated galvanized fencing/gate;

17) Supports of pipe work, instrumentation and electrical cabling and foundation;

18) One reinforced concrete chimney structure of 200m tall and two steel flue stacks inside;

19) Construction of all necessary roads and hard standing within the Site boundaries; main roads must be 2-lane traffic in each direction;

20) Owner's Site office of 1000 sq. m;

21) Owner's Hostel for its operational staff and visitors consists of 50 rooms of size 24 sq. meter each. Each room shall have attached bathroom with shower, 6 feet wide full height wardrobe and heated water facilities

22) Site clearance (removal of temporary works, debris, contractor's properties and personnel) after construction;

23) Structure and foundation for air cooled condenser and mechanical draft cooling tower;

24) Control building, central control room (CCR), electronic rooms, equipment rooms, offices areas and meeting rooms;

25) Administration building of 3400 sq. m; a fully covered corridor must be provide from administration building to CCR; and a car park space for 20 cars at ground floor with top cover only;

26) Canteen of 750 sq. m with cooking utensils and catering facilities for two seating of 100 persons each;

27) Buildings and enclosures for other necessary facilities and auxiliary plant;

28) Passenger and goods lifts for Central Control Room, administration building and boiler house for each Unit; and a passenger lift for chimney;

29) Landscaping design, excluding trees, shrubs and plants;

30) Workshops of 1500 sq. m and equipment required for essential maintenance of electrical, mechanical and instrumentation systems, also for building maintenance;

31) Station garage including gasoline storage facilities and vehicle compound;

32) Permanent stores, warehouse facilities, dangerous goods stores, scrap yard and store and other storage buildings;

33) Various services (lighting, HVAC, water etc.) for each building ; and

34) Others structures and buildings, as required.

1.4.2 Boiler and Auxiliaries

The CFB must be in full compliance to ASME and include all necessary pressure parts, cyclones, bottom ash cooler, coal feeders and limestone feeders, ESP, fan groups, air pre-heaters, burners, soot blowers, ductwork, dampers, complete start up fuel system and oil burners, flame monitoring system, and all other associated ancillary plant, including but not limited to the following. The boiler must be fully enclosed. The duty percentage expressed in the following must be based on BMCR rating.

1) The boiler must be fully enclosed type for site cold conditions

2) The boiler design and flow/hour apart from meeting 150 MW generation requirement for temperature range of -40 to 30 Deg C shall also meet the maximum

heat load of all buildings, its occupants and facilities in the plant boundary including additional load for the following facilities:

a) Two KM of enclosed coal conveyor from the mine to the coal storage yard.

b) Staff quarter at site. 500 flats of average 100 Sq. meter size with average occupancy of three persons.

c) Due to CFB type boiler being selected for the type of coal being available, all material and equipment exposed to combustion, flue gas and ash shall be of design to withstand velocity/flow and abrasion.

3) 6 x 25% gravimetric belt coal feeders for firing Worst Coal, equipped with electronic weighing, flow and totalizer system; with frequency convertor motor;

4) 6 Coal bunkers of 10 hours' storage for Performance Coal;

5) 2 x 100% limestone rotary feeders; with frequency convertor motor;

6) one limestone silo of 10 hours' storage feeding the two rotary feeders;

7) 2 x 100% limestone crushers and handling equipment to limestone silos;

8) Fuel oil start up system for the Unit complete with oil burners; its capacity must be sufficient for the minimum boiler stable load (without coal firing);

9) 2 × 50% FD fan, ID fans, and PA fans;

10) 3 x 50% fluidized fans,

11) 2 × 50% ESP of 5 electrical fields; hopper storage sufficient for 8 hours' storage for Worst Coal; with stainless steel (or erosion resistant material) on the slanted surface of the hopper

12) 2 x 50% cyclones, with high temperature, anti-abrasive and anti-corrosive lining;

13) 2 x 50% bottom ash coolers; with high temperature, anti-abrasive and anti-corrosive lining; complete with cooling water pumps and auxiliaries;

14) 2 x 50% air pre-heater with less than 3% leakage;

15) Deaerator of storage capacity sufficient for 5 minutes' operation;

16) A set of soot blowers;

17) One passenger / goods lift per boiler;

18) Pipework and manifolds for auxiliary steam system, with connection to auxiliary boiler;

19) Flame monitoring systems with 2x100% cooling fans;

20) Various design and calculations including

- Steam pipe stress analysis;
- Combustion analysis;
- Hydraulic and flow calculations for various pumps and fans;
- Equipment capacity and rating calculation

1.4.3 Turbine and Auxiliaries

The steam turbine must be of two cylinder design (HIP cylinder and LP cylinder), complete with air-cooled condenser, four governing valves, six stages of HP/LP feed heating, , drains, capable to work for a wide range of back pressure and must include, but not limited to the following. The

extraction-condensate and turbine must be capable of taking larger fluctuation and range of flow due to large heating requirement as detailed under item 1.4.2.2 above. The duty percentage stated below must be based on BMCR rating.

1) HP/LP bypass of 40%/40% capacity;
2) Motorized turning gear with manual rotating;
3) Redundant electronic governor control; redundant turbine protection, control and supervisory system; interfaces with grid control;
4) 3 x 50% motor driven boiler feed pumps;
5) 2 x 100% condensate extraction pumps;
6) 3 liquid ring vacuum pumps (3 pumps running at startup to build up vacuum of 20kPa in less than 60 minutes);
7) 2 x 50% condensate polishing plant for 100% condensate flow;
8) 3 x 100% lube oil pump (1 shaft driven, 1 AC driven and 1 DC driven), with 2 x 100% oil coolers
9) Auxiliary steam system, complete with auxiliary steam boiler and pipe work;
10) one overhead crane or two overhead crane which can work in tandem to lift the single heaviest item during maintenance ;
11) Gland sealing system with 2x100% exhaust fans;
12) Turbine drain system;
13) Various studies including
    - HP/IP/LP steam piping stress analysis;
    - HP/IP/LP feed water piping stress analysis;
    - Hydraulic and flow calculations for various pumps and fans;
    - Turbine bypass system piping stress and dynamic analysis; and
    - Equipment capacity and rating calculations such as boiler feed pump capacity, valve size, safety valve sizing.

1.4.4 Generator

The generator must operate to a wide range of ambient temperature as defined in this OTSR; it must generate a minimum of 177 MVA at pf=0.85(lag), at ambient air temperature of 35 deg C and operate continuously in the range of 48.5-51.5 Hz; including but not limited to the following auxiliaries. The duty percentage stated below must be in BMCR rating.

1) Excitation system with excitation transformer (if required), continuous operation at 1.1 times the field voltage and field current;
2) Redundant automatic voltage regulation (AVR) system;
3) Redundant generator protection system;
4) Generator air cooling system (with 2 x 50% axial rotor fans);
5) 4 x 33% generator cooler, failure of any one will not reduce the generator output;

1.4.5 Electrical Systems

1) 220kV SG6 gas insulated switchgear (GIS) in an enclosed building;
2) Generator transformers (separate transformer for each phase) with on-load tap changer, its rating shall not be less than the generator rating less the rating of unit

transformers, cooling type of ONAF or ODAF, top oil and winding temperature rise not more than 50/65 degC;

3) Two startup transformers for the whole Plant, with on-load tap changer, cooling type of ONAF or ODAF, top oil and winding temperature rise not more than 50/65 degC

4) Unit transformer; cooling type of ONAF or ODAF, top oil and winding temperature rise not more than 50/65 degC

5) Isolated phase bus with natural cooling;

6) Plant electrical MV, LV, MCC and all AC distribution systems;

7) MV/LV transformers;

8) Battery, charger and the DC distribution system; capable to support the essential loads for 1-hour without charging from AC and diesel generator

9) Two 1MW Emergency diesel generator for the whole Plant;

10) Uninterruptible power supply system with static changeover switchgear;

11) 2 x 100% 220V DC supplies for power use; with battery capacity of 1 hour;

12) 2 x 100% 110V DC supplies for control use; with battery capacity of 1 hour;

13) Grounding and lightning protection system;

14) Cathodic protection system;

15) Protection, metering and monitoring of all system;

16) Plant and switchyard control, metering and instrumentation;

17) Wave trap, power line carrier (PLC), and remote terminal unit (RTU) equipment and outgoing line protection;

18) Raceway system (cable trays, conduits); and

19) Various studies including the following:
    - Short circuit and fault level study of all electrical systems;
    - Power system stability study to confirm the excitation/governing system parameters to suit the Grid Code requirements;
    - Voltage-drop and voltage-dip study of all electrical systems;
    - Cable sizing calculation for all cables and wires;
    - Equipment capacity and rating calculation for all electrical equipment (including bus ducts, transformers, switchgear, batteries, diesel generator, motor, etc.);
    - Protection and relay setting & coordination study for all electrical equipment;

1.4.6 I&C Systems

1) Complete DCS including the hardware, software and function requirements for Unit and common control systems, with redundancy in processor, memory, communication and data bus, and power supply;

2) Complete remote measuring and plant monitoring system for the boilers, turbines, generators and their auxiliary plant systems;

3) Complete remote analogue and logic control system for open and close loop controls for the boilers, turbines, generators and their auxiliary plant systems;

4) Complete set of the furniture with desks, chairs, cabinets located respectively in central control room (CCR) and engineer room;

5) Remote measurements, indications and switching controls for EHV/MV/LV and DC electrical switchgears and auxiliaries;

6) Complete interfaces with plant programmable logic controllers (PLC), turbine electronic governor, SCADA, RTU and AGC (automatic generation control) with grid dispatch center;

7) Instrumentation system including all plant instruments, sensors, and actuators;

8) CCTV system for Plant surveillance; a total of 32 cameras and 6 LCD displays for the Plant to be installed in central control room (CCR);

9) CCTV system for Plant perimeter surveillance, a total of 32 cameras and 6 LCD displays to be installed in gate house;

10) Personnel card access system to be installed near gate house and strategic locations (such as CCR) of the Plant;

11) Master clock system with interface to DCS;

12) Telecommunication systems including fixed line telephone, radio, LAN cabling for computers for all office area, store and workshop;

13) Turbine generator shaft vibration monitoring system;

14) Continuous Emissions Monitoring System (CEMS) at chimney, with its installation location and type/make agreed with local authority;

15) Power supply system for control and monitoring system;

16) Air supply system for instrument and maintenance; and

17) Control instrumentation laboratory and testing equipment.

1.4.7 Balance of Plant Systems

1) Air cooled condenser of 16 cells, capable to maintain back pressure for the steam turbine to deliver rated gross output of 150MW at an ambient temperature of between -40 t0 30^{o}C. Able to operate without freezing up to air temperature of -46 Deg C. Sufficient margins and redundancies must be provided; motors shall be frequency control

2) Coal handling system of 1000 t/h capacity, consists of
   - one stacker / reclaimer
   - 2x 100% for screens, crushers and magnetic separators,
   - totally enclosed belt conveyors with walkway inside and side panels with transparent windows from first junction tower and coal stockyard to boiler bunkers, the conveyor system must be capable of simultaneously unloading the coal and feeding the coal to boiler bunker,
   - a conveyor from coal yard to second junction tower for emergency use,
   - coal sampling and weighting instruments,
   - 4 dozers and 4 front end loaders
   - dust suppression sprinklers and pipework

3) Ash handling system of transfer capacity of 2 times the bottom ash production rate and 1.5 times the fly ash production rate at 100% BMCR, consists of 2 bottom ash silos and 2 fly ash silos, each of storage capacity of not less than 10 hours for Worst Coal at 100% BMCR;

4) 2 x 100% closed loop cooling water pumps; the cooling medium must be condensate or demineralized water;

5) 5 x 25% mechanical draft cooling towers for the whole Plant with rated output at ambient temperature of 30^{o}C;

6) Raw water pre-treatment system with tank of 4 days consumption for 4 Units at 100% TMCR, with 2 x 100% pumps, completed with pre-treatment and treatment plant if necessary;

7) Potable water system with tank of 7 days consumption by the station personnel, with 2 x 100% pumps, complete with conditioner and filter to fulfill the local potable water quality standards;

8) 3 streams of demineralized water system with tank of 3 days consumption for 4 Units at 100% TMCR,

9) Waste water treatment system to treat effluent from station water treatment plant, boiler blowdown, coal yard dust suppression and run off, oily water, clarifier sludge, sewage water, canteen waste;

10) Air compression and conditioning plant to supply instrument air and general service air, complete with redundant compressors, air receivers, and a ring main arrangement with sectional valves at suitable intervals

11) 2 x 1000t fuel oil tanks for the Plant; 3 x 50% fuel handling pumps, complete with trace heating if required

12) HVAC equipment;

13) Fire protection systems, including fire detection panel in central control room, together with fire water pumps and main, and fire engine;

14) All necessary lifting and handling equipment for plant operation and maintenance;

15) Chemical Laboratory with furniture, utilities (power, lighting, phone, LAN, central type air-conditioning), equipment and instrument;

16) Workshop and garage with necessary tools,

17) Maintenance tools and test equipment

1.4.8 Miscellaneous

1) Operation and maintenance training for Owner's personnel at manufacturer's work and Site;

2) Supply of spare parts (including commissioning, operating and routine spares for first two years of operation;

3) Supply of all consumable required during erection including initial charge of all lubricating oils and greases, fuses, indicating lamps, filters, lubricants, gases, and chemicals etc. till to the taking over;

4) Manufacture and shop test inspection for Owner's personnel;

5) Performance Guarantees Testing and 168 hour Reliability Test

6) Design, operating, maintenance and systems manuals for all systems and equipment supplied;

7) Reports, documents, as built drawings on completion for record purposes, O&M manuals etc.;

Chapter 2 – Design Concept and System Description

2.0 Machine Ratings

Boiler Maximum Continuous Rating (BMCR) shall be 3% in excess of Valve Wide Open (VWO) Rating of the turbine

2.1 Operating Modes and Cycle, Availability and Utilization

It can be assumed that the Plant will operate as a base load power generating station, generating close to the Plant rated output for much of the time. In later years of its operating life, it is possible that the Plant may be required to operate on a two-shifting basis and hence, the Plant and its control system must be designed to maximize efficient operation, under both these operating regimes.

The control and supervision of the Plant must be carried out in a CCR, from where the generators will normally be started, auto-synchronized, and initially loaded. The Plant must be designed to ensure that automatic hot, warm and cold starts, as well as shut downs, are achieved on a reliable basis throughout its design life. In addition, the Plant must also meet the following steady state and transient operating conditions:

1) Operate under automatic control for sustained periods at all loads above minimum load (without oil support), for the given ambient temperature range.

2) Ensure safe shut down of the Plant in normal and emergency conditions.

3) Automatic controls must account for boiler and turbine operating conditions (hot, warm or cold), in setting the ramp rates for start up, loading and shutdown. The Unit must respond to despatch center command in accordance to grid code requirement through the automatic generation control (AGC).

4) Each turbine generator must be provided with a flexible governing system with characteristics so that it can be readily adjusted as well as any changes in the operating regime that may arise during the life of the Plant. The governing system must be provided with a set of control algorithms that allow the Plant operators to change governor control parameters, if required. The Plant must be designed with good capability for load cycling between the minimum load (without oil support for firing) and full load.

The Plant must be designed to operate at sliding pressure between 40% and 90% TMCR while the pressure will remain constant above 90% and below 40% TMCR. The minimum stable load without oil firing must not be less than 40% TMCR. The Plant must be capable of operation at 50Hz within a range of 48.5-51.5Hz. Resonant vibration of generator and turbine parts must be out of this range.

The Unit must be designed for the following minimum number of starts and load cycling throughout its life:

Very hot start (1 hour restart after unit trip)	300 times	
Hot start (shutdown <18 hours)	4500 times	150 times per year
Warm start (shutdown between 18-48 hours)	1260 times	40 times per year
Cold start (shutdown > 48 hours)	210 times	7 times per year
Load cycling (between 40-100% load)	6000 times	200 times per year

The Plant must be designed to be synchronized and run to full load within the following duration for different starts:

Start types	First ignition to synchronization (min)	Synchronization to full load (min)	Total time (minutes)
Hot (Shutdown < 18 hrs)	45	45	90
Warm (Shutdown between 18 - 48 hrs)	150	120	270
Cold (Shutdown > 48 hr)	255	215	460

The Plant must be designed to vary (including ramp up and ramp down) the loads during normal operation at the following rates.

0-40% load	2% TMCR per minute
40-50% load	3% TMCR per minute
50-100% load	4% TMCR per minute

All electrical components, including selection of the component design, provision for ventilation, air-conditioning etc, must be designed to operate at an ambient air temperature of 40^{o}C for outdoor and indoor installation.

The startup / shutdown procedures including draining and venting of the equipment must be selectable and controlled automatically according to the Unit's status such as hot start, warm start and cold start respectively. All valves, drains and vents required to be operated during startup and shutdown of the Units must be motorized and controllable from central control room through the DCS.

Plant interlock must be designed and provided with all required protection devices, logic circuits, relays, instruments and other pertinent equipment.

Under emergency circumstances, the Unit output may be reduced suddenly from any load to house load with the successful operation of the HP/LP bypass. Re-establishment of full load must then be required as soon as possible after the cause of the load rejection has been cleared. Under such circumstances the Unit control devices must keep the Unit in a controlled condition and free from troubles such as thermal stress, differential expansion, vibration and other undesirable effects. Any limitations on rapid re-loading after such a load excursion must be stated.

In case of blackout, the Plant must be able to shutdown safely with control systems designed to be "fail safe". The control air receiver capacity, the control electric power system and battery capacity must be rated sufficiently for safe shutdown. Facilities for black starting of the Units are not required.

With the loss of all AC supplies, the Units must be capable of being placed onto barring gear operation if required. During this period a number of essential services must be switched to and maintained by DC supply and emergency diesel generator.

All Unit auxiliary supplies must be arranged on a unitized basis such that individual Unit is capable of supporting its own auxiliaries.

2.2 Unit Operating Fuels

The normal operating fuel for the Plant will be coal. The Units must be capable of economic and efficient operation up to the extreme limits of the Worst Coal as given in the following section for coal specification.

Coal Specification	Performance Coal	Worst Coal
As Received Basis		
Total Moisture, %	41.60	49
Total Ash, %	10.6	13.8
Total Sulfur, %	0.60	1.0
HHV, kcal/kg	3190	2200
LHV, kcal/kg	3070	2080
Proximate Analysis (Air Dry Basis)		
Inherent Moisture, %	25.00	30.6
Ash, %	13.30	19.0
Volatile Matter, %	30.90	26.2
Fixed Carbon, %	30.80	17.4
Total, %	100	1
Ultimate Analysis (Dry Ash Free Basis)		
Carbon, %	74.00	69.60
Hydrogen, %	4.10	0.90
Nitrogen, %	1.80	4.2
Oxygen, %	18.90	22.9
Sulfur, %	1.20	1.4
Chlorine, %	0.005	0.01
Total, %	100%	100%
Grindability, Hardgrove Index	44	38

Specifically, the results of the Performance Guarantees Testing must be corrected to the typical parameters of the Performance Coal.

For the design, sizing and testing of ESP and ash handling system, Worst Coal of ash content of 13.8% (arb) must be used.

For the design and corrosion resistant capability of the Plant, Worst Coal of sulfur content of 1% (arb) must be used.

For the design, sizing and testing of the furnace and combustion equipment, Worst Coal of LHV of 2540 kcal/kg must be used.

Ash Specification

Ash Fusion Temperature (Reducing)

Deformation, deg C	1195	1130
Hemisphere, deg C	1235	1195
Flow, deg C	1235	1205

Ash Analysis (%)

SiO_2	43.7	53.9
Al_2O_3	17.0	20
Fe2O3	13.9	27.5
CaO	10.8	14.8
MgO	4.60	6.1
K_2O	0.8	1.3
Na_2O	0.6	1.0
TiO_2	0.8	0.9
P_2O_5	0.3	0.6
SO_3	7.5	10.5
Total, %	100%	

2.3 Quality of Mine Water

Analysis of Mine water to be used as Raw Water is given in Appendix B.

2.4 Environmental Conditions

Without limiting the Contractor's other obligations, the following emission levels must be achieved and guaranteed.

2.4.1 Flue Gas Emissions from Stack (Chimney)

SOx	<	600 mg/Nm^3
NOx	<	450 mg/Nm^3
CO	<	300 mg/Nm^3
Particulate	<	50 mg/Nm^3

Above figures are measured volumetric dry, at 273K, 1 atmosphere and 6% O_2.

Chimney must be at least of 215m in height and of separate twin flue ducts made of steel, protected by RCC windshield.

Mongolian Standard MNS 6298:2011 must be compiled with.

2.4.2 Effluent/Water Discharge

The Plant must adapt a zero-discharge design concept. During normal operation, there must not be any effluent discharge from the Plant. The effluent, sewage and waste water must be treated in accordance to Mongolian Standard MNS4943:2011 before re-use for landscaping.

2.4.3 Noise

The following noise level must be guaranteed not more than:-

85dB(A), at 1m distance from one source;

90dB(A), at 1m distance from any multiple sources; and

70dB(A) at Plant boundaries (ie at the boundaries of the EPC works)

2.4.4 Chemical/Solid Waste Disposal

A suitable storage area must be provided to store various kinds of chemical/solid waste which must include contaminated oil, degreasing solvent, paint & thinner, sulfuric acid, miscellaneous acids and alkalines. The Contractor must provide suitable unloading facilities to enable the removal

Chapter 3 – Boiler and Auxiliaries

3.1 Boiler Proper

The boiler must be circulating fluidized bed (CFB) type, high pressure, high temperature, natural circulation, single-drum, single-reheat, balanced draft, and suspended heating surface, top support with steel superstructure and totally enclosed.

The boiler(s) and auxiliaries must be sized to operate over the full range of ambient temperatures specified without limiting the plant output. They must include economizer, evaporator, superheater and reheater tube bank section(s) with tubing, as appropriate, to maximize heat transfer.

The thermal cycle must be designed to suit the specific requirements of the OTSR.

Pressure parts must be designed, manufactured and tested in accordance with "ASME Boiler and Pressure Vessel Code, Section 1, Power Boilers" or equivalent standards. Design pressure for boiler combustion system (including burners) must in compliance to NFPA85.

The boiler and auxiliaries must be sized to operate over the full range of ambient temperatures anticipated for the Site.

Each boiler must be equipped with regenerative type air heaters, two FD fans and two ID fans. The furnace cross section, volumetric size and heat release rates of the burners must be selected conservatively to match the characteristics of the fuel. The design of the air heaters, fans and associated boiler auxiliaries must be provided with adequate margins to avoid limiting the capability of the Plant to achieve full rated output throughout the design life of the Plant. Steam sootblowers must be provided to support the cleaning operation of the boilers to allow continuous full load operation. The furnace must be equipped with wall sootblowers and long retractable sootblowers for the superheater, reheater and economizer areas.

The boiler maximum continuous rating (BMCR) must be designed with the inclusion of auxiliary steam flow for the use of Plant and heating requirements of various buildings within the Site. The boiler exit flue gas must pass through an electrostatic precipitator prior to entry into the stack.

Boiler drain must be designed with a flow of 1% BMCR and make up water of 3% BMCR (normal) and 6% (emergency). Firing with oil support must not be required at or above the 30% of boiler maximum continuous rating (BMCR).

In load range of 50-100% for fixed / sliding pressure operation, the superheater outlet temperature must not be deviated for more than 5^{o}C from its rated value. Fluidized bed surface temperature must not be differed by more than 50^{o}C.

The boiler and auxiliaries and all ancillary plants must be of standard proven design. Designs incorporating components which may be considered prototype in nature must not be used.

Equipment and the components must be designed and supported to permit free expansion and contraction without causing excessive strains, distortion or leakage.

Parts subject to wear, corrosion or other deterioration, or requiring adjustment, inspection or repair must be accessible and capable of reasonably convenient removal, replacement and repair. All such parts must be of suitable material. All hand rails, ladders, grids, platforms, metal frames must be hot galvanized to a thickness of not less than 610g/m2.

The equipment must be designed to permit interchangeability of parts and ease of access during inspection, maintenance and repair.

The Contractor must ensure that the furnace is properly sized in respect of the fuel/coal burner system, in order to meet the requirements of low NOx emissions in the flue gas whilst maximizing burnout to minimize the amounts of unburned carbon. The arrangement of the combustion zone must be designed so that no flame impingement on the walls would occur when firing the specified fuel under all conditions of load up to BMCR.

The boiler must be designed to minimize temperature differences in the furnace walls by installing individual tube orifices of correct sizes, quantity and locations, so that the flow can be distributed evenly.

The flue gas velocity must be chosen based on the proven experience of the Contractor, taking into account the ash properties of the specified coals.

3.2 Pressure Parts

Pressure parts must be designed, manufactured and tested in accordance with "ASME Boiler and Pressure Vessel Code, Section 1, Power Boilers" or equivalent standards and in compliance with the local codes and standards, and must include, but not be limited to, the following:

(1) Furnace water wall tubes, headers, down comers, supply tubes and risers
(2) Steam drum with all suitable internal fittings
(3) Super-heaters and re-heater including attemperators and all associated headers and pipe-works
(4) Economizer including headers and pipe-works
(5) Valves and pipe-works associated with the above items.

The Contractor must provide complete material schedules of all headers, separator, tube banks, integral pipework, main steam pipework, cold and hot reheat pipework, attemperators, flash vessels and other high pressure pipework for Owner’s review.

All boiler pressure parts must be designed to achieve the required design life and do not require replacement.

Headers must be provided with access arrangements, allow full internal visual inspection and cleaning. Wherever possible, the access openings must be through header ends and must be arranged so the number of inspection openings is minimized.

The openings must have an internal diameter of at least 75mm to allow tele-visual inspection of the complete header. The closure of these openings must be of a permanent type, fixed by means of fully penetrating butt welds with suitable length allowance for future cutting and re-welding. Where header ends are attached by welding this must be by using a fully penetrating plain butt weld joint.

All nozzles, branches and tube stubs must be of a sufficient length to ensure adequate access for welding on the adjoining tubes or pipes and to permit effective post weld heat treatment of these butt welds so as not to affect the integrity of the headers.

Headers must be self draining and provided with drain valves where necessary.

3.3 Welding

The qualification/approval of welding procedures and welders must be carried out as per the standard specified in ASME. Welding procedures for pressure part welding, together with their procedure qualification information must be submitted to the Owner for approval prior to manufacture during design stage.

Design of welded joints must accommodate NDE to be performed. Weld preparations if not formed as an integral part of a casting, must be formed by machining. All branch, nozzle, stub and butt welds must have at least the root run made by a TIG plus filler process. Tube butt welds must be made by using TIG welding. Where automatic welding is impractical and manual welding is used, an inspection technique must be used to demonstrate that acceptable bore protrusion and concavity are maintained over the entire weld length. Procedures for the storage, baking and usage of welding consumables must be submitted before welding commences. Post welding heat treatment procedures must be submitted before production welding commences.

NDE must be carried out by appropriately qualified personnel as required by a recognized standard or international certification scheme which is complied with Local regulation.

3.4 Chemical Cleaning of Boiler

The Contractor must supply the material, equipment and chemicals and carry out the pre-operational chemical cleaning of the boiler to ensure that the boiler internal surface can achieve a clean condition with a protective magnetite layer to assist in preventing later on-load corrosion of the boiler.

The Contractor must provide all necessary temporary neutralizing and sedimentation facilities including pipework for treatment of effluent from chemical cleaning operations and must carry out treatment work of the effluent to meet the requirements of the local regulation for discharge. The Contractor must submit in his proposal, detailed procedure and equipment required for the chemical cleaning.

3.5 Boiler Vents, Drains and Blowdown System

All drains must enter the blowdown tank tangentially. Steam drains must enter separately from water drains.

All boiler blowdowns and drains must have double isolation valves.

Adequate permanent connections must be provided for the purpose of chemical cleaning of the boiler.

The blowdown tank vent must have silencer and terminate 3,000 mm above the boiler roof structure, suitably supported, sleeved and weatherproofed.

The blowdown system must be designed to permit to receive blowdown of 3% of boiler evaporation at normal operation and of 6% of BMCR evaporation in emergency cases.

Drain disposal from the plant must be discharged into the general drain basin after the temperature is reduced by the raw water through the blowdown tank attemperator.

Particular attention must be paid to the routing and supporting of the high pressure drain lines to allow for expansion, movements and thermal shock.

3.6 Sootblowers

A complete set of automatic steam-operated soot-blowing equipment must be provided for cleaning the furnace water walls, super-heaters, re-heaters, economizer and air-heater elements.

The soot-blowing system must include, but not be limited, to the following:

- All steam and drain piping, valves fittings, supports and steam pressure reducing valve
- Motorized isolating valves in the steam supply line in addition to the reducing valve
- Sealing air piping, fittings and valves if necessary
- Shielding of boiler tubes in the vicinity of sootblower head to prevent erosion

All sootblowers must be capable of operating manually and sequentially in series from the Central Control Room. Local manual operation must also be provided for testing.

Adequate walkways and platforms must be provided for access during operation, repair and maintenance purposes.

The Contractor must submit together with his proposal details of sootblowers proposed for various sections including layout showing the position of sootblowers and spare holes, angle of blow, etc.

3.7 Coal Bunker, Feeder and Combustion

The shape of the bunkers must be designed to give mass flow of coal under all conditions particularly when reclaiming wet coal from stock, without material holding up on the bunker sides or in any valley angles.

The feeders must be variable speed and be able to supply the required quantity of coal to the mill under all circumstances without interruption. The feeders must be able to re-start against a full bunker head of compacted coal.

Powered means of isolation must be provided between bunkers and feeders. The feeder must be fitted with liners to combat abrasion and corrosion such that the feeder casing is not sacrificial.

The liners must have a wear life in excess of 25,000 hours at BMCR when handling the Worse Coal specified. The wear life of the belt must exceed 3 years, and the rattler, weigh system, inlet and outlet gate and bearings exceed 40,000 hours.

Cross correlation type flame monitors must be provided to detect the presence or absence of a stable flame under all conditions.

Means must be provided for measuring the combustion air flow rate.

The oil burners must be automatic operated from the central control room. The mill and the coal burners must also be controlled from the central control room. The DCS must control both according to the signals from the furnace and other path. The Contracting Counterparty must provide the minimum number of oil burners required to safely initiate and establish the boiler load in their design submission

The ignition and support firing equipment must be designed such that at any time when the boiler is firing on coal, oil burners are available for immediate operation on demand from the DCS or the boiler front local control panels.

The oil firing rate(s) must be selected taking account of the operational requirements for coal combustion support and part load carrying duties. The range of oil burner firing rates must operate satisfactorily.

3.8 Boiler Valves, Casings and Access Gantries

The Contractor must provide details of all the safety valves to be fitted to the boiler in design submission.

The boiler must be furnished with sufficient safety valves and power control valves (PCV) to meet ASME requirement before the main steam stop valve along the steam flow. The selection of the safety valves and other valves must satisfy ASME codes.

All safety valves must be located at the place where enough space can be provided for setting and maintenance work. All ordinary valves must be located at readily accessible areas as near as possible to the headers. All connections to pressure parts must not be less than 25 mm nominal bore.

Where two blowdown valves or isolating valves are arranged in series they must be supplied as two separate units. Twin-type valve in a single body is not acceptable.

All pressure parts must have double isolation valves for instruments, drains and vents.

Silencers must be provided for escape pipes of all safety valves and relief valves.

The lifting and reseating pressure of safety valves after setting must be correct and reliable to avoid failure to lift or reseat of them.

The reseating pressure difference of safety valves must be no more than 7% of lifting pressure.

The safety valves must have good features of tightness under operation pressure.

The safety valve must be fully open when the steam pressure is 3% above the lifting pressure of the safety valve. For the boiler, the total pressure rise when all safety valves are fully open must not be more than 8% of the design working pressure.

The super-heater outlet must be fitted with safety valves having a capacity of not less than 20% of the maximum evaporation rate of the boiler. The safety valves of re-heater outlet must have a capacity not less than 20% of the maximum steam flow. T

All valves must be at ready state for use before shipping.

A suitable gas tight boiler casing must be provided. The Contractor must indicate the design pressure range. The casing must withstand taking account of anticipated normal and abnormal operational conditions. The flexibility of the casing must allow for thermal expansion and must cater for changes in section at corners and access door.

The Contractor must provide all necessary galleries and access and inspection doors to allow comprehensive visual monitoring of boiler operation and provide ready access for tube failure repairs in any area of the boiler. In particular adequate properly placed observation ports must be provided to permit inspection of the furnace and windbox. Operating platforms must be provided to allow operation of all valves and on load maintenance of boiler cleaning equipment. Walkway access must also be provided for furnace and dead space areas for planned maintenance during overhauls.

3.9 Electrostatic Precipitator (ESP)

The electrostatic precipitator must be designed and capable of being operated such that emissions do not exceed the limit of 50 mg/Nm^3 when firing the Worse Coal with one transformer/rectifier unit in each train of the electrostatic precipitator out of service. This must include allowances for furnace and tube cleaning operations and any effects of fouling. Design gas volume must be at least 115% of BMCR gas flow when burning the

Worse Coal with the maximum ambient temperature. The particulate removal efficiency must not be less than 99.96%. The gas treatment velocity must not exceed 1.3m/s at the precipitator design gas low condition of 115% BMCR on the Worse Coal specified.

Each zone of a precipitator must have an independent drive for the rapping of both the discharge and collecting electrodes.

High voltage support insulators must be installed out of the gas stream. Where possible the housing must be subdivided to give one section for each zone. Insulators in contact with flue gas must be fitted with electrical heaters, the heaters must be controlled by adjustable thermostats.

Hoppers must have heating arrangements to prevent ash sticking to the sloping sides and down pipes. Level indicators to indicate and trip the ESP in case of high ash levels in the ash hoppers which must jeopardize the safety of ESP otherwise. Safe arrangements must be made, such as poke rods or agitator chains to aid clearing of the hoppers. Provision for a safe means of hopper emergency emptying must be made.

No access must be possible into the gas passages unless all the zones in that particular flow are safely isolated and earthed.

ESP transformer rectifier sets must use high fire point oil as the cooling medium. The Contractor must provide documentary evidence including references to demonstrate that the design (including protection systems) of the proposed high voltage power supply has operated safely and reliably under similar operating conditions and all anticipated fault conditions during design stage.

The high voltage power supply for precipitators must be controlled by a solid state system which continuously adjusts the electrical input in order that the optimum voltage is impressed to the discharge electrodes. In the event of any faults, alarms must be initiated. Control of individual high voltage supplies to each zone must be independent of each other and based on solid state technology.

3.10 Fan Groups (FD, ID, PA and Fluidized Fans)

The draught plant comprises ductwork dampers, air and gas fans associated with the boiler plant. In addition to the operational requirements of the power island the draught plant has its own particular requirements with regard to maximum number of start-up/shut-down cycles, flexibility (including turndown) and emergency shut-down conditions.

The margin between the fan operating point and the onset of instability (such as stall) must not be less than 10% of the BMCR flow, firing Worst Coal.

The fans must operate in a completely aerodynamically stable manner over their entire operating range when operated alone or in parallel with another fan. The operating range includes transient states such as boiler load changes, start-up and shut-down.

Emergency shut-down of the fans, initiated by either the operator or protection system, must be entirely automatic. A manual method of bringing a decelerating fan to rest and preventing fan impeller rotation during maintenance must also be provided.

The fans must be controllable at all loads without significant hysteresis (ie hunting due to poor mechanical design or construction) or the need for operator intervention.

Fan impellers must have sufficient fatigue strength to prevent failure from repeated application of centrifugal loading, aerodynamic loading, acoustically induced load and surging due to interaction of fans throughout design operating life. Fan impellers must not impose aerodynamic pulsations on the gas flow which could induce fatigue failure of adjacent ducts.

The Contractor must ensure that suction fans do not create a significant risk of implosion of the boiler under any plant fault conditions.

All air intake ductwork must have safety grillage suitable to prevent damage or blockage of fans and downstream components.

Automatic drainage provision must be made for all flues and ducts where significant quantities of water are liable to collect including conditions such as airheater fire fighting or boiler tube leakage.

All dampers must be operable and have position indicators both locally and in control room. A manual method of operation, such as a hand wheel, must be provided on all dampers.

The Contractor must provide 100% sealing efficiency for those areas where man access is required for maintenance through the use of a double damper system.

Chapter 4 – Turbine and Auxiliaries

4.1 General

The proposed steam turbine and auxiliaries must be of proven, reliable design with high availability and efficiency; combined HP/IP cylinder and separate LP cylinder; at 3000RPM. The selection of steam turbine must be based on a robust design suitable for frequent two shifting operation. The turbine must be directly coupled to the generator. Proven electronic governor control must be provided for startup / shutdown, normal running and to prevent operation of the over-speed trip in the event of a unit trip. Turbine supervisory and monitor systems must be provided to allow close monitoring of the turbine conditions in control room. Protection and interlock system must be provided to safeguard the equipment during abnormal operating conditions.

The steam turbine and generator must be located within buildings, serviced by overhead cranes.

Full details of the materials proposed for the casing, rotors, blades, diaphragm and connecting pipework must be supplied to the Owner for review, at design submission stage, including composition and specified mechanical properties. Details of heat treatment procedures, fabrication and repair welding procedures, inspection procedures and defect acceptance standards must be made available for inspection by the Owner at the work place.

Details of all casing joint bolts including materials, nominal sizes, waisting and initial tightening strain must be given. Bolts and studs strain controlled tightening method must be described. Details for pipe connection to the turbine to accommodate thermal expansion must be supplied to the Owner for review at design submission stage.

The Contractor must provide details of the arrangement of supports and fixture to assure the alignment of the power train and allows for the thermal expansion to the Owner for review at design submission stage.

Atmospheric relief diaphragms must be provided in the turbine exhaust hood to prevent positive pressurization. Motor operated vacuum breaker valves with inlet filter must be provided at the condenser.

The insulation must be designed for ease of removal and replacement, using segmental units insofar as possible.

Cladding and suitable acoustic enclosure must be furnished for the turbine generator unit.

The noise attenuation insulation must reduce the noise level to meet the requirement of noise emissions.

4.2 Operational Requirements

The design of steam turbine must be suitable for base load operation as well as for cyclic duty and frequent start-up requirements with minimum start-up and shut down time, and capable of achieving the specified service life of the Plant. The steam turbine must be designed to withstand without sign of strain or leakage for any load up to VWO output. Vibratory stresses must be low and no component may have a resonant frequency within the operating range.

The steam turbine must be designed for the maximum removal of water particularly during start-up. The turbine internals must be self-draining and the design must include passageways and inter-stage drainage where appropriate. Special attention must be given to avoid erosion damage of LP blading and in this respect all necessary cylinder or diaphragm water grooves must be included.

All operating controls, gauges and thermometers mounted on the steam turbine must be readily accessible, easily operated and observed.

The location and arrangement of all equipment and piping must minimize the potential for oil fires as a result of leakage onto hot areas of the turbine or associated equipment and piping. The pressure oil piping to bearings in area of the high temperature turbine parts must be installed with suitable guarding to prevent such fires.

The steam turbine must be capable of operating under sliding pressure control for 90% and part load conditions and also capable of being throttle governed for low loads.

The steam turbine control system must provide the required rapid reaction to generator load loss transients so that the stability and synchronization of the Unit can be maintained without excessive level of stress.

Feed water heater bypass operation must be possible. In the case of all high pressure (HP) feed water heaters being bypassed, the Unit must be able to maintain the 100% rating load operation.

Plant interlock must be designed and provided with all required protection devices, logic circuits, relays, instruments and other pertinent equipment.

Under certain emergency circumstances the output of the steam turbine generator of the Unit has to be reduced suddenly from approximately base load to house load. Re-establishment of full load must then be required as soon as possible after the cause of the load rejection has been cleared. Accordingly the plant must be capable of sustaining such a severe load rejection, which may require the tripping of the steam turbine generator. Under such circumstances the plant control devices must keep the Unit in a controlled condition and free from such trouble as thermal stress, differential expansion, vibration and other undesirable effects.

Any limitations on rapid re-loading after such a load excursion must be stated in the design submission.

In case of blackout, the Unit must be able to shutdown safely; every control system must be designed to be "Fail Safe". The control air receiver capacity, the control electric power system and battery capacity must be safely and sufficiently able to shutdown the plant in case of an emergency.

Following a severe system disturbance resulting in tripping of the Plant from up to full load with the loss of all AC supplies, the plant must be capable of being placed onto barring gear

operation if required. During this period a number of essential services must be maintained by DC supply and emergency diesel generator.

All unit auxiliary supplies must be arranged on a unit basis such that individual turbine generators are capable of supporting their own auxiliaries and continuing to run even in the event of major electrical failure which results in the total or partial loss of the EHV supply.

4.3 Turbine Materials and Casing

The materials of all components of the turbine must be suitable for the steam conditions and the load cycling nature of the steam turbine.

The arrangement of the turbine casings together with their supports and location details must be described and basic details of the proposed casing materials must be provided at design submission stage. Full details of the casing materials must be provided as part of design submission, including composition and specified mechanical properties. In addition, the proposed casing inspection, defect acceptance and weld repair procedures must also be specified.

The outermost casings of all the turbine cylinders which operate with internal steam pressures above ambient pressure must be hydraulically tested in-works, the gauge test pressure exceeding the maximum working pressure difference by 50%.

Instrumentation must be provided for continuous monitoring of thermal stresses in the HP/IP casing and differential expansion between rotor and casing. Control of transient thermal stresses in the HP/IP rotor must be provided to ensure they are well within design limits.

All the casing joints must be designed to remain steam-tight for a minimum operation period of 45,000 hours without the need for bolt re-tightening or gasket replacement. The associated high temperature fasteners must be adequately wasted and controlled tightened during assembly. The Contractor must provide details regarding the proposed bolting material and methods of tightening the bolts and studs at design stage. The Contractor must provide all necessary tightening Equipment.

4.4 Rotors

The turbine rotors must be of forged construction and designed to avoid high geometric stress concentration and self weight bending stresses.

Rotors must be designed to withstand 20% over-speed. Completed rotors must be dynamically balanced at high speed and tested to an over-speed of 10% for 5 minutes in-works. The Contractor must state whether any in situ testing or balancing of the rotors at Site is necessary at design submission stage.

The rotor must be designed so that all combined rotor critical speeds on the turbine foundations are adequately clear of running speed to ensure satisfactory operation of the Unit. Adequate provision and access must also be provided for in situ Site balancing of the rotors without requiring major dismantling. The rotors must be designed such that combined rotor critical speeds are well apart from the normal running speed to ensure satisfactory operation of the Unit. The rotor must also be capable of safely withstanding the worst case short circuit of the generator at 100% voltage and current.

The rotors must be interchangeable between Units. The Contractor must submit during the manufacturing stage, any information regarding deviations between the rotors that would detrimentally impact on the ability to interchange rotors.

4.5 Blades

The blading must be of proven design with good operational record and constructed to avoid the possibility of damage from vibration, thermal stress and metal fatigue when the set is running continuously at any speed between 6% below and 3% above normal running speed. The natural frequency of all the rows of blades must be such as to avoid resonant vibration at or near the normal operating speeds. A Campbell diagram must be provided as part of design submission for last stage having resonant vibration modes below 500 Hz. Blading requiring through holes for damping or lacing wires are not allowed.

The Contracting Counterparty must demonstrate successful service elsewhere of the latter LP turbine blading stages, indicating where and which units with identical blading have been commissioned.

The Contracting Counterparty must state the proposed method of protecting the leading edge of the LP moving blades from erosion in the wet region at design submission stage. If erosion shields are offered, details of their location, material specifications including heat treatment, method of attachment to the blading and details of the inspection requirements with acceptance standards must be stated in design submission. If flame, induction or laser hardened leading edges are being offered, the means by which residual stresses after hardening are monitored and relieved must be explained in the design submission.

4.6 Glands and Gland Sealing System

All shaft and inter stage diaphragm gland must be of an established spring-backed design and must be arranged for easy maintenance. Turbine gland sealing system must be included to provide automatic, efficient sealing of turbine shaft glands against steam leakage. Complete gland steam sealing system including gland steam condenser, gland steam de-superheater, attemperator and air exhauster fans together with associated pipework and control systems must be provided to prevent in-leakage of air into the main steam system and leakage of steam into the turbine hall through the steam chests and steam turbine casing. The gland steam sealing system must be fully automatic in operation, including arrangement for adjustment, and also for manual control. The sealing line pressure control loop must cater for changes in steam demand due to gland wear.

The system must be designed for efficient shaft end gland sealing during start-up and under all conditions of operation including bypass operation if appropriate. The system must therefore be capable of fully sealing the turbine shaft end glands without the main steam stop valves being open.

Gland steam desuperheaters of the direct injection type must be provided. They must be designed to operate satisfactorily during all conditions of operation, including temporary loss of electric power.

4.7 Turbine Bearings

The bearings of the turbines must be of horizontally divided type, readily accessible, adjustable and replaceable without damage to the adjacent glands. Provision must be made for ease of cylinder re-alignment. Tilting type bearing must be provided.

All bearings must be designed to compensate for limited misalignment to withstand loads transmitted in both normal and unusual operating conditions. All bearings must be split to permit removal of both halves for inspection without lifting the shaft more than a small amount and without lifting the tip half casings. The bearing supports must be so

designed that shims can be fitted to adjust the alignment.

Turbine bearings must be mounted separately from the casings to minimize rotor misalignment with cylinder mounted diaphragms or stator blades. The thrust bearing must be of the tilting pad type with thrust and surge pads, and must be capable of withstanding the maximum loads imposed during any conceivable transient condition of operation. The thrust bearing must be fitted with wear monitoring devices that must raise an alarm to the CCR.

Each main bearing must be provided with a positive visual checkpoint of oil flow through the bearing incorporating a local dial type thermometer. Thermometer pockets must also be provided local to each sight glass.

Under thermally stabilized base load operation at nominal speed, the relative shaft vibration for the steam turbine according to ISO 7919-2 must be within Zone A. The pedestal and the bearing housing vibration must be within Zone Z of the ISO 10816-2. The vibration level must be verified during the performance testing (with normal plant instrumentation). Approved proximity vibration detectors must be provided at the X and Y directions and seismic detector must also be provided at each rotor bearing for the continuous monitoring of the machine vibration.

Provisions must be made by the fitting of an earthing brush or other approved means for prevention of damage to the bearings, reduction gears and oil pump drives due to any electrostatic charges which may be produced. Each of the generator and exciter bearings and oil pipes must be insulated from the bedplate and foundations to prevent circulation of possible shaft currents. The generator bearing insulation must be bridged by a removable copper strap to facilitate the routine testing of the insulation.

4.8 Shaft Turning Gear

A fully automatic shaft turning gear must be provided by an AC motor. The motor must have capacity to rotate the turbine generator shaft continuously without undue stress during periods of shutdown. The shaft turning gear must be arranged for automatic disengagement of the drive when the speed of the turbine generator shaft exceeds the turning gear speed and automatic engagement when the turbine generator speed falls below turning gear speed. Electrical interlocks must be provided so that the turning gear cannot start until the gear is fully engaged and an adequate supply of lubricating oil is available. In the event of failure of the lubricating oil supply the tuning gear must become inoperative immediately. A remote zero speed indicator at local and an alarm at CCR must be provided to indicate that the shaft has stopped. All necessary equipment must be provided to enable local control of the turning gear.

Hand turning and also shaft inching facilities must also be provided. An interlock must ensure that electrical turning cannot be initiated while hand turning is being attempted. To minimize damage between internal rotating and stationary parts, safeguards must be included to prevent excessive torques from being transmitted to the shaft in the event of a seized rotor.

4.9 Pipework and Valves

The HP Turbine must be fitted with two combined stop and control valves for main steam admission. Two combined intercept stop and control valves must be installed at the IP-Turbine for hot reheat steam admission. Provisions must be made for exercising all stop valves and the throttle valves in turn with the turbine on load.

Each combined valve consists of a stop valve and a control valve that must be mounted on a common body. Every stop valve and control valve must be equipped with an electro-hydraulic-actuator.

All piping system must also be designed to latest issue of the relevant local and an acceptable international standards and codes such as BS806 or ANSI B31.1 or equivalent. All main steam piping must be seamless alloy steel of suitable grade. Rolled and welded piping are not acceptable. Pipework supports and hangers must be allowed for movement due to thermal expansion, hydrostatic testing, water hammer and other possible dynamic impacts.

Suitably designed drains and vents complete with necessary pipework must be provided for the pipework. Drain valves must operate in a failsafe (open) mode with an orifice installed downstream to limit the steam flow and pressure drop across the drain valve. These valves must either be parallel slide valve or globe valve. All drain and vent valves required operating during start up and shutdown must be remotely controllable from CCR.

4.10 Lubricating Oil System

Lubricating oil system with one shaft driven pump, one AC pump and one emergency DC pump of 100% capacity each, must be provided with lube oil purifier and 2 x 100% coolers. Space must be reserved to allow future additional clean lube oil storage tank and dirty lube oil storage tank of replacement capacity for a whole Unit, when required.

The Contractor must provide a static coalescer type lube oil purifier for each Unit. The unitised lube oil purifier must be permanently connected in a bypass to the unit lube oil module such that it can be used whether the turbine generator is running or not. The capacity of the purifier must be adequate to process at least 10% of the total oil charge in the system per hour. The purifier must be capable of removing all solid particles down to five micron in size.

4.11 Extraction Steam

The extraction steam system must supply bled steam for regenerative feedwater heaters and direct contact heater (deaerating heater). Extraction steam system piping must be routed and supported in such manner as to provide for thermal expansion and to maintain end reaction forces and moments within allowable limits. At least one reverse flow check valve and a motor operated stop valve must be provided in each extraction line as required. The check valves must protect the turbine from overspeeding due to reverse flow of steam from the extraction piping when the turbine is tripped and is under a vacuum condition. During a turbine trip, controls must automatically initiate the closing of all the in-line motor operated shut-off valves and the opening of all the drain valves. High water level in a heater must initiate these operations in the extraction line supply steam to and bypass the feedwater of that heater. All piping drains must cascade and be routed to the condenser.

4.12 Feedwater System

The feedwater system must operate with varying flows, pressures, and temperatures. Feedwater flow must be regulated by a feedwater control system measuring feedwater and steam flow and monitoring the separator level. Steam temperature controls must regulate flow of feedwater into superheater and cold reheat steam attemperators.

The boiler feed pumps must receive the suction water from deaerating heater storage tank and then pump it through high pressure feed water heaters to the boiler. The deaerator must be supplied with extraction steam from the IP turbine and must normally operate at a variable pressure depending on the extraction pressure at different loads. A steam connection from the auxiliary steam header / cold-reheat pipe must be provided for initial heating and deaeration at start-up as well as pegging at low extraction steam pressure.

The leak-off control must be independent of the feed pump sequence control system and must be rated at least 25% of the pump rated flow, with isolation valves upstream and downstream of the leak-off valves, and connected to the deaerator.

Characteristic curves for boiler feed pumps must be submitted as part of design submission to the Owner for review. The curves must show total head, NPSH, power, horsepower, and efficiency, all plotted against pump capacity flow.

4.13 Deaerating Heater and HP Feed Heaters

The deaerator and HP feedwater heaters must be designed and tested in accordance with the latest applicable international codes and standards including Heat Exchange Institute standards and applicable ANSI and ASTM standards. Heaters must be of horizontal arrangement and must have integral desuperheating and drain cooler sections to minimize risk of water entering the turbine due to flooding within that section. Bypass of HP heaters must be provided. Deaerator level indicators and alarms must be provided in the CCR.

4.14 Condensate System and Condenser

The condensate pumps must also be used for filling the boiler during start-up, by-passing the low pressure heaters, deaerating heater, and boiler feed pumps. Condensate must flow from the hotwell of the condenser shell to the condensate pumps. LP heaters must be provided with bypasses in groups of 2 heaters.

LP Heaters must be designed and tested in accordance with the applicable codes and standards including Heat Exchange Institute Standards and applicable ANSI, and ASTM standards. Heaters must be of horizontal arrangement and must have an integral drain cooler and desuperheating section, as applicable.

4.15 Condenser Air Extraction System

Three liquid ring pumps must be provided for venting and removal of non-condensable gases during normal operation and to rapidly reduce the condenser pressure from atmospheric during start-up and admission of exhaust and/or bypass steam to the condenser. The holding capacity of single pump must be selected according to the condenser worst air-in leakage rate. Sealing liquid makeup must be from the cool condensate tank.

4.16 Drains Recovery System

The functions of the heater drain and vent system must provide a flow path for condensed extraction steam from each heater to the next lower heater or the condenser, to remove non-condensable gases from the feedwater heater shells, to provide shell and channel side pressure relief, and to facilitate filling and draining of the heaters.

The system must be a cascade type arrangement with HP drains directed to the deaerator and the LP drains directed to the condenser.

Each heater must be provided with shell side safety valves for protection from over-

pressurization. Channel side relief valves must be provided for the heaters to protect them from over-pressurization due to thermal expansion of the fluid when the heaters are isolated on the channel side only. Channel side vents and drains and shell side drains must be provided to facilitate filling and draining of the heaters and drain cooler.

Vents and drains from turbine, low point of main, reheat and extraction steam system must go to enclosed drains vessels with suitable desuperheating facilities and finally discharge to the condenser hotwell. Each drains line must be run separately from its collection point towards the point of discharge with continuous flow. Motorized valves and manual isolating valves must be provided in each drains line which operates according to the Unit control sequences. All valves must be located in accessible positions local to the drains vessels. Vents from drains vessels must be connected to the condenser.

4.17 Turbine Bypass System

The capacity of the bypass system must meet the requirements of all start-up during cold, warm, hot and very hot conditions. The turbine bypass systems must be fast-acting and reliable in operation during start-up, shut-down and transient conditions to protect the steam turbines. The turbine bypass system must be capable of operating at full load, part load, and various start-up and shut-down conditions.

Appropriate preventive measures must be provided to avoid back flow of bypass steam to the turbine cylinders. A non-return valve must be provided on the cold reheat common header to safeguard against the back-flow of steam into HP turbine while HP bypass is in operation. Desuperheating facilities must be available to reduce temperature and pressure of the bypass steam. Complete turbine bypass system must include HP and LP bypass isolating and control valves, dump diffusers, desuperheating spray water valves, actuating fluid supply package, accumulator, and instrumentation.

Chapter 5 – Generator and Auxiliaries

5.1 Generator

The steam turbine generator must deliver power to the generator transformer through the isolated phase bus duct. The generator must be directly connected, horizontal shaft, cylindrical rotor, 15kV, 0.85 lag p.f., 50Hz, 3-phase, wye-connected, in IP55 enclosure. The generators must have overload capacity as per IEC 60034-3. The unbalance load capability must be 0.08 pu continuous with I_2^2t equal to 10 sec. The generator must be able to continuous supplying 1.05 times of its nominal rated output at rated voltage and power factor over the frequency range 47.5 Hz to 51.5 Hz, and at rated frequency and power factor with a voltage variation of ±10% within temperature rise limits.

The Generator must be designed and provided with all necessary accessories:

- Automatic high speed digital dual channel (auto-manual) AVR, be able to maintain steady-state terminal voltage within ±0.5% of the preset value under all operating conditions and be able to smooth and continuous running over the operating band width.
- Excitation control cubicle.
- Surge protection equipment.
- Neutral grounding equipment.
- Current and potential transformers.

- Generator control and relay panels.
- Hydrogen cooling & stator water cooling Systems.
- Jacking oil, bearing oil and seal oil systems covered under turbine.

5.2 Stator Casing and Winding

The windings must be copper with class "F" insulation system, and temperature rise must be limited within “B” insulation. The stator core must be made of high permeability low loss material, insulated on both sides. The material specification for the stampings, the insulation between stampings, and the procedure adopted in debarring the plates and checking the finished, stampings, must be such as to eliminate the possibility of inter stamping shorts and resultant core faults. The choice of materials, proportioning, clamping, and arrangement of the core in the casing, must ensure the minimum noise and 100Hz vibration within the core plus the minimum transmission of vibration to the generator foundations, pipes and associated equipment.

The design must prevent movement of the coils in the slots and the winding overhang under normal operating conditions. It must eliminate slot discharge and ensure that slot wedge tightness and radial pressure on the coils is maintained to provide satisfactory operation over the life of the plant. The end winding structure must incorporate provision for re-tightening the end winding clamping after a period of service.

The stator slot wedges must be able to withstanding the force imposed during the most arduous electrical short-circuit between adjacent coil connections of different phases at the turbine end, such that there is an indeed of fault current from the system.

5.3 Rotor, End Ring and Brush Gear

The rotor must be manufactured from a single forging, however, that separate couplings must be allowed. No castings must be used in the rotor assembly, and the number of small parts must be minimized.

The centre of the shaft forgings may be bored to permit the inspection and testing of the interior. If, following metallurgical examination, it is necessary either to bore a previously unbored rotor, or to increase the bore diameter, it must be demonstrated that the effect on the magnetic characteristics must not limit the performance of the Unit.

In the design of the shaft system particular attention must be given to the quality of surface finish and the avoidance of sharp internal corners which may give rise to high stress concentration.

The packing blocks used in the rotor winding must be entirely suitable for the high temperature and mechanical forces existing in generator rotors. The rotor insulation system must be of sufficient mechanical strength and flexibility to cope with the stress in service without cracking or otherwise becoming damaged. Attention must be given to the insulation and securing of the coil connections to avoid vibration and possible failure of either the connections or their insulation. An effective damper winding must be provided in the rotor. It must be designed to divert negative sequence and 50 Hz current from the rotor teeth, wedges, pole-faces and end rings.

A suitable discontinuity must be provided on an accessible part of the rotating shaft system for use as a vibration phase reference. Means must be provided for detecting rotor winding shorted turns in service e.g., air gap search coil or similar device. The rotor shaft must be earthed.

The satisfactory and consistent dynamic behavior of the generator rotor must be assured by the design, manufacturing, testing and balancing. The generator rotor must be capable to withstand an over-speeding of 110%. Asymmetric rotor inertia compensation must be incorporated. There must be adequate provision for making in-situ correction to the generator rotor balance without major dismantling.

The rotor end winding retaining rings must be made of 18/18 Mn/Cr material, which is resistant to stress corrosion cracking in the operational environment.

The brush gear must operate continuously at full load for at least two years without the need to shutdown for brush gear or slip ring maintenance. The brushes must be capable of being safely replaced with the unit on load. The slip ring brush gear assembly must be totally enclosed to prevent the ingress of oil. Constant brush pressure devices or individual brush tension devices, capable of radial adjustment, must be provided. The design of slip rings and connections must be such that carbon dust from the brushes cannot accumulate on insulation surfaces.

5.4 Generator Cooling

The generator must be of TEWAC (totally enclosed water to air cooled) type. Cooled air must be circulated by two axial fans into the generator. The hot air must be cooled by 4 water coolers.

The capacity of the coolers must be adequate to cool the generator when the ambient air is 40^{o}C. The generator must be capable to generate its rated capacity when the cooling air at inlet is not higher than 40^{o}C.

5.5 Excitation

The excitation system must be static type. The excitation equipment must be rated for continuous operation over the full range of generator rated conditions and comply with IEC 60034-3.

Rated current and voltage of the exciter must be at least 120% of normal excitation current and at least 110% of no load excitation voltage with minimum ceiling voltage of 200% of rated.

It must be possible to remove the exciter for repair without the need to dismantle the main generator.

The excitation control equipment must consist of an automatic voltage regulator (AVR) (with power factor controller) and power system stabilizer (PSS).

The excitation control must include the following protective device which remove the faulty equipment from service, trip to manual if necessary, and bring up appropriate alarms and indications:

- Under-excitation - operates if the converter output is low in relation to demand.
- Over-excitation - operates if sustained high levels of excitation are attained.
- Over-current - operates when excessive current draw from the excitation supply.
- Over Voltage - operates when terminal voltage is high in relation to demand.
- VT supply failure - operates if the VT supply is lost.
- Over-fluxing - operates if the terminal voltage is high in relation to frequency.
- AVR power Supply - Operates if the AVR system power supply fails.

The excitation must be rapidly suppressed in the event of a major fault or main protection trip.

Chapter 6 – Electrical Systems

6.1 General

The Contractor must ensure the equipment to comply with Mongolian Grid Code's connection requirement and the results of system impact study. The equipment must operate satisfactorily under sudden variations of load and voltage as may be met under operating conditions, including those due to starting loads and short circuit and other fault conditions. All equipment must be designed to a minimum fault level of 50 kA for 1 second for 220kV and 40kA for 1 second for other voltage levels.

The design of the electrical equipment must be such that all maintenance and operational activities can be performed safely and with ease. Means must be provided to prevent unauthorized access to equipment. Equipment must be installed with interlocks to prevent accidental contact with live parts. Equipment such as switchgear and control cubicles must be provided with a main earth bar for the equiv-potential bonding to earth of all exposed conductive parts, which may become alive under fault conditions.

Equipment enclosure must provide a degree of protection of not less than class IP31 for indoor installation and IP55 for outdoor installation. Indoor equipment must be designed for an ambient temperature of 40^{o}C and outdoor equipment for 50^{o}C. Cable access to outdoor equipment must be by bottom entry. For outdoor panels, it must be made of stainless steel and with suitable shelter against rain water ingress.

The electrical systems and equipment must be designed to minimize the generation of harmonics and the effects of electrical interference between power and control/instrumentation circuits, and comply with international requirements on electromagnetic compatibility.

6.2 Plant Voltage Levels

The voltage levels for the power distribution system including generation, auxiliary power, controls, transmission and start-up power must be designed as stated below. Nominal system frequency must be 50 Hertz.

System	Nominal Voltage
Power Evacuation	220 kV
Generation	15 kV
Auxiliaries	6.0kV/380V/220V
Control and Instrument	220V DC
DC power	220V DC

6.3 Electrical Studies

Comprehensive fault level study, load flow study, voltage regulation / drop study and protection coordination study must be performed and submitted in design stage, it is ensured that the equipment provided is adequately rated for the service, even under the worst case short circuit conditions. Calculations must include voltage drop when starting the largest motor with all other required auxiliaries running. Fault level studies must take full account of the contribution from motors and the increased fault levels arising from the running of diesel generators parallel with the supply system during on-load testing.

The electrical auxiliaries system must be designed on the unitized principle. Power for the supply of all the auxiliaries associated with the starting and running of each Unit must

be supplied from unit boards. Equipment which does not have an immediate effect on the running of the Unit must be supplied from station or common services boards.

Switchboards must be provided with a permanent alternative supply where a second supply is needed for flexibility of operation or to cater for planned or forced outages. Where connection is provided between supplies that may be paralleled but may be out of phase and frequency check synchronization facility must be provided. Where connection may produce unacceptable fault levels at the switchboard an interlocking system must be provided to prevent the two supplies being paralleled in the event of operator error.

6.4 Isolated Phase Busbar

The isolated phase bus must be enclosed-type and mounted out-of-doors with weather-proof (IP55) and must be naturally cooling type. Conductor must be made of copper or aluminum which possess high conductivity, and supported by single porcelain insulators at appropriate intervals. Conductor, insulator, and supporting steel frame must be so constructed to be capable of safe withstanding the mechanical and thermal effects due to momentary current and short circuit conditions. Flexible connections must be provided at the connecting points to adjacent equipment and at intermediate points in order to alleviate the stress due to vibration and thermal expansion. At the point of bolted connection, the terminal surface must be silver plated. The enclosure of isolated phase bus must be made of aluminum which possesses high conductivity. Flexible connection of enclosure must be provided where the vibration-proof connection is needed, and rubber or aluminum bellows must be adopted. The inspection manholes must be provided in suitable place of main bus enclosure such as connection part with generator and transformers, and adequate places necessary for periodic inspection.

The necessary accessories like Voltage Transformer (PT) and capacitor (if required) must be installed in an enclosed metallic cubicle. Generator neutral equipment must also be installed in the isolated metallic cubicle. Removable links must be fitted in the IPB adjacent to all transformer connections such that any given transformer can be disconnected readily for maintenance and testing. Tee-off connection to unit auxiliary transformers must be equipped for disconnection between the transformers and the bus duct for maintenance or reparation.

6.5 Generator Transformer

Generator transformers must comply with IEC 60076.

Generator transformer must be rated at 180MVA, ONAF or ODAF cooled, oil-immersed outdoor type with on-circuit tap changer having range of ±8×1.25%.

The generator transformer must be provided with winding temperature indicator having contacts for temperature high alarm and trip functions. The temperature rise of the top oil and winding must not be higher than 50^{o}C and 60^{o}C, its definition in accordance to IEC60076-2.

Each generator transformer having bushing connections to external circuits must be provided with lightning surge arresters on each phase.

A concrete containment basin with sump must be provided to contain oil in the event of a tank rupture with a provision for draining it out. Fire walls must be provided on three sides of the transformer.

When the generator transformer is at full load, the capacity of the power grid is set to infinite and at any position of the regulating tap changer, the generator transformer must withstand short circuit from the HV side of the generator transformer and the short circuit lasting time is three seconds.

6.6 Start Up Transformer

Start-up transformers must comply with IEC 60076 and must be 3 phase 220/6.0kV ONAF cooled, oil-immersed type with on-load tap changer having range of ±8×1.25% on HV side. Depending on the design, the transformer can be of two-winding or three-winding design. The rating must not be sufficient to start up one Unit and provide the power for common services.

The temperature rise of the top oil and winding must not be higher than 50^{o}C and 60^{o}C, its definition in accordance to IEC60076-2. The start-up transformer must be provided with winding temperature indicator which must have alarm and trip functions for high temperature.

The start-up transformer having bushing connections to external circuits must be provided with a lightning surge arrester on each phase.

6.7 Unit Transformer

One unit transformer for each generator must be provided and it must comply with IEC 60076. Depending on the design, the transformer can be of two-winding or three-winding design. Unit transformers must be ONAF cooled, oil-immersed type with off-load tap changer having range of ±8×1.25% on HV side. The unit transformer must be provided with winding temperature indicator having contacts for temperature high alarm and trip functions. The rating must be sufficient to start up one Unit, plus 50% load requirement of another Unit.

6.8 Switchgear

All switchgear, control gear and fuse gear must be of metal enclosed indoor type, having degree of protection class IP40 and be manufactured and tested in accordance with relevant international standards. Main switchboards must be extendible at both ends.

The main busbars together with the tee-off busbars connecting the main busbars to the isolating/protective devices on all incoming and outgoing circuits must be contained in a separate compartment(s) within the switchboard. The busbars must be air insulated except where solid insulation is a design feature. The main busbars must have the same current rating throughout their length.

Apparatus which must be capable to be removed from a panel or cubicle for maintenance purposes in which the design must be either withdrawable type or readily removable without disturbing other apparatus or wiring.

MV switchgear must be in compliance with IEC 60056 with circuit-breakers of the vacuum or SF6 type. Fused switching devices used for motor and auxiliary transformer circuits must afford both adequate protection and reliability in service.

LV switchgear and control gear must be in compliance with IEC 60439 Form 4 with air break circuit-breakers. All points of isolation must incorporate a feature for fitting a padlock in the open position.

Circuit earthing facilities must be provided for all incoming and outgoing circuits of MV switchboards. In addition, provision must be made to earth each MV busbar at two separate points.

Withdrawable units must be provided with lockable shutters to prevent inadvertent access to live connections when the unit is withdrawn.

All operational and maintenance interlocking and any other feature necessary to comply with IEC standards must be provided, including a padlocking facility on:

- Busbar and circuit shutters.
- Voltage transformer shutters.
- Truck position selector mechanism (busbar earth/service/circuit earth).
- Circuit-breaker/fused switching device open/close control switch.
- Circuit-breaker/fused switching device local/remote control selector switch.

Full maintenance interlocking must be provided to render the primary and tee-off connections safe for access by personnel from all points of supply. The maintenance interlocking must be of the mechanical interference (trapped key) type employing a system of unique keys.

6.9 Motor and Motor Protection

Motors must comply with the following Standards as applicable:

IEC 60034	Parts 1 to 9 & 12 Rotating Electrical Machines
IEC 60072	Dimensions and Output Ratings for Rotating Electrical Machines
IEC 60085	Classification of Insulation and Materials for Electrical Machinery and Apparatus on the basis of thermal stability in service

All motor designs must be based on established and proven practice and suitable for tropical application.

AC motors must be of the squirrel-cage induction type suitable for direct on-line starting. The rating of each motor must be adequate to meet the requirements of its driven load and motors must be continuously rated unless otherwise specified or approved.

All AC motors up to and including 750W must be rated at LV level, single phase or 3 phase and must be supplied from power supply panel or MCC.

All AC motors up to 200 kW must be rated at LV level, 3-phase, and must be supplied from LV switchgear.

All AC motors including and more than 200kW must be rated at MV and must be supplied from MV Switchgear.

All DC Motors which are operated from the station batteries must be rated in accordance with specified DC voltage. All DC operated valve motors must be rated for operation from +15% to -30% of rated voltage. All other DC motor must be suitable for continuous full load operation from + 15% to -15% of rated voltage.

All motors provided are adequately protected against electrical faults, mechanical faults and overloads. Motors rated at 50kW and above must be provided with earth protection.

6.10 DC Systems

High performance lead acid sealed-in (free maintenance) type batteries having a design life of at least 10 years must be provided. The batteries system must comply with the requirement of recognized international standard. The duty cycle of the battery must be sufficient to support all DC essential loads (including DC/AC converter loads) for at least one-hour, without the charging from an AC sources or diesel generator.

Two sets of 220V DC battery, float & boost chargers and distribution boards must be provided for power loads for each Unit. Common services will be shared among the four Units.

Two sets of 110V DC battery, float & boost chargers and distribution boards must be provided for control loads for each Unit. Common services will be shared among the four Units.

Depending on the Mongolian Grid Codes, separate DC supplies may be required for 220kV switchyard to be installed in switchyard control building

One (1) sets of 220V DC battery, float & boost chargers and distribution boards must be provided for auxiliary plant.

The mean ambient air temperature surrounding the batteries must be maintained in the range 20 - 25°C. Adequate ventilation must be provided for the removal of hydrogen.

Charging modes must include boost charging for equalizing/refreshing purposes where suitable for the battery type.

The batteries must be supplied completely with all necessary connectors, racks/cabinets, stand insulators, connector bars and sundries together with local and remote alarms for abnormal conditions.

The battery chargers must normally float charge the batteries and must also supply the normal DC loads. The battery chargers must equalize the batteries when needed. They must also be capable of recharging their respective batteries in 10 hours at the end of the battery discharge load cycle while supplying the normal load of their respective batteries. 20% spare margin over the maximum charging rate must be provided.

6.11 Uninterruptible Power Supply (UPS)

Single phase, 220V, 50 Hz, 0.8 lagging to 1.0 PF, power supplies including, but not limited to, the associated input rectifiers, inverters, and the output power distribution panels.

The UPS must furnish highly reliable 220V AC power for vital electrical and C&I loads in the Plant, including DCS and PLCs. The UPS supply must be an integrated system consisting of one static inverter with a static switch, a solid state rectifier, circuit breakers and a fused distribution panel. An indication panel must be provided to indicate the status of UPS and diagnostic/test facilities must be provided for fault finding.

6.12 Earthing and Lightning Protection

The grounding system must be designed in accordance with IEEE 80, and IEEE 665.

The site rise of earth potential under fault conditions must not exceed 650V unless otherwise approved.

Where resistance earthing is employed, the protective/earthing conductors must be designed to withstand the effects of an unrestricted earth fault at the most onerous point on the system.

The main protective/earthing conductors must be installed as ring circuits with duplicated connections to items such as main switchboards. The switchyard earth conductor must be connected to the station earth system via a link pit to permit disconnection for testing purposes.

All exposed conductive parts of Plant control cubicles, valve actuators, cable glands and armours etc., must be effectively earthed.

All extraneous conductive parts such as structural steelwork, cable support steelwork, steel tanks and pipe work, compound and station perimeter fences, gates etc., must be

effectively bonded to the earthing system. Supplementary equipotential bonding must be applied where it is necessary.

A separate instrument earth network must be provided, single point connected to the main earth system, to which all alarm, control, computer and instrument etc., earth connections must be made.

Control and instrumentation cable screens must be single point bonded to the instrument earth network to minimize the effects of electrical interference.

The size of the control and instrumentation protective/earthing, conductors must be in accordance with an internationally recognized standard.

The lightning protection scheme for the Plant must be in accordance with IEC 62305.

6.13 Cabling

All cable runs must be continuous. Control and instrumentation cables may be interconnected for marshalling purposes in suitable enclosures where point to point cabling would be uneconomic.

The cables must include measures to prevent insect damage e.g. cables exposed to direct sunlight must have ultra-violet resistant over sheaths. Control and instrumentation cables must be capable of withstanding the voltage transients associated with unsuppressed coils etc.

Cables must have either copper or aluminium conductors with extruded insulation/sheath in accordance with internationally recognized standards, and be of the following or equivalent types:

- All MV cables must be of stranded copper / aluminum conductor, XLPE insulated, screened, PVC inner sheathed wire / strip armored, fire retardant low smoke (FRLS) overall PVC sheathed type with IEC 502.
- All LV power cables must be of 1000 V grade copper / aluminum conductor, XLPE insulated, PVC inner sheathed, steel wire / strip armored, FRLS PVC outer sheathed type.
- Control cables must be of multi-core 1000-volt, grade 2.5mm^2 stranded copper conductor, PVC insulated, PVC sheathed, steel wire armored, FRLS, and PVC sheathed type.

LV power and control cables for essential services must be of copper conductor and fire survival type. Fire resisting cable tested to the highest test temperature in IEC 331 must be used for essential circuits required to remain functional in the event of a fire. Fire barriers and penetration seals through walls, floors and ceilings must have a minimum fire rating of at least one hour.

Segregation of cables between the following groups must be provided:

- Between different Units;
- Duty and standby plants;
- Duplicated essential supplies;
- Power and control cables

All cables are to be allocated unique numbers which must be clearly and securely fastened to both ends of the cables as soon as possible after installation.

All cables must be terminated using mechanical glands of the metallic or insulated type.

MV cable terminations must be fully insulated where the risk of failure due to condensation is high e.g., outdoors and in plant areas. Air terminations must have adequate clearance and creep age distances.

Cable termination boxes for high current single core power cables must have non-magnetic gland plates etc, to avoid cable heating due to closed magnetic loops.

Chapter 7 – Control and Instrumentation

7.1 Design Principles

The technical requirements for control and instrumentation (C&I) must apply to all equipment, including but not be limited to all mounted measuring devices and related ancillaries, conditioning devices, transmitters and related circuits, microprocessor based and computer based devices, control drives and actuators, control pipework and control circuits, marshalling racks and panels, cabling and wiring, and the control side of all switchgear. The C&I systems must conform to the following design principles:

- No single component failure can result in the loss of the Unit protection.
- No single component fault can cause an immediate risk to the Unit trip. The Contractor must provide, as part of design submission, details of Unit protection and tripping scheme for the review of the Owner.
- No single component failure can cause the failure of the distributed control system (DCS) which renders the Unit inoperable from CCR.
- All important control and instrumentation equipment which affecting unit operation must be supplied by a direct current (DC) or uninterruptible power supply (UPS) system.
- All transmitters and sensors, which directly or indirectly trip the Unit(s), must be triplicated and arranged in two-out-of-three voting logic for binary signals or median selection logic for analogue signals.
- All protection, tripping or interlock instruments/circuits which affecting unit operation must be redundant.
- The start up, normal running and shutdown operation must be carried out in CCR with no attendant required to attend various plants outside the CCR. The design must allow only one operator to operate one Unit during normal operation. Assistance from another operator is allowable during Unit start up and shut down.
- All electrical switching (i.e. closing and opening of switchgear) of 220kV, station MV/LV electrical supplies and tap changing of main transformer, start-up transformer and unit transformer must be achieved by operator commands via the DCS in CCR.
- A minimum hardwire equipment, independent of DCS, must be provided in CCR for emergency shutdown
    - All actuator must be provided with torque switch and position switch.

7.2 Programmable Logic Controller (PLC)

Programmable logic/process controllers can be used in common services as well as standalone control systems. PLC’s must be arranged in redundant configuration. Single configuration PLCs can be only accepted provided that the system can be operated in manual by operator if the PLC fails. The controllers must be 100% hot standbys with bumpless transfer facility.

The programmable logic/process controller must be designed to a popular communication protocol that must be able to communicate to the DCS. Plant signals must be called up in the DCS in CCR. At most, two types of PLCs can be used in the Plant.

PC type programming tools with colour monitors and printers must be provided. The programming tools must display and print the control algorithm in either ladder circuit diagram form, Boolean logic form, or program statement form. Each PLC system must be provided with its own programming tool and must not share the programming tool of other systems. Training for PLC hardware installation and application programming must be provided.

PLC for balance of plant (BOP) systems must be controlled and monitored in CCR. BOP PLC will form its own network or integrate with the main DCS. If separate operator stations for BOP are required, they must be installed in CCR and interface with the main DCS.

7.3 Distributed Control System (DCS)

The DCS must accommodate the data acquisition, modulating and sequence controls of the Unit to a high degree of automation. The CCR control console must enable centralized and fully automatic operation of the Plant with minimal staffing level in CCR and outside Plant.

The DCS must consist of data acquisition system (DAS), modulating control system (MCS), sequence control system (SCS), furnace safeguard supervisory system (FSSS), digital electro-hydraulic control system (DEH) and so on. Emergency tripping system (ETS), steam turbine safety inspection system (TSI) are independent systems (which may be supplied by turbine manufacturer) must interface to DCS by hardware and / or software communication.

Electrical equipment control and switching must be realized by DCS in CCR and no local routine operation is required. However, a minimum of hard-wired operating equipment for ensuring unit shutdown safely and their associated signals must be provided.

The DCS must be capable to control the following electrical equipment. The scope of supply must include, but not limited, to the following:

1) Generator
2) Main transformer
3) Excitation regulating system
4) Unit transformer
5) Start-up transformer
6) Low voltage auxiliary transformer
7) Emergency power supply and diesel generator
8) Switching of circuit breakers at EHV, MV and LV levels
9) Direct current power supply system
10) UPS device

7.4 DCS Reliability and Capability

The DCS must include on line self surveillance monitoring and diagnostic facility so that a failure or malfunction can be diagnosed automatically down to the level of individual input / output channels or hardware modules with display and print out. The reliability of DCS must at least fulfill the following requirement:

- System availability: ≥99.9% (test time is 90 days)
- Data acquisition system MTFB＞8600h
- Control system MTFB＞16000h

The DCS must be designed with sufficient hardware so that the loading can be distributed evenly among CPU processors, memory and I/O channels. The following minimum requirement must be met:

- Controller CPU load rate at the busiest time: < 60％
- Operator station CPU load rate at the busiest time: < 40％
- Occupancy capacity of internal memory: < 50％
- Occupancy capacity of external memory: < 40％
- Communication bus load rate: < 30％

In the event of complete failure of the DCS, a minimum hardwired back-up controls and indications must be provided in CCR to allow the safe shutdown of the Unit.

The DCS must provide at the I/O rack with 15% spare slots, fully equipped with input / output cards and wiring terminals. A space must be reserved for installing a new I/O cubicle in the computer room.

7.5 Testing

DCS must be tested in the following three stages.

- Factory acceptance tests, which must be carried out during and after the completion of the manufacturing of the DCS. The Owner must be given the opportunity to witness the test and the DCS must not be shipped until the Owner is satisfied that there has been a successful completion of factory acceptance test.
- Site tests, which must form part of the installation and commissioning of the DCS and which must be witnessed by the Owner.
- Availability tests, which must be included within the overall Reliability Test of the Unit.

The Contractor must provide the testing details and procedures for above tests for Owner’s review.

7.6 Training

The Contractor must provide a complete hardware training course for Owner’s personnel. It must be highly practical oriented, incorporating considerable hand-on contact with the equipment. Similarly, the Contractor must provide a comprehensive software training course for Owner's personnel. Detailed instructions must be provided on all aspects of operating system software, system software, and application software. A detailed course of instruction on the writing of application algorithm (data base system, control logics, sequence, graphic mimics, historian and other relevant programs) in the language appropriate to the proposed computers must be provided.

7.7 Special Calculation Packages

The DCS system must provide the following packages. If the DCS system cannot provide the packages due to its own limitation, special dedicated systems must be provided and connected to DCS for display.

- Unit and Plant Efficiency Monitoring Package;
- Vibration Monitoring Package;
- Tariff Metering and Summation Package;
- Continuous Emission Monitoring Package;

Some of the packages may require special instrumentation mounted onto the equipment of the Plant to provide the necessary measurement signals for inputting to the DCS. The Contractor must ensure that all such special additional instrumentation, as well as

sufficient signals as may be required from instrumentation that has been provided for other duties, must be supplied for the effective implementation and operation of each of these packages.

The DCS must allow Owner's management information system to obtain plant parameters from DCS and display them in remote sites. All the cables laying along the route must be inside cable tray.

7.8 Operator Functions of DCS

The DCS must provide diagrammatic mimics with real time data representing the various plant equipment and processes. The production of mimics must be arranged with the Owner to give comments at the preparation stage. The color coding, mimic symbol, and convention must be consistent throughout all mimics. The DCS must also be capable to produce the various logs, on request or at predetermined times.

7.9 Other Control Systems

7.9.1 Master Clock

A redundant (duyt/standby) master clock system synchronized to satellite must be provided. The clock must have a resolution of less than 1 ms. The DCS and other suitable equipment (such as high-speed SOE logger) must be synchronized to this master clock. A certain number of slave clocks must be installed.

7.9.2 Continuous Emission Monitoring System (CEMS)

The CEMS must be used to monitor the quality of combustion and to display the emission levels of O_2, NOx, SOx, CO, CO_2, particulate matter and opacity on DCS display.

The monitor must be weather proof, microprocessor based with automatic zero and span calibration at selectable intervals from one to twenty four hours and be capable of self diagnostics.

The equipment offered must include all necessary equipment including monitor/analyzer, probes, power supply, signal processor, filters, purging air fans for the supply of dust free clean air to the monitors or the system supplied. The type of equipment and the probe location must be agreed by Mongolian authority.

The instrument must be located in an easily accessible location on the flue gas duct leading to the chimney stack.

7.9.3 Interface with Grid Dispatch Centre

The necessary data and information to be exchanged between the Plant and the dispatch centre must be agreed with the Mongolian Grid Dispatch Centre. The Contracting Counterparty must be responsible to provide all the necessary interface hardware and software for this purpose.

The different control modes must at least include the following:

Automatic Generation Control (AGC): Unit output shall closely follow the load demand signal from dispatch centre or governor set point.

Automatic Frequency Control (AFC): Unit output shall respond to power system frequency deviation and adjust accordingly. Another mode of AFC shall enable the output

to respond not only to frequency deviation but also the difference between the actual output and the set point.

Emergency Generation Control (EGC): In case power system frequency deviates beyond the normal range, Unit output shall respond at its maximum instantaneous allowable rate in order to pull back the frequency to the normal range.

The actual calculation algorithm for the above control modes must be programmed to suit the requirement of the dispatch centre.

7.9.4 Communication Systems

A 150 extension 20 incoming line Digital Private Automatic Branch Exchange (EPABX) must be provided. Adjacent to each telephone socket in the workplace, a PC LAN socket must also be installed. A PC LAN cable must be also provided together with the telephone cables to all the telephone / PC sockets.

A solid state public address system with page and party channels and a number of walkie-talkie or radio pagers must be used for through out the plant.

7.9.5 Closed Circuit Television System (CCTV)

Two sets of closed circuit television system (CCTV) must be provided for security purpose and operational purpose. The security-purpose CCTV system must be used to observe the access road, entry gate area, the boundary line (fence) and other yards considered for security observing purposes. This set of CCTV must be installed in the gate house at the main entrance of the Plant.

The operational-purpose CCTV must be used to observe the operational area such as boiler area, turbine hall, coal yard, transformer, and other machineries and equipment. This set of CCTV must be installed in the central control room.

Cameras must be provided for each set of CCTV and the cameras must be located at strategic points. Cameras with remote-controllable pan tilt and zooming facilities must be furnished. The CCTV systems must have multi-window capability. The console must be able to select and control individual camera. High resolution LCD color monitors of 533mm size must be provided and recorders up to 7 days recording capability must also be provided.

Chapter 8 – Balance of Plant Systems

8.1 Air Cooled Condenser (ACC)

The extracted steam from the LP turbine must be cooled by an air-cooled condenser. From the turbine exhaust box, the steam must be directed evenly by the distribution header to different paths of the ACC. The steam ducts must be adequately sized to minimize the pumping power.

The ACC must be designed to deliver its rated cooling capacity at an ambient temperature of 30^{o}C. At this temperature, the turbine and generator must be capable to generate the rated gross output, although at the expense of higher heat rate. ACC must also be able to operate between air ambient temperature range of -40 to 30^{0} C while the unit is able to deliver gross power output of 150MW.

The ACC must consist of 16 cells; each cell is equipped with a fan motor set. The fan motor must be of VVVF (variable voltage, variable frequency) type so that fan speed can

easily be adjusted in CCR to control the cooling air flow rate. Each cell must be individually controllable. To prevent heat re-circulation, wind shielding wall must be provided at ACC platform. High pressure water jet cleaning system must be provided to ensure good heat conductivity of the cooling surfaces. The ACC support structure must be made of steel framework consisting of necessary columns, bracing and platforms with easy access walkways for maintenance.

Contractor shall indicate if separate hogger is required. Separate hogger if required shall be provided.

8.2 Mechanical Draft Cooling Tower

Mechanical draft cooling tower must be provided with induced draft counter flow. The superstructure of the tower must either be concrete or steel structure. Tower ladders and railings must be of stainless steel. The tower must be capable to deliver its rated cooling capacity at an ambient temperature of 30^{o}C.

8.3 Closed Circuit Cooling Water System

Unitized closed circuit cooling water (CCCW) system must be provided for removing heat from the components of various plant equipment and rejecting heat to the mechanical draft cooling tower. Combined with the mechanical draft cooling tower, the CCCW must be capable to deliver its rated cooling capacity at an ambient temperature of 30^{o}C. All coolers shall be fin type.

The system must continuously circulate demineralized water as a cooling medium for equipment in the closed loop cooling system. Make-up to the system must be obtained from the reserve feed water system.

The system must be sized to supply adequate cooling water to the closed loop system when the exchangers are supplied with highest circulating water system temperature. Strainers must be provided at inlet to the circulating water pumps. The system must provide sectional isolation to permit shutdown and maintenance of the individual equipment without interruption of the cooling function of the rest of the system.

An elevated head tank must be provided for surge capability, system make-up, venting, and adequate net positive suction head for the circulating water pumps. A chemical dosing tank complete with associated dosing facilities must be provided to add corrosion inhibitor to the system. Sampling connections must be provided in the pipework to enable checks to be made of the quality of water within the system.

8.4 Water Treatment Systems

It is assumed that the Power Plant will use Mine Pit water from the mine as the main water source.

The water treatment systems must be provided to treat Mine Pit water, store and distribute the station requirements for demineralised and potable water. It must also provide adequate storage for fire fighting requirements.

The condensate polishing system must be designed to remove dissolved and suspended solids corrosion products & other impurities from condensate during startup, normal operation and periods of condenser tube leakage to maintain the feed water and steam purity requirements of the boiler and turbine. The condensate polisher must be located in condensate feed water cycle between the condensate pump discharge and the gland steam condenser. Separate external regeneration arrangement must also be provided.

The normal mode of plant control must be automatic changeover and regeneration, dosing, back-flushing or cleaning of the various treatment streams at pre-determined intervals,

volumetric throughput or when some control parameter is exceeded. In normal operation there must be a minimum of operator intervention.

There must be provision for manual override of the automatic control system activated from the local Plant control panel.

Each stream of the WTP must be sized for a net demineralized water capacity equivalent to a minimum of 3% of the total boiler flow at BMCR. The WTP must be based on the ion-exchange process and must be rated to supply the specified demand at the outlet main irrespective of any water used for backwashing, rinsing, de-sludging, regenerations, or any other purposes. Hydrochloric acid must be used as acid cation.

Each stream of the WTP must be designed for not more than one regeneration per day when the Plant is operating at rated output. All the systems must be sized such that regeneration can be accommodated in a period of 8-hour. Under emergency conditions, both streams of the WTP must be capable of being operated at the same time.

8.5 Wastewater Treatment Systems

Wastewater treatment plant must treat the following contaminated waste water generated by the Plant:

- PH adjusted waste water from the neutralization basin of demineralization plant;
- Boiler blowdown water;
- Boiler and turbine area equipment and floor drains;
- Oily waste water from fuel oil storage yard, transformer yard, turbine lube oil area (including rain water of those areas);
- Air heater washing water;
- Bottom ash water;
- EP washing water;
- Rain water from coal pile runoff pond;
- Chemical laboratory drain;
- Workshop drain

Rain water from boiler and precipitator area and from oil tank yard, transformer yard, and overflow water from coal pile run-off pond are contaminated; therefore it must be treated in the wastewater treatment plant. Other rain water from buildings, roads, etc., is not contaminated, which are within the effluent limits can be discharged without treatment. The capacity of storage pond must be sized based on a "zero discharge" design concept.

The wastewater treatment plant must be equipped with continuous pH, flow and suspended solids monitoring of wastewater discharge. Wastewater composition for other contaminants must be tested by sampling method. Provisions to allow treated water for use on coal yard dust suppression control and landscaping must be included.

Oil interceptors of gravity type must be provided to collect and remove oil from the oily drains. The removed oil must be transferred to separate collection tanks through submersible pumps to the main boiler for burning. The de-oiled water must be pumped to the wastewater treatment plant for further treatment prior to discharge.

8.6 Coal Handling System

The coal handling system between first receiving hopper and coal bunker in boiler house must be fully covered and provided with all necessary accessories of lighting, heating, walkways and fire detection / fighting equipment. The side cover of the conveyor must have windows at regular intervals.

Coal sampler for as-received coal and belt scale must be installed in order to confirm the quality of the as-received coal. Magnetic separators and metal detectors must be installed to remove iron from coal on the belt conveyor.

Screener and crusher must be provided to protect the coal handling plant from damage by any over-sized material delivered in the coal. The coal must be crushed to a size of less than 10mm diameter.

Dust suppression and vacuum systems must be included to ensure a safe working environment and to reduce the release of dust to the external environment to acceptable levels. Coal water run-off pond and a nullah surrounding the coal yard must be provided to contain rain water.

8.7 Fuel Handling System

Fuel handling system to handle distillate as per specification in APPENDIX-D shall be provided to receive, store and supply fuel oil for boiler start up and support. The Contractor must build fuel oil receiving and metering facility. The storage tank must be 2x 1000 ton capacity with all required instrumentation to indicate fuel oil level and temperature. Fire fighting facility to protect the oil tank and receiving facility must be provided. If any heating facility is required to maintain the fuel oil to above its freezing point during winter temperature at site it shall be provided. Fuel oil piping valves, pumps and instruments shall be provided and protected by heat tracing if required for winter temperature

8.8 Ash Handling System

The fly ash handling system must be provided to remove the fly ash from ESP hoppers, economizer and air heaters. The equipment must be suitable to handle the dust burden from the Worst Coal under all loading conditions. Each hopper must be furnished with the ash transmitters and use positive pneumatic fly ash handling system to convey the ash into fly ash silo via ash transfer piping system.

The bottom ash must be removed from the ash cooler and transferred by chain bucket conveyors to the ash silo.

Air cannons must be installed for bottom ash silos and fly ash silos to facilitate easy ash removal. Level indicators for bottom ash and fly ash silos must be provided. The fly ash and bottom ash systems must be air-tight and without leaking of ash.

8.9 Ash Pond

Ash Pond (ash storage yard) shall be designed to have a capacity to store both furnace bottom and dry ash production for ten years assuming worst coal ash content. The design shall be such that the ground water is not polluted by ash water. Sprinkler system to wet the ash at discharge point in the ash pond shall be provided. The ash pond bottom shall be provided with suitable material geo-membrane impermeable layer of sufficient thickness to last for the life of ash pond. This may also be advisable to further cover it with clay protection layer of sufficient thickness. Ash pond shall have suitable structure for ash receiving station, water intake and an overflow spillway shall be provided. Retaining walls/dam of the ash pond shall also be protected with suitable material geo-membrane impermeable layer of sufficient thickness. Contractor must submit along with his proposal sufficient preliminary details of ash pond design and geo-membrane impermeable layer to be used.

8.10 Steam and Water Chemical Monitoring System

A unitized steam and water chemical monitoring system must be provided to monitor the chemistry of the steam and water cycle of each Unit to ensure that a consistently high quality of steam / water is maintained. The chemical monitoring system must consist of sampling probes, the sampling conditioning units, the chemical analytical Equipment, and associated pipework, controls, fittings and valves.

Condensate, feedwater, boiler water and steam samples must be collected by sampling probes at specified sampling points, which must be conditioned via the sampling conditioning units prior to the chemical analytical Equipment for analysis.

All the sample lines from each Unit must be run to a chemical monitoring room where the sample conditioning units and the analytical Equipment room must be positioned.

The monitoring rooms must be air-conditioned, and must be equipped with bulkhead for incoming connection from the plant, bulkhead for drain connections, furnishings and facilities in enabling on-plant analytical test to be conducted.

The chemical monitoring system must be designed for continuous unattended operation except for hand sampling, routine inspection and maintenance. The sampling probes must be designed to suit the conditions at the sampling points and must be made from a material with high corrosive resistance. All sampling lines and valves must be of 316 stainless steel material. Isolating valves must be provided in single, or double isolation valve configuration, depending on the sampling conditions.

8.11 Auxiliary Boiler & Steam System

Auxiliary coal fired steam generating boiler shall be provided for securing auxiliary steam supply in the power plant for period when none of the four units are in service. Contractor can bring this boiler during start of construction and use it for heating before first unit is available to supply steam. The auxiliary steam system is for startup and general operation of Unit. In addition, the auxiliary steam system must also provide all buildings of the Plant and 500 staff quarters, for the purpose of heating in winter. Installation of piping to supply the heating steam to staff quarters is not required. The Contractor shall provide a flange connection point at the boundary of the Plant. The auxiliary steam system of the four Units must be interconnected to enable start up steam to be derived from the running Unit. Flow/pressure control valves, isolating valves, non-return valves and distribution pipework must be provided as necessary. The Contractor must arrange its own auxiliary steam supply (such as a temporary auxiliary boiler) for commissioning.

8.12 Fire Detection and Protection Systems

The fire protection system must consist of various detection, suppression, and alarm systems as well as fire water storage and supply covering the entire Site.

The detection and alarm system must actuate various horns, bells, and suppression systems upon the detection of fire, smoke, or heat. Manual call points must be used at strategic points throughout the Plant with alarm and indications to the fire alarm panels. The main control panel must monitor, and record the events of the various fire protection systems.

The design and rating of the fire protection systems must comply to NFPA 72 standard.

All equipment employed for the fire protection systems, including pumps, motors, valves, sprinklers, hydrants, extinguishers, detectors, control units, alarms, etc. must be approved or listed by Mongolian authority (or, in the absence of Mongolian standard, by internationally recognized standards)

The Contracting Counterparty must supply all necessary information for permit

application, installation and maintenance of the equipment furnished as and when required.

The fire detection and protection systems of the Facility must comprise the following systems:

- Freshwater hydrant system (for general area etc)
- Water spray protection system (for coal handling system etc)
- Automatic sprinkler system (for office etc)
- Foam protection system (for oil tanks etc)
- Gas protection system (for electronic rooms etc)
- Portable system (water extinguishers, CO_2 extinguishers, Dry chemical extinguishers, Foam extinguishers)

A sounder system must be installed covering all areas of the Facility. A separate sounder/beacon alarm system must be provided for CO_2 protection areas, with sounder alarms differentiated from other type of fire alarm.

8.13 Instrument and General Services Compressed Air System

The compressed air system must provide, oil-free compressed air for instruments and controls, hose stations, air motor drives, and general uses. It must produce two classes of compressed air for instrument use and general use to all user points through ring main distribution pipework. Section valves must be provided between users of different Units. A station air header must be provided around the turbine area with hose connections for maintenance at floor elevations. Another station air header must be provided in the boiler area with risers on two sides of the boiler and connections at floor elevations.

The capacity of the air receivers must be designed sufficiently for safe shut down of the Plant in the event of blackout conditions (with all compressors down) and to meet peak demands under transient conditions.

8.14 Cranes and hoists

Adequate number of cranes and hoists must be provided with the proper capacity and lift to facilitate assembly, repair and maintenance operations of major plant. As a minimum, provisions for the following must be made.

One overhead traveling crane must be provided in the turbine haul for maintenance work. The crane must be a double girder electric overhead traveling crane with hoist, cross travel and long travel motion. It must be equipped with a main hoist and an auxiliary hoist. Control of the crane must be either through a remote control unit or from an air conditioned control cabinet. The crane must be capable to lift up the heaviest single item in turbine hall during major overhaul.

The Contractor must make a comprehensive review of the plant handling requirements, and must work out a comprehensive list of lifting facilities required for maintenance of equipment for Owner's review.

8.15 Workshop and Store Equipment

The Contractor must provide necessary equipment and tools for the Mechanical. Electrical and I&C workshops and store building, as appropriate, to meet the operations & maintenance requirements of the Plant. The supply of the equipment for the workshops and store must include the following:

- Special tools and material handling lifting gears for major overhaul of the plant. All

equipment and tools required for the maintenance of the mechanical, electrical, instrumentation equipment including such as lathes (two one medium and one small size), shaper, medium milling machine, bench drilling machine, pedestal grinder, horizontal cutting saw machine, electrical and pneumatic driven machine tools, hand tools, working benches and vices, electric and tig welding sets, gas cutting sets, electrode heating cupboards, precision, calibration and test equipment etc.;

- For Store all bins, shelves, containers and steelwork structures for the stocking of equipment, tools, spare parts, pipes etc. Dry storage room for motor storage shall be provided. The store must be divided into different functional areas such as light duty store, heavy store, tool store, paint store, dangerous goods store etc. to enable safe and proper storage of Equipment/tools.
- All portable partitions and protective devices required in the workshops and stores;
    - Mobile lifting vehicles such as fork lift, pallet truck etc for transportation of medium weight objects;
    - Portable blowers, vacuum cleaners, and dust extractors etc.

The Contractor must carry out a comprehensive review of station maintenance and storage requirements, and must recommend further equipment he considers necessary in addition to the above minimum provisions.

Separate workshops for Mechanical, Electrical and Instrument trade shall be provided to facilitate maintenance of each type of equipment. The Contractor must submit general arrangement drawing of workshop and store with equipment layout as part of the design submission for Owner’s review and approval.

8.16 Laboratory Equipment

The Contracting Counterparty must provide necessary Electrical and C&I laboratory and its equipment.

The Contracting Counterparty must carry out a comprehensive review of the station requirements, and must provide the list of equipment for the Owner’s review.

8.17 Spares

The Contractor must provide the spares for erection and commissioning; and routine spares for the first two years' operation and maintenance of each Unit.

8.18 Training

The Contractor must submit a training programme for the Owner's staff review 18 months before COD. The training package must include suitable training on operation and maintenance of the CFB Units both at the manufacturer's work and class room training at Site. Number of trainees and duration of training programme must be reviewed and agreed with the Owner, as and when required.

Chapter 09 – Civil Works : The plant is situated in Mongolia which have cold weather lasting six months in a year. The effective anti-freezing measures must be taken in designing the plant and especially foundation and civil works. Freezing resistant concreter shall be used within the range of maximum freezing soil depth observed at plant site.

9.1 Building and Structures

Due to cold weather conditions at site design of external enclosure walls must be off sufficient thickness with required insulation to withstand temperature up to -46 deg C. Doors exposed direct to external weather and windows shall be double glazed. The Contractor must provide a list of buildings and structures with typical layout drawings with area size and information of building services in their proposal. They must include at least the following:

- Boiler house (with one goods / passenger lift per boiler);
- Turbine hall;
- Central Control building (with one passenger lift);
- Switchgear rooms and battery rooms (can be included in central control building);
- Laboratory (can be integrated within central control building);
- Administration building;
- Gatehouse/security building;
- Dormitory for Owner's 50 single-bed rooms with bathroom facility for staff
- Workshop (mechanical, electrical and instrumentation);
- Stores;
- Dangerous goods store (can be included in others, subject to safety constraints);
- Canteen (can be included in administration building);
- Clinic (can be included in administration building);
- Compressor house (can be integrated within other building);
- Fire fighting pumphouse;
- Sampling room (can be integrated within turbine house);
- Coal handling control building (include coal sample preparation room, garage and petrol station) ;
- Coal yard and transfer towers;
- Air cooled condenser structure;
- Mechanical draft cooling tower structure;
- Various water reservoir / tank and fuel oil tanks;
- Water treatment plant buildings;
- Waste water treatment plant and sewage treatment facilities;

The Contractor must provide the following details of each building as part of the design submission:

- Type of building chosen (RCC or steel);
- Materials to be used. For structural steelwork, the type of surface treatment must be specified;
- Method of construction ;
- Foundation preparation;
- Layout plan;
- Services requirements;
- Finishes schedules;
- For each manned building, number of staff allowed.

The Contractor must submit the recommended floor area and layout to Owner in his proposal. Minimum floor area required for following buildings is mentioned below:

- Administration building : 3400 sq.meter
- Central Control and technical building 1300 sq. meter
- Canteen building: 750sq.meter
- Workshops: 1500sq.meter
- Store/ware house 2300 sq. meter
- Guard (security) house at main entrance:100 sq.meter
- Dormitory/hostel: 50 rooms. Each room shall be 24sq.meter including attached bathroom with hot water facility. Wardrobe of 2 meter wide and full height shall be provided.

9.2 Building and Superstructure Design

The turbine hall must be an enclosed building made of steel structure. The elevated floors must be concrete slab welded steel grating in certain areas. The wall and roof must not cause leakage and must be structurally strong to withstand the wind loading caused by the maximum gust speed. Welded steel grating may be applied in certain areas. The walls and roof must be of profiled metal cladding to the approval of the Owner. Interconnection walk-ways between the turbine building levels and the adjoining boiler house must be provided.

The boiler house must be an enclosed steel framed structure.

The administration building, control building, canteen and gate house and other auxiliary buildings must be steel-framed or reinforced concrete structures whichever are appropriate to their use and are the most cost-effective.

The local building regulations must be met for all aspects to include but not be limited to the floor and superimposed loadings, safety evacuation, emergency exits, fire protection and adequate stairs and access.

9.3 Water Quality for Mixing Concrete (Mixing Water for Concrete)

Ground water have been allowed to be used during construction but the Contractor Shall ensure that quality of ground water or any other water used as mixing water for concrete must meet the specification BS EN 1008:2002 for sampling, testing and assessing the suitability of water as mixing water for concrete. Sampling of water shall be done from time to time and as requested by the owner to ensure quality of water used is suitable for mixing water for concrete. If ground water is found not suitable Contractor must install required water purification facility to purify the water such that it is suitable for use as mixing water for concrete.

9.4 Services

The scope of supply must include provision and distribution of all services (electrical/telecom, fire/potable/service water, hot water for heating purpose, accommodation and facilities for operations, canteen services and dining areas, first aid room and other medical facilities, lifts, parking spaces for vehicles, roads and walkways, sewage treatment, general drains, foul/storm drainage) within the Plant. The Owner must provide the furniture.

The Contractor must design the buildings and services with the following manning requirements:

- Owner’s staff during construction of 50;
- Total permanent O&M staff of 300;

- A space for containerized office for additional 240 contractor's maintenance staff during major overhaul periods.

9.5 Fire Escape

The buildings must be designed and constructed so that there are safe means of escape from fire to a place of safety at all times.

The maximum travel distance for personnel where there is a normal fire risk must be less than 25m where travel is possible in one direction only and 45m otherwise. The maximum travel distance where there is a high fire risk must be 12m where travel is possible in one direction only and 25m otherwise.

All major or important Facility areas must where practicable have safe means of escape in at least two directions. All floors, walls or other structural elements which provide a fire compartment or barrier function must have an appropriate design fire resistance. The Contractor must ensure that all services ducts, cables etc. which are required to penetrate such fire protection walls must be sealed with appropriate fire barriers, dampers etc. after installation as to give an equivalent fire rating not less that of the wall.

9.6 Design Loadings

The design of the civil structure / buildings must take account of all loads applied including dead, imposed, wind, thermal, dynamic, settlement, movement, seismic and other loading conditions where appropriate. Temporary loads during maintenance and erection must also be considered. The standards used and loading assumptions made must be stated in the design basis and calculations. Special precautions must be taken to prevent thawing of permafrost. Lagging, heating or other special design features (such as semi-submerged water tanks) must be provided to ensure the smooth flowing of liquid under the sub-zero ambient temperature environment in winter.

Foundations must be designed to support the anticipated loadings without any distress or excessive settlement. A factor of safety against exceeding allowable bearing capacities must be selected which must not result in excessive settlement. The maximum permissible absolute and differential movement of the foundations must be stated in the design basis for each building and structure.

The following minimum floor and roof load must be used into the design:

General:

- Roofs	100 kg/m^2
- Offices	200 kg/m^2
- Assembly and locker rooms	500 kg/m^2
- Laboratories	200 kg/m^2
- Stairs and walkways	400 kg/m^2
- Hand railing	100 kgf in any direction at top
- Platform & gratings	400 kg/m^2
- Ground floors	1250 kg/m^2
- Surcharge adjacent to plant structures	1000 kg/m^2

Power Buildings:

- Turbine Bay operating floor	1250 kg/m^2
- Auxiliary Bay operating floor	1000 kg/m^2
- Turbine Lay-down area	4000 kg/m^2
- Mezzanine	750 kg/m^2

- Control room 750 kg/m^2
- Switchgear floor 750 kg/m^2
- Cable spreading room 750 kg/m^2
- Battery room 500 kg/m^2
- Coal conveyor Gallery, Tripper area or Surcharge adjacent to plant structures 400 kg/m^2
- Transfer House Conveyor head / main body 1000/400 kg/m^2
- Steel grating 400 kg/m^2

9.7 Stack (Chimney)

The four Units must have a common stack (chimney) with a reinforced concrete wind-shield and individual flues. The stack (chimney) must have a height of at least 215 meters with internal lining system. If acid-resistant interlock brick is proposed for the construction of flues, The Contractor must provide proven field experience and provide specification and construction method of the internal lining (or brick) system for Owner's review when the design begins. The stack (chimney) must include thermal and corrosion protection to ensure that minimum maintenance is required over the operational life of the Plant.

Platforms and provisions for sampling and monitoring flue gases must be provided. Other provisions must include access staircases to various platform levels, aircraft warning lights, aviation safety painting, lightning protection, reference monitoring the long-term inclination changes and settlements. A rack-and-pinion lift (Alimax) must be provided.

9.8 Building Design

For enclosed buildings, wall and roof cladding and building service systems must meet Mongolian standards and satisfy the following criteria throughout the design life of the Plant:

- Provide a completely watertight envelope around all plants, equipment and personnel within;
- Create an acceptable, controllable working environment for all building users;
- Be sufficiently flexible to allow necessary change and expansion with minimal disruption to Facility operation;
- Be readily replaceable if damaged during the design life;
- Be sufficiently robust to resist all anticipated wind, thermal, loading and other movements during the design life;
- Be of an acceptable consistent appearance;
- Satisfy all appropriate standards, regulations and quality requirements;
- Be capable of resisting any environmental or chemical effects produced by the Facility or external environment;
- Allow penetrations in the building enclosure to be formed and sealed easily.

9.9 Cladding and Roofing

The selection of cladding materials must be compatible with the constraints of the buildings and structures in accordance with good practice. Details of materials proposed for building exteriors and their respective finishing colors must be submitted for Owner's review when the design starts.

Equipment located on flat roofs must be avoided wherever possible. If location of Equipment on flat roofs is unavoidable then the waterproof and surfacing system must take account of maintenance and other access required.

9.10 Finishes

Walls and floors to kitchens, washroom and WC facilities must in all cases be finished with ceramic tiling. The external surface of administration building and control building must be covered by mosaic tiles. The choice of mosaic tiles must be agreed with the Owner before the selection is made.

Office area in administration and control buildings must be paved with ceramic floor tiles as appropriate. Floor finishes in general must be designed to withstand any vehicular and pedestrian traffic, washdown or chemical exposure without flaking, dusting or excessive cracking during the design life. The criteria for which the finishes are specified must be stated in the basis of design for the element.

9.11 Doors and Windows

The location of pedestrian and vehicular door accesses and windows must be coordinated with the requirement for Plant and service penetrations through the building elevations. Door locations must be determined from access requirements identified during the layout planning study. All electrical room doors must be equipped with master key system.

Windows must generally only be provided for office type environments or where daylight is a specific benefit to movement about buildings of personnel or of carrying out maintenance functions. Opening lights must be specified where appropriate for ventilation or cleaning purposes. The location of windows must take into account building exposure orientation and control of solar gain. They must be visually harmonious with the building elevations.

Where surface openings in the high level cladding areas cannot be avoided they must be carefully coordinated and their appearance must be such that they relate to the building visually and have an uncluttered appearance.

Double door and double glazing for windows where ever these are exposed to outside cold weather shall be provide.

9.12 Access and Handrails

All handrails and ladder pipes must be 32mm nominal bore MS pipes (medium class). It must be galvanized to a minimum of 610gm/m^2 for operating floor or outdoor application.

Adequate access must be provided to allow satisfactory and safe operation and maintenance of all buildings and equipment. The requirements for equipment and crane access, access to manholes, pits and trenches, maintenance access and staircase access to the upper floors of buildings must be considered during the layout planning study. Safety barriers and handrails must be provided wherever necessary to meet the requirements of the adopted standards.

In any case the design superimposed loading for handrails or accessways must not be less than 2.5kN per linear meter. Surface finish to access ladders, stairs and handrails must be compatible with the design environment and must give satisfactory performance without deterioration during the design life and must have a non-slip surface on walking areas.

9.13 Roads and Hardstandings

The road pavements must be designed for a maintenance free life of 25 years and must provide a level of service which must be free from significant cracking or rutting. Roads and access ways must be designed to carry a minimum level of traffic of 50 of the heaviest laden commercial vehicles per day and must also be capable of carrying all abnormal construction traffic, operational traffic and heavy maintenance traffic.

All areas which may be used for chemical, oil or other unloading must have a pavement material capable of withstanding the likely exposure to chemicals or oil without significant deterioration during a 25 year design life.

Car parking area must be covered and be based on 20 cars.

Footpaths where provided must be 1200mm minimum width. All road pavements must be constructed to discharge surface water into the Site drainage system.

The plant roads must connect every functional area. In addition, ring roads must be provided surrounding the main power house, the coal storage yard, the 220kV switchyard building and oil tank area etc. Each trunk road is around 7.0m wide and each auxiliary road is around 4.0m in width. The type of roads must be urban mode and the road surface is paved with cement concrete. Sufficient space must be reserved for landscaping (trees to be planted by Owner).

9.14 Fencing

Fences to transformer compounds and other electrical areas must be galvanised steel palisade type of minimum height 2.0 meters.

Fire walls as per NFPA850 must be provided for generator transformer and station transformer.

Perimeter fencing to the Site must be 2.0m (excluding top strands of galvanized barbed wires) high above the ground level. The top of the wall must have strands of galvanized barbed wire drawn through slots in vertical Y shaped fence posts 600mm high embedded at a spacing not exceeding 3m centers and fabricated out of mild steel angle sections.

9.15 Heating, Ventilation and Air Conditioning (HVAC)

The Facility must be provided with all necessary HVAC Equipment including plant, ductwork, pipework, controls, instrumentation, interlocking and cabling systems designed to maintain appropriate environmental conditions for Equipment/personnel. With the external ambient conditions defined in this OTSR, the HVAC systems must be designed to keep the indoor temperature to a comfort level based on variable outside temperature during the year for air conditioned environment. For environment where heat must be removed by ventilated air, the indoor temperature must not be $6^{o}C$ higher (than the background temperature without ventilated air).

Air conditioning system must be, as a minimum, provided for the following areas:

- Gatehouse and security building;
- Administration/canteen building;
- All laboratories and coal samples preparation room;
- Central control room and adjacent offices;
- DCS Equipment room;
- All computer rooms and electronic rooms;
- All working offices;

Chapter 10 - Project Management

10.1 Site Construction Programme

The Contractor shall submit to the Owner the Construction Programme for the Project which shall fully inter-relate the various activities of design, manufacture, erection and commissioning until Commercial Operation Date. The Programme must be broken down further into the boiler, turbine modules and elements of system and equipment. Both softcopy and hardcopy of the Programme in an agreeable format must be submitted to the Owner.

In addition to above, information on resources proposed for the construction work shall also be submitted. The manpower requirement and resources and labour at Site must be segregated into trade categories.

10.2 Project Management

The Contractor must provide to the Owner a comprehensive Project Management Plan and explain his proposed management organisation, provide the names, qualifications and experience of the proposed managerial and senior supervisory staff. The Contractor must notify any proposed changes to senior staffing arrangements to the Owner for agreement prior to implementation. The Contractor must designate a Project manager plus a separate Site manager who must be stationed at Site and readily available to interact with the Owner. Both of them must be of high seniority, to be able to direct the Contractor's design and Site staff team , subcontractors and mobilise the appropriate headquarter staff to exercise the work in order to complete the activities of the Programme in time.

Contractor shall agree the format of Monthly Progress Report of the Project. Monthly progress report must be provided to the Owner for review. In addition, regular and/or ad-hoc progress review meetings may be required and must also be held between the Owner and the Contractor throughout the design, manufacture, construction and commissioning stages, to enable the Owner to understand the progress and problems. If necessary and when requested by the Owner, the sub-contractors of the Contractor must also attend the progress review meetings.

The monthly progress report for the Project must be sent to the Owner no later than seven days after the end of each calendar month. The format of the progress reports must be agreed with the Owner and must cover a wide range of subject and issues including, but not limited to, the following:

- progress report to the end of each month;
- expected progress for the following three months;
- status of critical outstanding items and issues;
- overall progress, with S-curve showing percentage of completed, late and outstanding works;
- design submissions review;
- list of drawings and documents received and reviewed;
- list of equipment ordered and under manufacturing.
- shipping schedule for arrival of equipment with date of FOB and expected date of arrival at Site;

- equipment received at Site and installed in position;
- details and status of inspection and testing plans (ITP);
- quality plans and their implementation;
- required or planned and available work force at Site, efforts in meeting any

shortfall. labour relations and community relations;

- site safety and statistics review. environmental issues with statistics;
- commissioning procedures and practices agreed with the owner and monitor their implementation;
- test procedures and practices and monitor their implementation;
- losses and claims including insurance claim, if any;
- Any other matter

10.3 Occupational Safety, Health and Environmental Requirements

A very high priority is given by the Owner to safety, health and environmental standards to be maintained at Site. The objective is to achieve zero lost time incidences as well as injury to person and damage to equipment. The Owner expects that the Contractor will maintain and achieve best world standards. To meet this objective, the Contractor must take full responsibility for the management of health, safety and environment on Site. In addition, he must also be responsible for safety of work done by sub-contractor and co-ordinate the activities of its sub-contractors to ensure all Site works are in compliant with all aspects of health & safety and environmental legislation, Owner safety requirement and guidance. Contractor shall establishment and maintain at all times a safe and healthy environment. Safety Incentive scheme to promote safety shall be established for all worker and sub-contractors at site

The Contractor must submit and agree a safety, health and environmental plan (**SHE Plan**) with the Owner three month before the start of construction. The SHE Plan must outline in adequate details the essential elements, including SHE policies, performance targets, organization structure, training, risk assessment, safety inspection/observation and audit programme, use of PPE (personal protection equipment), incident reporting, investigation and follow up, emergency drill and response procedure, and SHE management of sub-contractors. If required the Owner can supply the guideline to assist the Contractor in developing an acceptable international standard SHE Plan. The Contractor must amend the plan as required to incorporate comments/suggestion of the Owner.

The Owner must have the right to review the management and control of health and safety and environment on Site at any time. It must have the right to conduct observations and independent audits at site on the SHE management systems to check compliance of statutory requirement and SHE plan. The Contractor and its sub-contractors must co-operate with the Owner's observer/auditor or reviewer to carry out audit and observations. Recommendations by the Owner given to the Contractor after the observations/audits or review must be implemented as soon as practical and without delay. Actions taken to implement recommendations must be detailed and discussed in the monthly progress report.

Record of safety and environment incidences and near-miss happened at Site shall be maintained. It is important to record all incidents to collect data so that true analysis and follow up action for any improvement can be carried out. In addition, the Contractor must have a system in place to investigate the incidence including near miss and follow up and implement actions. Contractor must report all lost time incidents to the Owners within 24 hours and any fatality must be reported immediately or as soon as practical. The Owner has the right to independently investigate serious incidents and any fatality happened at Site and Contractor or its cub-contractor involved in the incident must cooperate with the Owner to complete the investigation as soon as possible. The Contractor must be aware that this does not relieve him from his statutory obligation in regard to industrial accidents. Monthly reporting of safety statistic in an agreed format is required by the Contractor as a part of regular monthly report. The statistics must include the following data:

- No of fatalities

- No of lost time injuries
- No of restricted work injuries
- No of medical treatment cases
- No of first aid cases
- No of near-misses
- Time since previous lost time incidence
- Total work hours (man-hours)
- Number of total workers on site during the month
- Number of Site safety observations done
- Number of environmental exceedances
- Required safety statistics as required by the local labor authority

The Contractor must report the following Monthly statistics of Incidence Rates for its employees and each sub-contractors, separately as well as combined.

1) FIR
2) LTIIR
3) DIIR
4) TRIIR

The formulae and definitions to be used for the above incidents reporting shall follow the Owner's system which will be provided to the Contractor. Soft copy of the data must be - provided every month

Personal Protection Equipment (PPE)

- It is mandatory for all personnel including sub-contractors working at site to wear PPA suitable for the trade and work they perform. The Contractor must provide, maintain and replenish when necessary, and enforce mandatory wearing of PPE by All personnel including their sub-contractors entering construction site. The mandatory PPE shall include safety helmet (standard EN397), safety shoes with steel toe cap and midsole (standard EN345 / EN ISO 20345), reflective vests (with 3M/Non 3M 2"/3" width reflective strips). The Contractor must provide appropriate PPE pertaining to trade requirement, work nature and processes such as hearing protection in noise area, eye protection for welders and hand protection which could be general or specific gloves.
- The Contracting Counterparty must provide and enforce proper use of PPE by All respective personnel (including sub-contractors) as required by the specific work nature and processes. These PPE must include but not limit to that required for hearing protection (ear plug / earmuff), eye protection (welding/laser eyewear), hand protection (general and specific gloves). General safety goggles are also recommended to be available to all workers for use when windy condition exit at site which is common in Mongolia (standards EN 166 / EN 172 / ANSI Z87). The Contractor must also provide and enforce proper use of safety harness, safety belts ("5-points parachute type" in accordance with standards EN 361 / ANSI / CSA) by workers working at height.

10.4 Contractor's Obligations

The Contractor must comply with all statutory and local regulations and Mongolia government safety and environmental requirements for executing the Site works. In addition the Contractor must comply with Owner specific safety and environmental requirement advised as a result of site routine observations, incident investigation and site safety audit. In particular, the Contractor must implement operational systems for the following specific environment and safety requirements which are necessary and important for its employees and sub-contractors:

The Contractor must observe and follow all environmental standard and requirements. The Contractor must have detailed plans to address the following environmental issues.

a) Environment monitoring method and mitigation measures
b) Earthworks, control of fugitive dust emission and proper discharge of solid waste and waste water.
c) Emergency procedures
d) Site housekeeping
e) Noise control at site
f) Air quality maintenance
g) Management of groundwater
h) Water management , control and disposal
i) Management of contaminated material
j) Management of oil, fuels and chemical
k) Legislative compliance and public complaint handling
l) Compliance with environmental approval and licensing issued by the government

The Contractor must have detailed plans to address the following Safety and Health Management system

- Establish independent management organisation for implementation of health and safety on Site
- Prohibition for the use of alcohol and drug at Site
- The identification of Site hazards and assessment of risks
- A register of hazardous material inventory and movement at site
- Control of work in confined space
- Hot Work permit or Controls for hot work e.g welding
- Handling and use of lifting appliances and lifting gears.
- Scaffolding Erection and dismantling
- Working at Height
- Compressed gases cylinders handling and operation
- Permit to Work safety system during commissioning of plant
- The system for conveying all employees of the Site safety plan, method statements and Site safety rules
- Induction Training and specific training
- Conduct a regular schedule of safety meetings. Site security and the arrangements for emergency plans and evacuation
- Maintain a team of safety inspectors and conduct its own site safety audit as well as combine safety audit with the Owner; at least quarterly frequency safety audit schedule is to be followed
- Use of fire protection and equipment and first aid facility

10.5 Penalty and Bonus for Safety Record

As detailed in above clauses Owner pays top priority to safety and environmental record and performance at its site by Contractor and its sub-contractor. Owner require that the Contractor and its management at site also pay similar priority to safety and environmental and maintain good safety and environmental. Owner has the right to stop work for certain duration and instruct the Contractor to take necessary remedial measure if any fatality happens at site. In order to promote safety at site both Owner and Contractor will contribute US$250,000.00 each to Safety Promotion Fund which will be used for promotion of safety and awards to personnel and sub-contractor/contractor at site. Project Manager of Owner and Contractor will jointly promote safety at site and control this Safety Promotion Fund.

Following penalty and bonus will apply for safety performance:

Penalty:

1. For each fatality at site US$0.50 million
2. For each accident involving loss of Limb US$100,000.00
3. For each accident involving hospitalization for more than four weeks : US10,000.00

Bonus:

1. No fatality at site during duration of contract: US$0.5 million
2. Zero accident involving loss of limb during duration of contract. US$100,000.00
3. Zero accident involving hospitalization for more than four weeks during duration of contract: US$10,000.00

10.6 Documentation

The Contractor must submit design submissions for the works as part of the Project documentation to allow and enable the Owner to fully understand and review the proposed system design. Each design submission must include, but not be limited, to a "system design manual "and an "equipment design manual"

A system design manual must be provided for each major system. It must include a system description stating the function, required equipment, design basis, process data, and methods of operation and control, and interface requirements with other systems. The system design manual must be submitted for Owner's review.

In addition to the system design manual, the Contractor must also submit, for all major equipment, the equipment design manual, which is basically the specification of the equipment for tendering purpose by the Contractor. The Contractor must agree with the Owner for the schedule for the submissions of these two sets of documents for review.

After tendering and before order placement by the Contractor, the technical agreement of the equipment contract must again be submitted for the Owner's final review. The final agreed system/equipment design manuals must also be supplied as part of the Operation & Maintenance Manual.

The other design information to be submitted must include, but not be limited, to the following

- General arrangement drawings
- Civil Information
- General layout drawings
- Equipment layouts and arrangement
- System design manuals
- Equipment design manual

- Mechanical flow diagrams
- Piping and instrument diagrams (P&ID)
- Site services piping / cabling coordination drawings
- Pump and fan characteristic curves
- Performance curves and heat balance diagrams
- Start-up and shut-down curves
- Single line diagrams, relay metering diagrams, protection settings etc.
- Quality manuals and plans
- Results of various design calculations, analysis and test reports
- Instrument schedule
- Complete schedules for summary of equipment such as valves, piping, motor, actuator, painting, lubrication ... etc.
- Control philosophy/logic/sequence diagrams
- Panel wiring diagrams
- Electrical fault level study
- C&I piping installation diagrams
- Other documentation as reasonably requested by the Owner

All the drawings must be submitted with AutoCAD and PDF formats.

The Contractor must supply adequate documentation for all computer systems. This is to enable the Owner to obtain a complete understanding of the operation of the system and of the individual programs, and if necessary to enable modifications to be carried out to the programs. The document must at least include the following.

- Overall system description and network
- Input/output schedule
- Detailed programme descriptions with flow charts and block schematics, showing information flow within and between the programs
- Computer architecture
- Power supply as well as earthling arrangement
- Programming handbooks
- Application software manuals
- Standard software manuals
- Computer manufacturer manuals
- Peripheral manufacturer manuals
- Diagnostic software manuals

10.7 Quality Assurance Plan

The Contractor must submit its proposed quality assurance plan, Inspection and test Plan (ITP) and proposals for assessment by the Owner, within 25 days of NTP.

Contractor shall incorporate any comments by the Owner and amend the plan. After comments, review and agreement by the Owner of the quality assurance plan, these must form an integral part of the Contract. Changes shall not be made to the agreed proposal without the written consent of the Owner.

The Owner may audit and monitor and review the implementation of the quality assurance plan and proposal from time to time. A corrective action must be agreed and implemented in respect of any deficiencies revealed during such monitoring.

The Contractor must perform regular reviews of sub-contractors' quality assurance plan for equipment. Such review documentation must be made available to the Owner on request.

The Owner reserves the right to participate on an as-needed basis in the Contractor's monitoring of subcontractors' quality assurance plan.

On completion of the manufacture or work and completion of inspections and tests the Contractor must provide to the Owner a Certificate of Conformity/Compliance or a Quality Release Note.

The Contractor must allow and arrange the Owner or its representative/inspector to visit the manufacturing factories of the equipment, inspect and review the quality, observe the manufacturing process and witness the testing.

For all welding works, the following quality control procedures, as a minimum must be submitted to the Owner for review before the appropriate manufacturing activities commence at Site.

- Welding Procedures
- NDT Procedures
- Heat Treatment Procedures
- Defect Acceptance Criteria

Mill certificates and material certificates from suppliers for high pressure and high temperature metals must be obtained by the Contractor and submitted to the Owner.

10.8 Owner's Participation

The Contractor must allow the Owner to review the documents in advance and attend the meetings for the following activities between the Contractor and its sub-contractors.

- Preliminary Design
- Master Drawing Design
- Construction Drawings
- Design Review Meeting and Design Liaison Meeting
- Witness Inspection at suppliers' works

Besides, the Contractor must submit the technical specification to the Owner for review in advance of the equipment tendering. The Owner must have the right to participate in bid assessment (technical portion only and not the price).

10.9 Inspection and Testing Plan

The Contractor must provide a list of equipment for an inspection and testing plan (ITP). The Owner shall have the right to add equipment to the list. Detailed list of ITP to be conducted for equipment must include the review point, hold point and witness point for each inspection item. The Owner must have the right to amend the ITP and suggest additional inspection and test point. The Contractor must incorporate amendment suggested by the Owner to ITP. Owner shall be notified in advance and given the opportunity to review, hold and witness the inspection and testing before the equipment is released for delivery. Any defect omission observed by the Owner, its representative/ inspector shall be corrected and another inspection arranged by the Contractor.

The Contractor must exercise close quality control and frequent visits to his sub-contractors and supplier of equipment to ensure the equipment is manufactured to meet the standard stated in the Contract. The Contractor must ensure that sub-contractors follow the requirements of the OTSR.

The Contractor must ensure that the validity of certification on all Equipment subject to statutory inspection is maintained up to and including the date of issue of the Certificate of Commercial Operation.

Equipment which require and will have Inspection and test at Site must be detailed in the Commissioning Plan. The Commissioning Plan must describe in details the procedures of starting the equipment from cold state up to the normal running state, including tuning and optimisation of equipment parameters.

10.10 Technical Support from Original Equipment Manufacturer (OEM) or Suppliers

Technical support from OEM or suppliers must be arranged by the Contractor to cover at least the major equipment such as boiler, turbine, air cooled conditioner, generator, ESP, generator transformer, stacker re-claimer, water treatment plant and DCS. The scope of technical support must include the provision of technical advisors/expert on Site giving instructions for erection / commissioning and prompt in timely solution to any problem encountered. Further expert advice from OEM and suppliers' headquarter if felt necessary must also be provided

10.11 Training

Training must also be provided to Owner's staff either at Site or at suppliers' place to cover the operation and maintenance aspects of above mentioned Equipment. C&I staff will require training in DCS system at works as well as at site. General appreciation training of power plant systems and design philosophy shall be provided at site to all O&M staff.

10.12 Site Management and Control

The Contractor must provide temporary accommodation for the personnel employed by the Contractor and his sub-contractors. The accommodation and associated services must be maintained in a clean and sanitary condition.

The Contractor must maintain a human resources record to meet all labor obligations of Mongolia. These records must be maintained and retained until handover on completion of all Works on the Site and must be subject to review by the Owner.

During the period of construction of the Work, the Contractor must maintain the area of his operations in a clean, tidy and safe condition. The Contractor must arrange storage of his materials at site in an orderly manner and to the satisfaction of the Owner. The Contractor must be responsible for waste collection and transfer to a suitable disposal site. The Contractor must clearly state, what provision is being made for disposal of waste materials both on and off Site.

The Contractor and his employees must not trespass beyond the boundary of the Site on to any adjoining land and adjacent mine site. The Contractor must take all necessary measure and action to prevent trespass occurring. An access control system must be enforced at Site to identify all personnel entering or working at Site.

The Owner may need to bring forward the delivery of the fire engine, ambulance and first-aid clinic to make them available at early stage of construction. The delivery dates of these facilities must be agreed by the Contractor with the Owner.

10.13 Submission Dates of Important Documents

The documentation must submit according to the following table, or in accordance with other time table agreed by the Owner.

Document	**Date required:**

Document	Date required:
Project Management Plan	40 days following Notice To Proceed (NTP)
Safety Health and Environmental Plan	60 days before Site works begin
System Design Manual	As required to support the Work
Preliminary Quality Plan, Design Document Submission Plan	25 days after NTP
Inspection and Test Plans –List of equipment subject to ITP ITP plan of each equipment	45 days after Site works begin 15 days after placement of order to the OEM or supplier.
Final Quality plan	60 days after NTP
Draft O&M Manuals	180 days prior to the COD
Final O&M Manuals	60 days before COD
Training Schedule and Programme	1.5 year prior to the COD
Performance Testing Plan and Procedures	90 days before Performance Test
Commissioning Schedule	90 days before commencement of any commissioning activity
As-built Drawings	60 days after COD

Chapter 11 – General Technical Requirements

11.1 General Overall Requirements

The Contractor shall design, install, construct and commission the units and common plant so that it is suitable to be run continuously at high availability factor with high reliability.

The Units must be designed so that the maximum acceptable air /noise pollution values and water discharges are as per the statutory requirements and OTSR.

Equipment to be used by the Contractor must be new and unused and must be manufactured by reputed manufacturers having sufficient experience of the particular equipments proposed for the power station.

The Units must be designed to permit unconstrained operation over the full range of ambient and other environmental conditions. Further, each Units / item must be designed to withstand the most extreme ambient conditions to which it may be subjected at site in Mongolia. All equipment shall continue to function normally whilst the Units is operated at its maximum continuous rating.

The plant must be fully automated and require minimum operator intervention for normal operation. It must be possible to start the plant and bring it to full capacity without operator intervention outside of the control room. All motors, valves, dampers, etc. which

must be operated during startup, shutdown, normal, emergency or special operations of the plant and auxiliaries must be automatically operable from the central control room.

The International SI system of units must be used for design, drawings, diagrams and instruments, etc.

Suitably certified equipment must be used in the designated hazardous and potential flammable areas. To the maximum extent practicable, equipment requiring operator attention and/or electrical equipment must not be installed in hazardous and potential flammable areas.

The Contractor must implement all special requirements concerning the nature, handling and storage of all classified substances including fuels, oils, gases and chemicals. Toxic, radioactive, inflammable and explosive materials must be declared and approved as per local rules and laws before importation to the Site.

11.2 Plant Layout

Consideration must be given to maintenance and overhaul requirement for access during plant layout design, i.e. free access to equipment shall be provided in the power plant layout design. Sufficient means must be provided to meet the requirement of hoisting for shifting, maintaining and overhaul of equipment. Requirement of platform for access for maintaining valves, flanges, motors and small equipment shall be considered where appropriate.

For the overhaul requirement, it is necessary to consider the requirement of lifting up the upper cover and dismantling the main components of steam turbine generator units during general overhaul. To allow this the operating floor around the steam turbine must have a very clear open space.

The Contractor must provide all platforms, footpaths and stairs conforming to the requirements of safety and of providing exclusive entrance and exit for equipment operation and maintenance. For design of all platforms and footpaths, the minimum clearance height is 2.2 m shall be maintained. All the lifting platforms and walkways must be provided with stop bar.

Appropriate safety regulations must be used in designing dangerous areas for equipment by striving to reduce the hazard to the minimum.

Ample space for ease of operation and maintenance including equipment removal, cartridge/ rotor pulling etc. must be provided. All valves, gates, dampers and operating devices must be located and oriented in such a way that they are easily accessible from operating floor levels. Where this cannot be achieved, platforms and walkways with access ladders must be provided to facilitate operation and maintenance.

Motorised lifting devices, ie. hoists, chain pulleys, jacks, etc. must be provided for handling and carrying out maintenance of any equipment and/ or part having weight in excess of 400 Kg. Manual lifting devices can be accepted for equipment weighing below 400Kg. Suitable beams, hooks etc. for lifting purpose must be provided.

Lifting devices like lifting tackles, slings, etc. to be connected to hook of the hoist/ crane must be provided by the Contractor for lifting the equipment and accessories covered. All heavy parts (400 Kg and above) must be provided with a convenient arrangement for slinging and handling during erection and overhaul.

11.3 Selection of Materials

In selecting materials of construction of equipment, the Contractor must pay particular attention to the atmospheric and climate conditions existing at the Site and the nature of material/ fluid to be handled. Wherever deviations are taken in respect of materials specified, the reasons must be spelt out clearly in the proposal.

All materials must be new, and must be of the quality most suited for the proposed application. All materials used must have demonstrated satisfactory service in similar or more arduous conditions over a sufficient long period .

Parts which could deteriorate or corrode under the influence of the atmospheric meteorological or soil conditions at the Site, or under the influence of the working environment and conditions must be suitably and effectively protected so that such deterioration or corrosion is a minimum over the life of the plant.

11.4 Care for Vibration

Where there is vibration induced by the equipment or any other reason, it must be reduced to the minimum as far as possible and practical. Amplitude and frequency limitation in the design and supporting structure must be considered.

Special care must be taken to avoid resonance of operating equipment with foundations, packing, duct, platform, piping or other components.

11.5 Care for Safety Design

Special importance must be given to all aspects related with the safety of personnel operating the plant, assembling and maintaining the equipment, including other persons who may come in contact with it or working in the vicinty.

The possibilities of human failure must always be foreseen. Provisions must be made to avoid damage caused by human error. It shall be ensured where ever practical that such damage both to persons as well as to the equipment is the least possible.

Adequate protection must be provided to rotating or any other moving part of the machinery, hot parts or any part that may cause accident to personnel.

All components, items with surface temperatures exceeding $50^{o}C$ and exposed to personnel must be fitted with insulation to protect personnel. The insulation shall be designed such that the surface temperature must not exceed $50^{o}C$ in the condition of the ambient temperature being $35^{o}C$.

The equipment must be provided with the necessary elements to keep possible failure of the main, auxiliary or control elements from causing serious consequences. For this purpose, protections must be installed where necessary such as stops in case of failure of shafts, auxiliary suspensions that will keep parts from failing or coming loose because of centrifugal forces or other safety device and stops to limit movement in case of failure of normal limiting devices, etc. Protections that will decrease or deviate liquid or gas escapes must also be provided for the same safety purpose.

Access stairs to the equipment must be safe, with anti-skid design and handrail. Strong guard rails protection must be provided. Platforms must have kicking plates to keep loose objects placed on the floor from dropping off.

11.6 Plant Labeling and Identification

The Contractor must establish a single identification numbering system to provide consistent numbering throughout the Plant. A KKS (Kraftwerk Kennzeichnungs System) or approved equivalent plant identification system comprising of alphanumerical characters must be used to identify all equipment and components of the Plant. The plant identification system must be integrated into the DCS, main plant and all auxiliaries. All electrical devices, control and instrumentation equipment, valves, and other items of similar nature must be permanently identified with the identification number supplied by the Contractor.

The Contractor must provide to the Owner detailed training sessions and full documentation for the supplied plant identification system prior to commissioning work. The Contractor must supply soft and hard copies of the KKS (or equivalent) component list for the plant and for all components requiring maintenance. The list must include: KKS, number of levels (layers of details), plant item, reference drawings, O&M manual reference and spares part reference.

The Contractor must provide details of the proposed Schedules on Plant Identification System in its proposal.

11.7 Numbering System, Labels and Nameplates

Except as specified elsewhere, the numbering and identification name shall be engraved on stainless steel or laminated phenol tags acceptable to the Owner and permanently affixed to the device. The Contractor's identification numbers shall be included on the manufacturer's drawings.

Owner require that all nameplates on equipment must be written in English. Nameplates and labels must also be fitted to all equipment that will require operation and maintenance so as to assist the Plant operation and maintenance personnel to perform operation and maintenance functions safely and effectively.

Each item of plant including, field devices and drives must be durably and legibly labelled, indicating the purpose, plant identification number and where necessary any operating position functions. Each item must have its unique plant identification system number. Equipment descriptions must be agreed with the Owner.

The description and number of each item of plant must be consistently applied throughout all drawings, documents, manuals and labels.

Labels/signage for safety, hazardous and flammable material, and dangerous goods including flammable and toxic gases, acids and alkalis must be in accordance with local safety requirements and relevant local standards.

Interconnecting pipes and all pipes in trenches and carrying potentially hazardous substances must be colour coded and have markings on the outer surfaces complying fully with relevant International Standard.

For underground pipe work and/or cables installed underground the Contractor must supply and install reinforced concrete marker posts at each change of direction point and at intervals of no greater than 30m along the route. These marker posts must indicate the directions and functions of the services involved.

Labels must be provided on front and rear access doors of all cubicles. Labels must also be provided inside cubicles to assist the identification of apparatus and terminals.

11.8 Piping Runs

Piping runs must be arranged aboveground as far as practicable. When the Site conditions dictate other arrangement, the following criteria must be observed.

Underground : Living, fire-fighting, storm drains and waste water pipes;
Overhead : Hydrogen, fuel gas, fuel oil and heating pipes;
Overhead or inside trench: Compressed air, oxygen, acid and alkaline pipes;

Centralized piping support racks, and piping trenches must be used as far as practicable.

11.9 Padlocking Facilities

A uniform system of padlocks, keys and key cabinets must be supplied for all the Plant items such as valves, switchgear isolators etc., which have to be locked off for operation safety and/or prior to the issue of "Safety Permit to Work" for the maintenance.

11.10 Site Storage and Packaging.

During transportation and field storage all equipment and instruments must be fully packed and protected from damage during transportation and field storage. The equipment instruments must be provided with thorough protecting measures before packing. All machine surfaces must be protected with planks or similar materials and reinforced with metal strips or plates from the outside.

Inside the packaging, all equipment such as motors, switches, control devices, instruments and components must be sealed with polyethylene insulation board and a corresponding drying agent must be provided.

For all piping ends as well as pipes and tanks, the openings must be protected from damage and sealed to avoid the entrance of moisture and air. These protection measures must be kept intact before the start of installation or moving the items for periodic inspection. If any packaging or protection is damaged or worn out the cost spent for the moving, modification and replacement of the packing and protection device must be borne by the Contractor.

The name of articles in the packing case must be marked clearly on the packing list so as to be identified easily.

The Contractor must ensure that good storage (with air condition, if necessary) will be provided for temporary storage at Site

11.11 Panel Lighting and Heating

Panels containing apparatus that requires regular routine testing and maintenance must be fitted with a lamp (or lamps) to adequately illuminate all wires and apparatus as evenly as possible without glare.

Electrical equipment including switchgear, panels and cubicles must be provided with totally enclosed, metal clad type anti-condensation heaters with thermostat control. The surface temperature of the heater with which accidental contact may be made must not exceed 60^{o}C.

11.12 Wire and Terminal

Thermocouple, coaxial and other special cables and their installation, must require specific Owner's review for the particular application.

All wiring must be protected from abrasion and the location and routing must minimize the risk of damage from heat, steam, oil and hydraulic fluids.

To prevent accidental contact, shrouds or covers must be provided over terminals that are energized above 110V.

All cubicle wiring must be neatly run and either securely fixed in cleats, run in wiring troughs, bunched in neat forms, or run in non-corrodible tubes.

Terminal block for outgoing connections must provide 15% spare ways, in excess of those required for active cores.

Not more than two connections may be made to a terminal on one side of a terminal block.

Internal and external connections of a cubicle etc. must not be on the same side of a terminal.

Terminals must be numbered systematically and all wires must have an identification marker at each end numbered. Terminal numbers and wire marker must be shown and matched in relevant drawing.

11.13 Electromagnetic Interference

Equipment must not generate electrical or electromagnetic interference at a level which could be detrimental to the performance of other equipment or which could cause annoyance or discomfort to personnel.

The earthing and cabling arrangements must be such that detrimental interference is not generated.

Equipment manufacturers must, in the design of their equipment, take reasonable precautions so as to make the equipment immune to the interference.

11.14 Local Instruments

11.14.1 Transmitters

The transmitter must be of the 2-wire 4-20mA design or of smart type and its output must be isolated from earth and input. The transmitter output must be clamped below 125% of the maximum rated output (e.g. 25mA for 4-20mA transmitter) during input overload,

input fault, output short circuit or other fault conditions. Transmitters must be capable of withstanding open or short circuits of the output without damage.

11.14.2 Temperature Measurement

Temperature measurement and control must have linearizing facility for non-linear temperature sensors such as thermocouple/RTD/thermistor such that the output from the circuit is linearly proportional to the temperature measured. SS316 stainless steel sheathed thermocouples with pockets must be used unless otherwise specified.

Only K-type, E-type and N-type thermocouples must be used for above and below 450 °C measurement respectively throughout the whole Plant. Thermocouples must be manufactured from a continuous length of cable from the hot junction to the first termination box or cold junction cabinet whichever is appropriate. Compensation cable must be used for further extension.

Where measurement of a small temperature differential at high absolute temperature is required, thermocouples may be used providing that they are manufactured from the same batch of material. The differential signal must preferably be obtained by connecting the thermocouples 'back to back' at the first terminating box from the hot junctions. The terminal arrangement must be designed to minimize the risk of picking up stray EMFs. The transmitter or the measuring device must be able to detect the positive or negative differential signal.

Resistance thermometers must comply with and must have been type tested in accordance with Standard BS 1904 or equivalent. Type Pt100 resistance thermometers must be used unless otherwise specified.

For high accuracy requirements, 3 wire bridge measuring system must be used.

11.14.3 Pressure Measurement

All pressure transmitters and switches must be located as far as practicable near to the equipment to minimize the pipe length and to avoid the pressure drop and high pressure lines. Filters and snubbers must be added to pressure measurement pipework as required to reduce undesirable effects that cause fluctuations and other imperfections on the measured signal. Not more than one pressure measuring device for control or interlock or protection purpose must be connected to the same tapping point. Not more than two pressure measuring devices for indication purpose must be connected to one tapping point

11.14.4 Actuator

Actuator must have motor protection, a hand wheel for manual operation, position and torque limit switches, and position indicator. Alarms must be provided for loss of power supply, air supply and signals. Owner prefer that all actuators are supplied from one manufacturer. If the Contractor propose more than one manufacturer he shall take approval of the Owner.

11.15 Prohibited or Not Allowed Materials

Following materials are prohibited at the plant and the Contractor must ensure that the plant manufacturer does not incorporate these while manufacturing equipment and plant items:

- Cast iron for any oil service;
- CFC's or other ozone depleting substances;
- Asbestos or asbestos-containing materials
- PCBs for transformer oil;
- Carcinogenic materials; and
- Any other materials generally known in the construction industry at the time of use to be deleterious to health

11.16 Paint and Corrosion Protection

Proper surface preparation of metallic surfaces of the Plant that are subject to corrosion must be done and parts properly cleaned (e.g. sand-blasted) prior to the application of suitable anti-corrosion primers and top coats. All paints must be products of renowned paint suppliers and painting standards and application direction and procedure provided by the paint manufacturer observed and followed.

Protection must be provided by electroplating, suitable gaskets, cathodic protection or other means where dissimilar metals are in contact or close proximity and corrosion may occur through electrolytic action or differences in electric potential,.

All surfaces must be adequately protected in transit and any damage must be renovated after off-loading and on completion of erection.

Suitable protective coatings must be applied to materials subject to corrosion, including all exterior equipment surfaces and structural steelwork.

Surfaces that are inaccessible after shop assembly shall be finish coated/painted for lifetime protection. All access ladders, security fencing and hand railing etc. must be hot-dip galvanized. Galvanized coating must also be applied to structural steel members, where deemed necessary.

11.17 Pipework and Cladding

The cladding's exterior and insulation must be covered by aluminium sheets of thickness of not less than 0.8mm for hot air and gas ducts, heaters and drain tanks and 1.0mm for pipes. Flat aluminium sheets must be used for pipework and valves while ductwork and large flat outdoor located surface shall use corrugated aluminium sheets. All accessories for fixing the cladding and insulation shall be made of aluminium or stainless steel to prevent corrosion. For outdoor installation, the Contractor must apply approved type of sealant for sealing the gap between the claddings wherever necessary to prevent ingress of water and moisture.

11.18 Hazardous Area Classification

The Contractor must carry out a thorough, comprehensive plant-wide assessment of all areas, in particular the gas and oil areas (fuel oil, lub oil), that could be deemed hazardous in accordance with IEC 60079/10 and must complete the Works to meet all the requirements of the relevant codes and standards

Chapter 12 – Laws, Standards, Regulations, Code and Guidelines:

12.**1** Contractor shall be responsible for obtaining all approvals required from Mongolian's local and central government authorities for construction activities and approval of design, drawings and pressure vessels from expert agency of the government.

12.2 The Contractor must be in compliance with all applicable local and Mongolian government Laws, Regulations, Standards, Code of practice and Guidelines applicable to the design and construction of the Power plant. International and PRC standards as mentioned in this Owner Technical Specification and Requirement must be observed. Following is a list of some of the laws, regulations, standards, code and guidelines applicable to the project. This list is not exclusive and Contractor must check applicable laws, regulations, standards, code of practice and guidelines applicable and observe them. The standards, regulations, code and guidelines applied in each case must be the latest revision applicable.

ASME	American society of Mechanical Engineer
ASTM	American society of testing and material
AWS	American welding society
BS	British Standard
EN	European Standard
IEEE	Institute of Electrical and Electronics
ISO	International Standard Organization
NFPA	NFPA 85: Boiler and Combustion systems Hazards Code
NFPA	NFPA72: National Fire Alarm and Signaling code
BS EN 1008: 2002	Mixing water for concrete-specification for sampling, testing and assessing the suitability of water, including water recovered from process in the concrete industry, as mixing water for concrete.(can be made available to owner on request)
Mongolian Laws and Standards	1. The Law on Construction adopted on 5th February 2008 2. The Laws on Special Permits for Business Activities 3. The Laws on Protection of the Nature and Environmental 4. Energy Law 5. Air Law 6. The Law on Water 7. Town building Law 8. Sanitation Law 9. Law of chemical hazards and dangerous substance 10. Household and Industrial waste utilization Law

	11. Railway transport Law 12. General taxation Law 13. Custom tariff Law 14. law of sending labor force abroad and receiving labor force 15. The Law on Anti-Corruption
MNS 6298:2011	Air Pollution Standard for flue gas (CO, SO2, NOX ,Fly ash)
MNS 4943:2011	Discharging treated waste water- general environmental requirement
Grid code	Grid code of Mongolia
Code for Construction norms	Construction norms & design at seismic zone BHb 22.01.01, BD 22 -101-07, National Centre of Construction Urban Development and Public Utilities (can be made available to Contractor on request)

ATTACHMENT A

Limestone Specifications

Particle size	Maximum 100 % by weight less than 100 mm
Composition	
Total moisture	Maximum 0.03 % by weight
$CaCO_3$	Minimum 95 % by weight
$MgCO_3$	Maximum 3 % by weight
Inerts	Maximum 3 % by weight
Foreign Materials	
Trash, wood, metal, other foreign material	Maximum none

ATTACHMENT B

Mine Pit water specification

Central Water Laboratory

Sample name: "East Energy Development" LLC

Number	Product standard number	Sample
34	MNS 4943:2001	Treated waste water

Received by: Ganbat
Sample: B-409 pit ground water, 1 liter
Assayed date: 2012/03/06-2012/03/09

№	Assayed standards	Indicator, unit	B-409
1	MNS ISO 10523:2001	Water surroundings	**7.33**
2	MNS ISO 4810:1999	Electro conductivity	**1360**
3	MNS 2570-1978	Transparency (cm)	**12.4**
4	MNS ISO 7887:2001	Color (mg/L)	**3.8**
5	MNS ISO 11923:2001	… substance (mg/L)	**27**
6	MNS ISO 6060:2001	Chemical essential oxygen (mg/L)	**89.86**
7	MNS ISO 5815:2001	Biochemical essential oxygen (mg/L)	**13.6**
8	MNS ISO 6777:2001	Nitrite (mg/L)	**0.04**
9	MNS ISO 7890-3:2001	Nitrate (mg/L)	0.13
10	MNS ISO 4428:1997	Ammonium Nitrogen (mg/L)	10.45
11	MNS ISO 9963-1:2005	Composite alkaline (millimole/L)	0
12	MNS ISO 9963-1:2005	Total alkaline (mg/L)	7.68
13	MNS ISO 9297:2005	Chloride (mg/L)	**46.71**
14	MNS ISO 6878:2001	Orthophosphate (mg/L)	0.07
15	MNS ISO 6878:2001	Total Phosphorus (mg/L)	0.1
16	CS 11-0037:2008	Dissoluble salt	82
17	MNS 5597:2006	Hydrosulfuric acid (mg/L)	3.33
18	MNS ISO 9280:2001	Sulfate(mg/L)	509.65

Assayed by: Chemist: B.Chuluunchimeg
Ch.Buyanjargal

2011-10-03

Central Water Laboratory

Sample name: “Chandgana coal” LLC

Number	Product standard number	Sample
148	MNS 4943:2011	Treated waste water

11110919-08517 – Khentii Aimag, Chandgana Tal (water from mine pit)
Received by: Ganbat (Driver)
Sample: 0.2 L
Sampled date: 2011/09/15
Received date: 2011/09/19
Assayed date: 2011/09/19-2011/09/24

Assay results from ICP-OES

	Assayed standards	Indicator, unit	Contemporary standard		Acceptable max. content	11110916-65802
			Approx.	Measured		
1	**MNS ISO 11885:2007**	Ag mg/L	0.1	0.099		0
2		Al mg/L	0.5	0.504	**0.5**	82.742
3		As mg/L	0.1	0.101	**0.01**	0.006
4		B mg/L	0.5	0.507	**0.3**	2.095
5		Ba mg/L	0.5	0.501	**1.5**	0.275
6		Be mg/L	0.1	0.1	**0.001**	0
7		Ca mg/L	100	100.34		79.658
8		Cd mg/L	0.1	0.101	**0.3**	0.0011
9		Co mg/L	0.1	0.1	**0.02**	**0**
10		Cr mg/L	0.1	0.099	**0.3**	0.156
11		Cu mg/L	0.5	0.503	**0.3**	0.507
12		Fe mg/L	20	20.168	**1**	**7.6116**
13		K mg/L	20	20.264	**-**	6.418
14		Mg mg/L	20	20.118	**-**	74.1232
15		Mn mg/L	20	19.967	**0.5**	0.1412
16		Mo mg/L	0.1	0.13	**0.5**	0.285
17		Na mg/L	100	99.725	**-**	215.074
18		Ni mg/L	0.1	0.1	**0.2**	0.131
19		Pb mg/L	0.1	0.102	**0.1**	0.011
20		Sb mg/L	0.1	0.16	**0.05**	0.18
21		Se mg/L	0.1	0.125	**0.02**	0.109
22		Sr mg/L	0.1	0.099	**2.0**	0.966
23		Zn mg/L	0.5	0.502	**1.0**	0.142

ATTACHMENT C

Ground Water Specification

WATER LABORATORY OF WATER SUPPLY AND SEWERAGE AUTHORITY, UB

Number	Product Standard Number	Determination of sample
157	MNS 0900:2005	Drinking water

Sample name: Chandgana Coal LLC

11110916-69705- Khentii Province, Tsagaan Hudag dug south east of the Chandagana Tal mine pit

Sampler name: Driver Ganbat

Sample amount	Sampled date	Received date	Analyzed date
1.5 liter	2011/09/15	2011/06/16	2011/09/16- 2011/09/17

Measurement result

№	**Standard of Determination Method**	**Indicator, measuring unit**	**Standard**	**11110916-69705**
1	MNS 4432:1997	Color, degree	**20**	**489**
2	MNS 3900:1986	Odor, grade	**2**	**5**
3	MNS 3900: 1986	Taste, grade	**2**	**5**
4	Horiba U-10	Turbidity	**5**	5
5	MNS ISO 4889:2005	Electro conductivity, µs/sm		1.34
6	MNS ISO 6059:2001	Total amount of Calcium and Magnesium (hardness) mg-equ/l	**7**	**10.42**
7	MNS ISO 9297:2005	Chloride, mg/L	**350**	8.68
8	MNS 4428:1997	Ammonium, mg/L	**1.5**	**9.777**
9	MNS ISO 4431: 2005	Nitrite, mg/L	**1**	0.164
10	MNS ISO 7890-3:2001	Nitrate, mg/L	**50**	0.026
11	MNS ISO 10523:2001	pH	**6.5-8.5**	6.424
12	MNS ISO 4430:2005	Iron. mg/L	**0.3**	**68.8**
13	MNS ISO 4818 :1999	Oxidation, mg/L		11.68

Remark: We used filter paper for determining the chloride and hardness due to water sample contained mechanical mixture of grass and soil

Number	Product Standard Number	Determination of sample
157	MNS 0900:2005	Drinking water

Sample name: Chandgana Coal LLC

11110916-65802- Khentii Province, Tsagaan Hudag dug south east of the Chandagana Tal mine pit

Sampler name: Driver Ganbat

Sample amount	Sampled date	Received date	Analyzed date
1.5 liter	2011/09/15	2011/06/16	2011/09/19

Measurement result of ICP-OES equipment

№	Standard of Determination Method	Indicator, measuring unit	Contemporary standard		Maximum permissible amount	11110916-65802
			Actual	Measurement		
1	**MNS ISO 11885:2007**	Ag mg/L	**0.1**	**0.098**	**0.1**	0.005
2		Al mg/L	**0.5**	**0.497**	**0.5**	0
3		As mg/L	**0.1**	**0.101**	**0.01**	0.008
4		B mg/L	**0.5**	**0.494**	**0.5**	**0.15**
5		Ba mg/L	**0.5**	**0.499**	**0.7**	0.119
6		Be mg/L	**0.1**	**0.099**	**0.0002**	0
7		Ca mg/L	**100**	**99.766**	**100**	**115.444**
8		Cd mg/L	**0.1**	**0.099**	**0.003**	0.002
9		Co mg/L	**0.1**	**0.1**	**-**	0.018
10		Cr mg/L	**0.1**	**0.099**	**0.05**	0.001
11		Cu mg/L	**0.5**	**0.498**	**1.0**	0
12		Fe mg/L	**20**	**19.792**	**0.3**	**19.1615**
13		K mg/L	**20**	**19.803**	-	2.1035
14		Mg mg/L	**20**	**20.061**	**30**	**48.2748**
15		Mn mg/L	**20**	**0.103**	**0.1**	**0.5974**
16		Mo mg/L	**0.1**	**98.931**	**0.07**	0.011
17		Na mg/L	**100**	**0.099**	**200**	32
18		Ni mg/L	**0.1**	**0.1**	**0.02**	0.053
19		Pb mg/L	**0.1**	**0.098**	**0.01**	0.004
20		Sb mg/L	**0.1**	**0.101**	**0.02**	0
21		Se mg/L	**0.1**	**0.098**	**0.01**	0
22		Sr mg/L	**0.1**	**2.0**	**2.0**	0.549
23		Zn mg/L	**0.5**	**5.0**	**5.0**	0.011

Remark: We measured after using membrane filter

ATTACHMENT D

FUEL OIL-DIESEL FUEL SPECIFICATION
TECHNICAL DESCRIPTION
TECHNICAL REQUIREMENT OF DIESEL FUEL

MNS 216:2006

№	NAME OF INDICATORS	Permissible content		National Standard
		/summer/	/winter/	
1	Cetane number, not less	45	45	MNS 229:1960
2	50% is distilled at a temperature	280	280	MNS 3405:2000
	95% distilled at a temperature, ° C, max	360	340	
3	Kinematic viscosity at 20 ° C, mm ^{2} / s (cSt)	3,0-6,0	1,8-5,0	MNS 480:1983
4	Freezing point, ° C, not less, for climatic zones: • moderate • cold	-10	-35 -45	MNS 3192:1996
5	Cloud point, °C, not less, for climatic zones: • moderate • cold	-5	-25 -35	MNS 3594:1983
6	Flash point in closed crucible, ° C, not lower • for locomotive and marine diesel engines and gas turbines • diesel engines for general use	62 40	40 35	MNS 333:1983
7	Total sulfur content, %, not less type I. type II.	0.2 0.5	0.2 0.5	MNS 337:1983
8	Mass fraction of mercaptan sulfur,%, max	0.01	0.01	MNS 3627:1983
9	The content of hydrogen sulfide, %	absence	absence	MNS 3627:1983
10	Test on copper plate	tolerable	tolerable	MNS 326:1985
11	Water soluble acids and alkalis, %	absence	absence	MNS 324:1983
12	Concentration of actual pitches, mg on 100 cm^3 of fuel, no more	40	30	MNS 477:1983
13	Acidity, mg KOH per 100 cm^3 of fuel, no more	5	5	MNS 334:1996
14	Iodine number, g iodine per 100 g of fuel, no more	6	6	MN3 3500:1983
15	Ash content,%, max	0.01	0.01	MN3 3501:1983
16	Coking, 10% residue,%, not more	0.3	0.3	MNS 336:1983
17	The coefficient of filterability, no more	3	3	ГОСТ 19006-73
18	Content of mechanical impurities	absence	absence	MNS 3697:1984
19	The water content	absence	absence	MNS 332:1996
20	Density at 20 ° C, kg / m ^{3,} not more	860	840	MNS 481:1988
21	The limiting filterability temperature, ° C, above,	-5	-	MNS 332:1996

Auto ignition temperature for summer type diesel is 300ºC and for winter type diesel is 310ºC.

ATTACHMENT E

GEOTECHNICAL STUDY REPORT AND BORE HOLE DATA
Attached separately to this document.

ATTACHMENT F

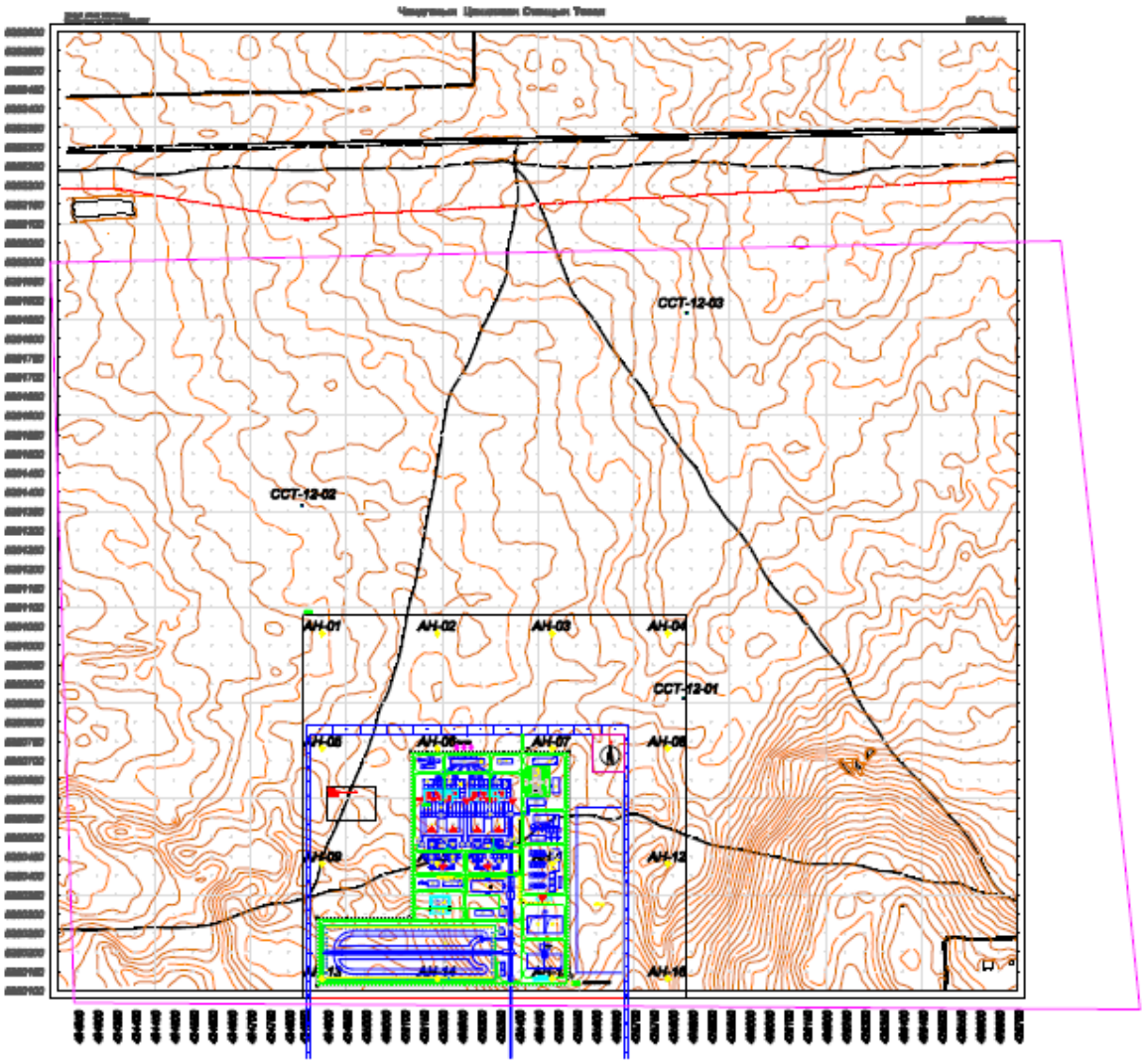
ADDITIONAL SITE BORE HOEL DATA

Three more bore holes were drilled to determine the mine resources and data for these bore holes already supplied to SEPCO 2. Attached separately to this document.

ATTACHMENT G: SEISMIC HAZARD ASSESMENT STUDY REPORT: Already supplied; pdf file. To be attached

ATTACHMENT H

SITE SURVEY COUNTOUR MAP



COMMERCIAL SCHEDUELS;

FOR SCHEDULE 01 SEE EPC AGREEMENT FOR AGREED PRICE

SCHEDUEL 01: SCHEDUEL OF CONTRACT PRICE-PHASE 1 OF 2X150MW ONLY

1. Please fill in breakdown prices in the following table for 2x150 MW to be constructed as single phase.

	Item	Price(USD)
1	Boiler and auxiliaries	
2	Steam Turbine and auxiliaries	
3	Generator and auxiliaries	
4	Coal handling	
5	Ash handling	
6	Ash Pond at site	
7	Electrical and control & instrumentation systems	
8	Balance of plants including Air Cooled Condenser.	
9	Civil Works including Stack (Chimney)	
10	Project management, engineering and design	
11	Construction and commissioning	
12	Site formation and leveling	
13	Transport without marine or related insurance (insurance to be taken by owner)	
14	2-year spares with list	
	Total EPC cost	
15	Total Man Months of foreign citizen to be imported to work for the project *	
16	Price for work and activities for first 6 month if Limited Notice to Proceed is given	

*We understand that Mongolia has Work Place Payment as per paragraph 5, Article 9, of the Laws of Exporting and Importing labor force and professional. Contractor will require to pay this Work Place Payment for all personnel who come to work on this Project in Mongolia. We understand at present it is MNT280k per person per month. The contractor shall indicate the no of man months he will import for the project in order for the Owner to calculate this element of cost and compare the EPC price. Contractor shall pay this import tax and Owner will reimburse the Contractor based on actual man months spent on the project subject to maximum man months indicated in ITEM 15 of the above table of Schedule of Contract Price.

Item 16 of Schedule of Contract price: Contractor shall submit detailed bar chart for major activities which are absolute necessary for first six months of the project and price breakdown for each activity. Owner may consider to issue Limited Notice to Proceed to start this work in case there is some delay in achieving financing for the project.

2. Validity of Price: Price shall be valid up to -------

COMMERCIAL SCHEDULES
SCHEDUEL 02: SCHEDULE OF GUARANTEED DATES
Contractor has guaranteed the following mile stone dates: Guaranteed date for the following milestone from Commencement Date

Sr. No	Milestone Guaranteed	Unit (Months)	Unit (Months)
1	Performance Acceptance Test	32	36
2	168 hours Reliability Test	30	34

COMMERCIAL SCHEDUELS
SCHEDULE 03: SEE EPC AGREEMNET
SCHEDUEL 03: SCHEDUEL OF PAYMENT PROFILE AND MILE STONE PAYMENT

3. A; Milestone payment of Offshore Portion (unit 1-2) ; Schedule submitted by SEPCO 2 to be inserted here
4. B: Milestone payment of Onshore portion (Unit -2); Schedule submitted by SEPCO 2 to be inserted here

5. For construction work payment apart from linking to monthly progress as above it shall also be linked to the Key mile stones items as indicated by the Owner Technical Schedule-Schedule 1-item 2. Detailed below:

S.N	MILESTONE FOR PAYMENT	FOR UNITS (%)
	Dispatch of offshore supplies on pro rata basis as per a shipment schedule as approved by the Owner. The Following milestones event to be inserted in SEPCO 2 above schedule submitted by SEPCO 2: • Commencement of work, • Completion of site formation and foundation, • First fill of concrete, • Drum lift, • Turbine bed plate in position • Hydraulic testing • Acid clean • First ignition, • Grid synchronization, • Performance testing • Commercial operation	

6. After issue of Final Acceptance Certificate: 5%

COMMERCIAL SCHEDULES

SCHEDUEL 04: SCHEDULE OF PERFORMANCE LIQUIDATED DAMAGES (L/D) & BOUNS FOR EARLY COMPLETION - SAFETY RECORD PENALTY AND BONUS

A) Liquidated Damage:

For failure to achieve performance Owner will charge and Contractor must pay liquidated damages as follow:

1. Performance L/D for failure to achieve guaranteed HEAT RATE are US$13,216/ kj/kwh
2. Performance L/D for failure to achieve guarantee GROSS OUTPUT are US$2.0 million/MW
3. Performance L/D for failure to achieve guaranteed AUXILIARY POWER CONSUMPTION are US$2000/kw and pro-rata for part thereof to three decimal places
4. Delay in construction after agreed Commercial Operation Date US$85,00/day/unit

B) Bonus for Early completion:

Owner will pay US$35,000/day/unit for every day of early completion up to maximum of US$1.05 million/unit.

C) Penalty and Bonus for Safety Record:

1. Safety Promotion Fund: Owner pays top priority to safety and environmental record and performance at its site by Contractor and its sub-contractor. Owner require that the Contractor and its management at site also pay similar priority to safety and environmental and maintain good safety and environmental. Owner has the right to stop work for certain duration and instruct the Contractor to take necessary remedial measure if any fatality happens at site. In order to promote safety at site both Owner and Contractor will contribute US$250,000.00 each to Safety Promotion Fund which will be used for promotion of safety and awards to personnel and sub-contractor/contractor at site. Project Manager of Owner and Contractor will jointly promote safety at site and control this safety fund.
Following penalty and bonus will apply for safety performance:

2.Penalty:

1. For each fatality at site US$0.50 million
2. For each accident involving loss of Limb US$100,000.00
3. For each accident involving hospitalization for more than four weeks : US10,000.00 per accident

3.Bonus:

1. No fatality at site during duration of contract: US$0.5 million
2. Zero accident involving loss of limb during duration of contract. US$100,000.00
3. Zero accident involving hospitalization for more than four weeks during duration of contract: US$10,000.00

D) Environmental Guarantees: Owner has the right to reject the plant if Environmental performance guarantees mentioned under Item 3 of Technical Schedule: Schedule 03: Schedule of Performance Guarantees are not met.

COMMERCIAL SCHEDULES
SCHEDUEL 05: SCHEDULE OF FORMS OF CERTIFICATES

7. Owner will provide certificate after completing the Completion Tests for each Unit as mentioned in Technical Schedule 02- Schedule of Tests
    - Certificate of Notice to Proceed
    - Provisional Acceptance Certificate
    - Completion Certificate
    - Final Acceptance Certificate and
    - Certificate of Release for warranty
    -

Form of Certificate of Notice to Proceed

[ON OWNER'S LETTERHEAD]

[*Insert Date*]

Contractor Representative
[*Address*]
NOTICE TO PROCEED
Dear [ ]

Engineering, Procurement and Construction Contract ("Contract")
Chandgana Power Project

We refer to Clause--------of the Contract.

You may now commence the performance of the Works on the Commencement Date which is *[insert date]* in accordance with the Contract.

This notice, to the extent the Contractor has not been previously informed, can be taken as notice that the all remaining conditions precedent have been satisfied or waived, as the case may be.

Yours sincerely

Owner's Representative

[ON OWNER'S LETTERHEAD]

[*Insert Date*]

Contractor Representative
[*Address*]
PROVISIONAL ACCEPTANCE CERTIFICATE
Dear [ ]

Engineering, Procurement and Construction Agreement
Chandgana Power Project

This Certificate relate to Contract between ----------(Owner)-and -------- (Contractor) dated ----

We refer to Clause -11.1.1 --------of the Contract. We advise you that on *[Insert date]* Provisional Completion was achieved.

By signing this Provision Acceptance Certificate of Provisional Completion, the Owner acknowledges and accepts that Provisional Completion has been achieved. This Provisional Acceptance Certificate is executed by an official duly authorised to bind the Owner.

This Provisional Acceptance Certificate does not relieve you of your obligation for remedying defects and deficiencies and performing and completing the Works in accordance with this Contract.

Yours sincerely

[ ]
Owner's Representative

[ON OWNER'S LETTERHEAD]

[*Insert Date*]

Contractor Representative
[*Address*]
COMPLETION CERTIFICATE
Dear [ ]

Engineering, Procurement and Construction Agreement
Haryana Power Project

This Certificate relate to Contract between ----------(Owner)-and -------- (Contractor) dated ----

We refer to Clause 11.2.1----of the Contract. We advise you that on *[Insert date]* Completion was achieved.

On the Date of Completion the Facility the Contractor has completed items detailed in clause 11.2.1 and 3.3 of OTSR Technical Schedule – Schedule 02- Schedule of Tests and both Units operating together and Power Plant has achieved the following performance guarantees and emissions output levels:

1. Unit 1 &: Unit 2:

(a) Gross Electrical Unit Output = *Unit 1*---------*Unit 2*------- *[insert];*

(b) Net Unit Heat Rate (LHV) = *Unit 1*----------*Unit 2*-------- *[insert];*

(c) Auxiliary Power Consumption =*Unit1*--------*Unit 2*-------- *[insert]*;

(d) NOx emissions = Unit 1-----Unit2------ *[insert];*

(e) SOx emissions = Unit1------Unit2------ *[insert];*

(f) *CO emission = Unit 1----Unit2---- (Inert);* and

(g) particulate emission guarantee = Unit 1------Unit 2----(Insert)

2. Power Plant or Facility

(h) Nosie level guarantee= (insert)
(i) Effluent Discharge as per requirement of government of Mongolia Environmental Law.
(j) Reliability Test as defined in Clause 3.5 of Technical Schedule – Schedule 02- Schedule of Tests

By signing this Completion Certificate, the Owner acknowledges and accepts that Completion has been achieved. This Completion Certificates executed by an official duly authorised to bind the Owner.

This Completion Certificate does not relieve you of your obligation for remedying defects and deficiencies and performing and completing the Works in accordance with this Contract.

Yours sincerely
]
Owner's Representative

Form of Final Acceptance Certificate

[ON OWNER'S LETTERHEAD]

[*Insert Date*]

Contractor Representative
[*Address*]

FINAL ACCEPTANVE CERTIFICATE

Dear [ ]

Engineering, Procurement and Construction Agreement
Haryana Power Project

This Certificate relate to Contract between ----------(Owner)-and -------- (Contractor) dated ----

We refer to Clause 12.9 of the Contract. We advise you that on *[Insert Date]* Final Completion was achieved.

By signing this Final Acceptance Certificate, the Owner acknowledges and accepts that Final Completion has been achieved. This Final Acceptance Certificate is executed by an official duly authorised to bind the Owner.

This Final Acceptance Completion does not relieve you of your obligation for remedying defects and deficiencies and performing and completing the Works in accordance with this Contract.

Yours sincerely

Owner's Representative

Form of Certificate of Release

[ON CONTRACTOR LETTERHEAD]

[*Insert Date*]

Owner's Representative
[*Address*]

DEED OF RELEASE

Dear [ ]

Engineering, Procurement and Construction Agreemnet
Chandgana Power Project

This deed of release relate to Contract between ----------(Owner)-and -------- (Contractor) dated ----

1 The Contractor warrants that it has lodged with the Owner all claims that it has which arise out of or in connection with the contract between the Contracting Counterparty and the Owner in relation to the Contract and all works and services performed in connection with the Contract and, subject to the Owner making the final payments in accordance with Clause --------- and ----------of the Conditions of the Contract, that such claims have been satisfied in full by the Owner.

2 The Contractor releases the Owner from all claims, actions, suits and demands which it presently has or which might in the future arise out of or in connection with the Contract or the works and services performed in connection with the Contract other than claims, actions, suits and demands made by third parties.

3 The Contractor acknowledges that the Owner will make the Final Payments in accordance with Clause -------and------ of the General Conditions of the Contract in reliance on the warranties and releases contained in this Deed.

EXECUTED as a Deed

THE COMMON SEAL of (INSERT NAME OF CONTRACTOR) is duly affixed by authority of its directors in the presence of:)

.....	.....
Signed	Signed
.....	.....
Name of Authorised Person	Name of Authorised Person
.....	.....
Office held	Office held
.....	.....
Signature of Witness	Signature of Witness
……..	……..
insert Name of Witness (block letters)	insert Name of Witness (block letters)

COMMERCIAL SCHEDULES
SCHEDUEL 06: SCHEDULE OF FORMS OF SECURITIES
SEE DETAISL IN THE EPC AGREMENT

COMMERCIAL SCHEDULES

SCHEDUEL 07: SCHEDULE OF INSURANCE REQUIREMENT

Final details and schedule of Insurance shall be agreed between the Contractor and the Owner before placement of Contract.

PART I – INSURANCES TO BE EFFECTED BY THE OWNER

The Owner must secure, maintain and administer the following insurance coverage in the name of the Owner, Lenders, the Contractor, Subcontractors and/or suppliers in any tier.

1. Contract Works Insurance

The policy sum insured must be adequate to enable claims to be settled on a full replacement basis.

The coverage must be in respect of loss of or damage to the Works and Equipment including temporary works, during inland transit of locally sourced items to the Site and whilst on Site during construction, erection, installation, testing and commissioning until the Date of Commercial Operation for the relevant Works plus 24 months of the Defects Liability Period in respect of damage to property insured occurring during the Defects Liability Period arising as a result of a cause on Site prior to the commencement of the Defects Liability Period and/or caused by an act or omission of the Contracting Counterparty in the course of carrying out its Defect Liability Period obligations.

(a) The policy deductibles are expected to be as follows for each and every occurrence:

(i) in respect of loss or damage arising from testing and commissioning, faulty design material and workmanship and during the Defects Liability Period the first USD ----------(to be agreed) each and every occurrence,

(ii) in respect of loss or damage arising from major perils (storm, tempest, flood, tsunami, water damage, cyclone, earthquake, subsidence, collapse) the first USD ---------- (to be agreed) each and every occurrence; and

(iii) in respect of loss or damage not included in Paragraphs 1(a)(i) or 1(a)(ii) above the first USD ---------- (to be agreed) each and every occurrence.

(b) Exclusion to include, inter alia:

(i) war; radioactive contamination; unexploded ordnance; deliberate acts or omissions of the insured party claiming indemnity; corrosion and erosion; normal wear and tear; gradual deterioration; unexplained shortages revealed during routine inventory; sabotage and terrorism; additional cost of working;

(ii) repairing, rectifying or replacing the Works which are defective in material, workmanship, design, plan or specifications on London market DE4 - 1995 or LEG 2/96 wording or equivalent (i.e. physical loss or damage to the insured property as a result of a defective condition resulting from a defect in workmanship, material or design is excluded; but physical loss or damage to insured property free of a defective condition resulting from a defect in workmanship, material or design in respect of all other Works is covered);

(iii) consequential loss, loss of use, loss of earnings and/or loss of value consequent upon physical loss, destruction of or damage to the Property Insured.

(c) Extensions to include, inter alia:

(i) extended maintenance/ defects liability; Automatic cost escalation (15.0%); lost/damaged plans, documents and computer records; additional costs of complying with public/local authority requirements; automatic reinstatement of sum insured; basis of settlement; marine cargo 50/50 clause; expediting expenses cover; 72 hours clause;

(ii) waiver of subrogation against the Insured to include the Contracting Counterparty's affiliated and/or parent companies (as supplier/ manufacturer), Subcontractors, manufacturers and/or suppliers;

(iii) cover for the Contractor temporary Site offices and buildings plus their contents for an amount to be agreed, any one event;

2. Public Liability Insurance

Public liability coverage must be provided to cover the liability of the parties covered by the Contract Works policy for accidental injury or damage arising from the construction, erection, installation, testing, commissioning and making good and remedying defects of the Works. Public liability coverage will be provided with the following extensions:

1. motor contingent liability;
2. hoist, cranes and/or unregistered vehicles liability;
3. loading and unloading of vehicles;
4. sudden and accidental pollution liability;
5. property in care, custody and control;
6. food and drink liability; and
7. first aid treatment.

The limit of indemnity must be USD ----------(to be agreed) for each single occurrence and in the aggregate with an anticipated deductible of USD------- any one occurrence.

The policy must contain a cross liability clause to enable the insured parties to benefit as though a separate policy were issued to each. The policy must expire on the date falling 24 months after the Date of Commercial Operation.

3. Marine Transit Insurance

The Owner must insure all Equipment for incorporation in the Works (but not Construction Equipment) against all risks of loss or damage normally insurable including war, strikes, riots and civil commissions, from the time that such insured property leaves the premises of the Contractor or Subcontractor until arrival and unloading at the Site. The sum insured under such insurance must not be less than 110.0% of the full replacement value of the insured property shipped including freight and insurance. The limit for anyone conveyance and any one interim storage location is USD ----------.

The policy conditions are expected to include:

- Institute Classification Clause;
- specific warranties in respect of surveys for loading, storage and unloading operations;
- deductible of USD ---------- to be advised each and every loss; and

- excluding rust, oxidation or dis-coloration;
- Institute strike clause;
- Termination of transit clause (terrorism);
- Institute Cargo ‘A’;
- Concealed damage 90 days;
- Institute war clause
- Inland Transit (A) Clause;
- SRCC clause;
- Marine cargo concealed damage 50/50 clause;
- Excluding electrical and/or mechanical derangement unless caused by an insured peril;
- Airfreight replacement shipments and return shipments included;
- Loss payee clause;
- Good faith clause; and
- Waiver of subrogation, subject to duty and survey warranty clauses, to apply
- Unsuitable packing clause to not to waive insurance if packing adheres to Contractor packing/transport specification and/or normal customs;
- Payment on account.

4. General Requirements

The insurance policies to be maintained by the Owner described above will be subject to policy terms, conditions, exclusions and deductibles.
the deductibles under the policies outlined in Part I of this Schedule of Insurance Requirements must be borne by the Contractor except where a claim is made solely as a result of:

(a) the negligence of the Owner; or

(b) the act or omission of a contractor employed by the Owner to perform work on the Site.

COMMERCIAL SCHEDULES
SCHEDUEL 08: SCHEDULE OF SPARE PARTS

See list in Contractor EPC bid submitted SCHEDULE 07 supplied by SEPCO 2 for phase I and II

COMMERCIAL SCHEDULES
SCHEDUEL 09: SCHEDULE OF TAXES AND DUTY

Final Agreed list of taxes and who is responsible for payment:
Refer to Clause 1.15 of EPC agreement

VARIATION ORDER

PROJECT NAME: Chandgana Power Project

VARIATION ORDER NUMBER:

DATE OF VARIATION ORDER:

OWNER:

CONTRACTOR:

DATE OF CONTRACT: _____

In accordance with Clause 13.3.3 of the Contract, the Owner hereby gives notice of a Variation Order for the following Variation to the Works: *(attach additional documentation if necessary)*

If not submitted before and agreed the Contract please submit the following information to the Owner's Representative within 15 days of receipt of this notice:

(a) detailed particulars of the Variation;
(b) the work required or no longer required;
(c) an estimate of the increase or decrease in the Contract Price;
(d) any requisite adjustment to the Date(s) for Provisional Completion; and
(e) any proposed modifications to the Contract and/or any effect such Variation would have on the Works and/or on any other provisions of the Contract.

TECHNICAL SCHEDULES

SCHEDUEL 01: SCHEDULE OF MASTER PROGRAMME

Note: SEPCO 2 GUARANTEED DATES SUBMITTED IN ITS BID AND DETAILED IN COMMERCIAL SCHEDULE: SCHEDULE 02 WILL APPLY

1. Please supply schedule of master programme: Refer to Master programme submitted in SEPCO 2 bid document Technical Schedules; Schedule 01.

In addition to your master programme, please provide a simplified programme indicating the following milestone events: Commencement of work,

- Completion of site formation and foundation,
- First fill of concrete,
- Drum lift,
- Turbine bed plate in position
- Hydraulic testing
- Acid clean
- First ignition,
- Grid synchronization,
- Performance testing
- Commercial operation

Simplified programme to be submitted by SEPCO 2 .

TECHNICAL SCHEDULE

SCHEDULE 02 – SCHEDULE OF TESTS

1 Objectives

The Plant must be capable of operating safely, efficiently, reliably, and without undue maintenance or operator attention, in everyday operation and under all specified operating conditions.

The Performance Guarantees and Emissions Guarantees the Contractor is providing and the type of remedy to be applied in the case of failure to meet the guarantees are summarised below:-

Note: This table is provided for information purposes only. The details of both parties' obligations are set out in the Conditions of Contract.

Guarantee Parameters	Contractor's responsibility to remedy	Liquidated Damages Applicable	Owner's right to refuse to issue Certificate of Completion, Certificate of Final Completion
Gross Electrical Output Guarantee at Site Performance Conditions	Yes	Yes	No
Auxiliary Power Consumption at Site Performance Conditions	Yes	Yes	No
Net Heat Rate LHV basis, at Site Performance Conditions	Yes	Yes	No
SOx, NOx, CO, PM emission at 40% to 100% TMCR	Yes	No	Yes
Noise levels	Yes	No	Yes
Effluent discharge	Yes	No	Yes

2 General Testing Requirements

All tests must be conducted by the Contractor, and the Owner must be given the opportunity to witness these tests.

All measurements must be taken with appropriately calibrated test instruments as per the requirements of the relevant international test codes and standards. All data must be recorded using a computer system as far as practicable.

For operating and ambient conditions (including atmospheric pressure, air temperature and humidity, etc.) that vary from the Site Performance Conditions, as the case may be, corrections must be made, in accordance with the procedures specified in the test codes referred to below and correction curves given by the Contractor and agreed by the Owner.

3 Functional Tests of Various Systems

3.1 General

In preparation of the Provision Completion Tests for each Unit, various systems of the Plant must be tested to verify their functions and performances are acceptable. The functional tests of various systems must be conducted in an orderly sequence and it must include at least the following systems:

- Lube oil system
- Governor control system
- Turbovisory monitoring systems
- Safety, interlock, protection and tripping systems
- Cooling water system
- Condensate extraction and vacuum raising systems
- Closed circuit cooling water system
- Electrical (EHV/MV/LV) switchgear system
- Generator and Transformers
- Excitation and AVR control
- Fire protection and fire fighting system
- Air compressor system
- Water treatment plant
- Steam Purity and Water Chemistry
- Electrostatic Precipitator
- HP/LP bypass
- Waste Water Treatment Plant
- Coal Handling System
- Ash Handling System
- DCS availability tests;
- Diesel Generator Tests
- Correct operation of safety valves of the boiler
- Other Tests as required to be demonstrated under the Mongolian Grid Code and PPA

3.2 Test Records

During the conduct of the functional tests for various systems, a report comprising of observations and recordings of various parameters measured in respect of the tests must be prepared by the Contractor. The reports, besides recording the details of the various observations during the tests must also include the start and finish dates and must be signed by the Owner and the Contractor. The reports must have sheets

recording all the details of interruptions occurred, adjustments made and any repairs undertaken or necessary to be made subsequently. Modifications, repairs to the equipment must be carried out by the Contractor to the full satisfaction of the Owner to enable the latter to accord permission for the Performance Guarantees Testing to be carried out.

A procedure document must be prepared by the Contractor and agreed with the Owner prior to the commencement of the functional tests for various systems. This procedure document must set out the programme and scope of the functional tests based on the minimum test parameters as specified earlier in this Chapter.

3.3 Completion Tests

The Completion Tests must consist of the following Tests:

- Emissions Guarantee Tests
- Reliability Test
- Performance Guarantee Tests

3.3.1 Measuring Equipment

All test instrumentation and test equipment must be provided by the Contractor. All instruments must be calibrated by a certified body in accordance with the test codes. The calibration certificates must be submitted to the Owner prior to the Tests. The calibration certificates must be valid for a period of 6 months from the date of their calibration. Measurement uncertainties must be calculated in accordance with ASME PTC codes and standards to verify the quality of the Test.

3.3.2 Test Codes

A detailed test procedure document, including all correction curves, must be prepared by the Contractor and must be agreed with the Owner in advance of the start of the Provisional Completion Tests. The procedure must refer, where appropriate, to the latest edition of Mongolian standards, international test codes and standards, including the following:

- Performance test code on fired steam generators - ASME PTC 4
- Performance test code on steam turbine - ASME PTC 6
- Performance test code on Overall Plant Performance - ASME PTC 46
- Steam Tables - International Formulation Committee (IFC)
- Test uncertainty - ASME PTC 19.1
- NOx concentration measurement in flue gas - US EPA Method 20 and 7E
- SOx concentration measurement in flue gas - US EPA Method 6C
- Particulate matter concentration measurement in flue gas - US EPA Method 5b, 17, 201/a and 202
- Flue gas flow rate - Both US EPA Method 2 by measurement and US EPA Method 19 by calculation
- O_2 concentration measurement in flue gas - US EPA Method 20
- CO_2 concentration measurement in flue gas - US EPA Method 3A

- CO concentration measurement in flue gas - US EPA Method 10
- Noise far field - ISO 6190 or ANSI B 133.8
- Noise near field - ISO 3746 or ANSI S 12.36

The Contractor's test procedure documents must set out the scope of Tests and a programme, the Contractor's responsibilities and Owner's responsibilities, as well as details on the measurements to be made, methods of measurement, test duration, supply of staff and testing apparatus, methods of calculation, test correction curves, calibrations and reporting etc.

3.4 Emission Guarantee Tests

The measurement of flue gas emissions of the Unit when operating in accordance with the Site Performance Conditions must be measured at 40% to 100% TMCR load condition at the outlet of the stack. The measurement must be corrected to the basis of 6% excess O_2, 0^oC and 1.013kPa dry conditions and expressed as mg/Nm^3.

The measurement of noise must be taken at any load conditions for central control room, equipment inside the building, equipment outside the building and at Site boundary.

The measurements of the effluent discharge must be taken at any load condition at the agreed discharge point at Site boundary specified in the OTR.

3.5 Reliability Test

Without prejudice to the more detailed requirements as given elsewhere in the Contract, the Contractor must demonstrate that while the Unit is operating in accordance with normal operating procedures (except as necessarily modified for testing purposes) and within the limits of output specified, either continuously or intermittently as may be more convenient for the Owner and in compliance with all applicable laws and statutory approvals:

(i) The Unit (including all unitized and station common auxiliaries which are deemed by the Owner to be essential for the safe, efficient and reliable operation of the Plant) must be available for use for not less than 168 hours of generation at whatever loads the Owner deems necessary per what is nominated by grid company without any forced outage caused by the Plant itself.; a continuous 72 hours Reliability Test out of 162 hours must be at full load and auto operation.

(ii) Air emissions and noise levels of the Unit must be in compliance with guaranteed requirements; and

(iii) Effluent discharge from the Unit must be in compliance with guaranteed requirements.

If any failure or interruption occurs in the Plant or any portion of the Plant due to, or arising from, defects in design, materials or workmanship which is sufficient to prevent the agreed usage of the equipment, the Reliability Test must be repeated after the Contractor has remedied the causes of failure.

The Reliability Test procedure must be agreed between the Owner and the Contractor prior to the Provisional Completion Tests being commenced.

3.6 Performance Guarantee Tests

The Performance Guarantee Tests must be conducted to verify the following Performance Guarantees:-

Performance Guarantees at Site Performance Conditions:-

- Gross Electrical Output Guarantee at Site Performance Conditions;
- Auxiliary Power Consumption at Site Performance Conditions; and
- Net Heat Rate LHV basis at Site Performance Conditions and firing Performance Coal.

Turbine plant heat rate data must be furnished by the Contractor indicating basis and procedures. In case the Contractor anticipates the use of spray for superheater and reheater during the Performance Guarantee Tests, the corresponding effects must be taken into consideration.

The results of Performance Guarantees Tests must be corrected with correction factors taking into account effect of ambient air temperature, barometric pressure, relative humidity, power factor, and grid frequency. Corrections curves must be provided in advance and agreed with the Owner for the corrections to Site Performance Conditions.

TECHNICAL SCHEDULES

SCHEDUEL 03: SCHEDULE OF PERFORMANCE GUARANTEES

1. Site Reference and Operation Conditions: The site reference and operating conditions are given below. The performance guarantees must be achieved under following site reference and operating conditions:

   a) Site Reference Conditions:

Ambient Air Temperature:	15 Deg C
Relative Air Humidity:	60%
Ambient air pressure:	89.26kPa(a)

   b) Operating Conditions:

Grid frequency	50+/- 0.2%
Power Factor	0.85
Make up water	0
Rated condition	100% TMCR

   All feed heaters must be in service

   c) Performance Coal Specification: as detailed in Chapter 2- Design Concept and System Description item 2.2

2. Performance Guarantee
   a) Gross Electrical Unit Output Guarantee
      The gross electrical unit output guarantee must be equal to or greater than 150 MW at 100% TMCR
   b) Auxiliary Power Consumption Guarantee : Contractor shall indicate auxiliary power guarantee figure of a unit at site design conditions based on the operating conditions: Contractor guarantee 9.8 %
   c) Net Unit Heat Rate (LHV) at 100% TMCR in xxxxxx kJ/kWh : final guaranted number by Contractor is 10818kj/kwh

3. Emission Guarantees
   a) Air Emission Guarantees: Air emission guarantees must be achieved in an ambient temperature range of -40 to 30 deg C and whole operating range of the plant within limit as defined in Chapter 2- Design Concept and System Description item 2.4.1 Flue Gas Emission from Stack (Chimney) and detailed below:

SOx	<	600 mg/Nm^3
NOx	<	450 mg/Nm^3

CO	<	300 mg/Nm^3
Particulate	<	50 mg/Nm^3

Above figures are measured volumetric dry, at 273K, 1 atmosphere and 6% O_2.

b) Noise Level Guarantees:

i) Overall noise level at the Plant boundary: at a distance of 1 meter in the horizontal plane from the boundaries of EPC works and 1.2 meter above ground level must not exceed A-weighted sound pressure level of 70dB(A)

ii) 85dB(A), at 1 meter distance from any one source

iii) 90dB(A), at 1 meter distance from any multiple source

TECHNICAL SCHEDULES

SCHEDUEL 04: SCHEDULE OF OWNER SUPPLIED MATERIALS:

Owner will supply or arrange for following material/utilities to the Contractor and Contractor shall submit the quantity required. **SEPCO 2 to submit breakdown of SCHEDULE 04 submitted along with their bid in to Phase I and Phase II for insertion here**

Item	Material and Utilities	Required date or delivery point	Quantity Required
1	Construction power: Owner will arrange 1.45 MVA, 6KV power supply as detailed in Chapter 1 item 1.3.11but the Contractor is responsible for payment as per tariff of Mongolian government	At plant boundary 9,000,000kWh	 8,000,000kWh
2	Raw water for commissioning and testing of four units	16,280 m3	16,280 m3
3	Lime stone for commissioning and testing of four Units	7,500 t	7,500 t
4	Sand for first fill of boiler furnace for four units	150 t	150 t
5	Fuel oil for refractory drying of four units	600 t	600 t
6	Fuel oil for commissioning of four units	1200 t	1200 t
7	Back Energization Power for first unit	3,000,000 kWh	3,000,000 kWh
8	Coal for commissioning and testing of four units	98,250 t	98,250 t
9	Coal for heating boiler during construction of first unit	21,600 t	21,600 t

Notes: 1 Owner supplied material and utilities up to the quantity as indicated above and to be agreed will be supplied free of charge to the Contractor. The Contractor will be responsible for quantities exceeding those specified above.

TECHNICAL SCHEDULES

SCHEDUEL 05: SCHEDULE OF PERMITTED SUB-CONTRACTORS

Contractor shall submit name of only one manufacturer for following equipment:

1. Boiler
2. Turbine
3. Generator
4. Please name the suppliers/sub-contractors for the following items. Up to 3 names can be given. All three subcontractor selected shall be of same level/tier
    - Supplier for main / station / unit transformers, 220kV / MV / LV switchgear, DC and UPS, DCS,
    - Supplier for Air Cooled Condenser
    - Supplier for fan groups (ID, FD, PA, fluidizing fan)
    - Supplier for coal handling equipment, electrostatic precipitator, air preheater
    - Supplier for pumps (boiler feed pump, condensate pumps, circulating pumps)
    - Sub-contractor for engineering and design
    - Sub-contractor for civil and construction
    - Any other subcontractor you will use and the area where they will be employed

Final agreed list of subcontractors to be attached here.

TECHNICAL SCHEDULES

SCHEDUEL 06: SCHEDULE OF WORKS INSPECTION (Inspection and Testing plan)

Contractor shall submit schedule of Inspection and Testing Plan (ITP) as detailed in Chapter 10-Proejct Management item 10.7 if it is available. If not available this can be submitted after placement of Contract. Owner have the right to amend this ITP as detailed in the OTSR and Contractor must follow Owner‘s amendments.

TECHNICAL SCHEDULES

SCHEDUEL 07: SCHEDULE OF GOVERNMENT APPROVALS:

Contractor is responsible for obtaining all relevant approvals as required by Mongolian Laws, regulations and Standard as mentioned in Chapter 12 and for scope of EPC to be undertaken by him and detailed in OTSR. Contractor shall submit a list of government approvals that he wishes the Owner to obtain on his behalf.

#	Law	Documents	Permit or document. (Article of the Law)
1	Law of Mongolia on administration and territorial unit	General plan of power plant and workers town. 1.Introduce General Plan of Power Plant site including its workers town to Aimag and Soum Khural to include Aimag and soum land use long term program. (18.1.2 з/), (29.1.4 д/)(30.1.3)(31.1.3)	Land use certificate for Power Plant construction site ,workers town . (31.1.3)
2	Law on licensing	During Power plant technical project (drawings) development and implementation.	License for: 1.Export import and utilization, destruction of toxic chemicals. (15.6.3) 1.Installation and maintenance boiler, vessels under pressure and pipelines.(15.8.5) 2.Installation and maintenance electric elevator , crane.(15.14.3) 3. Development of construction drawings , construction, production building materials, production of elevators and its spare parts and their construction, maintenance. (15.14.6) 4. construction of auto road and road facilities.(15.15.4)

3	Energy law.	During Power plant project development and implementation.	1. License for production electric energy.(13) 2. License for transmission of electricity .(14) 3.License for electricity distribution (16) 4. License for the supplying energy with regulation .(17) 5. License for the supplying without regulation.(18) 6.License to import or export electric energy. (19) 7. License for construction energy facility.(20)
4	Land law	General plan of power plant and workers town.	Land use Certificate for: 1.Power plant site 2.Workers town. (20.1.2) (21.4.3)(23.4.2)
5	Land fees law		Land subject to fee charge: 1. Power plant (4. Article), (6.4), (9.1),(9.2)(10.1) 2. Workers camp (4. Article) 3. Transmission line (6.4) 4. Mine site (7.4)
6	Water law (amended)		Power plant : Water reserve integrated management 4.4, 4.5, 4.6, 4.9, 5.3, 5.4, 5.5, 21.2, 24.2, 24.4, 25.1, 26.2.1, 28, 29, 30, 31 Workers camp: 26.2.1 27,
7	Law on Natural resource use fee		10.1.3, 20.1.3, 23.2
8	Law on cadastral mapping and land cadaster		

9	Air law	During construction of Power Plant.	1.Permit to use air pollution source from Soum Governor (18.1)
10	Town building law	Workers town construction technical project.	1. Permit for development of town building document. (7.1.4) 2. State expertise of town building documents.(7.1.3) 3. Approval general plan of town or village(8.1.1, 8.1.2) 4. Land use permit for town or village. (9.1.1)
11	Environment protection law		Environmental Assessment , research, database, audit (Article 7.1)(9.3, 9.4) Environmental monitoring (10.1, 10.10, 10.2) Protection from environmental pollution (article 21) Rehabilitation of natural reserve (25.1) Duties of Business Entities and Organizations in Protecting the Environment and Natural Resources (article 31) Compensation for damage caused to the environment (49.1) Fees and payments for use of natural resources (54.1, 54.2)
12	Environment impact assessment law		Impact assessment (7 article) Detailed impact assessment (8 article)

			Environmental management plan (9) Review(article 11) Rights of a project implementer (13) Duties of a project implementer
13	Law on fauna		5.4.9
14	Law on protection of flora		Duties of Rights of citizen and, entity (13.3.1)
15	Law on natural plants		Protection on flora, rehabilitation (7.1)
16	Law on biosafety		This law annihilated
17	Law on cultural heritage protection		Protection and preservation of items of historical and cultural value 17.10, 17.11, 17.12
18	Sanitation law		Conclusion from sanitation Authority and other inspection Agency during definition town construction area , development drawings (technical project)and commencing its activity (4)
19	Law on protection from toxic chemicals		
20	Household and industrial waste utilization law	During development general plan of Power plant and workers town(Camp)	Permit for house hold and industrial waste storage area location (9.4.4)
21	Building construction law	1. General Plan of Power plant and workers town.	1.License for development of construction drawings (technical project), construction, production building materials, production of elevators and its spare parts and their construction, maintenance. (6.1.6)
		2. Land use permits. 3.Engineering geological survey	2. Conclusion of experts of Drawings (technical project) of Power plant and town buildings

		4. Drawings of Power Plant and workers town.	(6.2.9)(13.2) (13.3) 3. Permit to commence construction activity. (6.2.7) 4.Permit for exploitation. (6.2.7) (7.2.2) (7.2.4) (6.2.9) (6.2.7) (10.1.1) (13.2) (13.3)(13.5) (14.1)(14.2)
22	Auto road law	1. Feasibility study of road 2. Engineering geology survey 3. Drawings (technical project)of road 4. Budget	1.License for road construction 2.Approval of road feasibility study, exploration, technical project its budget. 14.2.2
23	Railway transportation law		
24	Subsoil law	Before construction of power plant.	1. Permit for exploitation common minerals from Soum . Article 18
25	Minerals law		2. Land possession permit from soum for common minerals. 7.5
26	Law on controlling on explosive substance and blasting equipment circulation		
27	General taxation Law (other supplementary Laws)		
28	Customs tariff law		
29	Law on exception from custom tax certain materials, equipment machinery		

30	Radio wave law	
31	Labour law	
32	Law on sending labor force abroad and receiving labor force.	Permission prior to receiving labor force and specialists from abroad.(8.1)
33	Law on legal status foreign citizens	
34	State inspection law	
35	Foreign investment law.	
36	Fire safety law	Permit for Power plant drawings and workers town.(16.1.4)