If required by the medium to be analyzed, all samples shall be adequately cooled and pressure reducing devices shall be provided where necessary. Manual sampling shall be possible.

A protective device shall be incorporated in the sample cooler to isolate the analyzer in the event of excessive temperature. .

In order to eliminate the influence of conditioning agents on the conductivity measurement, cation filters shall be provided. The cation filters shall have visible colour indicators to show when they have to be regenerated.

For all analyzers temperature compensation shall be provided, with the temperature sensor being an integral part of the probe.

Chlorine residual monitors and hypochlorite concentration meters shall preferably be able to measure high and low concentrations. Measurement of hypochlorite concentration shall not be affected by the presence of other oxidizing components in the sample.

Individual or multiple prefabricated analyzer installations shall be used to reduce site installation work. This prefabrication shall include sample conditioners, analyzers, air and electrical distribution, cooling water distribution or coolant circulating system all piped and wired on a common frame. Interconnecting pipework and accessories shall be of stainless steel. The arrangement shall permit testing of the entire assembly before dispatch to site and shall be arranged for convenient removal from on-line operation to facilitate routine maintenance and calibration.

The sampling system shall include but not be limited to all probes, valves, filters, coolers, drainage facilities, flow regulators, flow meters, piping and pumps as necessary, to give the analyzer a representative and suitably conditioned sample.

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Analyzers shall be provided as follows:

Sample Point	Analyzing Required
Condenser make up water	specific Conductivity
Condensate pump discharge water	pH, cation Conductivity, DO
Condensate at deaerator inlet water	pH, specific Conductivity
Deaerator effluent water	pH, DO
Economizer inlet water	pH, cation Conductivity, DO
Boiler blow down steam	pH, specific Conductivity
Saturated steam	cation Conductivity, SiO2, Na
Main steam	cation Conductivity
HP5 heater drain water	pH, specific Conductivity
Closed cooling water	pH, specific Conductivity

Note:

DO: Dissolved Oxygen

Chemical reagent for the sampling system commissioning period but not exceeding 180 days shall be provided.

Each automatic analysis sampling point shall be provided with a manual sampling point to permit a sample to be easily taken. Manual sampling shall not interrupt automatic sampling. All sampling lines shall be run to common sampling racks on which shall be fitted all the analysis associated equipment.

The sampled points of analyzers shall be indicated and monitored at the local panel.

The corresponding analogue measuring signals (4-20 mA) and the status signals (24V DC) shall be transmitted over serial link to the DCS.

The SWAS system, for both Units should be located at ±0.0 meters in an air conditioned room.

B0.6.19.13.2 Effluent Monitoring

The operational philosophy of water supply/ distribution system shall be based on a continuous Possur river water quality analysis, potable water quality monitoring, sampling and analyzing concept and shall consider preventive and active measures against water pollution and adaption of operating mode(s) to changes in water conditions.

Sample Extraction for Laboratory Analyses:
A tapping shaft for extraction of samples for laboratory test shall be provided and installed at the various measuring locations, before the waste waters are mixed with the circulating cooling water and discharged to the sea.

Continuous Effluent Monitoring:
A continuous monitoring shall also be implemented for water quality measurements of all kinds of discharges to the river.

The sensors for continuous monitoring of effluent parameters shall be located within the sample-tapping shaft. Additionally flow and temperature sensors shall be mounted within the discharge lines.

Following kind of analyzers shall be considered at least:

- pH analyzer
- conductivity analyzer
- chemical oxygen demand (COD) analyzer
- biological oxygen demand (BOD) analyzer

- total suspended solid (TSS) analyzer
- oil in water (OIW) analyzer

Continuous quality monitoring system shall be installed at the CES. The corresponding electronic equipment shall be mounted in a weatherproof container to be located nearby the point of measurement at the discharge pipes of waste water.

The corresponding analogue measuring signals (4-20 mA) and the status signals (24V DC) shall be transmitted by multicore cables to the DCS.

B0.6.19.13.3 Potable water quality monitoring system

Water quality control and monitoring of the Plant's drinking water shall be performed at the Plant interface (downstream the potable water tanks).

The water quality monitoring system shall at least consist of, but not be limited to the following online metering, measurement, sampling and analyzing equipment, including data acquisition and data storage facilities:

- alkalinity
- conductivity metering
- pH monitoring
- temperature measurement
- turbidity monitoring
- residual chlorine monitoring
- TDS (computed value)
- LSI (computed value)
- sampling points and equipment for potable water sampling at the online measuring units.

B0.6.19.13.4 Quality monitoring for fuel

For fuel oil a sampling point for discontinuous manual analysis shall be provided for the facility at the fuel oil storage tanks.

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B0.6.19.13.5 Analysis of exhaust gas (CEMS)

The analysis of O_2, CO, CO_2, NO_X, SO_2, particulate matter (opacity) in the exhaust gas shall be performed by appropriate analyzers of proven type.

The equipment shall be constructed for operation in dusty and humid environments at high ambient and exhaust gas temperatures. The use of equipment capable of multi-parameter measurement shall be considered.

The reliability and response time of the O_2-analyzer shall be of the quality required for closed-loop control. The accuracy of the system shall be better

than 2.0% of the span and the drift shall be not more than 0.1% O_2 per week. A zirconium oxide measuring cell shall be used. Maintenance shall not be more than once a week.

Analyzers provided shall have auto-calibration for zero and span as well as self-diagnostic functions. Analyzers and sensors can be of extraction or insitu type.

All equipment of the continuous emission monitoring system (CEMS) shall be suitable for operation in dusty and humid environments at high ambient and flue gas temperatures. Continuous Emission Monitoring System (CEMS) shall be provided for each unit.

If sampling of exhaust gas is used, sampling probes shall preferably be vertically installed on the top of horizontal exhaust gas ducts, in order to avoid blockages.

In order to keep the sampling lays to acceptable limits the analyzers shall be located close to their sample take-off point, so that easy access to the sample take-off point and to the analyzers shall be provided for maintenance.

The exhaust gas sampling lines shall be heated to prevent condensation and shall not form a siphon in the case where condensate may be collected during heater failure. Condensate drainage facilities shall be provided at the analyzers.

Generally, the analyzers and the sampling probe equipment shall be suitable for mounting in ambient plant conditions, e.g. within a standard cubicle. However, if this is not feasible, the equipment shall be mounted in an air-conditioned room or container.

Power failure and system failures of analyzers shall be monitored in the DCS by a group alarm.

Measured values and certain status signals shall be processed by an emission evaluation computer via serial interface, to be installed within the central control room. The emission data shall be calculated, converted, printed out and stored according to the governmental requirements. Possibilities for on-line data readout for authorities shall be provided.

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B0.6.19.13.6 Ambient air quality monitoring system (AAQMS)

An ambient air quality monitoring system shall be provided consisting AAQMS stations and metrological stations. A centralized data acquisition PC shall be installed to collect all information from the AAQMS. The AAQMS stations shall be suitably distributed on the Plant area.

The AAQMS stations shall contain at least the following:

- Analyzers for SO_x, NO_x, CO, O_3, mercury
- Multi gas calibration system
- PC based data logger
- UPS
- Suspended particulate monitors (TSP)
- Sampling inlet heads

Metrological station shall include at least:

- Metrological sensors such as wind speed, wind direction, air temperature, relative humidity (rH), solar radiation, rain gauge
- Metrological mast

All ambient gas analyzers and dust monitors shall conform to the US EPA reference of equivalent method. A proof of approvals and certificates of the compliance of internationally reputed agencies such as US EPA, German TUV, etc shall be provided.

A sampling system compatible with the analyzers shall be provided. The system shall be compatible with analyzers for Pb (which the Employer may procure in the future). The system shall have the facility for moisture removal.

Built-in calibration facilities shall be provided for all analyzers. To cross check the built-in calibration facilities of the analyzers/ monitors, a standard multi-gas calibration system for each AAQMS station with fast response time shall be provided.

The metrological sensors for wind speed and wind direction shall have an accuracy of 2% of full scale. The accuracy of the relative humidity sensor shall be 3% for the range between 10 and 90% rH.

The rain gauge shall be of self recording type and of reputed make. Electronic recording facilities shall be provided. The instrument shall have automatic functions for computing rainfall for pre-set time periods. The gauge shall be rugged and be of material resistant to atmospheric corrosion. The accuracy shall be 1% for rainfall ranges above 125 mm/hr and 5% below this value.

A metrological mast shall be provided for mounting of the metrological sensors. It shall be complete with all necessary hangers and holders along with electrical earthing for the installation of the sensors. Material and construction of the mast shall be robust and shall be resistant to atmospheric corrosion.

There shall be PC based data loggers for each AAQMS station. The entire data capture and mean value calculation as well as control of analyzers shall be through user friendly software and operate on the latest Windows operating system. Diagnostic features shall be included in the software and

any unauthorized access shall be prevented by appropriate measures such as password protection.

Data loggers for the metrological station shall be provided with the necessary analogue and digital inputs and internal memory for all collected parameters. The data loggers shall have the capacity for future extension with additional sensors.
Location for centralized data collection PC stations shall be decided during basic/detailed design stage

B0.6.19.14 .Electrical value measurements

For the processing of electrical values such as voltage, current, power, frequency etc. electronic type transmitters shall be provided to convert the output of current and voltage transformers into an impressed direct current in the range 4 - 20 mA. The transmitters shall be housed in the switchgear.

For power measurements precision electricity meters for asymmetrical three-phase networks are to be supplied. Connection of the meters shall generally be to 3 x 1 A current transformers and 3 x 110/√3 V voltage transformers. The meter accuracy class is to be approximate to the respective transformer classes. Instrument transformers with an accuracy class of 0.5 or better shall be used for metering purposes.

For the purpose of billing for electrical energy and for acceptance tests, an instrument transformer of at least class 0.2 (precision) accuracy and high precision electricity meters of class 0.2 have to be provided. Meters for billing purposes shall be of the approved calibrated type (certified by independent testing stations). All meters for billing purposes are to be provided as double 2 x 100% meters.

At all points where power direction reversal is possible, the necessary meters for both directions are to be provided.

The meters in the local switchgear are to be arranged behind the clear plastic fronts of the cubicle doors so that the counter readings can be taken without opening the doors.

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B0.6.19.15 Control valves

Control valve spindles and internals shall be made of chromium steel and shall have a high resistance to wear and corrosion. Cones and seats shall be hard faced with materials with a high resistance to wear and corrosion. Housings shall be made of forged or cast steel. A hand wheel, with provision for switching to manual operation and a local position indicator shall also be provided.

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All control valves, orifices and nozzles shall comply with the relevant international standards such as DIN, BS or any other which may be agreed to by the Employer/Engineer.

Control valve characteristic shall allow smooth and continuous control of the control parameter.

Valves shall not generate noise in excess of 85 dB(A), measured at a point 1 meter downstream of the valve outlet and 1 meter from the pipe centerline. Where this requirement must be exceeded because of physical limitation, suitable sound attenuators shall be provided in terms of special valve trim, in-line attenuators, isolators and enclosures to satisfy the noise requirement.

Valves shall have trim designed to avoid cavitation damage. If an application cannot avoid cavitation entirely, material selection shall be such as to withstand the effects without damage.

Line strainers shall be provided upstream of control valves where required.

The valve sizing shall be suitable for obtaining maximum flow conditions with valve opening at approximately 80% of total valve stem travel and minimum flow conditions with valve stem travel not less than 10% of total valve stem travel. All the valves shall be capable of handling at least 120% of the required maximum flow. The design pressure drop across the valve should be 15 to 20% of the total available pressure drop at no flow.

Although control valves shall not be used for shut-off service, to provide reasonable shut-off performance, leakage through a closed control valve shall not exceed 1% for single ported valves or 2% for balanced ported valves.

All control valve materials shall be compatible with the fluid handled. Materials shall be in accordance with the piping materials standard and/or as approved by the Employer/ Engineer.

Valve characteristics shall be selected to suit the process and control system dynamics.

All the control valves for boiler feedwater services should be of anti-cavitation type with flash-flow trims and cage type to avoid cavitation problems.

The installation shall include upstream and downstream isolating valves and, for critical control valves, a bypass valve for each control valve on all services. Unless otherwise agreed by the Employer/Engineer the bypass valve shall have a similar characteristic as the control valve but shall provide tight shut-off. Any exceptions or variations to the requirement shall be subject to the approval of the Employer/ Engineer. Where a service is subject to a pressure above 3 bar a 25 mm vent valve shall be provided, between the upstream and downstream isolating valves, in order to relieve the pressure to enable maintenance to be carried out on the control valve.

Control valves shall be adequately supported in all cases and shall be accessible for maintenance. Local pressure gauges shall be provided upstream and downstream of each control valve.

If as per steam turbine OEM's proven design, isolating valves or bypass valves are not envisaged for control valves of internal piping, same is also acceptable.

For normal duty globe type valves shall be used.

The use of butterfly valves shall be avoided in the main plant. Where very large sizes are involved (on high flows), or low pressure drops and low static pressure are a determining factor, making globe valves unattractive or impossible, butterfly valves may be used, They shall be of the "balanced torque" type disc usable to the fully open position (90° opening).
The overall shaft rating shall be at least 25 % above the static pressure as differential across the closed valve.

Multi-stage valves (e.g. multi seat or multi cage valves) shall be used on services, e.g. steam and gas, having very high pressure drops which would result in supersonic velocity inside a conventional body and shock waves in the piping, creating unacceptable noise levels.

Angle valves shall be provided.

- for steam pressure reducing de-superheating stations of the "combination" type,
- for erosive services, e.g. slurries,
- on applications where solid contaminants might settle in the valve body,
- on hydrocarbon services with a tendency for "coking".

Ball valves shall be used for on-off and throttling services under moderate operating conditions.

The control valves must be provided with all data important for their identification, such as flow direction, type, nominal diameter, nominal pressure, seating, CV value.

B0.6.19.16 Actuators

Intelligent drives with integrated power switch unit and further electronics shall be installed. Actuators equipped with integral controls shall be supplied which can be operated via the operation elements on the local controls as soon as power is connected. Only operation commands and feedback signals shall be exchanged between the control system and the actuator. Motor switching shall be performed within the device and virtually without delay.

Unless otherwise specified actuators for modulating valves and dampers shall either be pneumatic or electrically operated. Self contained sealed hydraulic units may be considered where high thrusts or high speeds of operation are required.

Actuators for ON/OFF duty or manually positioned units shall generally be electrical motor and/or pneumatic driven, however the use of solenoid types on small valves shall be allowed dependent on duty.

The various types and sizes of actuators shall be rationalized and as far as possible each type shall be from a common manufacturer to facilitate interchangeability and spares.

In order to prevent the risk of fire or explosion pneumatic actuators shall be used in hazardous areas and associated equipment (e.g. positioners) must be intrinsically safe in accordance with IEC 60079-11.

Pneumatic actuators must be designed in such a way that in the event of air failure the actuator will remain in the position immediately prior to loss of power, or assume a position which is safe for the process.

With either action the failure mode shall be suitably monitored and the Plant operator informed by some form of alarm. The failure response of all actuators in the event of the loss of the prime mover (air pressure, oil pressure, electrical power) shall be indicated on the Piping and Instrumentation (P&I) diagrams, valve schedules, etc.

All pneumatic tubing to control drives or actuators shall, unless otherwise agreed to by the Employer/Engineer, be in copper which shall be sheathed in PVC or alternatively in stainless steel.

For all actuators of control valves and dampers of main systems local indicating pointer and position transmitters for remote indication and closed loop feedback shall be provided in accordance with the most severe operating conditions to be expected. The transmitters shall be designed to withstand conditions such as high temperature, vibrations and leakage of steam and of hot water wherever required. The protection class shall be IP 65 according to IEC 60529.

All actuators shall have a handwheel for direct manual operation. The diameter of the handwheel and geared effort shall be such that they can be reasonably operated by one man. A lockable mechanical clutch mechanism shall be provided to inhibit power control of the actuators when the handwheel is operated.

The speed of response of actuators used for modulating control shall be chosen to suit each particular application. Facilities shall be provided for limiting the actuator movement in each direction.

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Special attention must be paid to adequately dimensioned drives and care must be taken to avoid any unintended displacement of the actuator on sudden rises of pressure in the piping.

Actuators shall have fail safe operation and actuator locking device in the event of abnormal conditions. Any abnormality on the valve shall be transmitted to the DCS.

All electrical actuator drives necessary for the safe operation and shut-down of the Plant in the event of 0.4 kV switchgear failure shall be connected to the UPS.

B0.6.19.17 Solenoid valves

In lines with nominal diameters of up to DN 25, as well as for piloting pneumatic actuators, suitable solenoid valves shall be used. Valves with power ratings up to 30 W shall be controlled directly at 24 V DC from the DCS. For powers over 30 W, solenoid valves for 230 V AC shall be employed. Solenoid valves for 110 V, 230 V AC and above shall be secured with blade fuses. Electrical connections are made by means of plug connectors, with the mating connector forming part of the scope of supplies.

B0.6.19.18 Cabling and wiring

The general requirements for cabling are as stated under relevant chapter in **Section B0**.

In particular, wiring within desks and panels shall be supported on trays and shall be segregated according to voltage level. Wiring carrying AC and D.C. voltage shall also be segregated.

All desks, panels, cubicles and racks shall be factory-wired with regard to the internal connections. Where desks or panels will be supplied in more than one Section, electrical connections between the Sections shall be via terminal strips provided for this purpose.

All cables must be provided at both ends, at every 20 m and every bend with identification with identification in the form of numbered labels corresponding to the coding system. The individual cores will be numbered or identified by colour-coding.
Instrumentation cables will be identified by colour codes and band marking, follow VDE 0815. The cables must be laid to ensure that they can be replaced or renewed in a simple manner.
Spare cores shall be terminated at terminal strips in such a way as to give a maximum length of core and shall be ferruled in such a way as to indicate that they are spare cores.

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All instrumentation cables including both prefabricated and non-prefabricated type shall be with Fire Retardant Low Smoke (FRLS) type Poly Vinyl Chloride (PVC) overall sheath. For cables that are exposed to ambient temperatures above 60°C, teflon or silicone cables are to be provided. For safety related equipment fire surval cables shall be provided. The cables must be suitable for laying indoors, in the open (direct or indirect sunlight), in ducts, on trays, in the ground and in water. The cables must be resistant to solar radiation, the effect of oil, seawater, bacterial action, insects and rodents. Shields for individual pair and overall shield shall be provided for cables for analogue signals. Cables for binary signals shall have an overall shield. Multipair cables of 0.5 sq. mm, shall be used extensively for I&C cables, wherever required, prefabricated cables may also be used.

For thermocouple measurements compensation cable NiC r-Ni 2x0.5sq. mm or 4x0.5 sq. mm with silicone insulation and pair screen will be used. Fiber optic cables shall be provided for Remote I/O bus, CCTV, Station LAN etc.

The fiber and cable specifications shall comply with ITU-T Recommendation G652 and the relevant IEC standards. Each fiber cable shall be supplied with at least 50% spare cores. A minimum number of four spare cores are required.

Suitable fiber optic cable junction boxes, patch panels and patch leads shall be provided. These shall conform to the following:

- They shall support, organize, and protect the optical fibers and the fiber splices whilst ensuring that the optical fiber minimum-bending radius is not exceeded.
- The splice tray shall not have any sharp edges or protrusions that may damage the optical fiber cable.
- They shall provide entry for all cables.
- Include number tags for tube and fiber identification.
- They shall provide mounting positions for the bulkhead mounted connectors on which the cable will be terminated.
- They shall allow patching of fibers.
- Outdoor mounted boxes shall be rated to IP65 in accordance with IEC 60529.

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The junction boxes/ patch panels shall have a fiber capacity equal to the total number of fibers (connected and spares) for all cables to be connected. Patch panels shall be designed for 19-inch rack mounting within a standard equipment cabinet.

All unused couplings shall have protective dust covers. The patch area in patch panels shall be accessible and covered behind a door or removable cover.

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Sufficient factory manufactured patch cords with suitable colour coding shall be provided.

Fiber optic connectors shall be standardized for ease of maintenance.

B0.6.19.19 Instrument and measuring impulse piping

Instrument impulse piping shall be supported at intervals as defined in BS 6739. The correct size of tube clips shall be used to suit the tube outside diameter.

The Contractor shall fabricate and erect all mounting brackets for control and monitoring apparatus including all pressure switches and miscellaneous instrumentation. If it is found after commissioning that any mounting frame vibrates excessively under operating conditions, instruments within the frames shall be isolated with vibration dampers by the Contractor or moved to areas of low vibration.

Impulse lines shall have venting, draining and blowdown facilities. Impulse lines between process and sensor shall be as direct as possible and shall include allowance for vibration and vertical and horizontal movement. Joints in impulse lines shall be kept to a minimum.

All pneumatic instrument lines shall be soap tested and any leakage shall be rectified.

While process instrument lines are being pressure tested all instruments shall be completely isolated or disconnected.

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B0.7 Inspection and Testing

B0.7.1 General

This Section contains general requirements for inspection of material, parts, equipment and workmanship of the Plant during manufacture, assembling and erection and upon completion to demonstrate compliance with specification, codes and standards and to ensure overall reliability of Plant operation and performance.

Development and implementation of test procedures for the construction inspection, start-up and performance testing and capacity demonstration of the Plant shall be the responsibility of the Contractor.

The Contractor shall be responsible for providing all supplies required for carrying out such tests, except to the high speed diesel and coal used during Reliability Test Run and Performance Tests.

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The overall testing program for the Project shall consist of the following:

- workshop inspections and testing
- construction inspections, and testing
- mechanical completion
- pre-commissioning tests
- tests on completion
- reliability test run and performance tests.

The Employer shall have the right to have their representatives present during inspections and tests of Plant equipment and systems in the workshops and during construction. The presence of the Employer's representatives during any inspection or test shall in no way relieve the Contractor of its responsibility for supplying the equipment or systems in accordance with the milestone dates.

The Employer will be notified by the Contractor in writing at least ten (10) days prior to such testing and inspection at workshop and two (2) days for test at site.

Three (3) months after effective date of Contract, the Contractor shall submit to the Employer all relevant test documents, which shall include:

- inspection and test program
- test standards
- type of inspection and tests
- tests which are to be witnessed by third parties.

Six (6) months prior to the proposed start of commissioning the Contractor shall submit to the Employer:

- commissioning test program
- commissioning procedures
- tests on completion.

Six (6) months after effective date of Contract the Contractor shall submit to the Employer for the Performance Tests:

- test program
- test standards
- manpower and deployment schedule of the Contractor for performing the tests forms of test records and report
- description of instrumentation to be used, including accuracy, and calibration test results
- method of data recording
- method and equations/correction curves used for adjustment of recorded data to the design conditions.

The results of all tests shall be certified by the manufacturer, Contractor or independent agency as appropriate.

Document files containing material certificates, welding procedures, test report etc. shall be compiled for each item of plant and shall be suitably identified (including equipment classification reference) and bound.

B0.7.2 Testing during manufacturing

B0.7.2.1 Material tests

Major steel forgings
Purchase specifications shall clearly state the quality and inspection requirements and should include:

a. Chemical composition range
b. Heat treatment
c. Mechanical test specimen locations
d. Mechanical properties
e. Magnetic properties (when applicable)
f. Non-destructive testing
   - methods and procedures
   - stage and extent of application
   - recordable indication size
   - allowable indication size
g. Thermal stability test (HP and reheat turbine shafts only).

Each forging shall be suitably marked with an identification number which shall transfer throughout all machining stages. The identification number shall be indicated on all documents relating to the forging.

Repair welding will not be permitted on rotating parts and on other components the proposal will be subject to approval by the Employer's Representative.

Rotor forgings
The profile of forgings at the stage of final ultrasonic inspection should be such as to minimize the regions where complete coverage is not possible. Ultrasonic indications should be measured by the equivalent flat bottomed hole or AVG (DGS) method.

The toughness of rim and core (where applicable) material shall be evaluated by testing Charpy V impact specimens over a range of temperatures and thus determining the 50% fibrosity fracture appearance temperature (FATT).

Allowable indication size and material toughness are interdependent design related criteria and the Contractor must be prepared, if requested by the Employer's Representative, to justify his proposals by reference to fracture mechanics calculations.

Bores, when provided, shall be magnetic particle inspected and a suitable intrascope used for examination.

Residual stress measurement shall be provided for rotor forgings.

Major steel castings
Purchase specifications shall clearly state the quality and inspection requirements and should include:

a. Chemical composition range
b. Heat treatment
c. Mechanical test specimen locations
d. Mechanical properties
e. Non-destructive testing
   - methods and procedures
   - stage and extent of application
   - recordable indication size
   - allowable indication size
f. Other tests
g. Standard weld repair-procedure

Each casting shall be identified by hand stamped or cast-on reference numbers which shall be indicated on all documents relating to the casti

Non-destructive testing
Minimum requirements are as follows:

a. Crack detection of critical areas of castings which in the case of castings to operate at high temperature or high pressure shall consist of 100% of all accessible areas. Magnetic particle inspection shall be used for ferritic steel castings.
b. Ultrasonic inspection of all surfaces of castings to operate at high temperature or high pressure.
c. Ultrasonic thickness check of critical areas.
d. Radiographic examination adjacent to future butt weld regions (Acceptance Standard Level 1 of ASTM E446 or E186 as appropriate).
e. Radiographic examination shall also be used to assist in defining defects indicated by ultrasonic inspection.
f. Blue matching on the parting plane between upper half and lower of the turbine casing
g. Creep test shall apply for high chrome casting and forging, in particular when used for more than 540°C.

In addition to being applied as necessary quality control on as cast items, inspections outlined in a) and b) above shall be applied to the finally heat treated casting.

Prior to non-destructive testing all surfaces shall be satisfactorily prepared and visually examined.

Either colour matching of casting by putting two halves together or feeler gauge thickness check from outside to ensure required contact area and joint tightness are acceptable

Repair Welding

Unacceptable defects observed by visual examination or indicated by non-destructive testing shall be excavated by chipping or thermal gauging and grinding and their complete removal proved by crack detection.

In the case of excavations which penetrate more than 25 mm or 50% of the wall thickness or cover more than 10,000 mm^2 area the Employer's Representative written approval of the proposed repair must be obtained.

Only welders qualified by performance tests on similar cast materials shall be used.

On completion of repair welded areas shall be ground smooth and carefully blended into the surrounding material. The repaired areas shall be surface crack detected; magnetic particle inspection being used for ferritic steel castings and in addition ultrasonic inspection shall be used on castings to operate at high temperature or high pressure.

After repair weldings hardness shall be checked.

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Steel Plates and Sections

The following requirements, which may be supplementary to the applicable material standards, shall be considered when selecting material grades:

- impact testing of plate or Sections over 50 mm thick (impact requirements to be dependent on application).
- ultrasonic testing of plate where the presence of non-metallics may interfere with the interpretation of ultrasonic testing of future welds;
- ultrasonic testing and through thickness ductility measurement, where the application involves the risk of lamellar tearing in the material at regions of high restraint (e. g. at set-on nozzle locations or cruciform joints);
- ultrasonic testing clad materials to detect lack of bonding. (Proposed rectification procedures shall be submitted for the approval of the Employer's Representative).

Reinforced Thermosetting Resin Pipes

Checks shall be made on all raw materials to ensure that they comply with the relevant ASTM Standard.

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All deliveries of resin shall be checked for consistency by viscosity and reactivity. Any resins deviating from the manufacturer's published figures shall not be used.

Testing of reinforced thermosetting resin pipes:

- Long term hoop strength (type test for pressure pipes only)
- In accordance with ASTM D2992 Procedure B with the exception that the test results shall be extrapolated to determine the stress which the pipe can withstand for a period of 60 years without failure. The lower 95 % confidence limit at 60 years shall also be calculated.
- Hydraulic test
- 100 % of the pipes shall be subjected to an internal hydraulic pressure test at the manufacturer's works prior to delivery. The test shall be applied to a pressure equal to 1.5 times the maximum working pressure stated for each classification of pipe. The test pressure shall be applied for a minimum period of 5 minutes without signs of leakage.
  In addition to the above the first pipe and every thirtieth thereafter of each class and diameter shall be maintained at test pressure for a minimum of 4 hours without signs of leakage.
- Each pipe and fitting shall be subjected to an internal low pressure air test at the manufacturer's works prior to delivery. The test pressure shall be an overpressure of 0.1 bar and this shall be applied for a minimum period of 5 minutes without signs of leakage or distress. Fittings which are of mitred construction shall be manufactured from pipes which have successfully passed the tests defined above.
- Dimensions
  The dimensions and tolerances of all pipes shall be determined in accordance with the relevant standards (e.g. DIN 16965, DIN 16964, DIN16867, DIN 16868, DIN EN 14364)
- Stiffness
  A minimum of one pipe for every 30 pipes manufactured shall be tested for stiffness in accordance with AD 2000 HP110R and N1. A minimum of one pipe of each class and diameter of pipe shall be tested.
- Longitudinal and hoop tensile strength
- The tensile strength properties of a minimum of one pipe for every 100 pipes manufactured shall be measured in accordance with AD 2000 HP110R and N1. A minimum of one pipe of each class and diameter of pipe shall be tested.
- Cure
  Curing, to be tested by the Barcol Hardness test determined in accordance with DIN EN 59: 100% of the produced pieces. Minimum acceptable hardness is 90% of the value recommended by the resin manufacturer of the particular resin used, when non-reinforced.
  The sample pipe shall also withstand a commercial acetone test on the internal portion of the laminate.

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- Loss on ignition
  A minimum of one pipe for every 30 pipes manufactured shall be tested in accordance with ASTM-D 2584 "Standard Method of Test for Ignition Loss of Cured Reinforced Resins".
- Joint tests
- A minimum of two pipes in every 100 pipes manufactured shall be jointed and tested in accordance with the requirements of **Section 7.2 of ASTM-D 3262.**
- Visual inspection
- Each pipe and fitting shall be subjected to a complete visual inspection before shipment in accordance with ASTM-D 2563.
- Vacuum test
- Vacuum test for those piping Sections being operated under vacuum shall be carried out for each diameter once at beginning of production. The vacuum to be applied shall be equivalent to the condition which occurs during full vacuum. The corresponding derated vacuum for this test shall be proved by the pipe manufacturer.
- Failure of tests on completed pipes
- In the event of a specimen not fulfilling the minimum requirements for strain corrosion resistance, all pipes of that class and diameter which have been manufactured shall be rejected and shall be replaced entirely.

Any pipe or fitting which fails any of the quality control tests which are to be carried out on each and every pipe or fitting shall be rejected. In the event of any pipe failing any of the remaining tests outlined above that pipe shall be rejected and the relevant test shall be carried out on a further ten pipes of that class and diameter. If any one of these ten pipes fails than the manufacture of pipes of that class and diameter shall cease and the Employer reserves the right to reject all the pipes of that class and diameter.

Thermal insulating materials
Materials shall be tested for bulk density, specific heat, compressive strength, fire resistance under pressure, service temperature limit in accordance with VDI 2055 or equivalent standards.

HP Piping
Ultrasonic inspection of all HP piping shall be performed at manufacturers place and proven by certificates.

B0.7.2.2 Manufacturing tests

RT is not carried out for pulverizer component.

B0.7.2.2.1 Welding tests

Non destructive examination of pressure and vacuum containment welds
Welds shall be non-destructively tested in accordance with the construction

standard applicable to the item of plant. In addition the requirements of the following Table 1 shall be observed. Table 1 shall also apply in cases where the standards used for design and construction of an item of plant does not specify the quality requirements for welds. Fault limitations to be subject of agreement with the Employer's Representative prior to fabrication. Hardness testing shall determine the hardness for welds and heat affected zone according to all scale i.e Vickers (HV10) , HRC and HB.

Non destructive examinations of steam turbine internal piping will be performed by Radiographic examinations.

The Bidder/Contractor has to fulfil the requirements specified in ASME B31.1 and the stricter requirements of the VGB Guideline R 503.
For turbine internal piping 15% of welds will be checked by radiographic testing. If failures are detected the intensity of testing will be increased which means even more than 15% of the welds will be tested.

Hydraulic tests for steam turbine internal prefabricated pipe systems must not be executed, in case equivalent non destructive examinations of steam turbine internal piping are performed by radiographic examinations. The requirements specified in ASME B31.1 and the stricter requirements of the VGB Guideline R 503 shall be fulfilled.

The test procedure ISO 6507-1 or equivalent shall be used. Minimum 3 hardness locations shall be tested for the weld. On circumferential welds the test locations shall be located at 120° distance. Hardness tests shall be conducted after PWHT.

Following percentages of welds shall be hardness tested.

Carbon steels or low allow steels (<2%Cr)	10%
2.5% Cr steels	50%
9 - 12% Cr steels	100%
Austenitic steels	-

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TABLE 1

Type of Steel	Design factor (shell)	Wall thickness (mm)	Inside diam (mm)	Type and Extent of non destructive testing Butt	Nozzle	Fillet	Remarks
C and C-Mn steels with C content not exceeding 0.25%	≤ 0.85	≤ 10	all	-	-	-	Only applicable to: Atmospheric systems (excluded systems, which handle chemicals, toxics or inflammable media).
		40≤	all	20% R	-	-	
		> 40	all	100% R	10% M	10% M	
	> 0.85	≤ 40	≤ 100	20% R	-	-	
			> 100	100% R	10% M	10% M	
		> 40	all	100% R	100% M	100% M	Test after stress relief
C-Mn steels with C content 0.25 to 0.35%, CrMoVsteeis, C 1/2 Mo steels, low alloy steels, and CrMo steels except 12% Cr steels		≤ 30	all	20% R	10% M	10% M	
	all	> 30	all	100% R	100% M	100% M	Test after stress relief
Low alloy steels except CrMoV and 2 CrMo	all	all	all	100% R	100% U**	100% M	Test after stress relief
12% Cr ferritic/martensitic steels	all	all	≤ 100	100% R	100% M	100% M	Test after stress relief
			> 100	100% R*	100% M	100% M	Test after stress relief
				100% U	100% U		

* Radiographic examination may be omitted if done on as-welded joint

** If feasible, otherwise 100% M

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Type of Steel	Design factor	Wall thickness	Inside diam	Type and Extent of non destructive testing			Remarks
	(shell)	(mm)	(mm)	Butt	Nozzle	Fillet	
Austenitic Stainless Steels	≤ 0.85	≤ 15	all	-	-	-	Not applicable to Butt welds made from one side only Operating temperatures exceeding 200 °C
		≤ 30	all	20% R	-	-	
		> 30	all	20% R	10% D	10% D	
	> 0.85	≤ 30	≤ 100	20% R	-	-	
			> 100	100% R	10% D	10% D	
		> 30	all	100% R	100% D	100% D	

Legend: R = Radiographic examination
U = Ultrasonic examination
M = Magnetic particle examination
D = Dye penetrant examination

Note:

1. Where 10% examinations are shown for pipework under 100 mm diam bore this shall be the circumference of 10% of the welds by each welder selected at random with a minimum of one per welder.
2. Where 10% examinations are shown for vessels or large diameter pipework this shall be 10% of each weld length and must include all intersections of longitudinal and circumferential welds.
3. Where partial examinations reveal rejectable defects, adjacent welds or areas of weld shall be examined. In the event of rejectable defects being found welds shall be subject to 100% examination.
4. Welds in clad materials shall be tested in accordance with the requirements of the base material and the surface of the overlaid welds shall be dye penetrant tested throughout their length.

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Non-destructive examination of structural welds
Welds shall be non-destructively tested in accordance with the construction standard applicable to the item of plant. Where appropriate, the following requirements shall also be observed:

- magnetic particle testing of the tension side welds in major fabricated girders and Sections,
- ultrasonic examination of heavily restrained welds (e. g. cruciform joints) where there is a risk of lamellar tearing in the parent material.

Weld Repairs
Unacceptable defects observed by visual examination or indicated by non-destructive testing shall be completely removed by chipping or thermal gouging and grinding. The resulting excavation shall be crack detected prior to rewelding.

Details of the original defects and repair shall be recorded.
Repaired welds shall be subjected as a minimum requirement to the same inspection requirements as the original welds and test records should indicate that a repaired weld is referred to.

B0.7.2.2.2 Pressure testing

All items subjected in service to internal pressure or vacuum shall, unless otherwise agreed, be pressure tested in the manufacturer's works and at site and prior to any internal or external coating.
In case pressure test can't be executed at site NDT checking of welding shall be 100%.

Pulverizer assembly shall be excluded from Pressure testing, Required NDT will be carried out during manufacturing stage to ensure quality. (RT will not be carried out for Pulveriser Component)

Hydrostatic testing
Suitable water shall be used as the test media unless otherwise agreed. The test pressures shall be in accordance with ASME.

The test pressure shall be no less than the greater of

- the pressure corresponding to the maximum loading to which the pressure equipment may be subject in service, taking into account its maximum allowable pressure and its maximum allowable temperature, multiplied by the coefficient 1.25

$$p_{test} = 1.25 * PS * f_{test}/f$$

- maximum allowable pressure, multiplied by the coefficient 1.43,

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$$p_{test} = 1.43 * PS * f_{test}/f$$

Where:

- p_{test} test pressure (hydrostatic)
- PS design pressure
- f_{test} nominal design stress for design conditions at test temperature
- f nominal design stress for design condition at design temperature

The design pressure shall be in any case not less than 3.5 bar overpressure.

Test pressure of vacuum containment items shall be agreed with the Employer's Representative. Any local legal requirement prevails.

The test pressure shall be maintained for sufficient time to permit complete visual examination of all surfaces and joints and in no cases less than specified in the applicable construction standard.

The chloride content of water used for testing austenitic stainless steel items shall not exceed 30 ppm unless immediate flushing with water of this quality is done after the test.

Pneumatic testing
The Contractor shall apply pneumatic testing in cases where hydrostatic testing is impractical or undesirable (e.g. oil pipes). Safety precautions, test pressures/duration and degree of prior non-destructive examination of the subject items shall be agreed with the Employer's Representative.

Pneumatic or gas leak testing supplementary to hydraulic testing shall be applied in appropriate cases where specified by the applicable construction standard.

B0.7.2.2.3 Testing of corrosion protection

Surface coatings
Following tests have to be performed before, during and after coating:

- visual inspection of blasted surfaces according to ISO 12944
- test the blast profile with a profile gauge
- checking of coating material
- measurement of air humidity, air temperature and coating substrate temperature and determination of dew point
- visual inspection of coating
- checking of dry film thickness (DFT); All zinc rich paint used for such repairs must contain a minimum of 81% by mass of zinc in the dry film.

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- checking of adhesion with a dolly pull adhesion tester in accordance with ASTM D4541-09 type A1

Galvanized zinc coatings
Surfaces shall be visually inspected. Bare patches, lumps blisters or inclusions of foreign matter shall be cause for rejection.

Zinc coating thickness shall be determined non-destructively in accordance with ISO 2178 or coulometrically in accordance with ISO 2177 (or ASTM equivalent). For coatings with a weight exceeding 900 g/m^2 the coulometric test method specified in ISO 2177 shall be used.

Hard rubber linings
Surfaces shall be visually inspected. Uneven surfaces, splits, blisters or inclusion of foreign matter shall be cause for rejection.

The thickness of linings shall be measured in accordance with EN 14879 or equivalent. A tolerance of + 10 % is permitted for rubber coatings of 3 mm nominal thickness.

Hardness tests shall prove compliance with the rubber manufacturer's standards.

The absence of pores shall be proved by the induction sparking test method. The potential used shall be 5000 Volts for each mm of thickness plus an additional 5000 Volts (i. e. potential of 20,000 Volts for 3 mm thick lining).

B0.7.2.2.4 Testing of pressure part assembly

Trial assembly shall be checked at the manufacturing place before shipment.

B0.7.2.2.5 Testing of auxiliary and ancillary systems

The Contractor shall provide in his ITPs the specialised checks for various equipments like idlers, pulleys, conveyor belts, coal crusher, stacker reclaimer, coal unloaders, vacuum pumps, air compressors, bottom ash handling equipments, pumps, valves, pipes, EOT & hoists, inert gas system, deluge valves, foam system

The Contractor shall also follow the requirements for testing in the **Sections B1 to B12.**

B0.7.2.2.6 Hangers

Load Test for hangers (in particular spring type) and supports in particular for HP piping shall be executed. All hangers shall be pre-loaded at the manufacturing place.

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B0.7.2.3 Mechanical equipment

Rotating units

Balance testing of rotating units
Each rotating unit shall be first statically balanced and then dynamically balanced according to ISO 1940 (in the case of impellers this shall be done before and after mounting of the service rotor shaft). However, Generator rotor will be dynamically balaned according to ISO 11342. A check balance of items that have undergone overspeed test shall also be made.

Vibration testing of rotating units
The vibration characteristics of rotating units shall be measured during performance tests. Locations of measurement and standards to be achieved shall, on request, be subject to agreement by the Employer's Representative.

Pumps
Running tests and performance tests shall be conducted on all pumps: Performance tests shall be conducted through the full operation range of the pump to closed valve conditions. Graphs indicating flow/head, flow/ power absorbed, flow/ efficiency, flow/NPSH and speed shall be produced. Results for feedpumps shall be assessed with reference to ISO 9906 class 1 (without construction tolerances), and results for other pumps to class II or III as agreed. No negative tolerance on head, capacity and efficiency and no positive tolerance on power are accepted.

The lubricating oil used in the test shall be of the same brand and grade as that recommended by the manufacturer for service use.

Dismantling of the pump for visual examination of parts for damage following test shall be done when required by the inspection standard, when considered necessary by the manufacturer, or when requested by the Employer's representative witnessing the running or performance tests. Replacement of parts following test shall necessitate repeat testing.

Clearance check of the pumps and balancing test of the impeller (acc. to VDI 20160 or eq.) shall be conducted before pump commissioning.

Pump tests shall be carried out with the motor, as supplied with the pump. In case several pumps of same size and typ are supplied, test can be carried out with the same motor.

Pumps under the scope of auxiliary package/systems shall be tested with calibrated shop motor. The high energy pumps including turbine lube oil and control oil pumps shall be tested with job motor (with the motor, as supplied with the pump).

Full load full speed/back to back locked rotor torque test for one gearbox shall be ensured.

No-load mechanical run test for boiler feed pump drive turbine as per API 612 / ISO 10437 to be ensured.

Steam turbines

The turbines shall be completely assembled with their control; on a suitable erection rig at the manufacturer's works and shall be carefully inspected and measured for manufacture and assembly tolerances.

Stop and governing valves shall be delivered and installed separately.Therefore stop and governing valves will be inspected and measured for manufacture and assembly tolerance seperately.

Functional tests shall be performed on the safety equipment (running with steam is not requested).

Important items of turbine control equipment which cannot be adequately tested during the main tests shall be separately bench tested.
Furthermore, testing shall be in accordance with IEC 60953-1 and comprise:

- balancing and overspeed test of the assembled rotor,
- measurement of radial and axial clearances,
- assembling inspection.

Minimum clearances between shaft seal casing and shaft seal ring, radial and axial blade clearances in blading section. axial and radial alignment of rotor in respect of shaft seals, alignment of overspeed governor etc. shall be ensured and verified by Bidder/Contractor.

Testing of free standing blades natural frequency and moment weight shall be performed for IP & LP blades.

All moving blades over 225 mm of active length shall be moment weighed and assembled on shaft in a prescribed sequence to ensure optimum balancing of rotor. Natural frequency of LP turbine blades shall be determined before mounting on rotors to ensure that the same are outside operating frequency range.

No load run test or a rig test at the workshop as per Bidder's/Contractor's/OEM's practice for the two main turbines is acceptable.

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Air compressors

Air compressors shall be tested in accordance with the requirements of ISO 1217 or equivalent standards. Any request for deviation from the test conditions shall be accompanied by the manufacturers' proposals for the adjustment of the correction factors contained in the standard.
Tolerances will be allowed according to ISO 5167-1.

Cooling towers
One Cooling Tower per unit shall be tested on site to an appropriate CTI standard. Any request for deviation from the test conditions shall be accompanied by the manufacturers' proposals for the adjustment of the correction factors contained in the standard.

In addition performance testing to be carried out for the whole system (all cells).

Cranes and hoists
Where size permits cranes and hoists shall be completely assembled at the manufacturers works and functional tests without load conducted.

Flue gas (IDF) and air fans (FDF, PAF, SAF)
Axial and radial fans shall be tested in accordance with the requirements of ISO 14694 or equivalent standards for vibration. ISO 12499 shall also apply. Any request for deviation from the test conditions shall be accompanied by the manufacturers' proposals for the adjustment of the correction factors contained in the standard.

Performance tests shall follow VDI 2044, ISO 5801 or equivalent standard.

Before commissioning, the following tests shall be conducted: NDT, trial assembly of casing, blue matching, and clearances.

Dampers and Gates
Large dampers and valves shall be leakage / tightness tested (type test) in the workshop and at site the whole system shall be tested.

Rotary air preheater (RAPH)
Before commissioning, the following tests shall be conducted: NDT, trial assembly of casing, blue matching, and clearances.

Coal Pulverizer
Before commissioning, the following tests shall be conducted: NDT, trial assembly, blue matching, and clearances. The tests will be carried out during manufacturing stage wherever possible.

B0.7.2.4 Electrical equipment

Electrical equipment and material which is not covered by the tests specified elsewhere in this document shall be inspected and tested in accordance with the latest edition of standards listed hereafter. Alternatively, equivalent standards approved by the Employer's Representative may be used. Type tests shall be carried out if type test certificates certified by an independent test authority are not available.

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Installation Material
IEC 60130 Connectors for frequencies below 3 MHz

IEC 60364	Low voltage electrical installations/ Electrical installations of buildings
IEC 60423	Conduits for electrical purposes

Materials for earthing and lightning protection

IEEE 80	Guide for safety in AC Substation Grounding
IEEE 81	Guide for Measuring Earth Resistivity, Ground Impedance and Earth Surface potentials for Ground system
NFPA 780	Installation of lightning protection systems

Insulators and Bushings

IEC 60383	Insulators for overhead lines with a nominal voltage above 1000 V
IEC 60507	Artificial pollution tests on high voltage insulators to be used on AC systems
IEC 60137	Insulating bushings for AC voltages above 1000 V

Surge Protection Equipment

The surge protection equipment shall be tested in accordance with IEC 60099.

AC Switchgear for voltages above 1 kV

IEC 62271	High-voltage switchgear and control gear
IEEEC37.013	IEEE standard for AC-High-Voltage generator circuit breakers on a symmetrical current.

At least the following tests shall be performed in the manufacturer's workshop on the individual apparatus and on the complete installation, respectively, all in accordance with IEC Standards:

- Visual inspection
- Power frequency HV tests
- Dielectric tests of the auxiliary circuits
- Measurement of the main contacts resistance with dc
- Temperature rise test on circuit breakers (type test certificate)
- Test of mechanical endurance (type test certificate)
- Measurement of the contact opening period (type test certificate)
- Functional tests of the control circuits
- Check of the operational sequence
- Measurement of the instrument transformer's angle and ratio errors (according to IEC-standards 60044)
- Check of the denominations.

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Note 1: All MV switchgear shall be type tested according IEC 62271-1, IEC62271-100 and IEC 62271-200 including internal arc classification IAC

= AFLR. Related type test certificates shall be provided with the Tender. If the test has already been carried out on similar type switchgear, type test certificates may also be accepted.

Note 2: All GIS above 52 kV shall be tested according IEC 62271-1, IEC 62271-203.

Type tests shall be carried out, at the expense of the Contractor and without any impact on the projects overall time schedule, if type test certificates certified by an independent test authority are not available.

Note 3: Generator circuit breakers shall be tested according IEEE Std C37.013.

High voltage fuses
IEC 60282 High voltage fuses
IEC 60644 Specification for high voltage fuse links for motor circuit applications

Oil-immersed power transformers
IEC 60076 Power transformers
IEC 60214 On-load tap-changers
IEC 60404-2 Magnetic materials

a) Tanks

- Inspection of weld preparations, approved crack detection of major strength welds.
- Hydraulic test and vacuum test
- Visual and dimensional checks
- Certification of test results.

b) Cores

- Material
  - Checks on flatness
  - Checks for absence of burrs such as may be caused by slitting, cropping and punching
  - Electrical insulated tests
  - Visual and dimensional checks.
- Assembly
  - Inspection during assembly stage, whilst core is still horizontal
  - Visual and dimensional checks on complete core
  - Checks on straightness of clamps
  - Checks on clamp welding
  - High voltage tests between core packets, clamps and belts in all relevant combinations
  - Check actual weight of core steel in magnetic circuit against design weight
  - Check that all block and sheet insulation and all spacers are in position
  - Check earthing of core packets to clamps.

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c) Windings

- Windings
  - Copper checks
  - Fewest possible number of welds
  - Quality of weld and finishing
  - Insulation on copper
  - Check for correct material
  - Check correct application to conductor
  - Visual and dimensional checks
- Winding of turns
  - Checks during winding of different Sections of winding
  - Checks on positions of starts and finishes of Sections
  - Checks on correct directions of windings of turns (Polarity)
  - Visual checks
- Assembly of windings together
  - Check on relative positions and numbers of leads
  - Check that vertical and horizontal coolant ducts are clear and to full design dimensions
  - Visual checks
- Assembly of windings on core
  - Visual and dimensional checks.

d) Leads

- Checks on disposition, insulation and support of tapping leads
- Checks on insulation support and positioning of bushing leads and provision for connection to bushings
- Checks on lead connections (crimping, brazing etc.)
- Checks on interphase connections
- General visual checks.

e) Insulation

- Checks on arrangement of petalling
- Checks on inter-phase and earth barriers
- Checks on shields
- Checks on clearance and creepage distances
- General visual checks.

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f) Coolant flow ducts

- Check that vertical and horizontal passages are clear and to full design dimensions
- General visual checks.

g) Current transformers, links and connections

- Check that built-in current transformers are in the correct leads
- Check that the connections and alternative connections are clearly marked and that the marked ratios are correct.

h) Assembly of transformer in Tank

- Check insulation between transformer and tank
- Check security of fixing of transformer in tank and of any packing used
- Check electrical clearances between tank and leads and windings
- Checks for cleanliness and freedom from debris of inside of tank
- General visual check.

i) Valves

- Check action of valves after welding into position (especially butterfly valves)
- Checks for leaks under pressure.

j) Paint work

- Checks for preparation of surfaces
- Checks for use of correct paint system
- Visual checks on general finish.

k) Conservator

- Check for leakage
- Check capacity
- Visual checks.

l) Bushings

- Check against standards
- Check that routine tests have been done
- Checks for leakage when mounted on transformer
- Checks for distortion, flaws and chips.

m) Tap-changers (on-load and off-circuit as appropriate)

- Inspection on completion of manufacture, including a review of manufacturer's stage test records and procedures
- Mechanical and electrical checks in the manufacturer's works
- Tests in accordance with the appropriate IEC or other standard as applicable
- Check ten complete cycles from end to end of the range
- Check five cycles on full current
- Check five cycles at full voltage
- Check transmitters for correct number of steps and impedance values
- Check interlocks
- Check warning, alarm and trip contacts
- Visual and dimensional checks.

n) Pumps and fans

- Checks for direction of rotation against motor terminal markings

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- Visual and dimensional checks.

o) Heat exchangers

- Checks on radiators for leaks
- Checks on radiators for paint finish and inner cleanliness
- Checks on oil-to-water heat exchangers for leaks at manufacturer's works
- Checks on oil-to-water heat exchangers for cleanliness of oil chambers and passages
- General visual and dimensional checks.

p) Processing

- Checks on pressures and temperatures with manufacturer's process charts available.

q) Control cubicles, kiosks and terminal boxes

- Checks on functioning of contactors, overloads isolators and general operation of control circuits for cooling gear
- Checks on operation of circuits for thermometers, thermal images, pressure relief valves, oil and gas operated relays, flow detectors, heaters, lights and power output sockets
- Checks on wiring arrangements and terminal boards
- Checks on weather sealing of doors, cable glands and other external features
- Visual and dimensional checks.

r) Workshop tests on complete transformer

The following routine test in accordance with IEC 60076:

- Measurement of winding resistance
- Measurement of voltage ratio and check of voltage vector
- Measurement of impedance voltage, short circuit impedance and
- load loss
- Measurement of no-load loss and current at Ur, 1.05 x Ur and 1.1 x Ur
- Dielectric routine tests in accordance with IEC 60076-3
-
- Test on on-load tap changers
- Insulation resistance
- Separate source voltage withstand test
- Induced overvoltage test to be carried out on all main transformers (see item 3) acc. to IEC 60076-3, table 1 (ACLD/ACSD).
- PD test to be carried out for all generator transformers, interconnecting transformers and start-up/standby transformer together with ACLD.
- Frequency response analysis.
- FRA test to be carried out on all main transformers (see item 3).

The above tests shall be carried out on all transformers.

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The following tests in accordance with IEC to be carried out as type tests (type tests shall not be repeated if type test certificates of an identical/ similar rated transformer issued by a recognized test laboratory are available):

- Temperature rise test including direct measurement of hot-spot temperature
- Measurement of the harmonics of the no-load current
- Dielectric type tests in accordance with IEC 60076-3
- Measurement of zero sequence impedance
- For the above type tests, test certificates may be accepted at the discretion of the Employer/Engineer, in place of tests on the first transformer of each basic type excepting the generator transformer. In the case of generator transformers the type tests must be carried out
- Noise measurements.
- The generator step-up transformer, the 400/230 kV interconnection transformer, the unit auxiliary and the auxiliary transformers shall be dynamic short circuit withstand tested according IEC 60076-1 & -5 either in the manufacturers workshop or in a recognized 3rd party test lab (as special test).

In addition to the above tests, the following tests shall be made as routine tests:

- Tangent delta measurements on the insulation, the method to be agreed with the Employer/Engineer
- Core insulation test on magnetic circuit
- On windings of 30 kV rating or above either:
  - ration influence voltage tests, the method to be agreed with the Employer/Engineer or
  - partial discharge measurements in accordance with IEC
- Transformer oil analysis according to IEC 60296, IEC 60567 and according IEC 62535 for detection of potential corrosive sulphur in mineral oils
- Transformer tanks, conservators, oil pipework and air cooled cooling plant shall withstand without leaking or permanent distortion, the application for 24 hours of a pressure which is such that the test pressure at any point in the equipment is twice theworking pressure at that point or 0.7 kg/cm2 plus the working pressure at the point or 0.3 kg/cm2 plus the pressure exerted at that point when the pressure relief is opened slowly by oil pressure whichever is the greatest.
- Tank vacuum & pressure test
- Pressure test of radiators
- Oil leakage test
- Pressure relief device, Buchholz relay, oil, winding meters, oil level indicator, dry cool breather, dissolved gas analyzer test / check.

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Fault withstand (fault versus time) curve for all transformers shall be submitted by the Contractor.

Over-excitation curves shall be provided by the manufacturers for the station transformers.

Separate type and routine tests shall be carried out for all accessories like bushings, bushings CTs, tap changers, cooling fans, control panels, etc.

Dry type transformers
The following routine tests in accordance with IEC 60076 shall be carried out on all transformers:

- Measurement of winding resistance
- Measurement of voltage ratio and phase displacement
- Measurement of short circuit impedance and load loss
- Measurement of no-load loss and current
- Separate source AC withstand test
- Induced AC voltage test
- Lightning Impulse test
- Partial discharge measurement.

The following tests in accordance with IEC 60076 to be carried out as type tests (type tests shall not be repeated if type tests certificates of an identical transformer issued by a recognized test laboratory are available):

- Temperature rise test
- Measurement of sound level
- Short circuit test
- Environmental Test according Class E2
- Climatic test according Class C1
- Fire behaviour test according to Class F1.

Also, Lightning impulse test shall be a type test.

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Fault withstand (fault versus time) curve for all transformers shall be submitted by the Contractor.

Separate type and routine tests shall be carried out for all accessories like bushings, bushings CTs, tap changers, etc.

Current and voltage transformers
The current and voltage transformer shall be tested in accordance with IEC 61869

Generators
IEC 60034, IEEE 115, ISO 1680 and ISO 10816.

a) Generator test report

Comprehensive test reports for the generators are to be compiled and submitted by the Contractor, which shall include:

- Description of the test method, equipment used and any limitations of the test plant.
- Copies of the oscillographs recorded with appropriate calibration data
- Open circuit saturation, short circuit and loss curves for the generator
- A performance chart of the generator (being a diagram of constant stator and rotor current curves plotted on rectangular axis of MVAr and MW load) The recommended loading, stator core end heating and stability limits shall be shown on the chart.
- Calculations of full load temperature rise for the stator, rotor and exciter. Any correction factors used to allow for different voltage current and cooling conditions shall be justified by reference to published literature or to previous type tests.
- Calculations of the efficiency of the complete generator at 100%, 75% and 50% load. Any correction factors for losses that could not be measured at routine tests shall be justified by reference to published literature or to previous type tests.
- Calculations of machine parameters (according to IEC 60034-4) such as transient reactance and time constant, sub-transient reactance and time constant, short circuit ratio, synchronous reactance, negative phase sequence reactance, zero sequence reactance, capacitance and also the harmonic analysis of the neutral current.
- Calculation of full load excitation of the machine at rated power factor lagging and at unity power factor, excitation V curves.

b) Routine tests on generator

- Generator stator frame
  - hydrostatic test (if H2 cooling)
  - resistance check of temperature detectors
  - Generator rotor
  - ultrasonic examination
  - mechanical balance
  - over-speed test
  - measurement of 50 Hz rotor impedance (at 3000 RPM).
- Stator core laminations
  - Magnetization of stator core laminationlayer resistance between the layers of the core
- Generator H2 cooler (if H2 cooling)
  - hydrostatic test
- Generator assembled:
  - three phase short circuit characteristic test and current balance check
  - dielectric test

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- measurement of insulation resistance
- measurement of winding resistance
- open circuit characteristic test and voltage balance, phase sequence check
- segregation of mechanical loss and core loss
- segregation of stray load loss
- efficiency calculation
- unbalanced load test for negative-phase sequence and zero sequence reactance
- shaft voltage measurement
- oscillographing of verified voltage wave form and harmonic analysis
- measurement of vibration
- polarization index
- tan delta measurement of complete winding
- bearing insulation resistance.

c) Type tests on generator (as far as type test certificates are not available)

- Sudden short circuit test at reduced voltage (30%, 50% and 70% of rated voltage), extrapolated to 100% voltage
- Equivalent heat run test consisting of:
  - windage and friction heat run, open circuit heat run at 105% rated voltage, short-circuit heat run at rated line current, open-circuit heat run at rated line voltage
  - measurement of open-circuit direct-axis transient time constant
  - noise measurement
  - moment of inertia
- Measurement of excitation response time*)
  - overall characteristic coupled with generator and AVQC cubicle at no load*)

*) applicable to assembled unit consisting of generator, exciter and voltage regulator, may be carried out on site

Type tests shall be carried out if type test certificates (Not older than 5 years as on date of bid opening) certified by an independent test authority are not available.

Sudden short circuit test shall be carried out in line with IEC at voltage level to be finalized during detailed engineering.

d) Routine tests on generator exciter

- Resistance of windings
- Insulation resistance
- High voltage tests
- Short-circuit characteristic
- No-load characteristic.

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Motors
IEC 60034, ISO 1680, ISO 10816

- Type tests (each motor type) as far as type test certificates are not available
  - measurement of starting (locked rotor) current and torque
  - power factor and efficiency measurement
  - heat run test
  - noise measurement
  - temperature rise measurement
- Routine tests (each motor)
  - measurement of winding resistances
  - measurement of shaft current
  - no-load and current measurement
  - no-load short circuit measurement
  - open circuit secondary induced voltage test at stand still (wound rotor)
  - dielectric test (high voltage test)
  - measurement of insulation resistance
  - overspeed tests (120% for 2 minutes)
  - check of motor vibrations
  - oscillographic measurement of starting current.

Emergency diesel sets
All relevant routine and type tests according to:

ISO	3046	Reciprocating internal combustion engines - Performance
ISO	8528	Generating sets with reciprocrating internal combustion engines

a) Type tests
The diesel generator unit (DGU) and all auxiliary equipment shall be fully type tested. These tests shall include all type tests as defined in the relevant latest IEC and ISO recommendation (as a minimum requirement).

Evidence shall be given that the DGU together with the auxiliary equipment to be provided, under these specifications, have successfully passed all type tests of design, service frequency, impulse, insulation level, dynamic operating range, and electrical and mechanical endurance performance, as appropriate and as specified.

However, if deemed necessary, the Employer shall decide if additional tests are required to be performed by the Tenderer/Contractor.

The Tenderer/Contractor shall supply certified copies of type test certificates covering the proposed DGU of similar capacity or higher, operating range, data features, design and construction.

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b) Sample tests

Sample Tests shall be performed, comprising as a minimum the following tests:

- Visual checks and measurements of dimensions
- Functional tests.

c) Routine tests

The Tenderer/ Contractor is required to carry out routine tests on each assembled and finished diesel generator unit and its relevant auxiliary equipment to demonstrate the integrity of the system.

Routine test certificates shall be submitted for the Employer's review and approval before shipment of the DGU.

The DGU shall pass all the routine tests as laid down in the relevant latest revisions of IEC & ISO Standards. In addition, the visual Inspection, which shall determine conformity of the DGU & the relevant equipment with the requirement, shall be part of the routine tests.

The acceptance test for the diesel engine at the Manufacturer's workshop test bed shall include the measurements, calculations and functional checks stated in ISO 3046-1 (E).
A test report in English shall be issued according to ISO 3046-1 (E) giving evidence of the following data:

- Engine model, order No., rated output, operating speed, number of cylinders, bore, stroke, compression ratio, cylinder displacement, no. of strokes, date of test, the Employer's name, inspector's name, ambient air temperature, relative humidity, barometric pressure, fuel specific gravity, fuel net calorific value, setting data of injection pump, firing sequence, valve timings, type of fuel oil filter, type of lube oil filter, type of turbocharger and inter-cooler, type of governor, type of injectors.

The Tenderer/Contractor shall submit together with the test report a certificate showing the emission levels of the exhaust gases: NOx, CO and PM (particulate matter).

The diesel engine shall be proven to be capable of operating in steady state condition on all above mentioned loads. If the diesel engine fails to operate in steady state condition on one or more loads, this engine type shall be not accepted for the scope of the diesel generator units.

d) Special tests

The diesel engine shall be at least tested in total for one hour at the following loads:

• Warm-up of the diesel engine	as required
• 25 % load operation	10 minutes
• 50 % load operation	10 minutes

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- 75 % load operation 10 minutes
- Full load operation 20 minutes
- 110 % load operation 20 minutes
- Cool down of the diesel engine.

During the test run, temperatures, pressures and fuel consumption shall be measured and recorded.

The diesel engine shall be proven to be capable for operation in steady state condition on all above mentioned loads. If the diesel engine fails to operate in steady state condition on one or more loads, this engine type shall not be accepted.

Low voltage switchgear
The following standards and regulations or equivalent shall be used:

IEC 60947	Low-voltage switchgear and control gear
IEC 61439	Low-voltage switchgear and control gear assemblies
IEC 60529	Degrees of protection provided by enclosures (IP Code)
IEC 60898	Specifications for circuit-breakers
IEC 60079	Electrical apparatus for potentially explosive atmospheres
IEC 60947	Regulations for low-voltage switchgear

The "Design Verification" of all low voltage switchgears/ motor control centers shall be carried out by following methods:

- "Testing" for the Pos. No. 1., 2., 3., 4., 5., 9., 10., 11., 12. and 13 of IEC 61439-1/Annex D, Table D.1
- "Assessment" for the Pos. No. 6., 7. and 8 of IEC 61439-1/Annex D, Table D.1

In addition to the above tests for which certificates shall be submitted, at least the following tests shall be performed in the manufacturer's workshop on the individual apparatus and on the complete installation, respectively, all in accordance with IEC Standards:

- Visual inspection
- Power frequency HV tests at main circuit
- Dielectric tests of the auxiliary and control circuits
- Functional test of the control circuits
- Check of the operational sequence.

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Capacitors

IEC	60831	Shunt power capacitors
IEC	60871	Shunt capacitors for A.C. power systems
IEC	60931	Shunt power capacitors
IEC	60143	Series capacitors for power systems
IEC	60358	Coupling capacitors and capacitor dividers
IEC	60384	Fixed capacitors for use in electronic equipment

Batteries, charging equipment inverters and DC/DC converters

IEC	60086	Primary batteries
IEC	60119	Recommendations for polycrystalline semiconductor rectifier stacks and equipment
IEC	60146	Semiconductor converters
IEC	60896	Stationary lead-acid batteries
IEC	61204	Low voltage power supply devices DC output

Chargers and batteries shall be tested together in the factory. Testing of chargers and batteries together at site will also be accepted. All factory tests shall be repeated at site.

Chargers

- Visual inspection (to be repeated on site)
- Functional tests (to be repeated on site)
- Heat run (type test)
- Output voltage stability measured for 25% load steps
- Ripple voltage measurement without connected battery
- Ripple measurement (voltage and current) with connected battery (at site will also be accepted.
- Insulation test (to be repeated on site).

Batteries

- Visual inspection (to be repeated on site)
- Insulation test (to be repeated on site)
- Charge test and discharge tests

Fuse Box

- Visual inspection (to be repeated on site)
- Functional tests (on site)
- Insulation test (on site)

Inverters and DC/DC converters

- Visual inspection (to be repeated on site)
- Functional tests (to be repeated on site)
- Heat run (type test)
- Insulation test (to be repeated on site).

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Lamps and accessories

IEC	60081	Double-capped fluorescent lamps
IEC	61347	Lamp control gear
IEC	60921	Ballasts for tubular fluorescent lamps
IEC	60155	Glow starters for fluorescent lamps
IEC	60598	Luminaries
IEC	60188	High-pressure mercury vapor lamps
IEC	60400	Lampholders and starter holders for tubular fluorescent lamps
IEC	60901	Single-capped fluorescent lamps
IEC	60662	High pressure sodium vapor lamps
IEC	60192	Low pressure sodium vapor lamps
IEC	60923	Auxiliaries for lamps
IEC	61347	Part 2-13: lamp control gear for LED Modules
IEC	62031	LED modules for general lighting - Safety specifications
IEC	62560	Self-ballasted LED-lamps for general lighting services by voltage > 50 V - Safety specifications
IEC	62612	Self-ballasted LED-lamps for general lighting services by voltage > 50 V - Perforce requirements
IEC	62471	Photobiological safety
IEC	62384	DC or AC supplied electronic control gear for LED modules - Perforce requirements
IEC	60838	Part 2-2: miscellaneous lampholders - Connectors for LED-modules
IEC/PAS	62717	LED Modules for general lighting - Performance requirements
IEC/PAS	62722	Luminares Performance

HV-, MV- and LV-cables

All relevant routine and type tests according to:

IEC	60060	High voltage test techniques
IEC	60071	Insulation co-ordination
IEC	60230	Impulse tests on cables and their accessories
IEC	60811	Common test methods for insulating and sheathing materials of electric cables
IEC	60840	Power cables with extruded insulation and their accessories for rated voltages above 30 kV up 150 kV
IEC	62067	Power cables with extruded insulation and their accessories for rated voltages above 150 kV up 500 kV
IEC	60502	Power cables with extruded insulation and their accessories for rated voltages from 1 kV up to 30 kV

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a) LV-cables

LV cables shall be workshop tested as per IEC 60502-1 with the following tests as a minimum:

Type tests:

- electrical type tests acc. to: IEC 60502 - 1 Clause 17
- non electrical type tests acc. to: IEC 60502 - 2 Clause 18.

Also following additional type tests shall be carried by the Contractor at their own cost prior to the first shipment of all offered cable if no type test certificates of identical cables are available:

- Fire Resistant according to IEC 60331, BS 6387
- Flame Retardant according to IEC 60332
- Low Smoke Test according to IEC 61034
- Halogen Content Test according IEC 60754
- Water Tree Test of XLPE Insulation (accelerated)
- Test voltage = 3 x Uo
- Test frequency = 500 Hz
- Core environment = 400C water
- Duration of test = 4 month
- Test after 4 months: Dielectric stress withstand >14kV/mm.

Moreover, test certificates shall be provided, proving that each cable type to be used has successfully passed type tests as required by the applicable standards during the last 12 months before award of contract. Otherwise, these tests have to be repeated or sample Sections.

Routine tests: according IEC 60502 – 1, Clause 15

- measurements of electrical resistance of conductors according to Clause 15.2
- voltage tests according to clause 15.3.

Sample tests: according IEC 60502 – 1, Clause 16

- conductor examination according Clause 16.4
- check of dimensions according Clause 16.5 to 16.8
- hot set test for EPR, HEPR and XLPE insulations and elastomeric sheath according Clause 16.9.

b) MV-cables

MV cables shall be workshop tested as per IEC 60502-2 with the following tests as a minimum:

Type tests:

- electrical type tests acc. to: IEC 60502 - 2 Clause 18
- non electrical type tests acc. to: IEC 60502 - 2 Clause 19.

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Also following additional type tests shall be carried by the Contractor at their own cost prior to the first shipment of all offered cable if no type test certificates of identical cables are available:

- Fire Resistant according to IEC 60331, BS 6387
- Flame Retardant according to IEC 60332
- Low Smoke Test according to IEC 61034
- Halogen Content Test according IEC 60754
- Water Tree Test of XLPE Insulation (accelerated)
- Test voltage = 3 x Uo
- Test frequency = 500 Hz
- Core environment = 400C water
- Duration of test = 4 month
- Test after 4 months: Dielectric stress withstand >14kV/mm.

Moreover, test certificates shall be provided, proving that each cable type to be used has successfully passed type tests as required by the applicable Standards during the last 12 months before award of contract. Otherwise, these tests have to be repeated on sample Sections.

Routine tests: according IEC 60502 – 2, Clause 16

- measurements of electrical resistance of conductors according to Clause 16.2
- partial discharge test according to Clause 16.3 on cables having cores with conductor screens and insulation screens in accordance with Clause 7.1 and 7.2
- voltage tests according to clause 16.4.

Sample tests: according IEC 60502-2 Clause 17

- conductor examination according Clause 17.4
- check of dimensions according Clause 17.5 to 17.8
- voltage test for cables of rated voltages above 3.6/6 (7.2) kV according to Clause 17.9
- hot set test for EPR, HEPR and XLPE insulations and elatomeric sheath according Clause 17.10.

c) HV-cables

The 230 kV XLPE-Insulated Single-Core Underground Cables and Accessories shall be tested as per latest IEC 62067 including all subsequent amendments and relative standard. The Employer/Engineer shall witness the required Type and Sample tests.

The approval of the Employer/ Engineer or the passing of any such inspection or test will not however, prejudice the right of the Employer/ Engineer to reject the 230 kV XLPE-Insulated Single-Core Cables and accessories if it does not comply with the Specification.

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Defects discovered during the type/routine/sample tests shall entitle the Employer/Engineer to reject the cables/accessories fabricated for this Project.

The Tenderer/ Contractor shall fabricate without additional cost the cable lengths and accessories necessary for the tests, over and above those required to complete the Works at Site.

For the definitions of the Type Tests, Sample Tests, Routine Tests and Tests after installation, reference shall generally be made to the relevant IEC Standards.

HV cables and accessories shall be workshop tested as per IEC 62067 with the following tests as a minimum:

Type tests on cable systems: according clause 12:

- Electrical type test according Clause 12.4
  - Check of insulation thickness acc. to Clause 12.4.1
  - Bending test on the cables acc. to Clause 12.4.4 followed by installation of accessories and a partial discharge test acc. to Clause 12.4.5
  - Tan δ measurement acc. to Clause 12.4.6
  - Heating cycle voltage test acc. Clause 12.4.7
  - Partial discharge test acc. to Clause 12.4.5 (at ambient and at high temperature)
  - Switching impulse voltage test acc. to Clause 12.4.8
  - Lightning impulse voltage test followed by a power frequency voltage test acc. to Clause 12.4.9
  - Test of outer protection for joints
  - Examination of cable system with cable and accessories after completion of tests acc. to Clause 12.4.10.
  - Tesitivity of semi-conducting screen acc. to Clause 12.4.11.

- Non electrical type tests according to Clause 12.5
  - Check of dimensions acc. to Clause 12.5.1
  - Tests for determination the mechanical properties of insulation acc. to Clause 12.5.2
  - Tests for determination the mechanical properties of oversheats acc. to Clause 12.5.3
  - Aging tests acc. to Clause 12.5.4
  - Pressure test at high temperature on oversheets acc. to Clause 12.5.6
  - Other test on oversheets according to the type used.
  - Hot set test for XLPE insulation acc. to Clause 12.5.10
  - Measurement of carbon black of black PE oversheats acc. to Clause 12.5.12
  - Water penetration test acc. to Clause 12.5.14.

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Also following additional type tests shall be carried by the Contractor at their own cost prior to the first shipment of all offered cable if no type test certificates of identical cables are available:

- Fire Resistant according to IEC 60331, BS 6387
- Flame Retardant according to IEC 60332
- Low Smoke Test according to IEC 61034
- Halogen Content Test according IEC 60754
- Water Tree Test of XLPE Insulation (accelerated)
  - Test voltage = 3 x Uo
  - Test frequency = 500 Hz
  - Core environment = 400C water
  - Duration of test = 4 month
  - Test after 4 months: Dielectric stress withstand >14kV/mm.

Cables and accessories shall have passed type approval tests in accordance with IEC Specifications and details of the cable designs offered shall be given in the appropriate place in the Technical Schedules. Type test reports shall include cable design details and design drawings of each jointing accessory included in the type test.

The Tenderer/Contractor shall submit certified copies of type test certificates covering the proposed Cables.

Routine tests: according Clause 9
- partial discharge test according to Clause 9.2
- voltage tests according to according to Clause 9.3
- electrical test on oversheath according to Clause 9.4

Sample tests: according to Clause 10
- conductor examination according Clause 10.4
- measurement of electrical resistance of conductor according to Clause 10.5
- measurement of thickness of insulation and oversheath according to Clause 10.6
- measurement of thickness of metallic sheath according to Clause 10.7
- measurement of diameters according to Clause 10.8
- hot set test XLPE insulations and elatomeric sheath according Clause 10.9
- measurement of capacitance according to Clause 10.10
- lightning impulse voltage test follows by a power frequency voltage test according to Clause 10.12
- water penetration test according Clause 12.5.14
- Lead alloy composition and behavior (BS 3908, BS EN 12548).

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Type tests of accessories
All accessories shall be tested as per IEC 62067 and all subsequent amendments and relative standards considering Test of Outer protection for buried joints (if applicable).

Routine Tests, Insulation Joints
The insulation flange shall be designed to withstand tests voltages as specified in the Technical Data Sheets and shall be tested accordingly.

Routine Tests, Bonding/Earthing Leads
The Bonding/Earthing Leads shall be designed to withstand tests voltages and currents as specified in the Technical Data Sheets and shall be tested accordingly.

Telecommunication installations
IEC 60215 Safety requirements for radio transmitting equipment

Aerials
IEC 60169 Radio-frequency connectors

Power installations up to 1000 V
IEC 60364 Electrical installations of buildings
IEC 61439-4 Particular requirements for assemblies for construction sites (ACS)

Power installation above 1000 V
IEC 60060 High-voltage test techniques
IEC 62271 HV switchgear and control gear
(incl. Appendix AA "Internal Arc Test")

Protection equipment
Equipment for modular static protection systems (e.g. generator, distance, busbar, protection, etc.) pre-assembled in the relevant standardized boards/ cubicles etc. shall be tested in the manufacturers' workshops according to IEC 60255 as far as wiring and proper function is concerned. Simulated inputs (binary signals, current and voltage inputs from test power supplies) shall be used.

Fire alarm system
All relevant routine and type tests according to:
NFPA National Fire Protection Association
DIN VDE 0800 Telecommunications
DIN VDE 0833 Alarm systems for fire, intrusion and hold-up

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B0.7.2.5 Control and monitoring equipment

All control and monitoring equipment shall be tested at the manufacturers' works before dispatch to site. Certificates shall be issued for

- synchronizing units
- flow evaluators

On request the correct operation of equipment with specified temperature and humidity limits shall be demonstrated by tests conducted within the limits.

Electrical measuring instruments
All electrical measuring instruments shall be tested in accordance with the following rules and regulations. Alternatively, equivalent standards approved by the Employer's Representative may be used.

IEC 60051	Recommendations for direct-acting indicating electrical measuring instruments and their accessories
IEC 60258	Direct acting recording electrical measuring instruments and their accessories
IEC 61036	Alternating current static watt-hour meters for active energy
IEC 61010	Safety requirements for electrical equipment for measurement, control and laboratory use

Electrical remote indication
Meters for active power, reactive power and similar remote indication equipment:

VDE 0418	Regulations for electric integrating meters
IEC 60338	Telemetering for consumption and demand

Calibration Tests
The Contractor shall conduct calibration tests of the following instruments and equipment:

- all local indicators over the full range of the indicator
- all transmitters over the full range of the transmiter
- all binary transmitters over the full range including initial setting
- all remote indicators over the full range of the indicator
- all recorders over the full range of the recorder
- one of each type of indication loop with circuit resistance of the loop increased to a value which is equal to the highest value expected, and under worst case operating conditions
- all superheated steam thermocouples
- one of each type of thermocouple or resistance element
- all kinds of analogue transmitters over the full measuring range

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- all modules and subassemblies for measuring and control e.g. analogue limit monitors, flow evaluators, function generators
- all quantity meters
- all synchronizing units according to IEC standards
- the actual dimensions of all orifices, nozzles, Venturi nozzles have to be checked as per ISO5167.

Closed-loop control systems
All main closed-loop control systems shall be tested for polarity and function in accordance with the applicable standards. Control valves shall be tested in accordance with mechanical functional tests on control valves and shall be performed with the actuator mounted (open to closed position and vice-versa). Actuators shall be subject to mechanical and electrical function tests.

Sequence logic equipment
All sequence logic equipment shall be tested using simulated inputs.

Alarm annunciator and fault printing system
The alarm annunciator and fault printing system shall be tested using simulated inputs.

DCS system
The system shall be thoroughly tested at the manufacturers' workshops before dispatch to site. Test programs shall be devised and these shall subsequently be made available to the Employer's Representative. Tests shall be made to ensure that the system operates correctly within the ambient conditions as specified by the manufacturer and that if these conditions are exceeded, i.e. in the case of failure of the air-conditioning system, that the system will automatically fail safe and that neither hardware nor software will be damaged.

Further I&C equipment
Type test reports shall be provided for the following:

- UPS
- 24 V DC battery chargers
- Batteries
- Control valves
- Instrumentation cables
- Flow nozzle orifice plates
- Measuring instruments
- Local instrument enclosures
- Local instrument racks
- PLCs
- Etc.

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Type test reports

The minimum type test reports for each of the major I&C systems shall be as follows:

1. Surge Withstand Capability (SWC) for solid state equipment/ systems All solid state systems/ equipment shall be able to withstand the electrical noise and surges as encountered in actual service conditions and inherent in a Power Plant. All the solid state systems/ equipment shall be provided with all required protections that needs the surge withstand capability as defined in ANSI 37.90.1/ IEEE-472. Hence all front end cards which receive external signals like analogue input & output modules, binary input & output modules, etc. including power supplies, data highway, data links shall be provided with protections that meet the surge withstand capability as defined in ANSI 37.90.1/ IEEE-472. Complete details of the features incorporated in electronic systems to meet this requirement, the relevant tests carried out, the certificates etc. shall be submitted with the proposal. As an alternative to above, suitable class of EN61000-4-12 which is equivalent to ANSI 37.90.1/ IEEE-472 may also be adopted for SWC test.
2. Dry heat test as per IEC 60068-2-2 or equivalent
3. Damp heat test as per IEC 60068-2-3 or equivalent
4. Vibration test as per IEC 60068-2-6 or equivalent
5. Electrostatic discharge tests as per EN 61000-4-2 or equivalent
6. Radio frequency immunity test as per EN 61000-4-6 or equivalent
7. Electromagnetic field immunity as per EN 61000-4-3 or equivalent

Tests as listed under items number 5 to 7 as applicable for electronic cards only as defined under item 1 above.

B0.7.3 Testing at site

B0.7.3.1 Civil works testing

The Contractor shall carry out all required civil construction tests. Thereby part of the test like concrete and earthwork tests have to be carried out at site, other tests have to be performed in the manufacturer workshops.

The Contractor shall submit all test certificates of materials subject to approval and shall arrange for tests of all materials to be carried out in laboratories on site or elsewhere. The cost of all test equipment, samples, tests and transport to the laboratory shall be borne by the Contractor.

The testing operations shall be performed in accordance with the relevant codes and standards and under the supervision of the Employer.

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Where in the specifications materials are specified to be approved samples shall be submitted for approval at the earliest possible date and strictly before any purchasing or delivery to the site is made. The individual tests and inspection for the materials, supply and execution shall be carried out in compliance with the requirements of the individual technical specifications. In the case of rejection, further samples of the rejected materials shall be submitted to SC until they are approved or the material is replaced. The Employer may reject any material which in his opinion is not in accordance with the approved standard. All samples shall be submitted free of charge to the Employer.

The characteristics as determined in the samples which are approved shall indicate the standard to be maintained in the materials used in the execution of the works.

The test samples of materials subject to approval by the Employer shall be kept in a safe place and protected against damage or deterioration until completion of the works.

For materials (e.g. steelwork, pipes, ducts, etc.) to be manufactured in workshops respective manufacturer test certificates including test results shall be submitted to the Employer subject to approval.

After final completion of certain civil structures/ parts to be ready for erection of further equipment individual "Civil Completion Certificates" shall be issued by the Contractor under the following conditions:

- Except for minor items of work that would not affect the safety, all civil works for applicable parts, structures or buildings have been carried out and tested
- All such civil works are in a manner that does not void any subcontractor or vendor warranties or violate any applicable law or applicable permit
- Punch List has been agreed upon by the Employer and the Contractor
- Contractor warrants that all necessary works have been undertaken and all applicable parts, structures or buildings are ready for erection.

If the Employer is satisfied that the pre-conditions for the issuance of the Civil Completion Certificate for the respective civil structures/ parts have been met the Civil Construction Completion Certificate shall be signed off by the Employer.

Further testing requirements for civil works are specified in **Section B9**.

An indicative field quality plan for civil works to be followed by the Contractor at site is required to be submitted with the Tender.

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B0.7.3.2 Erection tests

General

During erection all required erection tests as well as final erection checks of the mechanical completion of the systems and part thereof have to be performed.

The Employer shall have the right to witness on request all tests on site and shall be informed of site test 24 hours in advance.

After successful mechanical completion of each system, Individual Erection Completion Certificates will be issued.

The activities necessary for mechanical completion shall include but not be limited to following testing:

- visual inspection after unloading at site
- checking of completion of relevant systems
- completion of buildings and civil works
- test of ventilating and air-conditioning units
- alignment of rotating equipment coupled on site
- safety audit
- testing of site welds (non-destructive examinations)
- pressure testing, leak tests, tightness tests
- checking of pipe hangers, supports, guides, etc.
- pipe line and equipment flushing and cleaning
- chemical protection of piping systems
- checking of coating
- testing of cranes and hoists.

Electrical equipment tests

The following tests or measurements must be made during and after erection but before any item of equipment is put on trial operation:

- design and visual checks
- screwed connections for correct assembly
- terminals and terminal connections for correct assembly
- checking of earthing connections and testing of earthing resistances
- measurement of insulation values (didactic tests)
- verification of earthing conditions
- fire-proof partitioning
- marking, inscription, provision of designation plates
- rotating-field measurement
- phase coincidence with 2 half-busbars
- voltage checks
- polarity checks in the case of DC voltages
- fuses, overcurrent trips, short circuit trips, time settings, relay settings
- oil levels

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- status indication, alarm and trip signals
- checks on wiring and cabling for conformity with the constructional circuit drawings and plans
- high voltage tests
- current and voltage transformer circuits
- functional test of all protection relays including winding and oil temperature monitoring as well as Buchholz protection etc.
- interface with the DCS and SCADA.

The tests shall be carried out according to relevant standards.

The Contractor shall submit for each test of all equipment a method statement, with relevant diagrams explaining the procedure of the tests and test criteria supported by relevant standards and test methods.

All major equipment shall have a separate test package.

All high voltage tests shall be carried out at 50 Hz. Equipment for which DC tests is proposed shall be justified and approved by Employer/Engineer. HV tests of switchgears shall be carried out with the relevant circuit breakers in open and closed positions.

Unless otherwise agreed, all erection and civil works related to the equipment shall be completed before starting any site tests.
All switchgears shall be verified by primary injection in addition to secondary injection.

Generators
This Section covers the specific requirements for the site tests and performance tests requirements in the turbine plant.

These tests shall include:

- Routine tests as per IEC 60034 - as far as practicable under site condition comprising of:
  - testing of running behaviour (overspeed)
  - determination of temp. rises of coolants and lubricants for bearing and shaft seals
  - determination of friction losses
  - recording of no-load saturation characteristics and determination of core losses
  - measurement of shaft voltage
  - verification of phase sequence and appropriate terminal marking
  - measurement of excitation current and determination of losses at rated current on short circuit
  - calculation of efficiency from sum of individual losses
  - winding insulation measurement
  - HV test on windings
  - functional test of accessories and attachments

- measurement of excitation response time – GTG: measuring will be carried out at site during commissioning
- overall characteristics coupled with generator and AVR cubicle at no load (applicable for the assembled unit consisting of generator, exciter and voltage regulator) – GTG: measuring will be carried out at site during commissioning.

The Contractor has to provide a detailed test procedure subject to approval by the Employer/Engineer.

Motors
Tests at Site (with motor coupled):

- measurement of insulation resistance
- measurement of shaft current
- measurement of motor vibrations
- at motors rated 47 kW or higher, in addition:
  - oscillographic measurement of starting current (if not performed during workshop testing)
  - measurement of starting period.

Switchgear for Voltages above 1 kV
The complete installation shall be tested at site as follows:

- dielectric test
- visual inspection
- contact resistance/torque test of bus bar joints
- CT's, VT's ratio, magnetisation characteristic and burden measurement
- HV test
- mechanical functioning test
- test of the functional sequence
- testing of all interlocks
- testing of all protection relays and circuits by primary/secondary injection and functional tests of the arc protection
- testing of high speed transfer systems
- testing of all alarms (local and remote).

LV switchgear (AC and DC)
The complete switchgear and the individual apparatus shall be tested on site as follows:

- visual inspection
- dielectric test
- contact resistance/torque test of bus bar joints
- CT's, VT's ratio, magnetisation characteristic and burden measurement
- testing of all interlocks
- setting and testing of all protection relays and circuits by primary/ secondary injection. Test kit of adequate rating to be provided

- testing of automatic change over devices
- testing of all alarms (local and remote)
- functional test
- test of the functional sequence.

Setting and functional test of protection devices (primary injection method). However, test plugs and socket facilities for secondary injection tests shall also be made available. Tests kits of adequate ratings shall be made available for the tests.

Batteries and chargers
Chargers and batteries shall be tested together in the factory. All factory tests are to be repeated at site.

Chargers
- visual inspection (to be repeated on site)
- functional tests (to be repeated on site)
- heat run (type test)
- output voltage stability measured for 25% load steps
- ripple voltage measurement without connected battery
- ripple measurement (voltage and current) with connected battery
- insulation test (to be repeated on site).

Batteries
- visual inspection (to be repeated on site)
- insulation test (to be repeated on site)
- charge test and discharge tests (100%).

Fuse Box
- Visual inspection (to be repeated on site)
- Functional tests (on site)
- Insulation test (on site).

Inverters & DC/DC Converters
Following test shall be carried out:

- visual inspection (to be repeated on site)
- functional tests (to be repeated on site)
- insulation test (to be repeated on site).

Earthing and lightning protection

The complete earthing and lightning protection systems shall be tested as follows:

- The earthing system as a whole shall be tested and verified before putting any major equipment into operation.
- visual inspection of exposed elements
- Measurement of the earth electrode potential UE by the voltmeter/ ammeter method, test current 100 300 A or an equivalent, approved method if above will be proved to be not feasible,
- measurement of the touch potential UB,
- measurement of step potential.

Diesel generator units

The diesel generator units (DGU) shall be thoroughly tested at site. The acceptance tests shall be performed according to the Technical Specifications and acc. to ISO 8528 6:1993 (E) and ISO 3046-1:1995 (E) and -3:1989 (E) for the diesel engine. At site the diesel engine shall be measured and documented according to the stipulations made in Clause 7.6.20. The exhaust gas shall be invisible when the Unit is operating at loads between 50 and 110%. The diesel engine's filter smoke number shall be measured according to BOSCH Index No. 3 or better within a load range from 60 to 100%. A test report in English language shall be issued according to ISO 8528:1993 (E). Upon full satisfaction of the Employer/Engineer after the successful operation tests, in every respect, and that all components are working properly, the DGU with all ancillaries shall be operated at 100% output for 48 hrs without failure or interruption whatsoever. The performance test measurements of the DGU shall be performed according to ISO 8528 6:1993 (E) for the diesel generator unit, ISO 3046-1:1995 (E) and -3:1989 (E) for the diesel engine and latest issue of IEC 60034-2 for the Generator. All guaranteed values shall be assumed to include all necessary tolerances for accuracy of testing, sampling, instrumentation, notwithstanding the performance test code standard. No further tolerances of any kind shall be permitted.

230 kV XLPE Cables

Test after laying is to be recommended by the manufacturer considering the following minimum requirements and recommendations from CIGRE WG.21.9 (Electra No.173 August '97), IEC 62067 and other applicable standards to Employer/ Engineers approval.

- visual and function test of bonding/earthing system
- phase Identification Test
- conductor and screen/sheath Continuity Test
- primary connection check
- cable connection bolt tightness check
- cable supporting check
- cable fixing check
- insulation resistance test before and after installation
- DC conductor resistance test (IEC 60228)
- contact resistance test of connecting bars in link boxes
- capacitance test
- earthing measurements
- positive/negative and zero sequence impedance measurements
- testing of SVL
- cross bonding check, primary injection Subsequent repeat tests (after guarantee period)
- DC sheath test according Clause 5 of IEC 60229 between metallic sheath/screen/armouring including cross bonding system, etc. and ground.
- AC voltage test according IEC 62067 Section 14.2.
- measurements of induced voltages on pilot/telephone cables installed in parallel with the power cables.

Tests accord the Electricity Transmission Code of Bangladesh and Great Britain

Any other tests required to demonstrate compliance with the above indicated Grid Codes.

B0.7.3.3 Pre-commissioning tests

Preconditions for the pre-commissioning are:

- the issue of the individual Erection Completion Certificates;
- the rectification of all relevant erection punch points; and
- the availability of the accepted commissioning test program and commissioning procedures.

The pre-commissioning tests shall cover mainly the functional tests of the individual items of all mechanical, electrical and I&C systems including their alarm and tripping systems. Following tests shall be included, but not limited to:

Mechanical equipment

- Individual pre-commissioning runs of all rotating equipment such as pumps, compressors, dosing equipment etc.
- Functional tests of the mechanical equipment
- Testing and adjustment of safety devices

Electrical equipment

As far as not already covered by the erection tests the pre-commissioning tests shall cover:

- Voltage tests
- Generator and transformer protection system checks
- Automatic voltage and reactive power control (AVQC), governor setting and adjustment and response to grid system signals
- Trip tests
- Functional tests of the equipment e.g.:
  - Motor checks
  - Circuit breakers, LV, MV, HV cabling and switchgears checks for operability
  - Batteries, chargers and UPS checks for operability
- Remaining tests on turbine generator: In addition, a repetition of winding resistance and insulation resistance measurement, as well as dielectric tests shall be carried out in any case on each turbine generator.

Control equipment

- Comprehensive loop tests shall be performed for all measuring loops at least for 0, 50% and 100% value.
- Closed loop control checks up to DCS (for all functions like indication, control, alarms, etc.):
  - Polarity and function test in accordance with the applicable standards.
  - Control valves shall be tested in accordance with mechanical functional tests on control valves and shall be performed with the actuator mounted (open to closed position and vice-versa)
  - Actuators shall be subject to mechanical and electrical function tests.
- All sequence logic equipment shall be tested using simulated inputs.
- The alarm annunciation and sequence of event recording system shall be tested using simulated inputs.
- Binary field contact circuit fault detection.
- Functional tests of control equipment, interlocks, inter-tripping, protection inputs, etc.
- Test of signal exchange with other systems (also with third parties – like LDC, etc.)
- Archiving system (capacity, consistency, redundancy, access times).

- Reports generation
- Emission analyser calibration and emission evaluation tests
- Calibration of metering system (accuracy shall be proven by certificates)

B0.7.3.4 Tests on Completion (Commissioning tests)

Preconditions of the Tests on Completion are:

- the successful completion of the individual erection checks of all items of the whole system;
- the issuing of the Final Erection Completion Certificate; and
- the successful completion of all pre-commissioning test.

Should the Employer decide that the preconditions for the Tests on Completion have not been adequately met, the Employer will advise the Contractor accordingly and withhold the commencement of the the Tests on Completion until the outstanding work is completed.

The Tests on Completion shall prove that the Plant is prepared and adjusted to ensure the correct functioning of the individual components and of the complete Plant.

The Tests on Completion shall cover at least following tests:

- Protection tests
  - Operation of selected turbine train protection devices including the following as a minimum:
    - fire protection
    - boiler protection
    - steam turbine protection
    - generator protection
    - transformer protection.

Method of alarm/ trip condition reset for subsequent starting.

- Operation of auxiliary systems:

Method of changeover of main equipment to stand-by equipment prior to Plant starting (see start-up tests) and during normal operation for fuel oil, coal handling, ash handling, oil lube and cooling systems

- Operation of fire protection systems.

- Isolation procedures
  - Method of isolation of plant equipment for safe shut-down and maintenance procedures including as a minimum:
    - HV station and unit supplies
    - LV supplies
    - fuel oil systems
    - coal handling systems
    - ash handling systems

- fire protection systems.
- Protection systems/ settings, in accordance with agreed design and the requirements of the transmission system.
- Start-up tests
  - normal semi-automatic start to preset load
  - staged semi-automatic including start to synchronous speed, manual synchronizing (including synchro-check), automatic synchronizing, manual and automatic loading
  - starting with stand-by auxiliaries
  - operation of all auxiliaries.
- Verification of start-up times and loading rates of power unit and steam generator at various downtime conditions.
- Power unit(s)/Plant, to test partial and full load rejection to demonstrate
  - full load rejection tests to measure transient maximum speed and steady state speed at normal governor droop setting
  - method of resynchronism to be demonstrated steam turbine bypass operation capability.
- Power unit(s)/Plant, to verify and check
  - operating stability when operated between 30% and 100% nominal load conditions with load variations by increasing or decreasing the electric load
  - start-up/main fuel change-over:
    - semi-automatic change-over from fuel oil operation to coal operation
    - semi-automatic change-over from coal operation to fuel oil operation.
- Demonstration of the capabilities of the power unit to operate at rated voltage and frequency, at power factors and reactive conditions between 0.85 (lag) and 0.95 (lead).
- Start-up tests of the Plant equipment, facilities and systems including checking of automatic change-over of standby facilities as well as fuel.
- Verification of vibration guarantees.
- Environmental monitoring equipment, water quality monitoring equipment, functioning tests and verification of guarantees.
- Demonstration of the teledispatching and telemetering systems.
- Verification of Active Power Response and Voltage Control Response according to the requirements specified in the Network Connection Conditions.
- Demonstration of proper controlling, monitoring and recording according to the requirements of the Grid Code, including but not limited to the following tests:
  - Reactive Power
  - Fault Detection and Clearing Limits
  - Load Following Capability
  - Black Start (if applicable)
  - Voltage Following Capability (AVQC)
  - Excitation System and Power System Stabiliser
  - Primary, Secondary and High Frequency MW Response

- Unit Start
- Despatch Ramp Rate
- Protection System
- House Load Operation
- Underfrequency Relay
- Loss of AC Power Supply
- Minimum Load
- Site Test for Validation
- Verification of completeness of scope of supply.

B0.7.3.4.1 Additional test in accordance with the PPA

Tests prior to synchronisation of each generating unit of the Plant
According to the requirements of the BPDB which are part of the PPA, the Contractor shall carry out the following additional tests prior to synchronisation of each generating unit of the Plant:

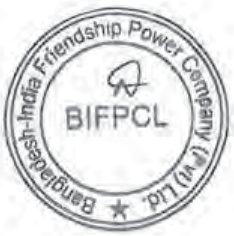
- automatic voltage regulator setting and adjusting in stand-still condition and with the generator running at no load
- turbine governor control checks, including (but not limited to) a steam governor overspeed test (This test may be performed after a specified period of running of the Unit on load as per the manufacturer's recommendation)
- open circuit and short circuit tests on the generator
- functional testing and timing of high voltage switchgear in the substation of the Facility
- The Company and BPDB shall verify that the protection level settings for switchyard protection equipment are as agreed by the Joint Coordinating Committee
- Voltage phasing checks will be carried out between the Grid System and the Facility; and

All inter-tripping circuits between the Plant and BPDB equipment shall be proved.

Tests for commissioning of each generating unit of the Plant
In addition to the above specified tests and according to the requirements of the BPDB which are part of the PPA, the following tests shall be carried out by the Contractor for commissioning of each generating unit of the Plant after completing the tests set out before:

a. **Dependable Capacity Test**
Refer to Section 0.7.4.

b. **Reliability Run**
Refer to Section **B.0.7.5**



c. **Automatic Voltage Regulator ("AVR") Droop Test**
The AVR will be demonstrated to control the steam turbine generator voltage over its entire set range.

d. **Steam Turbine Governor Operation Test**
The operation of the steam turbine speed governor will be demonstrated.

e. **Reactive Capacity Test**
This test will demonstrate the capability of the Plant to operate at rated voltage and frequency at power factors and under reactive conditions in accordance with the manufacturer's generator rating curves to be provided by the Contractor, insofar as these tests can be accommodated within the grid system.

f. **Minimum Load Capability Test**
This test will demonstrate the capability of each Unit to be operated at minimum stable load while the steam turbines, and auxiliaries remain in a stable and controlled condition, see also

B0.7.3.4.2 72h Full Load Continuous Test Run

After successful completion of the Tests on Completion and availability of the Commissioning Completion Certificate (CCC), signed by the Employer and the Contractor, the "Authorization to Start the 72 h Full Load Continuous Test" shall be signed.

No trip is admitted during these 72 h. Should the Plant or a Unit, as the case may be, not follow the requested load during the 72 h test, the test shall be restarted.

B0.7.4 Performance Tests

Performance Tests of the Unit(s)
After successful completion of the 72h Full Load Continuous Test Run and after relevant test protocols have been accepted by the Employer for the Unit(s) and Common Facilities, the Contractor shall be allowed to prepare the Unit(s) for the Performance Tests.

For the Unit(s) following guarantees given in the **Technical Schedule B0** shall be tested during the related Performance Test; this includes:

- Performance guarantees of the Unit(s)
- Operating guarantees
- Emission guarantees
- Guarantees of steam generator(s), steam turbine generator(s), flue gas treatment systems etc.

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Performance Test of the Plant

After completion of the Performance Tests of the Unit(s), the guarantees of the Plant and the common facilities shall be tested in a separate Performance Test; this includes:

- Performance guarantees of the Plant
- Emission guarantees of the Plant
- Emission guarantees of the auxiliary boiler
- Noise guarantees
- Guarantees of the water and waste water treatment systems
- Effluent and water outfall guarantees.

Dependable Capacity Test according to the PPA

Dependable Capacity means- means at any given time the net amount of capacity at the tariff metering; either for the first generating unit or for the Plant, as the case may be, as determined by the most recent dependable capacity test which shall be comply with ASME standards and shall be carried out as part of the Reliability Run. The Dependable Capacity of the Plant is measured at the Delivery Point. It equals the average Export Power Output, corrected to Reference Site Conditions using correction factors, delivered during twelve continuous thirty (30) minute periods divided by six (6) hours.

Dependable Capacity is the power output/capacity of a unit or the plant which can be reliable evacuated to the grid and which shall be verified by the "Dependable Capacity Test according to PPA". In additon refer to the defnition under B0.2.9.2

The Dependable Capacity Test and the Performance Testing in general will carried out under the the actual prevail conditions. The measued power output and other guaranteed performance data shall be corrected to the reference conditions using the correction curves to be provided by the Bidder/Contractor.

Performance Tests shall be conducted in accordance with following standards:

- the Plant ASME PTC 46
- steam generator ASME PTC 4
- steam turbine ASME PTC 6
- cooling tower ASME PTC 23
- FGD plant ASME PTC 40.

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As for supercritical steam power plants operation without make-up must be possible for a defined time period, the guarantee figures shall not include make-up.

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The curves required for the correction of the power output and specific heat rate to the site specified ambient conditions shall be listed in the technical schedules of the Plant performance and steam generator and steam turbine performance, and shall be submitted with the Tender. These curves shall be conclusive and no extra correction shall be given.

The margins required for instrument inaccuracies and for all other reasons shall be deemed to be included in the guarantee figures. The actual figures determined during performance tests shall hence be not corrected with any margins due to instrument inaccuracies prior to comparison with the guarantee figures.

Degradation and fouling during commissioning and other operation prior to Provisional Acceptance shall be deemed to be included in the guarantee figures. The actual figures determined during performance tests shall hence be not corrected for any degradation or fouling effect prior to comparison with the guarantee figures.

Degradation curves for the Plant and Unit(s) performance shall be submitted by the Contractor with bid. The curves shall show the equipment's degradation in power output and heat rate versus equivalent operating hours. The curves shall be applicable up to and including final major overhaul.

Test program

In due time prior to the tests a detailed procedure covering the testing to be undertaken and the methods to be employed shall be provided by the Contactor. The test procedure shall also detail areas of responsibility and the items that specifically require preparation and agreement before the tests can be carried out.

The test program shall cover the following documents but not be limited to:

- test procedure and standards (including proposed formulae / curves and standards)
- test schedule
- type of test
- manpower and deployment schedule of the Contractor for performing the tests forms of test records and report
- description of instrumentation to be used, including accuracy, and calibration test results
- method of data recording
- list of all auxiliary loads that will be operating during the tests. The list of auxiliary loads shall be provided with the test program and agreed in the Test Procedure.
- method and equations/correction curves used for adjustment of recorded data to the design conditions.

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Test responsibility
All tests shall be prepared and conducted by the Contractor. The Plant shall be operated by Contractor's operation personnel.

The Employer and/or an independent third party, awarded by the Employer.shall have the right to witness the tests.

Contractor's personnel appointed to carry out the tests shall be adequately skilled and experienced. Information on these personnel shall be provided to the Employer as part of the test program for review.

Test instrumentation
The Contractor shall supply and install all test instrumentation needed to conduct the tests. Temporary instrumentation installed for test purposes only and shall be retained at Site upon the satisfactory conclusion of all tests and shall be then removed.

All instruments to be used for the test shall be strictly dedicated calibrated measurement equipment. Each measuring instrument used shall be according to controlled and provided with a valid calibration certificate.

The calibration of PG Test instrument shall be carried out as per PTC-6 by an independent authorised company, which shall have appropriated quality standards and which shall be to be approved by the Employer, except for instruments which are calibrated and certified at a certified laboratory and holding the authorized traceability certificate. The certificate shall not be older than six (6) months.

Test Duration
The test shall begin after the Plant or a Unit including common facilities, as the case may be, has established stable operation, as judged by the Employer and/or an independent third party, awarded by the Employer.

The test duration shall be in accordance with the standards and codes.

One 60-minute test run shall be conducted for each guaranteed load point, during which the operating conditions shall remain within the defined plant stability criteria.

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Test conditions
Performance tests shall be conducted at conditions close to the conditions of the Guarantees. Thereby the boiler and steam turbine cycle shall be adjusted to the conditions of the corresponding heat balance diagram.

Since the accuracy of the test results highly depend on the exact water-steam cycle arrangement respective cycle isolation is required to avoid any unknown cycle leakages. The valve position list has to be provided by the Contractor prior to the performance test. This cycle arrangement shall fully remain during the whole testing period. Any changes of the performance

conditions during the tests are not allowed.

Test evaluation
The Contractor shall submit for the acceptance of the Performance Test all detailed measurements, calculations and individual test results (such as, but not limited to turbine efficiency calculations, generator and transformer details, condenser performance, feedwater heaters and deaerator details, boiler efficiency calculations, pulverizing fineness and other results, air heater temperature traverses and leakage results, coal handling system performance, ash characteristics and ash handling systems performance, ESP and FGD performance and emissions, individual auxiliary power consumption figures, major consumers performance, noise and effluents etc.) and the corrections made based on the correction curves.°

The Performance Test report shall be submitted by the Contractor. This report shall include, as a minimum, the following:

- description of the test procedures
- instrumentation details and calibrations (not older than six months)
- full process flow diagrams for fuel, air and flue gas and water and steam with indication of instrument position
- standards that were used
- test logs and summary (arithmetic average) of test readings used for performance calculations
- full set of correction curves
- calculations
- instrument calibration certificates
- list of all auxiliary loads that were operated during the tests
- performance tests results for the "As-run" condition and for the "Corrected as-run conditions"
- conclusions of performance tests: test passed or not.

B0.7.5 Reliability test run

After successful completion of all Performance Tests the Plant or a Unit including common facilities, as the case may be, shall start the 30 (thirty) days Reliability Test Run.

During the Reliability Test Run the Contractor shall demonstrate that the Plant or a Unit including common facilities, as the case may be, is fit for commercial operation.

During the specified periods, the Plant shall be operated continuously and in accordance with the prevailing power requirements of the Transmission System/BPDB or as required by the Employer.

During the Reliability Test Run the Employer's operation personnel shall operate the Plant under the full supervision and the responsibility of the

Contractor's Personnel and according to the O&M manual as supplied by the Contractor.

For the successful completion of the Reliability Test Run, a maximum of 4 trippings of not more than combined outage of 24 hours are allowed, otherwise the Reliability Test Run will be considered as failed and a new Reliability Test Run will have to be executed until the test has been completed.

At the conclusion of the Reliability Test Run the Contractor shall request from the Employer the issuing of the Provisional Acceptance Certificate (PAC).

A list of minor pending items, which are at the judgment of the Employer do not jeopardize the trouble-free operation of the Plant or a Unit including common facilities, as the case may be, could be attached to that certificate. The envisaged completion date for each item shall be stated in it.

With the issuing of the PAC the Employer takes legal possession of the Plant or a Unit including common facilities, as the case may be, and the Warranty Period will begin.

During the Warranty Period the Contractor has to keep at site at least three Warranty Engineers at Site. Part of their duty shall be inter alia to complete in time the works for the minor punch items mentioned in the PAC. They shall issue, together with the Employer, special reports, should any damages occur to any equipment. Moreover they shall assist the Employer during the daily plant operation and issue additional operational instructions, if requested. They shall assist the Maintenance Superintendent in his work organization and spare part handling procedure.

At the successful conclusion of the Warranty Period, the Contractor shall request the Employer to issue the Final Acceptance Certificate (FAC).

Additional requirements as per the PPA The Facility shall operate continuously (without interruption) for
Seventy two (72) continuous hours at then demonstrated Dependable Capacity. For ninety six (96) hours the output shall be as requested by BPDB in accordance with the Dispatch provisions as outlined in the PPA.

Abbreviations

(Please refer also to relevant Sections "**Standards and Codes**" and "**Units of measurement**")

AASHTO	American Association of State Highway and Transportation Officials
AC	Alternating Current
AGC	Automatic Grid Control

ASC	Average Site Conditions
ATRS	Automatic Turbine Run-up System
ATT	Automatic Turbine Testing System
AVQR	Automatic Voltage and Reactive Power Control
AVT	All Volatile Treatment
BFP	Boiler Feedwater Pump
BIMS	Building Information Management System
BMCR	Boiler Maximum Continuous Rating
BMS	Burner Management System
BOD	Biological Oxygen Demand
BOP	Balance of Plant
BOQ	Balance of Quantities
BPDB	Bangladesh Power Development Board
BPS	Boiler Protection System
CCR	Central Control Room
CCTV	Closed Circuit Television
CD	Chart Datum
CEMS	Continuous Emission Monitoring System
CHP	Coal Handling Plant
CO	Carbon Monoxide
COD	Commercial Operation Date
COD	Chemical Oxygen Demand
CT	Current Transformer
CW	Cooling Water
DAF	Dry Ash Free
DC	Direct Current
DCDB	DC Distribution Board
DCS	Distributed Control System
DDCMIS	Distributed Digital Control Monitoring & Information System
DCS	Distributed Control System
DOE	Department of the Environment, Bangladesh
DOSH	Department of Safety and Health, Bangladesh
DPC	Damp Proof Course
DWT	Dead Weight Tons
ECP	Electrochlorination Plant
EHG	Turbine Electro Hydraulic Governor Control System
EHSG - TTP	IFC Environmental Health and Safety Guidelines Thermal Power Plants
EHV	Extra High Voltage (500 kV)
EIA	Environmental Impact Assessment
EMC	Electro-Magnetic Compatibility
EPC	Engineering, Procurement, Construction
ESP	Electrostatic Precipitator
ETP	Effluent Treatment Plant
FDF	Forced Draught Fan
FEGT	Furnace Exit Gas Temperature
FGD	Flue Gas Desulphurization Plant
FTU	Field Mounted Termination Unit

GCV	Gross Calorific Value
G-EHSG	IFC General Environmental Health and Safety Guideline
GJ	Gigajoule
GPS	Global Positioning System
GRP	Glass Fiber Reinforced Piping
GWh	Gigawatt hour
GSO	Grid System Operator
HART	Highway Addressable Remote Transducer
HAZOP	Hazard and Operability Study
HCSD	High Concentration Slurry / Solids Disposal
HDPE	High Density Polyurethane
HHV	Higher Heating Value
HMI	Human Machine Interface
HRC	High Ruption Capacity Fuse
HV	High Voltage
HVAC	Heating, Ventilation, Air Conditioning
Hz	Hertz
I&C	Instrumentation and Control
IDF	Induced Draught Fan
IOD	Initial Operation Date
IP	Intermediate Pressure
IPL	Independent Protection Layer
IPP	Independent Power Producer
IR	Infrared
kV	Kilovolt
kW	Kilowatt
LAN	Local Area Network
LCC	Local Control Center
LCV	Lower Calorific Value
HSD	High Speed Diesel
LHV	Lower Heating Value
LIE	Local Instrument Enclosure
LIR	Local Instrument Rack
LP	Low Pressure
LV	Low Voltage
LVS	Large Video Screen
MCC	Motor Control Center
MCL	Maximum Continuous Load
MCR	Maximum Continuous Rating
MCWP	Main Cooling Water Pump
MDBFP	Motor Driven Boiler Feed Pump
MLSD	Land Survey Datum
MNCL	Minimum Continuous Load
MNCR	Minimum Continuous Rating
MOV	Motor Operated Valve
MV	Medium Voltage
MVA	Megavolt Ampere
MVAR	Megavolt Ampere Reactive
MWh	Megawatt hour

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MWQCS	Marine Water Quality Criteria and Standards
NCC	Network Control Center
NDE	Non Destructive Examination
NFPA	National Fire Protection Association
NLDC	National Load Dispatch Centre
NO_x	Nitrogen Oxides
NOR	Notice of Readiness
NPSH	Net Positive Suction Head
NRV	Non Return Valve
O&M	Operation and Maintenance
OEM	Original Equipment Manufacturer
OHL	Over head line
P&I	Piping and Instrumentation
P&ID	Piping and Instrumentation Diagram
PA	Public Address
PABX	Private Automatic Branch Telephone Exchange
PA	Primary Air
PADO	Plant Performance Analysis, Diagnosis and Optimization System
PAF	Primary Air Fan
PC	Pulverized Coal
PCDD	Polychlorinated Dibenzodioxins
PCDF	Polychlorinated Dibenzofurans
PF	Performance Fuel
PLC	Programmable Logic Controller
PPA	Power Purchase Agreement
PQR	Procedure Qualification Record
PSS	Power System Stabiliser
PVC	Polyvinyl Chloride
PWD	Public Works Department
PWHT	Post welding heat treatment
QA	Quality Assurance
RAPH	Regenerative Air Preheater
RC	Reinforced Concrete
RSC	Reference Site Conditions
SA	Secondary Air
SAH	Steam Air Heater
SCADA	Supervisory Control and Data Acquisition
SCAPH	Steam Coil Air Heater
SCS	Substation Control System
SER	Sequence of Events Recording
SG	Steam Generator
SI	Soil Investigation
SIL	Safety Integrity Level
SO_2	Sulphur Dioxide
SOE	Sequence of Events
SSC	Summer Site Conditions
ST	Steam Turbine
STG	Steam Turbine Generator

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Bangladesh-India Friendship Power Company (Pvt) Ltd.
BIFPCL

SWAS	Steam and water analyses system
TCS	Technical Comment Sheet
TDS	Total dissolved solids
TEFC	Totally enclosed Fan cooled
TG	Turbine Generator
TIG	Tungsten Inert Gas
TLA	Three-Letter Abbreviation
TMC	Turbine Maximum Capacity
TMCR	Turbine Maximum Continuous Rating
TSCS	Turbine Stress Control System
TSI	Turbine Supervisory Instruments
UHF	Ultra High Frequency
UV	Ultraviolet
VDU	Video Display Unit
VT	Voltage Transformer
VMS	Vibration monitoring system
VWO	Valves Wide Open
WSC	Winter Site Conditions
WPS	Welding procedure specification
WTP	Water Treatment Plant
WWD	Weather Working Days
WWTP	Waste Water Treatment Plant

SECTION-III

DOCUMENTS TO BE SUBMITTED ALONG WITH BID

SUB-SECTION IIIA – Documents Furnished along with offer

SUB-SECTION IIIB – Compliance cum confirmation certificate

SUB-SECTION IIIC – Electrical Load Data

SUB-SECTION IIID – Pre Bid Clarification

DOCUMENTS TO BE FURNISHED WITH OFFER FOR TECHNICAL EVALUATION

1) DEVIATION SHEET (COST OF WITHDRAWAL): TO BE FILLED UP BY BIDDER IN THE FORMAT ATTACHED AS ANNEXURE –II OF GENERAL CONDITIONS OF CONTRACT ISSUED ALONG WITH TENDER. ANY DEVIATION QUOTED ELSEWHERE/ IN OTHER FORMAT SHALL NOT BE CONSIDERED

2) SIGNED AND STAMPED COPY OF COMPLIANCE CUM CONFIRMATION CERTIFICATE.

3) CREDENTIALS WITH REFERENCE TO TECHNICAL PRE-QUALIFICATION REQUIREMENT.

4) FILLED ELECTRICAL LOAD LIST, DULY SIGNED AND STAMPED.

5) UNPRICED SCHEDULE IN THE PRICE FORMAT ISSUED ALONG WITH TENDER.

NOTE:

i) NO OTHER DOCUMENTS OTHER THAN THOSE LISTED ABOVE ARE REQUIRED TO BE SUBMITTED FOR TECHNICAL EVALUATION. IN CASE ANY OTHER DOCUMENT IS FURNISHED, THE SAME WILL NOT BE TAKEN INTO CONSIDERATION FOR TECHNICAL EVALAUATION.

	TITLE: 2X660 MW BIFPCL MAITREE KHULNA TECHNICAL SPECIFICATION FOR WORKSHOP EQUIPMENT (O & M STORE- STORE HANDLING EQUIPMENT AND MISC. STORES ITEMS) COMPLIANCE CUM CONFIRMATION CERTIFICATE	SPEC. NO.: PE-TS-421-568-A006A VOLUME: **III** SECTION: III REV. NO. **0** Date:

COMPLIANCE CUM CONFIRMATION CERTIFICATE

The bidder shall confirm compliance with following by signing/ stamping this compliance certificate (every sheet) and furnish same with the offer.

a) The scope of supply, technical details, construction features, design parameters etc. shall be as per technical specification & there are no exclusions other than those mentioned under “exclusion” in section C and those resolved as per ‘Schedule of Deviations’, if applicable, with regard to same.

b) There are no other deviations w.r.t. specifications other than those furnished in the ‘Schedule of Deviations’. Any other deviation, stated or implied, taken elsewhere in the offer stands withdrawn unless specifically brought out in the ‘Schedule of Deviations’.

c) Bidder shall submit QP in the event of order based on the guidelines given in the specification & QP enclosed therein. QP will be subject to BHEL/ CUSTOMER approval & customer hold points for inspection/ testing shall be marked in the QP at the contract stage. Inspection/ testing shall be witnessed as per same apart from review of various test certificates/ Inspection records etc. This shall be within the contracted price with no extra implications to BHEL after award of the contract.

d) All drawings/ data-sheets/ calculations etc. submitted along with the offer shall be considered for reference only, same shall be subject to BHEL/ CUSTOMER approval in the event of order.

e) The offered materials shall be either equivalent or superior to those specified in the specification & shall meet the specified/ intended duty requirements. In case the material specified in the specifications is not compatible for intended duty requirements then same shall be resolved by the bidder with BHEL during the pre - bid discussions, otherwise BHEL/ Customer’s decision shall be binding on the bidder whenever the deficiency is pointed out.

   For components where materials are not specified, same shall be suitable for intended duty, all materials shall be subject to approval in the event of order.

f) The commissioning spares shall be supplied on ‘As Required Basis’ & prices for same included in the base price itself.

g) All sub vendors shall be subject to BHEL/ CUSTOMER approval in the event of order.

h) Guarantee for plant /equipment shall be as per relevant clause of GCC /SCC /Other Commercial Terms & Conditions.

i) In the event of order, all the material required for completing the job at site shall be supplied by the bidder within the ordered price and within purview of the tender specification even if the same are additional to approved billing break up, approved drawing or approved Bill of quantities.

j) Schedule of drawings submissions, comment incorporations & approval shall be as stipulated in the specifications. The successful bidder shall depute his design personnel to BHEL’s/ Customer’s/ Consultant’s office for across the table resolution of issues and to get documents approved in the stipulated time.

k) As built drawings shall be submitted as and when required during the project execution.

l) The bidder has not tempered with this compliance cum confirmation certificate and if at any stage any tempering in the signed copy of this document is noticed then same shall be treated as breach of contract and suitable actions shall be taken against the bidder.

LOAD TITLE	RATING (KW / A)		UNIT (U)/STN (S)	Nos.		VOLTAGE CODE*	FEEDER CODE**	EMER. LOAD (Y)	CONT.(C)/ INTT.(I)	STARTING TIME >5 SEC (Y)	LOCATION	BOARD NO.	CABLE		BLOCK CABLE DRG. No.	CONTROL CODE	REMARKS	LOAD No.	VERIFICATION FROM MOTOR DATASHEET (Y/N)	KKS NO
	NAME PLATE (Range of Load)	MAX. CONT. DEMAND (MCR)		RUNNING	STANDBY								SIZE CODE	NOs						
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21

NOTES:
1. COLUMN 1 TO 12 & 18 SHALL BE FILLED BY THE REQUISITIONER (ORIGINATING AGENCY); REMAINING COLUMNS ARE TO BE FILLED UP BY PEM (ELECTRICAL)/ CUSTOMER
2. ABBREVIATIONS : * VOLTAGE CODE (7):- (ac) A=11 KV, B=6.6 KV, C=3.3 KV, D=415 V, E=240 V (1 PH), F=110 V (cc): G=220 V, H=110 V, J=48 V, K=+24V, L=-24 V
: ** FEEDER CODE (8):- U=UNIDIRECTIONAL STARTER, B=BI-DIRECTIONAL STARTER, S=SUPPLY FEEDER, D=SUPPLY FEEDER (CONTACTER CONTROLLED)

LOAD DATA (ELECTRICAL)	JOB NO.	421	ORIGINATING AGENCY		PEM (ELECTRICAL)
	PROJECT TITLE	2X660 MW BIFPCL MAITREE	NAME		DATA FILLED UP ON
	SYSTEM		SIGN.		DATA ENTERED ON
	DEPTT. / SECTION	MAX	SHEET 1 OF 1	REV. 00	DE'S SIGN. & DATE

PRE-BID CLARIFICATION SCHEDULE

S. No.	Section/Clause /Page No.	Statement of the referred clause	Clarification Required

The bidder hereby certifies that above mentioned are the only clarifications required on the technical specification for the subject package.

SIGNATURE: _____

NAME: _____

DESIGNATION: _____

COMPANY: _____

DATE: _____

COMPANY SEAL