



TABLE I

Type of Steel	Design factor	Wall thickness (mm)	Inside diam (mm)	Type and Extent of non destructive testing				Remarks
	(shell)	(mm)	(mm)	Butt	Nozzle	Fillet		
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).
	> 0.85	≤ 40	≤ 100	20% R	-	-		
		> 40	all	100% R	10% M	10% M		
C-Mn steels with C content 0.25 to 0.35%, CrMoV steels, C 1/2 Mo steels, low alloy steels, and CrMo steels except 12% Cr steels	> 0.85	≤ 40	≤ 100	20% R	-	-		
		> 40	> 100	100% R	10% M	10% M		Test after stress relief
		≤ 30	all	100% R	100% M	100% M		
Low alloy steels except CrMoV and 2 CrMo	all	> 30	all	100% R	100% M	100% M		Test after stress relief
	all	all	all	100% R	100% U**	100% M		Test after stress relief
	all	all	≤ 100 > 100	100% R 100% R*	100% M 100% M	100% M 100% M		Test after stress relief Test after stress relief

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

** If feasible, otherwise 100% M.

Type of Steel	Design factor (shell)	Wall thickness (mm)	Inside diam (mm)	Type and Extent of non destructive testing			Remarks
Austenitic Stainless Steels	≤ 0.85	≤ 15	all	Butt	Nozzle	Fillet	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	-	-	
		> 30	> 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:

- 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.
- 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.
- 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.
- 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%.

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,

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

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.
- 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/m² 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 auxilliary 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.

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). 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 I (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 type are supplied, test can be carried out with the same motor.

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, stop and governing valves on a suitable erection rig at the manufacturer's works and shall be carefully inspected and measured for manufacture and assembly tolerances. 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.

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

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.

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.

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

IEEC37.013

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.

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.

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.

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.

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.



Signature



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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
- 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 U_r , $1.05 \times U_r$ and $1.1 \times U_r$
- Dielectric routine tests in accordance with IEC 60076-3
- Transformers having $U_r \leq 300$ kV will be tested to Method 1
- Test on on-load tap changers
- Insulation resistance
- Separate source voltage withstand test
- Induced over voltage test & PD test
- Frequency response analysis.

The above tests shall be carried out on all transformers.

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 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 the working 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.

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.

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 coupled with exciter rotor
 - over-speed test coupled with exciter
 - measurement of 50 Hz rotor impedance.
- Stator core laminations
 - magnetic
 - layer resistance
- Generator H2 cooler (if H2 cooling)
 - hydrostatic test
- Generator assembled:
 - three phase short circuit characteristic test and current balance check
 - dielectric test
 - 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

d) Routine tests on generator exciter

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

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 reciprocating 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.

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: NO_x, 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 |
| • 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.

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).

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 - Performance requirements
IEC	62471	Photobiological safety
IEC	62384	DC or AC supplied electronic control gear for LED modules - Performance 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	Luminaires 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 to 150 kV
IEC	62067	Power cables with extruded insulation and their accessories for rated voltages above 150 kV up to 500 kV
IEC	60502	Power cables with extruded insulation and their accessories for rated voltages from 1 kV up to 30 kV

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 to IEC 60754
- Water Tree Test of XLPE Insulation (accelerated)
- Test voltage = $3 \times U_0$
- Test frequency = 500 Hz
- Core environment = 400C water



- Duration of test = 4 month
- Test after 4 months: Dielectric stress withstand $>14\text{kV/mm}$.

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 – 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.

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 = $3 \times U_0$
- Test frequency = 500 Hz
- Core environment = 400C water
- Duration of test = 4 month
- Test after 4 months: Dielectric stress withstand $>14\text{kV/mm}$.

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 elastomeric 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.

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.
 - Test 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 oversheats acc. to Clause 12.5.6
 - Other test on oversheats 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.

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 = $3 \times U_0$
 - Test frequency = 500 Hz
 - Core environment = 40°C 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 elastomeric 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).

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

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 transmitter
- 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
- 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.

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





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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.

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.

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
- 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.



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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 U_E 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 U_B ,
- 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 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.

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.

Performance Tests shall be conducted in accordance with following standards:

- | | |
|-------------------|--|
| • the Plant | ASME PTC 46 |
| • steam generator | ASME PTC 4 (or equivalent ISO) |
| • steam turbine | ASME PTC 6 (or DIN 1943 or equivalent ISO) |



- cooling tower ASME PTC 23
- FGD plant ASME PTC 40.

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 Contractor. 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.

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 shall be carried out by an independent third party, 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.

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.

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.

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.



B0.8 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
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
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
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



B0.9 Technical Schedules

The following technical schedules comprise part of this specification. The data and requirements specified in the respective forms are to be adhered to and the missing data of forms are to be completely filled in. The completed technical schedules are to be submitted with the Bid.

B0 Technical Schedule General

B0 Sub-supplier List





TITLE:
**TECHNICAL SPECIFICATION
COLTCS**

SPECIFIC TECHNICAL REQUIREMENTS

SPEC. NO.: **PE-TS-421-165-N002**

SECTION: **I**

SUB-SECTION: **IB**

REV. NO. **00** DATE **02.01.2018**

SHEET **1** OF **1**

SUB-SECTION – IB

SPECIFIC TECHNICAL REQUIREMENTS (ELECTRICAL)



TITLE: ELECTRICAL EQUIPMENT SPECIFICATION FOR COLTCS/SCS/DF/TWS 2X660 MW MAITREE SUPER THERMAL POWER PROJECT	SPECIFICATION NO.
	VOLUME NO. : II-B
	SECTION: I
	REV NO. : 00 DATE: 05/12/2017
	SHEET: 2 OF 3

SPECIFIC TECHNICAL REQUIREMENTS: ELECTRICAL

1.0 EQUIPMENT & SERVICES TO BE PROVIDED BY BIDDER:

- a) Services and equipment as per "Electrical Scope between BHEL and Vendor".
- b) Any item/work either supply of equipment or erection material which have not been specifically mentioned but are necessary to complete the work for trouble free and efficient operation of the plant shall be deemed to be included within the scope of this specification. The bidder without any extra charge shall provide the same.
- c) Supply of mandatory spares as specified in the specifications of mechanical equipment's.
- d) Electrical load requirement for COLTCS/SCS/DF/TWS.
- e) All equipment shall be suitable for the power supply fault levels and other climatic conditions mentioned under part B0 of FICHTNER Technical Specification.
- f) Various drawings, data sheet as per required format, quality plans, calculations, Type test & Routine test reports & certificates, operation and maintenance manuals, complete technical literature with catalogues etc. shall be furnished as specified at contract stage. All documents shall be subject to customer /BHEL approval without any commercial implications to BHEL.
- g) All electrical equipment (Motors, cables, cabling material etc.) shall meet requirements of specification B0- "General Technical Specification".
- h) All materials, components and equipment covered under this specification shall be procured, manufactured as per the requirements of specification B0- "General Technical Specification" For motors, BHEL standard quality plan for Motors (55KW & ABOVE) enclosed with the specification shall also be complied.
- i) Acceptance of motor less than 30kW is based on COC of manufacturer & contractor confirming as follows:
It is hereby confirmed that the above mentioned motor/ motors was/ were manufactured taking care of BIFPCL specific requirements regarding ambient temp., voltage & frequency variation, hot starts, pull out torque, starting kVA/kW, temp. rise, distance between centre of stud & gland plate and tested in accordance with approved drawing/ data sheets.
- j) Acceptance of motor rating between 30kW & 50kW is based on BIFPCL review of Routine Test reports as per relevant IEC by main contractor along with COC of manufacturer & contractor conforming as follows:
It is hereby confirmed that the above mentioned motor/ motors was/ were manufactured taking care of BIFPCL specific requirements regarding ambient temp., voltage & frequency variation, hot starts, pull out torque, starting kVA/kW, temp. rise, distance between centre of stud & gland plate, space heater and tested in accordance with approved drawing/ data sheets.
- k) The sub-vendor list for various electrical items is subject to BHEL/Customer approval without any commercial implications.
However, bidder to note that sub-vendor list attached with the specification is only indicative & shall be finalized with L1 bidder before placement of LOI.
- l) Vendor to clearly indicate equipment locations and local routing lengths in their cable listing furnished to BHEL.
- m) Cable BOQ worked out based on routing of cable listing provided by the vendor for "both end equipment in vendor's scope" shall be binding to the vendor with +10 % margin to take care of slight variation in routing length & wastages.



TITLE: ELECTRICAL EQUIPMENT SPECIFICATION FOR COLTCS/SCS/DF/TWS 2X660 MW MAITREE SUPER THERMAL POWER PROJECT	SPECIFICATION NO.
	VOLUME NO. : II-B
	SECTION: I
	REV NO. : 00 DATE: 05/12/2017
	SHEET: 3 OF 3

2.0 EQUIPMENT & SERVICES TO BE PROVIDED BY PURCHASER FOR ELECTRICAL & TERMINAL POINTS:

Refer "Electrical Scope between BHEL and Vendor".

3.0 DOCUMENTS TO BE SUBMITTED ALONG WITH BID

- 3.1** The electrical specification without any deviation from the technical/quality assurance requirements stipulated shall be deemed to be complied by the bidder in case bidder furnishes the overall compliance of package technical specification in the form of compliance certificate/No deviation certificate.
- 3.2** No technical submittal such as copies of data sheets, drawings, write-up, quality plans, type test certificates, technical literature, etc, is required during tender stage. Any such submission even if made, shall not be considered as part of offer.

STANDARD ELECTRICAL SCOPE BETWEEN BHEL AND VENDOR (FOR EPC PROJECTS)

PACKAGES: COLTCS/SCS/DF/TWS

SCOPE OF VENDOR: SUPPLY

PROJECT: 2X660 MW MAITREE SUPER THERMAL POWER PROJECT

S.NO	DETAILS	SCOPE SUPPLY	SCOPE E&C	REMARKS
1	415V MCC Starter cum control panel (if applicable)	BHEL Vendor	BHEL BHEL	240 V AC (supply feeder)/415 V AC (3 PHASE 4 WIRE) supply shall be provided by BHEL based on load data provided by vendor at contract stage for all equipment supplied by vendor as part of contract. Any other voltage level (AC/DC) required will be derived by the vendor.
2	Local Push Button Station (for motors)	Vendor	BHEL	Located near the motor.
3	Power cables, control cables and screened control cables for a) both end equipment in BHEL's scope b) both end equipment in vendor's scope c) one end equipment in vendor's scope	BHEL Vendor BHEL	BHEL BHEL BHEL	1. For 3.b) & c): Sizes of cables required shall be informed by vendor at contract stage (based on inputs provided by BHEL) in the form of cable listing. Finalisation of cable sizes shall be done by BHEL. Vendor shall provide lugs & glands accordingly. 2. Termination at BHEL equipment terminals by BHEL. 3. Termination at Vendor equipment terminals by Vendor.
4	Junction box for control & instrumentation cable	Vendor	BHEL	Number of Junction Boxes shall be sufficient and positioned in the field to minimize local cabling (max 10-12 mtrs) and trunk cable.
5	Any special type of cable like compensating, co-axial, prefab, MICC, fibre optical etc.	Vendor	BHEL	Refer scope/ C&I portion of specification for scope of fibre Optical cables if used between PLC/ microprocessor & DCS.
6	Cable trays, accessories & cable trays supporting system 100/ 50 mm cable trays/ Conduits/ Galvanised steel cable troughs for local cabling	BHEL Vendor	BHEL Vendor	Local cabling from nearby main route cable tray (BHEL scope) to equipment terminal (vendor's scope) shall be through 100/ 50 mm. FRP cable trays/ conduits/ Galvanised steel cable troughs, as per approved layout drawing during contract stage.
7	Cable glands and lugs for equipment supplied by Vendor	Vendor	BHEL	1. Cable glands shall be double compression Tinned brass conforming to BS: 6121. 2. Copper Cable lugs for control cable termination shall be PVC insulated/ sleeved type. The Material for lugs will be tinned copper only. Lugs for control cable shall be insulated & terminal shall be pin type/ flat type/ ring type / U type to suit terminal provided at panels.
8	Conduit and conduit accessories for cabling between equipment supplied by vendor	Vendor	BHEL	Conduits shall be medium duty, hot dip galvanised cold rolled mild steel rigid conduit as per IEC: 61386-1.

STANDARD ELECTRICAL SCOPE BETWEEN BHEL AND VENDOR (FOR EPC PROJECTS)

PACKAGES: COLTCS/SCS/DF/TWS

SCOPE OF VENDOR: SUPPLY

PROJECT: 2X660 MW MAITREE SUPER THERMAL POWER PROJECT

S.NO	DETAILS	SCOPE SUPPLY	SCOPE E&C	REMARKS
9	Lighting	BHEL	BHEL	
10	Equipment grounding & lightning protection	BHEL	BHEL	
11	Below grade grounding	BHEL	BHEL	
12	LT Motors with base plate and foundation hardware	Vendor	BHEL	Makes shall be subject to customer/ BHEL approval at contract stage.
13	Mandatory spares	Vendor	-	Vendor to quote as per specification.
14	Recommended O & M spares	Vendor	-	As specified elsewhere in specification
15	Any other equipment/ material/ service required for completeness of system based on system offered by the vendor (to ensure trouble free and efficient operation of the system).	Vendor	BHEL	
16	a) Input cable schedules (Control & Screened Control Cables) b) Cable interconnection details for above c) Cable block diagram	Vendor Vendor Vendor	- - -	Cable listing for Control and Instrumentation Cable in enclosed excel format shall be submitted by vendor during detailed engineering stage.
17	Equipment layout drawings	Vendor	-	For preparation of cabling layout drawings by BHEL, vendor shall furnish Electrical equipment layout drawings (both in print form as well as in AUTOCAD) of the complete plant (including electrical area) indicating location and identification of all equipment requiring cabling,
18	Electrical Equipment GA drawing	Vendor	-	For necessary interface review.

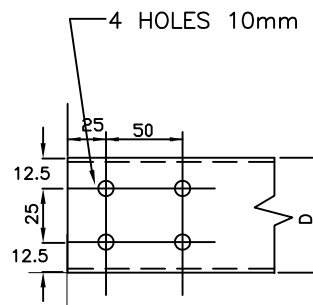
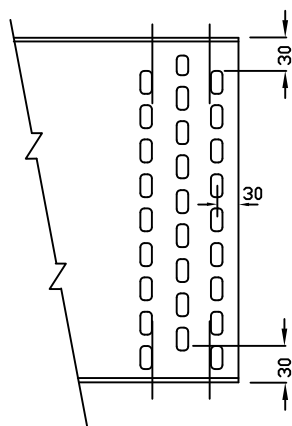
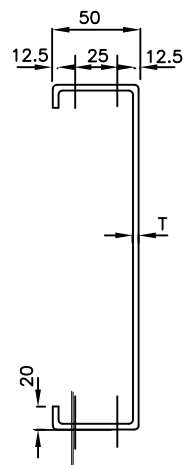
NOTES:

1. Make of all electrical equipment/ items supplied shall be reputed make & shall be subject to approval of BHEL/customer after award of contract.
2. All QPs shall be subject to approval of BHEL/customer after award of contract without any commercial implication.
3. In case the requirement of Junction Box arises on account of Power Cable size mis-match due to vendor engineering at later stage, vendor shall supply the Junction Box for suitable termination.

	TITLE	LV MOTORS DATA SHEET-A	SPECIFICATION NO.	
			VOLUME	II B
			SECTION	II
			REV NO. 00	DATE 27.11.2017
			SHEET 1	OF 1

1.0	Design ambient temperature	:	45 °C
2.0	Maximum acceptable kW rating of LV motor	:	<160KW
3.0	Installation (Indoors/ Outdoors)	:	As required
4.0	Degree of Protection	:	IP55
5.0	Type of Cooling	:	TEFC/CACA/TETV
6.0	Details of supply system		
	a)	Rated voltage (with variation)	: 415V ± 10%
	b)	Rated frequency (with variation)	: 50 Hz (Variation: +4% TO –6%)
	c)	Combined voltage & freq. variation	: 10%
	d)	System fault level at rated voltage	: 50 kA for 1 sec
	e)	Short time rating for terminal boxes	
		o 90kW & Above	: 50 kA for 1 sec
		(Breaker controlled)	
		o Below 90kW (SFU/MCCB+:	50 kA for 0.20 sec.
		Contactor controlled)	
	f)	LV System grounding	: Solidly
7.0	Class of insulation	:	Class 'F', with temp rise limited to class B.
8.0	Minimum voltage for starting (As percentage of rated voltage)	:	80% of rated voltage
9.0	Power cables data	:	Shall be given during detailed engg.
10.0	Earth Conductor Size & Material	:	Shall be given during detailed engg.
11.0	Space heater supply	:	240 V, 1Φ, 50 Hz
12.0	Rating up to which Single phase motor	:	Acceptable below 0.20 kW
13.0	Tests	:	As per motor spec. (enclosed)
14.0	Energy efficient/ Flame proof motor	:	Continuous duty LT motors up to 160 KW Output rating (At 45 deg.C ambient temperature), shall be Premium Efficiency class-IE3

- For further detailing please refer specification B0- “General Technical Specification”



TRAY WIDTH W (mm)	100	50
TRAY DEPTH D (mm)	50	50
T (mm)	2	2

COMPREHENSIVE & UPDATED LIST OF MAIN VENDORS FOR BoIs PROCURED BY ELECTRICAL, C&I, MPL & MSE TO BE USED AS APPROVED SUB-VENDORS FOR BoP/ BoI PACKAGES						APPLICABILITY OF ITEM AS PER PACKAGE
S. No.	Deptt.	Package	PMD Vendor/ Sub Vendor	Vendor Address	Remarks	COLTCS/SCS/DF/TWS
1	Electrical	LV MOTORS (NON FLAME PROOF)	ABB	14, MATHURA ROAD, FARIDABAD, HARYANA-121003	Sub vendor	YES
2	Electrical	LV MOTORS (NON FLAME PROOF)	BHARAT BIJLEE LTD.	BHARAT BIJLEE LIMITED, 1ST FLOOR, 7-B, RAJINDRA PARK, PUSA ROAD, NEW DELHI - 110 060.	Sub vendor	YES
3	Electrical	LV MOTORS (NON FLAME PROOF)	CROMPTON GREAVES	3RD FLOOR, EXPRESS BUILDING,9-10, BAHADUR SHAH ZAFAR MARG, NEAR ITO CROSSING,NEW DELHI-110002, INDIA	Sub vendor	YES
4	Electrical	LV MOTORS (NON FLAME PROOF)	GE-POWER	KAMAK TOWER, 3RD FLOOR, PLOT NO. 12-A, TVK INDUSTRIAL ESTATE, EKKADUTHANGAL, GUINDY, CHENNAI-600032	Sub vendor	YES
5	Electrical	LV MOTORS (NON FLAME PROOF)	KIRLOSKAR ELECTRIC CO LTD.	P.O. BOX 5555 , MALLESWARAM WEST ,BANGALORE 560055	Sub vendor	YES
6	Electrical	LV MOTORS (NON FLAME PROOF)	LAXMI HYDRAULICS PVT. LTD	129/130, INDUSTRIAL ESTATE PATIL NAGAR, HOTGI ROAD SOLAPUR-413003, MAHARASHTRA	Sub vendor	YES
7	Electrical	LV MOTORS (NON FLAME PROOF)	MARATHON	MARATHON ELECTRIC INDIA PRIVATE LTD.SECTOR - 11, MODEL TOWN, FARIDABAD - 121006	Sub vendor	YES
8	Electrical	LV MOTORS (NON FLAME PROOF)	NGEF	POCKET NO.10, FLAT NO. 37 & 38, EXPANDABLE DDA FLATS, NASIRPUR DWARKA, PHASE-I NEW DELHI-110 045	Sub vendor	YES
9	Electrical	LV MOTORS (NON FLAME PROOF)	RAJINDRA ELECT INDUSTRIES	14 SHAH IND.ESTATE VEERA DESAI RD,ANDHERI(W) MUMBAI-400053	Sub vendor	YES
10	Electrical	LV MOTORS (NON FLAME PROOF)	SIEMENS	RC-IN I S NR DEL AREA, JIL BUILDING, TOWER-B, PLOT NO. 78, SECTOR 18, GURGAON-122015, INDIA	Sub vendor	YES
11	Electrical	LV MOTORS (FLAME PROOF)	RAJINDRA ELECT INDUSTRIES	14 SHAH IND.ESTATE VEERA DESAI RD,ANDHERI(W) MUMBAI-400053	Sub vendor	YES
12	Electrical	JUNCTION BOXES (NON FLAME PROOF)	JASPER ENGINEERS PVT. LTD.	A-23, SECTOR - 8, NOIDA-201301	Sub vendor	YES
13	Electrical	JUNCTION BOXES (NON FLAME PROOF)	Electro Controls & Devices	M/S ELECTRO CONTROLS & DEVICES, F-41, SITE-C, SURAJPUR INDUSTRIAL AREA GREATER NOIDA, UTTAR PRADESH :201308	Sub vendor	YES
14	Electrical	JUNCTION BOXES (NON FLAME PROOF)	M/s Shrenik & Co.	39A/3, PANCHRATNA INDUSTRIAL ESTATE, SARKHEJ-BAVLA ROAD, CHANGODAR, AHMEDABAD – 382 213	Sub vendor	YES
15	Electrical	JUNCTION BOXES (NON FLAME PROOF)	M/s PHOENIX MECANO LTD.,	388 BHARE, TALUKA MULSHI, POST GHOTAWADE, PIRANGOOT, INDUSTRIAL AREA, PUNE-412115	Sub vendor	YES
16	Electrical	JUNCTION BOXES (NON FLAME PROOF)	Adroit Control Engineers Pvt.Ltd.	M/S ADROIT CONTROL ENGINEERS PVT.LTD. PLOT-3, KRISHNA INDL. AREA, SECTOR-25 FARIDABAD – 121004	Sub vendor	YES
17	Electrical	JUNCTION BOXES (NON FLAME PROOF)	M/s PHOENIX MECANO LTD.,	388 BHARE, TALUKA MULSHI, POST GHOTAWADE, PIRANGOOT, INDUSTRIAL AREA, PUNE-412115	Sub vendor	YES

18	Electrical	JUNCTION BOXES (NON FLAME PROOF)	MIKA ENGINEERS	BRANCH OFFICE : 'D'-101, DHEERAJ HERITAGE RESIDENCY II, SHASTRI NAGAR, SANTACRUZ (W), MUMBAI 400 054.	Sub vendor	YES
19	Electrical	JUNCTION BOXES (NON FLAME PROOF)	M/s PHOENIX MECANO LTD.,	388 BHARE, TALUKA MULSHI, POST GHOTAWADE, PIRANGOOT, INDUSTRIAL AREA, PUNE-412115	Sub vendor	YES
20	Electrical	JUNCTION BOXES (NON FLAME PROOF)	BAJAJ ELECTRICALS	BAJAJ ELECTRICALS LTD. ENGINEERING & PROJECTS BU (NORTH) 3rd FLOOR, GULMOHARHOUSE, COMMUNITY CENTRE 161/B-4, GAUTAM NAGAR, YUSUF SARAI NEW DELHI – 110049	Sub vendor	YES
21	Electrical	JUNCTION BOXES (NON FLAME PROOF)	AJMERA INDUSTRIES & ENGG. WORKS	AJMERA INDL. AND ENGG. WORKS. AJMERA HOUSE, A-61 / KHAIRANE MIDC. , TTC INDL. AREA, NAVI MUMBAI – 400705.	Sub vendor	YES
22	Electrical	JUNCTION BOXES (NON FLAME PROOF)	S.B. ELECTRICAL ENGINEERING CORPORATION	03, SARDAR GRIHA BUILDING, LOHAR CHAWAL, MUMBAI-400002	Sub vendor	YES
23	Electrical	JUNCTION BOXES (FLAME PROOF)	SUDHIR SWITCHGEAR	305/6, APEEJAY HOUSE, 130, BOMBAY SAMACHAR MARG, MUMBAI - 400 023. INDIA	Sub vendor	YES
24	Electrical	FRP CABLE TRAYS & ACCESSORIES	EPP COMPOSITES PRIVATE LIMITED	Mr. Jayraj Shah Plot No. 2646, Kranti Gate Main Road, Rajkot Phone- 02827- 287060 Pincode : 360021 Email : vaishalijoshi@epp.co.in	PMD	YES
25	Electrical	FRP CABLE TRAYS & ACCESSORIES	SUMIP COMPOSITES PVT.LTD.	Mr.Suhrud Shah/Mr.Pulin Shah 39-A Panch Ratna Industrial Estate Sarkhej- Bavla Road. Changodar Ahmedabad Phone- 0271-7610701 Pincode : 382213 Email : sales@sumip.com	PMD	YES
26	Electrical	FRP CABLE TRAYS & ACCESSORIES	ERCON COMPOSITES	Mr. Mukesh Maheshwari F-123, M.I.A., Phase-II, Basni, Jodhpur Phone- 0291- 2744064 Pincode : 342005 Email : ercon@ercon-india.com	PMD	YES
27	Electrical	CABLE TRAY SUPPORT SYSTEM - BOLTABLE	PREMIER POWER PRODUCTS (CAL) PVT. LTD.	Chatterjee International Centre, 33A, Jawaharlal Nehru Road, 6th Floor, Suit No. - 11A, Kolkata, Phone- 9331008739 Pincode : 700071 Email : pppdaga@airtelmail.in	PMD	YES
28	Electrical	CABLE TRAY SUPPORT SYSTEM - BOLTABLE	INDUSTRIAL PERFORATION (I) PVT.LTD.	MR. A. K. SAHA 327, R.N.GUHA ROAD, DUM DUM KOLKATA Phone- 9830241788 Pincode : 700028 Email : ipipl@cal2.vsnl.net.in	PMD	YES
29	Electrical	CABLE TRAY SUPPORT SYSTEM - BOLTABLE	RATAN PROJECTS & ENGINEERING CO. PVT.LTD.	MR. G.D. SINGHEE/MR. MAHESH SINGHEE 26, P.K. TAGORE STREET, MAIN BUILDING KOLKATA Phone- 9830177331 Pincode : 700006 Email : mahesh@ratans.com	PMD	YES
30	Electrical	CABLE TRAY SUPPORT SYSTEM - BOLTABLE	INDMARK FORMTECH PVT. LTD.	Mr. Narendra R. Meher J Block, Plot No.- 375, MIDC BHOSARI PUNE Phone- 020- 27130546 Pincode : 411026 Email : indmarkformtech@vsnl.net	PMD	YES

31	Electrical	CABLE GLANDS	ALLIED TRADERS & EXPORTERS	C-124 A, SECTOR-2, NOIDA -201 301, UTTAR PRADESH, INDIA	Sub vendor	YES
32	Electrical	CABLE GLANDS	ARUP ENGG & FOUNDRY WORKS	391/119,PRINCE ANWAR SHAH ROAD, CALCUTTA-700068	Sub vendor	YES
33	Electrical	CABLE GLANDS	BALIGA LIGHTING EQPT.PVT.LTD.	63A,CP RAMASWAMY ROAD, ALWARPET,P.B.No 6910, CHENNAI-600018	Sub vendor	YES
34	Electrical	CABLE GLANDS	COMMET BRASS PRODUCTS	NUTAN CHEMICAL COMPOUND, WALBHAT ROAD, GOREGAON, MUMBAI-400063	Sub vendor	YES
35	Electrical	CABLE GLANDS	DOWELLS	M/S. DOWELLS ELECTRICALS 47/47A, SATGURU INDUSTRIAL ESTATE. OFF AAREY ROAD, GOREGOAN (EAST). MUMBAI 400 063.	Sub vendor	YES
36	Electrical	CABLE GLANDS	ELECTROMAC INDUSTRIES	27/28AF NEW EMPIRE IND.ESTT., R.KRISHNA MANDIR RD.JB NGR ,ANDHERI(E),MUMBAI-400059	Sub vendor	YES
37	Electrical	CABLE GLANDS	INCAB	HARE STREET,KOLKATA,WEST BENGAL-700001	Sub vendor	YES
38	Electrical	CABLE LUGS	DOWELLS	M/S. DOWELLS ELECTRICALS 47/47A, SATGURU INDUSTRIAL ESTATE. OFF AAREY ROAD, GOREGOAN (EAST). MUMBAI 400 063.	Sub vendor	YES
39	Electrical	CABLE LUGS	UNIVERSAL MACHINES LTD.	4,B.B.D.BAG (EAST) 90,STEPHEN HOUSE,5TH FLR CALCUTTA-700001	Sub vendor	YES
40	Electrical	GI CONDUITS	BIS APPROVED MAKE		Sub vendor	YES
Note: No. of rows to be increased/ decreased based on the no. of entries for a particular package.						



TITLE:
**TECHNICAL SPECIFICATION
COLTCS**

SPECIFIC TECHNICAL REQUIREMENTS

SPEC. NO.: **PE-TS-421-165-N002**

SECTION: **I**

SUB-SECTION: **IC**

REV. NO. **00** DATE **02.01.2018**

SHEET **1** OF **1**

SUB-SECTION – IC

SPECIFIC TECHNICAL REQUIREMENTS (C &I)



Technical specification for

2X660 MW STPP, MAITREE-BANGLADESH

SECTION C

REV. NO. 00

DATE : 05.12.2017

SPECIFIC TECHNICAL REQUIREMENTS - C&I FOR COLTCS

1	PROJECT	2X660 MW BIFPL MAITREE TPP
2	SYSTEM	CONDENSER ON LOAD TUBE CLEANING SYSTEM
3	CONTROL SYSTEM	DCS
4	COMMON/ PER UNIT	PER UNIT
5	LOCATION OF CONTROL SYSTEM	CER
6	CONTROL SYSTEM SCOPE (BIDDER/ BHEL/ CUSTOMER)	DCS IN BHEL SCOPE
7	HARDWIRED INTERFACE WITH DCS (Y/N)	NA
8	SOFTLINK TO DCS (Y/N)	NA
9	PROTECTION CLASS FOR PLC / RIO PANEL/LOCAL PANEL	As per Datasheet for Local control panel
10	CONTROL FROM PB's ON LCP	Y
11	ANNUNCIATION ON LCP (Y/N) -- IF Y, MIN NO. OF HARDWIRED ALARMS / INDICATIONS	Y, NOS. SHALL BE DECIDED DURING DETAILED ENGINEERING
12	MIMIC ON LCP (Y/N)	N
13	CONTROL FROM DCS IN CER (Y/N)	Y
14	NO. OF OWS / LAPTOP	NA
15	NO. OF PRINTER	NA
16	POWER SUPPLY AVAILABLE FOR BALL MONITOR (24V DC / 110 V AC UPS / 230 V AC UPS)	Vendor shall provide as per standard practice subject to Customer approval.
17	ACTUATOR WITH INTEGRAL STARTER (Y/N)	Y
18	DPG/ DPT per Balls Collecting Strainer	DPT = 2 nos. DPG = 1 no.
19	REMARKS	Starter cum control panel along with MCC in vendor scope.
20	PROJECT SPECIFIC INFO	Refer Specific technical requirements-C&I given below.



**Technical specification
for**

2X660 MW STPP, MAITREE-BANGLADESH

SECTION C

REV. NO.

00

DATE : 05.12.2017

Specific Technical Requirements - C&I for COLTCS/SCS/DF:

- 1. The Contractor shall provide Starter cum control panel (Switchgear panel) and complete Instrumentation** for control, monitoring and operation of entire package. The requirements given are to be read in conjunction with detailed Technical specification. Further in case of any discrepancy in the requirement within the same section noted by the bidder in the specification, the more stringent requirement as per interpretation of customer shall prevail without any commercial and time implication.
- Bidder shall provide starter panel for local start/ stop monitoring of auxiliaries and equipment along with status indications and alarms as per requirement. The requirement shall be decided during detailed engineering. All local panel shall be NEMA 4X with canopy.
- Local push buttons in the field shall be in Vendor's scope.
- The scope of C&I cables and their erection & commissioning shall be as per Electrical scope sheet defined in Electrical specification.
- Bidder shall provide Cable Schedule in BHEL excel format which shall be provided during detailed engineering. Also, Cable Interconnections for Complete System shall be in Bidders' scope. DCS side details for hardwired signals shall be furnished by BHEL during detailed engineering.
- All transmitters shall be smart type and shall have 4-20mA DC signal with superimposed digital communication (HART). Each Temperature element shall be complemented with temperature transmitters, compensating cable, JB/rack & other erection hardware. All transmitters shall be fitted with a local analog/digital indicator displaying appropriate physical units which may be read clearly from an easily accessible position. Kindly refer clause no. B0.6.19.8 in Section B-0 of Customer's general technical specification for details.
- Instrument installation and accessories required shall be in Bidder's scope. The requirement indicated in the 'Instrument Installation Diagram', enclosed elsewhere in this specification, is minimal. Vendor submitted 'Instrument Installation Diagram' shall be subject to customer approval during detail engineering without any commercial and time implication. The instruments for which Installation Diagram is not attached, vendor's Installation Diagram for such items will also be subject to customer approval during detail engineering without any commercial and delivery implication.
- All fittings shall use metric threads. Use of process actuated switches shall be avoided unless unavoidable.
- Instruments must have separate tapping lines. Sharing of the same tapping pipe for redundant instruments or various different instruments is not acceptable.



**Technical specification
for**

2X660 MW STPP, MAITREE-BANGLADESH

SECTION C

REV. NO.

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DATE : 05.12.2017

10. Instruments & its accessories shall be complied with weather of the Coastal Area.
11. As a general rule, measuring points and measuring equipment for critical protection shall be separate from and not combined with measuring equipment for the automatic control equipment.
12. The instrumentation and control equipment shall have high electro-magnetic and radio frequency interference immunity and shall not be affected by portable radio transmitters operated in the vicinity of the equipment. Any limitations shall be stated.
13. All the instruments/equipment/electrical items shall be provided & designed with maximum star rating in line with energy conservation policies as per latest international standards at the time of supply.
14. All instruments shall be protected by cases. The cases shall have enclosure classification not less than IP 42 according to EN 60529 when mounted indoors in totally enclosed rooms with provision for limited ingress of dust, IP 54 else in an enclosed building and IP 55W for mounting outdoors.
15. Electronic instruments shall not be located close to hot lines, vessels or other hot equipment. Ambient temperatures exceeding 80°C shall not result in calibration difficulties or rapid deterioration of electronic components.
16. Electrical Actuators shall be with integral starter. For details, kindly refer clause no. B0.6.19.16 in Section B-0 of Customer's general Technical specification.
17. DP instruments with minimum Capillary length of 15m is to be supplied.
18. Instruments shall be suitable for sea or saline water application. MOC of impulse tubing & impulse pipe shall be CPVC (3/8") Sch 80 or better, Industrial grade up to manifold. MOC of impulse tubing, fittings (from manifold to instrument) and manifold shall be super duplex SS.
19. The junction boxes for termination of instruments /actuator limit switches etc. are in bidder's scope.
20. Power supply derived for transmitters, contact interrogation, interposing relay and solenoid shall generally be ungrounded 24V D.C only. In all cases redundancy in power modules shall be considered.
21. Bidder to note that all the transmitters/instruments supplied by Bidder shall be rack mounted. The racks shall be preassembled and provided by Bidder. Also no Instruments / analysers & JBs/Racks should be protruding on the walkway.



**Technical specification
for**

2X660 MW STPP, MAITREE-BANGLADESH

SECTION C

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00

DATE : 05.12.2017

22. Power Supply Requirement:

240 V AC (Supply feeder)/ 415 V AC (3 PHASE 4 WIRE) supply shall be provided by BHEL for all equipment supplied by vendor as part of contract. Further any electrical distribution shall be in bidder's scope. Any other voltage requirement to be arranged / derived by bidder by providing suitable control transformer.

23. Instrument installation and accessories required shall be in Bidder's scope and shall be subject to customer/BHEL approval during detailed engineering.

24. All field instruments shall be terminated on Junction box/Local control panel in field. All the instruments along with necessary fittings, accessories and valve manifold etc., erection hardware including racks, junction boxes, canopies, structural steel, LIE, LIR etc. as required shall be in vendor's scope of supply.

25. Redundancy of sensors shall be provided by bidder as per following:

- a. Triple redundancy for all analog and binary inputs required for protection of system /drives.
- b. For all other control functions & alarms dual redundancy of the sensors shall be provided by the bidder.

26. Bidder to perform tests of C&I items/instruments/systems as per quality plans/type test attached in the specification.

27. Each valve/instrument shall be fitted with a stainless steel or aluminium nameplate indicating the valve/instrument service and reference number in accordance with the approved equipment coding system.

28. Interface of control panel, field instruments, actuators etc. with DCS based control system shall be as per Drive Control Philosophy enclosed in Section-D.

29. Local representative of C&I related BOI supplier shall be available in India/Bangladesh.

30. The identification and numbering of equipment, systems, items, etc. of supply, as well as of all documents and drawings shall be in accordance with the **VGB guideline RDS-PP (Reference Designation System for Power Plants - KKS system)**.

31. The quantity of instruments for the system shall be as per tender P & ID of the respective system as a minimum, for bidding purpose. However, Bidder shall also include in his proposal all the instruments and devices that are needed for the completeness of the plant auxiliary system/ equipment supplied by the bidder, even if the same is not specifically appearing in the P & ID and as per detailed specification. During detail engineering if any additional instruments are required for safe & reliable operation of plant, bidder shall supply the same without any price implication.

32. The specifications for instruments mentioned in the specification are minimum



Technical specification for

2X660 MW STPP, MAITREE-BANGLADESH

SECTION C

REV. NO.

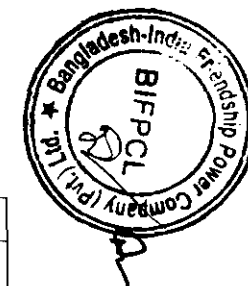
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DATE : 05.12.2017

requirements. Datasheets of instrument shall be subject to customer/owner approval.

33. The equipment shall be of modern, compact design incorporating the latest developments in proven technology. All instruments whether for local indication or remote transmission shall be of good quality and shall have an accuracy and repeatability appropriate to their duty.
34. The make/model of various instruments/items/systems shall be subject to approval of owner/purchaser during detailed engineering. No commercial implication in this regard shall be acceptable. In case of any conflict and repetition of clauses in the specification, the more stringent requirements among them are to be complied with. In case of any contradiction most stringent clause/condition shall prevail.
35. Generally, equipment shall be supplied from one composite range of measurements and control equipment as marketed by a reputable manufacturer of international standing and shall have a minimum of three years operational use on similar projects.
36. For applicable codes & standards, refer Clause no. B0.6.2 in Section B-0 of Customer's general technical specification. Indian and Chinese standards are not acceptable.
37. All approval/Inspection are to be carried out by Owner or owner appointed agency only.
38. Sea worthy packing capable of performing all necessary functions like prevention of damage to the contents, sufficient to support frequent handling and lengthy period of outdoor storage in adverse weather conditions are required.
39. Training as per **clause no: B0.3.7 of section-1A** to be provided shall be in vendor's scope.
40. Apart from specific design requirement for the package, Design of various systems/sub-systems and all equipments will also strictly meet the stipulation of Section B-0 of customer's general technical specification.
41. Drawings/Documents and data to be furnished after award of the contract shall be in line with MDL furnished elsewhere in the specification.
42. Mandatory spare list as per 'List of mandatory spares' attached elsewhere in the specification is in vendor's scope.
43. *All documents, including the installation and operation and maintenance manuals as well as the related software shall be in fluent, legible English. In addition, operation and maintenance manuals shall be translated into **Bangla** and provided as paper copies and in electronic format.*

	PROJECT: MAITREE, 2X660 MW PACKAGE: TG PACKAGE CONTRACTOR: BHEL HARIDWAR CONTRACT NO.:		LIST OF ITEM SREQUIRING QUALITY PLAN AND SUB CONTRACTOR APPROVAL SUB SYSTEM: C & I				REFNO.:00 REV NO.:00 Date:14.12.2015	
	SI No.	Item	LIST OF IT EMS	Vendor/Manufacturer Name	Place	SC A PP L_S	Remarks	

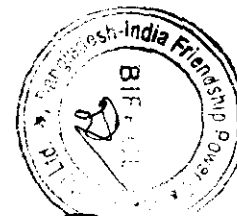


2.	Thermocouples	*		SiemensLimited	Gurgaon	DR	
3.	Fibre optic Gen End Winding VibrationMonitoring System	II		Vibro System INC	Canada	A	Refer Note 1
3.	Fibre optic Gen End Winding VibrationMonitoring System	II		MC-Monitoring SA	Switzerland	A	Refer Note 2
3.	Fibre optic Gen End Winding VibrationMonitoring System	*		SiemensLimited	Gurgaon	DR	
4.	Level Switch (Float/Displacer Type)	III		Chemtrols Samil	Mumbai	A	
4.	Level Switch (Float/Displacer Type)	III		Pune Techtrols	Pune	A	
4.	Level Switch (Float/Displacer Type)	III		Levcon Instruments	Kolkata	A	
4.	Level Switch (Float/Displacer Type)	III		SBEM	Pune	A	
4.	Level Switch (Float/Displacer Type)	III		SiemensLimited	Gurgaon	A	
4.	Level Switch (Float/Displacer Type)	III		DKInstruments	Kolkata	A	
4.	Level Switch (Float/Displacer Type)	III		V Automat&Instruments	NewDelhi	A	
4.	Level Switch (Float/Displacer Type)	III		Magnetrol Instruments	Belgium	A	
4.	Level Switch (Float/Displacer Type)	III		Endress& Hauser Instruments	Switzerland / Aurangabad	A	
4.	Level Switch (Float/Displacer Type)	*		Pratolina Instruments	Mumbai	DR	
5.	Pressure/Differential Pressure Gauge	III		Manometer India	Mumbai	A	
5.	Pressure/Differential Pressure Gauge	III		H Guru Instruments(South India)	Bangalore	A	

Prateek

Rajesh Kumar

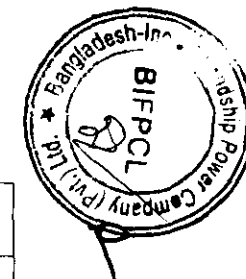
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	PROJECT: MAITREE, 2X660 MW PACKAGE: TG PACKAGE CONTRACTOR: BHEL HARIDWAR CONTRACT NO.:	LIST OF ITEM SREQUIRING QUALITY PLAN AND SUB CONTRACTOR APPROVAL SUB SYSTEM: C & I				REFNO.:00	
						REV NO.:00	
						Date:14.12.2015	
SI No.	Item	LIST OFIT EMS		Vendor/Manufacturer Name	Place	SC_A PP L_S	Remarks

5.	Pressure/Differential Pressure Gauge	III		H Guru Instruments	Muzaffarpur Risra	A	
5.	Pressure/Differential Pressure Gauge	III		FISCHER MESS & REGELTECHNIK	Germany	A	
5.	Pressure/Differential Pressure Gauge	III		Baumer Technologies	Vapi	A	
5.	Pressure/Differential Pressure Gauge	III		GluckIndia	Mumbai	A	
5.	Pressure/Differential Pressure Gauge	III		A N Instruments	Narendrapur	A	
5.	Pressure/Differential Pressure Gauge	III		Ashcroft	Gandhinagar	A	
5.	Pressure/Differential Pressure Gauge	III		Wika Instruments	Pune	A	
5.	Pressure/Differential Pressure Gauge	III		NSRT	Kolkata	A	
5.	Pressure/Differential Pressure Gauge	III		PTCI	Kolkata	A	
5.	Pressure/Differential Pressure Gauge	*		Siemens Limited	Gurgaon	DR	
5.	Pressure/Differential Pressure Gauge	III		Walchand nagar Industries	Attikolla, Dharwad	A	
5.	Pressure/Differential Pressure Gauge	*		New Scientific Repairs & Tradi	KOLKATA	DR	

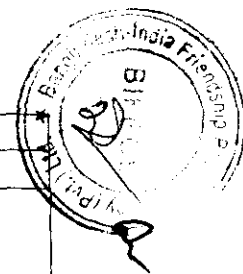
	PROJECT: MAITREE, 2X660 MW PACKAGE: TG PACKAGE CONTRACTOR: BHEL HARIDWAR CONTRACT NO.:		LIST OF ITEM SREQUIRING QUALITY PLAN AND SUB CONTRACTOR APPROVAL SUB SYSTEM: C & I				REFNO.:00 REV NO.:00 Date:14.12.2015	
	SI No.	Item	LIST OF IT EMS	Vendor/Manufacturer Name	Place	SC A PP L_S	Remarks	



5.	Pressure/Differential Pressure Gauge	*		Forbes Marshall (Hyd) Pvt Ltd	IDA Nacharam, Medak	DR	
6.	Pressure/DP/Flow Transmitters	II		ABB Limited	Bangalore	A	2600 T series
6.	Pressure/DP/Flow Transmitters	II		Emerson Process Management	Pawane	A	
6.	Pressure/DP/Flow Transmitters	III		Fuji Electric System	Japan /China	A	
6.	Pressure / D P / Flow Transmitters	II		Laxsons Automation	Daman	A	M/s Smar Brazil Make
6.	Pressure/DP/Flow Transmitters	III		ABB Utility Automation	Germany	A	2600 T series
6.	Pressure/DP/Flow Transmitters	III		Yokogawa India	Bangalore	A	Make M/s Yokogawa, Japan
6.	Pressure/DP/Flow Transmitters	III		Siemens Limited	Thane	A	
6.	Pressure/DP/Flow Transmitters	*		Chino corporation India	Ghaziabad	DR	
7.	Instrumentation Cables	II		Paramount Communication	Khuskhera	A	For PVC, FRLS
7.	Instrumentation Cables	II		KEI industries	Bhiwadi	A	For PVC, FRLS
7.	Instrumentation Cables	II		Delton Cables	Faridabad	A	For PVC, FRLS
7.	Instrumentation Cables	II		Cords Cables	Bhiwadi	A	For PVC, FRLS
7.	Instrumentation Cables	II		Elkay Telelinks	New Delhi	A	For PVC, FRLS
7.	Instrumentation Cables	II		Universal Cables	Satna	A	For PVC, FRLS

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R. S. Khan
12/12/2015



	PROJECT: MAITREE, 2X660 MW PACKAGE: TG PACKAGE CONTRACTOR: BHEL HARIDWAR CONTRACT NO.:	LIST OF ITEM SREQUIRING QUALITY PLAN AND SUB CONTRACTOR APPROVAL SUB SYSTEM: C & I				REFNO.:00	
						REV NO.:00	
						Date:14.12.2015	
SI No.	Item	LIST OF IT EMS		Vendor/Manufacturer Name	Place	SC_A PP L_S	Remarks

7.	Instrumentation Cables	II		NICCO Corporation	Kolkata	A	For PVC, FRLS
7.	Instrumentation Cables	II		Thermo Cables Ltd.	Hyderabad	A	For PVC, FRLS
7.	Instrumentation Cables	*		Advance Cable Technologies	Bangalore	DR	
7.	Instrumentation Cables	*		Manoj Cables Limited	Delhi	DR	
7.	Instrumentation Cables	*		Pagoda Cables Pvt. Ltd.	Delhi	DR	
8.	Gas Analyser Cabinet	I		ABB Limited	Bangalore	A	H2 Analyser imported from ABB, Germany
8.	Gas Analyser Cabinet	I		Adage Automation	Mumbai	A	Hydrogen Gas Analyser (Calomat 6) will be Imported from Siemens Germany
8.	Gas Analyser Cabinet	I		Yokogawa India	Bangalore	A	Analyser will be imported from M/S Yokogawa Electric Corporation (YEC), Japan (Micro Processor based, Working on Gas Density Principle).
8.	Gas Analyser Cabinet	I		Siemens Limited	India	A	H2 Analyser imported from Siemens, Germany
9.	Conductivity Analyser (Conduction Measuring Equipment)	*		Forbes Marshall	Pune	DR	
9.	Conductivity Analyser (Conduction Measuring Equipment)	III		ABB India Limited	Bangalore/Dehradun	A	Make:ABB,USA/UK

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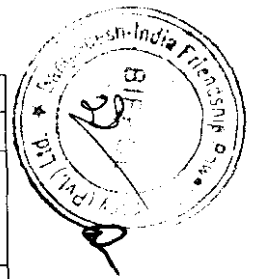
PROJECT: MAITREE, 2X660 MW
PACKAGE: TG PACKAGE
CONTRACTOR: BHEL
HARIDWAR
CONTRACT NO.:

**LIST OF ITEM SREQUIRING QUALITY PLAN AND
SUB CONTRACTOR APPROVAL SUB SYSTEM: C & I**

REFNO.:00

REV NO.:00

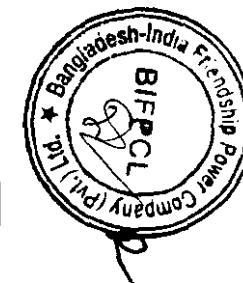
Date:14.12.2015



SI No.	Item	LIST OF ITEMS	Vendor/Manufacturer Name	Place	SC A PP L_S	Remarks
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11.	Pressure / DP Switch	*	BOLL & KIRCH	Germany	DR	
11.	Pressure / DP Switch	*	IMI Norgren Herion	India	DR	
11.	Pressure / DP Switch	*	Trafag Controls India Private	Gurgaon	DR	
12.	Capacitance type Level Transmitters/Switches	III	Magnetrol Instruments	Belgium	A	Application Capacitance Level Switches-Generator & Turbine Capacitance type Level Transmitters-Generator (Primary Water Tank)
12.	Capacitance type Level Transmitters/Switches	III	Endress+Hauser Instruments	Switzerland / Aurangabad	A	
12.	Capacitance type Level Transmitters/Switches	II	NIVO Controls	Indore	A	
12.	Capacitance type Level Transmitters/Switches	II	SBEM Pvt. Ltd.,	Pune	A	
12.	Capacitance type Level Transmitters/Switches	*	DK Instruments	Kolkata	DR	
13.	Guided Wave Radar Level Transmitters	III	Magnetrol Instruments	Belgium	A	Application-Main Oil Tank & Control Fluid Tank
13.	Guided Wave Radar Level Transmitters	III	Endress+Hauser Instruments	Switzerland / Aurangabad	A	Application- Main Oil Tank & Control Fluid Tank
14.	Position Transmitters	III	Siemens Limited	Gurgaon	A	Make-M/s Siemens, Germany
14.	Position Transmitters	III	ABB Limited	Bangalore/ Dehradun	A	Make-M/s ABB Germany
14.	Position Transmitters	III	Electronics Corporation	Hyderabad	DR	
14.	Position Transmitters	*	BI Enterprises	Mumbai	DR	

	PROJECT: MAITREE, 2X660 MW PACKAGE: TG PACKAGE CONTRACTOR: BHEL HARIDWAR CONTRACT NO.:		LIST OF ITEM SREQUIRING QUALITY PLAN AND SUB CONTRACTOR APPROVAL SUB SYSTEM: C & I				REFNO.:00	
							REV NO.:00	
							Date:14.12.2015	
SI No.	Item	LIST OF ITEMS		Vendor/Manufacturer Name	Place	SC A PP L_S	Remarks	
14.	Position Transmitters	*		Curtiss Wright Corporation	USA	DR		



LEGENDS :

DR-Detailed Required.

CAT- I:For those items the Quality Plans are approved by BIFPCL and final acceptance will be on physical inspection witness by BIFPCL.

CAT- II : For those items the Quality Plans are approved by BIFPCL. However no physical inspection shall be done by BIFPCL. The final acceptance by BIFPCL shall be on the basis of review of documents.

CAT- III : For those items Main supplier approves Quality Plans. The final acceptance by BIFPCL shall be on the basis of Certificate of Conformance by main supplier.

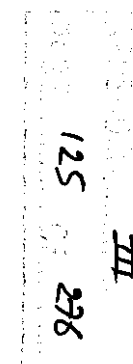
*- Inspection category will be decided during vendor evaluation.

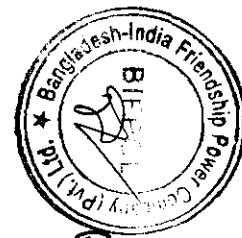
Note 1: Wired Panel along with standard bought out items like Blank panel / enclosure, accessories like Ethernet switch, Power Supply, Terminal, MCB are accepted from indigenous suppliers acceptable to BIFPCL and tied up in QP.

Note 2:For items covered in Annexure-I to B0, Part-B, Section-V, Amendment No 5 of technical specification, BHEL has to furnish the details to establish qualifying / provenness requirement to BIFPCL for review at the time of detailed engineering irrespective of the approval category "A" or "DR" mentioned in the vendor list.

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		PROJECT : Maitree STPP (2 x 660 MW)					LIST OF ITEMS REQUIRING QP			REF. NO :	
		PACKAGE : EPC PACKAGE					APPROVAL & ACCEPTABLE			REVISION NO : 00	
		CONTRACTOR : BHEL - PEM, HYD, Trichy, PC, EDN					VENDOR AS APPROVED BY			DATE : 12/12/2015	
		CONTRACT NO :									
No.	Major Equipment	QP Inspection Category	QP No.	QP Submission SCH	QP Approval SCH	Proposed Sub Supplier	Country	SS Approval Status	SS Detail Sub.SCH	SS Approval SCH	Remark
23	Temperature Transmitter	III				EMERSON	U.S.A/Pawane / Singapore	A			
		III				Yokogawa	Japan	A			Final testing at M/S YIL, Bangalore is also acceptable
		III				Moore	USA	A			
		III				M System	JAPAN	A			
		III				ABB	GERMANY/Faridabad	A			
		III				ENDRESS & HOUSER	Aurangabad	A			
		*				Khrone		DR			M/s BHEL will forward only two proposals after details review of BIFPCL Technical specification requirements.
		*				Tokyo Keiso	Japan	DR			
		*				INOR	Sweden	DR			
		*				P & F	India	DR			
		*				Siemens		DR			
		*				Yamatake	JAPAN	DR			
		*				Yamari	JAPAN	DR			
		*				Foxboro		DR			
25	Electronic transmitters (pressure, DP)	III				EMERSON (Rosemount)	USA/ Pawane	A			
		III				FUJI ELECTRIC	China	A			
		III				YOKOGAWA	JAPAN	A			Testing and Calibration at M/s YIL, Bangalore is also acceptable.
		I				ABB	FARIDABAD	A			Model - 2600 T
		III				ABB	GERMANY / Italy	A			Model - 2600 T
		III				Siemens	France / India	A			
		III				Honeywell	Pune	A			
		*				ENDRESS & HOUSER	Aurangabad/ Germany	DR			
26	Thermocouples, RTD & Thermowell	III				HERAUS SENSOR	GERMANY	A			
	Refer Note - 2	III				WISE Control	Korea	A			
		II				Tempsens	Udaipur	A			
		II				Pyroelectric	Goa	A			

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		PROJECT : Maitree STPP (2 x 660 MW)				LIST OF ITEMS REQUIRING QP			REF. NO :		
		PACKAGE : EPC PACKAGE				APPROVAL & ACCEPTABLE			REVISION NO : 00		
		CONTRACTOR : BHEL - PEM, HYD, Trichy, PC, EDN				VENDOR AS APPROVED BY			DATE : 12/12/2015		
		CONTRACT NO :									
No.	Major Equipment	QP Inspection Category	QP No.	QP Submission SCH	QP Approval SCH	Proposed Sub Supplier	Country	SS Approval Status	SS Detail Sub.SCH	SS Approval SCH	Remark
		II				Detriv Instrumentation & Electronics Ltd	Mumbai	A			
		III				Minco	USA	A			
		III				OKAZAKI corporation	JAPAN	A			
		III				Yamari	JAPAN	A			
		III				Yamari	Singapore	A			For RTD Reference list and Performance feedback is to be submitted
		III				ABB(SENSYCON)	Germany	A			
		III				EMERSON (Rosemount)	Germany	A			
		II				EMERSON (Rosemount)	Pawane	A			Imported from Emerson, Germany (make)
		II				Thermal Instruments(GIC)	Savantwadi	A			
		II				Techno Instruments	Ahamadabad	A			
		*				GOA Instrument Industries	GOA	DR			M/s BHEL will forward only two proposals after details review of BIFPCL Technical specification requirements.
		*				WIKA	Pune	DR			
		*				Toshniwai Industries	Ajmer	DR			
		*				E & H	Aurangabad	DR			
		*				Baumer	Vapi	DR			
27	Ultrasonic type level Transmitter	III				E & H	Aurangabad/ Germany	A			
		III				EMERSON	Pawane	A			
		III				SIEMENS MILTRONICS	CANADA	A			
		*				Wega	Germany	DR			M/s BHEL will forward only two proposals after details review of BIFPCL Technical specification requirements.
		*				Khrone	France / USA / Pune	DR			
		*				Yokogawa	Bangalore	DR			
		*				Honeywell	India	DR			
		*				Magnetrol	Belgium	DR			
		*				ABB	Germany	DR			
28	Orifice plate assembly	III				Instrumentation Limited	Palghat	A			
		III				Microprecision	Faridabad	A			
		III				Starmech	Pune	A			
		III				Flow Star	Faridabad	A			
		III				SEIKO	Austria	A			
		III				MINCO (GIC)	GOA	A			



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		PROJECT : Maitree STPP (2 x 660 MW)					LIST OF ITEMS REQUIRING QP			REF. NO :	
		PACKAGE : EPC PACKAGE					APPROVAL & ACCEPTABLE			REVISION NO : 00	
		CONTRACTOR : BHEL - PEM, HYD, Trichy, PC, EDN					VENDOR AS APPROVED BY			DATE : 12/12/2015	
		CONTRACT NO :									
No.	Major Equipment	QP Inspection Category	QP No.	QP Submission SCH	QP Approval SCH	Proposed Sub Supplier	Country	SS Approval Status	SS Detail Sub.SCH	SS Approval SCH	Remark
		*				HBL Power Systems	India	DR			M/s BHEL will forward only two proposals after details review of BIFPCL Technical specification requirements.
		*				Dubas	India	DR			
		*				Chloride Power Systems (caldyne)	India	DR			
		*				Universal Instrument manufacturing co P Ltd	India	DR			
		*				Hind Rectifier Ltd	India	DR			
38	Battery Health Monitoring System	III				Emerson	Mumbai	A			
		III				Eltek SGS Pvt Ltd	Gurgaon	A			
		*				B Tech Inc	USA	DR			
		*				Hitachi Hi Rel	Gandhinagar	DR			
		*				Hopeckee	Germany	DR			
39	Battery(Ni-cd)	I				AMCO SAFT	Bangalore	A			
		II				SAFT	France/Sweede	A			
		I				HBL POWER	Hyderabad	A			
		*				Hopeckee	Germany	DR			
40	Battery (Lead Acid Tubular / Plante)	I				Exide	Kolkata	A			
		I				HBL POWER	Hyderabad	DR			Only for tubular
		I				Hopeckee	Germany	DR			
41	Impulse pipe & tubes	II				Maharashtra Seamless	Raigarh	A			Carbon steel only
		II				Sumitomo/kawasaki/Nippon	Japan	A			
		II				TPS TECHNITUBE	Germany	A			
		II				Veluric & manessmann	Germany	A			
		II				BHEL	Trichy	A			
		II				Trouvay and Cauvin	France	A			Makes shall be as per approved list (Sr. No. 41)
		II				ISMT	Ahamadnagar	A			Carbon steel only.
		II				Sandvik		A			For SS only.
		*				Jindal saw	India	DR			
		*				Ratanamani Metal and	Ahamadabad	DR			
		*				Shubhalaxmi Metal and	Mumbai	DR			
45	Local Instrument Enclosure/Rack	I				Pyrotech	Udaipur	A			
		I				Instrumentation Limited	Kota	A			

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		PROJECT : Maitree STPP (2 x 660 MW)					LIST OF ITEMS REQUIRING QP			REF. NO :	
		PACKAGE : EPC PACKAGE					APPROVAL & ACCEPTABLE			REVISION NO : 00	
		CONTRACTOR : BHEL - PEM, HYD, Trichy, PC, EDN					VENDOR AS APPROVED BY			DATE : 12/12/2015	
		CONTRACT NO :									
No.	Major Equipment	QP Inspection Category	QP No.	QP Submission SCH	QP Approval SCH	Proposed Sub Supplier	Country	SS Approval Status	SS Detail Sub.SCH	SS Approval SCH	Remark
		I				Sajas electrical	Trichurapalli	A			
		I				Prammen	Puddukottai	A			
		I				Chemin	Pondicherry	A			
		*				Forbes Marshall	Pune	DR			
		*				Procon	Chennai	DR			
46	Instrument Cables	II				Paramount	Khushkhera	A			PVC,FRLS type,RQP
		II				Polycab	Daman	A			PVC,FRLS type,RQP
		II				Delton	Faridabad	A			PVC,FRLS type,RQP
		II				KEI	Bhiwadi	A			PVC,FRLS type
		II				Elkey Telelinks	Faridabad	A			PVC,FRLS type
		II				CORDS	Bhiwadi	A			PVC,FRLS type,RQP
		II				CORDS	Kaharani	A			PVC,FRLS type,RQP
		II				Nicco	Kolkata	A			PVC,FRLS type
		II				TEW & C	USA	A			
		II				Habia cables	Sweedan	A			
		II				Kerpen cables	Germany	A			
		II				Lapp cables	Germany	A			
		II				Thermo electra Bv	Netherland	A			
		II				Universal Cable	Satna	A			PVC,FRLS type
		II				Thermocables	Hyderabad	A			
		II				Finolex Cable	Pune	DR *			
		II				Incab	Pune	DR *			
		*				Lapp cables	India	DR			BHEL will forward only two proposals after details review of BIFPCL Technical specification requirements
		*				Lioni cable	Pune	DR			
		*				Gupta Cable	Orisa	DR			
		*				CMI	Faridabad	DR			
47	Electrical actuator	III				Auma	Germany	A			
		III				Limitorge	USA	A			
		III				Rotorg	UK	A			
		II				Limitorque	Faridabad	A			
		II				Rotork	Chennai/ Bangalore	A			
		III				Nippon gear	Japan	A			
		II				Auma	Bangalore	A			
		III				Harold Beck	USA	A			
		III				Drehmo	Germany	A			

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		PROJECT : Maitree STPP (2 x 660 MW)				LIST OF ITEMS REQUIRING QP			REF. NO :		
		PACKAGE : EPC PACKAGE				APPROVAL & ACCEPTABLE			REVISION NO : 00		
		CONTRACTOR : BHEL - PEM, HYD, Trichy, PC, EDN				VENDOR AS APPROVED BY			DATE : 12/12/2015		
		CONTRACT NO :									
No.	Major Equipment	QP Inspection Category	QP No.	QP Submission SCH	QP Approval SCH	Proposed Sub Supplier	Country	SS Approval Status	SS Detail Sub.SCH	SS Approval SCH	Remark
		*				Uniflex Cables	India	DR			
51	Pneumatic Actuator (Power Cylinder e. g. FOR	II				Dong Woo Valve Control Co. LTD	Korea	A			
		II				Shin Hwa Engineering Co. LTD	Korea	A			
		I				Instrumentation Limited	Palghat	A			
		I				Kelton		A			
		I				SMC Pneumatics	Noida	A			Up to 12 inch only
		I				Rotex	Mumbai	A			Conditional
		*				Festo	Bangalore	DR			
53	Transducer	II				AE	Mumbai	A			
		II				Southern Transducer	Chennai	A			
		II				Elster	Mumbai	A			
		III				Camilie Bauer	Germany	A			
		III				Metrawat	Germany	A			
		II				Rishab	Nasik	A			
		*				Pyrotech	Udaipur	DR			
59	Coupling / Interposing relays	III				PARAMOUNT	BANGALORE	A			* To be covered in DDCMIS QP
		III				OMRON		A			
		III				OEN		A			
		III				Jyoti	Baroda	A			
		III				ELSTA	SWITZERLAN	A			
		*				Schneider	Germany	DR			
		*				Siemens	Germany	DR			
		*				Phoenix	Germany	DR			
60	Solenoid valve	III				Rotex	Vadodara	A			
		III				Avcon	Mumabi	A			
		III				Herion	Germany	A			
		III				IMI NORGEN	GERMANY	A			
		III				Jafferson	Argentina	A			
		III				Asco	Chennai/USA	A			
		III				Festo	Bangalore	A			
		III				SMC	Noida	A			
		III				Parker	Brand Name	A			
		*				Schneider	Germany				

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		PROJECT : Maitree STPP (2 x 660 MW)				LIST OF ITEMS REQUIRING QP			REF. NO :		
		PACKAGE : EPC PACKAGE				APPROVAL & ACCEPTABLE			REVISION NO : 00		
		CONTRACTOR : BHEL - PEM, HYD, Trichy, PC, EDN				VENDOR AS APPROVED BY			DATE : 12/12/2015		
		CONTRACT NO :									
No.	Major Equipment	QP Inspection Category	QP No.	QP Submission SCH	QP Approval SCH	Proposed Sub Supplier	Country	SS Approval Status	SS Detail Sub.SCH	SS Approval SCH	Remark
		*				Neucon Industries Pvt. Ltd.		DR			
61	Lube oil control valve - Self Regulating	II				NUOVO PIGNONE	ITALY	A			
		II				EMERSON	CHENNAI	A			
		II				SAMSON	GERMANY / PUNE	A			
		II				Forbes Arca	Pune	A			Approved up to 4", 150 Class.
62	Guided wave Radar type level transmitter	III				Magnetrol	Belgium	A			
		III				Endress & Houser	Germany/ Aurangabad	A			
		III				Emerson	Sweden/ PAWANE	A			
		III				ABB(K-Tech)	USA	A			
		*				Yokogawa	Japan	DR			
		*				Khrone	France	DR			
		*				HONEYWELL		DR			
		*				Siemens	India	DR			
63	Maintenance and Calibration Equipment					Main Contractor will propose the vendors during detail Engineering.					
65	Furniture for computer	III				OTS office tech.	India	NOTE			
		III				Godrej boyce		NOTE			
		III				Fetherlite		NOTE			
		III				PAN Office		NOTE			
		III				Pyrotech		NOTE			
66	Terminal Block (Cage and Clamp type)	III				Weidmuller	Germany	A			
		III				Phoenix	Germany /	A			
		III				Wago	Germany /	A			
		III				Elmex	Vadodara	A			CE Mark only

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		PROJECT : Maitree STPP (2 x 660 MW)					LIST OF ITEMS REQUIRING QP			REF. NO :	
		PACKAGE : EPC PACKAGE					APPROVAL & ACCEPTABLE			REVISION NO : 00	
		CONTRACTOR : BHEL - PEM, HYD, Trichy, PC, EDN					VENDOR AS APPROVED BY			DATE : 12/12/2015	
		CONTRACT NO :									
No.	Major Equipment	QP Inspection Category	QP No.	QP Submission SCH	QP Approval SCH	Proposed Sub Supplier	Country	SS Approval Status	SS Detail Sub.SCH	SS Approval SCH	Remark
		I				Cosmos	Noida	A			
		I				Adarsh Control	Bangalore	A			
		*				Chemin Controls	Pondichery	DR			
		*				Harmony Systems	New Delhi	DR			
83	Digital Indicators	III				Masibus	Gandhi Nagar	A			For Non mosaic mounting
		III				ABB	Germany	A			
		III				Foxboro	UK	A			
		III				Yokogawa	Japan	A			
		III				Gossen / Metrowatt / Camille Bauer	Germany	A			
		III				Siemens	Germany	A			
		III				Chino	Japan	A			
		III				Weigell Messgerate	Germany	A			
		III				Pyrotech	Udaipur	A			For Non mosaic mounting
		*				Chino Corporation	Mumbai	DR			
		*				Yokogawa	Bangalore	DR			For Non mosaic mounting
		*				Lektrotek	Pune	DR			and submit only two
		*				Teletherm	Chennai	DR			proposals
84	Dust Emission Monitor	III				Land Combustion	UK	A			
		III				Durag	Germany	A			
		III				Sick Maihak	Germany	A			
		III				Emerson Process Management	Ireland	A			
		III				Codel	UK	A			
		II				Forbes Marshall	Pune	A			maint kit from M/s Codel, UK
85	Electrical Indicating Instruments (Mosaic Compatible)	III				Siemens	Germany	A			
		III				Gossen / Metrowatt / Camille Bauer	Germany	A			
		III				Ganz	Germany	A			
		III				Weigell Messgerate	Germany	A			
86	Flue Gas Analyser (CO)	III				Codel	UK	A			
		III				Emerson Process Management	Pawane	A			Analysers from M/s
		III				Land Combustion	UK	A			Emerson, Germany / USA

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SUB-VENDOR LIST FOR C&I
2X660 MW MAITREE STPP- BANGLADESH

Sl No	Package Code	Package Name	Supplier Name	Tech Limit
1	145-04000-A	CONTROL VALVE	FORBES MARSHALL ARCA PVT.LTD.	No technical limit exists except for feed control valve. For feed control valves, approved up to sub-critical power plants of 600 MW rating.
2	145-04000-A	CONTROL VALVE	INSTRUMENTATION LTD.	
3	145-04000-A	CONTROL VALVE	Koso India Private Limited,	
4	145-04000-A	CONTROL VALVE	BOMAFI SPECIAL VALVE SOLUTIONS PVT LTD	
5	145-04000-A	CONTROL VALVE	KSB MIL CONTROLS LTD.	
6	145-04000-A	CONTROL VALVE	SUZHOU DELAN ENERGY SCIENCE & TECHNOLOGY CO., LTD.	
7	145-04000-A	CONTROL VALVE	WALDEMAR PRUSS ARMATURENFABRIK GMBH	
8	145-04000-A	CONTROL VALVE	Mascot Valves Pvt. Ltd.	
9	145-04000-A	CONTROL VALVE	R.K.CONTROL INSTRUMENTS PVT. LTD.	For subcritical power plant up to 150MW
10	145-04000-A	CONTROL VALVE	Valitalia S.P.A. ,	
11	145-04000-A	CONTROL VALVE	PARCOL S.p.A	
12	145-04000-A	CONTROL VALVE	EMERSON PROCESS MANAGEMENT CHENNAI LIMITED	
13	145-04000-A	CONTROL VALVE	DRESSER VALVE INDIA PVT. LTD	
14	145-06000-A	PRESSURE SWITCH/DIFF. PRESSURE SWITCH	DRESSER INDUSTRIES INC.	
15	145-06000-A	PRESSURE SWITCH/DIFF. PRESSURE SWITCH	Barksdale GmbH, Germany	
16	145-06000-A	PRESSURE SWITCH/DIFF. PRESSURE SWITCH	SWITZER PROCESS INSTRUMENTS PVT. LTD.	
17	145-06000-A	PRESSURE SWITCH/DIFF. PRESSURE SWITCH	PRECISION MASS PRODUCTS PVT. LTD.	
18	145-06000-A	PRESSURE SWITCH/DIFF. PRESSURE SWITCH	INDFOS INDUSTRIES LIMITED	
19	145-06000-A	PRESSURE SWITCH/DIFF. PRESSURE SWITCH	GENERAL INSTRUMENTS CONSORTIUM	
20	145-06000-A	PRESSURE SWITCH/DIFF. PRESSURE SWITCH	SOR INC.	
21	145-06000-A	PRESSURE SWITCH/DIFF. PRESSURE SWITCH	INDFOS (INDIA) LIMITED	
22	145-06000-A	PRESSURE SWITCH/DIFF. PRESSURE SWITCH	Kaustubha Udyog,	
23	145-08000-A	PRESSURE GAUGE/ DIFF.PRESSURE GAUGE	H.GURU INDUSTRIES	
24	145-08000-A	PRESSURE GAUGE/ DIFF.PRESSURE GAUGE	BOSE PANDA INSTRUMENTS PVT.LTD.	
25	145-08000-A	PRESSURE GAUGE/ DIFF.PRESSURE GAUGE	A.N. INSTRUMENTS PVT. LTD.	
26	145-08000-A	PRESSURE GAUGE/ DIFF.PRESSURE GAUGE	PRECISION MASS PRODUCTS PVT. LTD.	
27	145-08000-A	PRESSURE GAUGE/ DIFF.PRESSURE GAUGE	Baumer Technologies India Pvt. Ltd.	
28	145-08000-A	PRESSURE GAUGE/ DIFF.PRESSURE GAUGE	H.GURU INSTRUMENTS (SOUTH INDIA) P. LTD	
29	145-08000-A	PRESSURE GAUGE/ DIFF.PRESSURE GAUGE	FORBES MARSHALL (HYD) LTD.	

30	145-08000-A	PRESSURE GAUGE/ DIFF.PRESSURE GAUGE	GAUGE BOURDON INDIA PVT. LTD.	
31	145-08000-A	PRESSURE GAUGE/ DIFF.PRESSURE GAUGE	SCIENTIFIC DEVICES (BOMBAY) PVT LTD,	
32	145-08000-A	PRESSURE GAUGE/ DIFF.PRESSURE GAUGE	Nesstech Instruments Private Limited	
33	145-10000-A	TEMPERATURE GAUGE	FORBES MARSHALL (HYD) LTD.	
34	145-10000-A	TEMPERATURE GAUGE	GOA INSTRUMENTS INDUSTRIES PVT.LTD.,	
35	145-10000-A	TEMPERATURE GAUGE	H.GURU INSTRUMENTS (SOUTH INDIA) P. LTD	
36	145-10000-A	TEMPERATURE GAUGE	GAUGE BOURDON INDIA PVT. LTD.	
37	145-10000-A	TEMPERATURE GAUGE	H.GURU INDUSTRIES	
38	145-10000-A	TEMPERATURE GAUGE	GOA THERMOSTATIC INSTRUMENTS PVT.LTD.	
39	145-10000-A	TEMPERATURE GAUGE	A.N. INSTRUMENTS PVT. LTD.	
40	145-10000-A	TEMPERATURE GAUGE	Baumer Technologies India Pvt. Ltd.	
41	145-10000-A	TEMPERATURE GAUGE	PRECISION MASS PRODUCTS PVT. LTD.	
42	145-11000-A	LEVEL GAUGE	BLISS ANAND PVT. LTD.	
43	145-11000-A	LEVEL GAUGE	TOSHNIWAL BROTHERS PVT.LTD.	MAKE:NIVO CONTROLS
44	145-11000-A	LEVEL GAUGE	SIGMA INSTRUMENTS CO.	
45	145-12000-A	FLOW ELEMENT	MICRO PRECISION PRODUCTS PVT. LTD.	
46	145-12000-A	FLOW ELEMENT	TM TECNOMATIC SPA	
47	145-12000-A	FLOW ELEMENT	STAR-MECH CONTROLS (I) PVT.LTD.	
48	145-12000-A	FLOW ELEMENT	INSTRUMENTATION LTD.	
49	145-13000-A	TEMP. ELEMENT	DETRIVE INSTRUMENTATION & ELECTRONICS LTD.	
50	145-13000-A	TEMP. ELEMENT	Thermal Instrument India Pvt. Ltd.	
51	145-13000-A	TEMP. ELEMENT	Tempsens Instrument (I) Pvt Ltd	
52	145-13000-A	TEMP. ELEMENT	PYRO ELECTRIC INSTRUMENTS GOA PVT.LTD.	
53	145-13000-A	TEMP. ELEMENT	TECHNO INSTRUMENTS	
54	145-13000-A	TEMP. ELEMENT	Baumer Technologies India Pvt. Ltd.	
55	145-13000-A	TEMP. ELEMENT	TM TECNOMATIC SPA	
56	145-13000-A	TEMP. ELEMENT	TOSHNIWAL INDUSTRIES PVT. LTD.,	
57	145-13000-A	TEMP. ELEMENT	GOA INSTRUMENTS INDUSTRIES PVT.LTD.,	
58	145-13000-A	TEMP. ELEMENT	GAUGE BOURDON INDIA PVT. LTD.	
59	145-13000-A	TEMP. ELEMENT	Nesstech Instruments Private Limited	

60	145-13000-A	TEMP. ELEMENT	SCIENTIFIC DEVICES (BOMBAY) PVT LTD,	
61	145-14000-A	TRANSMITTERS	ABB LIMITED	PRESSURE TRANSMITTER, DP TRANSMITTER and TEMP TRANSMITTER
62	145-14000-A	TRANSMITTERS	Pune Techtrol Pvt. Ltd.	Only for capacitance Type Level Transmitter
63	145-14000-A	TRANSMITTERS	V. AUTOMAT & INSTRUMENTS (P) LTD.	a)DISPLACEMENT TYPE TRANSMITTERS. b)PRESSURE AND DP TRANSMITTERS
64	145-14000-A	TRANSMITTERS	Moore Industries International Inc.	
65	145-14000-A	TRANSMITTERS	PANAM ENGINEERS	For Pressure and Diff. Pressure transmitter
66	145-14000-A	TRANSMITTERS	TOSHNIWAL INDUSTRIES PVT. LTD.,	
67	145-14000-A	TRANSMITTERS	Endress + Hauser (India) Pvt. Ltd.,	
68	145-14000-A	TRANSMITTERS	YOKOGAWA INDIA LIMITED,	
69	145-14000-A	TRANSMITTERS	SBEM PVT. LTD.	FOR CAPACITANCE TYPE.
70	145-14000-A	TRANSMITTERS	SIEMENS LIMITED	
71	145-14000-A	TRANSMITTERS	EMERSON PROCESS MANAGEMENT (INDIA) PVT.LTD.	
72	145-14000-A	TRANSMITTERS	SMART INSTRUMENTS LTD, BRAZIL	LD-301 & T-301 TRANSMITTER FROM M/S SMART EQUIPMENTS BRAZIL.
73	145-14000-A	TRANSMITTERS	NIVO CONTROLS PVT. LTD.	For Capacitance type only
74	145-14000-A	TRANSMITTERS	Honeywell Automation India Limited	
75	145-25000-A	JUNCTION BOX	Shrenik & Company,	
76	145-25000-A	JUNCTION BOX	SUCHITRA INDUSTRIES	
77	145-25000-A	JUNCTION BOX	FLEXPRO ELECTRICALS PVT. LTD.	Metal type junction box only
78	145-25000-A	JUNCTION BOX	K.S.INSTRUMENTS PVT.LTD.	
79	145-25000-A	JUNCTION BOX	AJMERA INDUSTRIAL & ENGINEERING WORKS	
80	145-32000-A	INSTRUMENTS TUBE FITTINGS	VIKAS INDUSTRIAL PRODUCTS	
81	145-32000-A	INSTRUMENTS TUBE FITTINGS	Fluid Controls Pvt. Ltd.	
82	145-32000-A	INSTRUMENTS TUBE FITTINGS	AURA INCORPORATED	
83	145-32000-A	INSTRUMENTS TUBE FITTINGS	PRECISION ENGINEERING INDUSTRIES	
84	145-35000-A	LEVEL SWITCH-CAPACITANCE TYPE	SIGMA INSTRUMENTS CO.	
85	145-35000-A	LEVEL SWITCH-CAPACITANCE TYPE	Sapcon Instrument Pvt Ltd.	
86	145-35000-A	LEVEL SWITCH-CAPACITANCE TYPE	V. AUTOMAT & INSTRUMENTS (P) LTD.	
87	145-35000-A	LEVEL SWITCH-CAPACITANCE TYPE	SCIENTIFIC DEVICES (BOMBAY) PVT LTD,	

88	145-35000-A	LEVEL SWITCH-CAPACITANCE TYPE	Flow Star Engineering Pvt. Ltd.,	
89	145-35000-A	LEVEL SWITCH-CAPACITANCE TYPE	NIVO CONTROLS PVT. LTD.	For Capacitance type level switch.
90	145-35000-A	LEVEL SWITCH-CAPACITANCE TYPE	Baumer Technologies India Pvt. Ltd.	
91	145-35000-A	LEVEL SWITCH-CAPACITANCE TYPE	Pune Techtrol Pvt. Ltd.	
92	145-35000-A	LEVEL SWITCH-CAPACITANCE TYPE	BLISS ANAND PVT. LTD.	
93	145-35000-A	LEVEL SWITCH-CAPACITANCE TYPE	SOR INC.	
94	145-35000-A	LEVEL SWITCH-CAPACITANCE TYPE	LEVCON INSTRUMENTS PVT. LTD.	
95	145-36000-A	LEVEL SWITCH-CONDUCTIVITY TYPE	SOR INC.	
96	145-36000-A	LEVEL SWITCH-CONDUCTIVITY TYPE	LEVCON INSTRUMENTS PVT. LTD.	
97	145-36000-A	LEVEL SWITCH-CONDUCTIVITY TYPE	V. AUTOMAT & INSTRUMENTS (P) LTD.	
98	145-36000-A	LEVEL SWITCH-CONDUCTIVITY TYPE	HI-TECH SYSTEMS & SERVICES LTD.	Vendor shall source import contents of Level Switch (Conductivity Type) from Levelstate Systems Ltd., United Kingdom.
99	145-36000-A	LEVEL SWITCH-CONDUCTIVITY TYPE	RAMAN INSTRUMENTS PVT.LTD.	Vendor shall source import contents of Level Switch (Conductivity Type) from Mobrey Measurement, an operating unit of Morbey Ltd., Slough, Berkshire, United Kingdom.
100	145-36000-A	LEVEL SWITCH-CONDUCTIVITY TYPE	Sapcon Instrument Pvt Ltd.	
101	145-36000-A	LEVEL SWITCH-CONDUCTIVITY TYPE	SIGMA INSTRUMENTS CO.	
102	145-36000-A	LEVEL SWITCH-CONDUCTIVITY TYPE	BLISS ANAND PVT. LTD.	
103	145-37000-A	LEVEL SWITCH-FLOAT TYPE	SIGMA INSTRUMENTS CO.	
104	145-37000-A	LEVEL SWITCH-FLOAT TYPE	Pune Techtrol Pvt. Ltd.	
105	145-37000-A	LEVEL SWITCH-FLOAT TYPE	D.K. INSTRUMENTS PVT.LTD.	
106	145-37000-A	LEVEL SWITCH-FLOAT TYPE	V. AUTOMAT & INSTRUMENTS (P) LTD.	
107	145-37000-A	LEVEL SWITCH-FLOAT TYPE	SCIENTIFIC DEVICES (BOMBAY) PVT LTD,	
108	145-37000-A	LEVEL SWITCH-FLOAT TYPE	LEVCON INSTRUMENTS PVT. LTD.	
109	145-37000-A	LEVEL SWITCH-FLOAT TYPE	GENERAL INSTRUMENTS CONSORTIUM	
110	145-37000-A	LEVEL SWITCH-FLOAT TYPE	Baumer Technologies India Pvt. Ltd.	
111	145-37000-A	LEVEL SWITCH-FLOAT TYPE	SBEM PVT. LTD.	
112	145-37000-A	LEVEL SWITCH-FLOAT TYPE	SOR INC.	
113	145-37000-A	LEVEL SWITCH-FLOAT TYPE	BLISS ANAND PVT. LTD.	
114	145-38000-A	INSTRUMENTS PIPE FITTINGS	VIKAS INDUSTRIAL PRODUCTS	
115	145-38000-A	INSTRUMENTS PIPE FITTINGS	Fluid Controls Pvt. Ltd.	
116	145-38000-A	INSTRUMENTS PIPE FITTINGS	PRECISION ENGINEERING INDUSTRIES	
117	145-38000-A	INSTRUMENTS PIPE FITTINGS	AURA INCORPORATED	
118	145-42000-A	ULTRASONIC FLOW METERS	CHEMTROLS INDUSTRIES PVT. LTD.	For Flexim Fluxus non-invasive ultrasonic flowmeter only;
119	145-42000-A	ULTRASONIC FLOW METERS	Rockwin Flowmeter India Pvt. Ltd.	
120	145-42000-A	ULTRASONIC FLOW METERS	FLASH FORGE PVT LTD	

121	145-42000-A	ULTRASONIC FLOW METERS	NIVUS GMBH	
122	145-43000-A	FLOW ELEMENT - ORIFICE	MINCO (INDIA) FLOW ELEMENTS PVT. LTD.	
123	145-43000-A	FLOW ELEMENT - ORIFICE	STAR-MECH CONTROLS (I) PVT.LTD.	
124	145-43000-A	FLOW ELEMENT - ORIFICE	TANSA EQUIPMENTS PVT. LTD.	
125	145-43000-A	FLOW ELEMENT - ORIFICE	SCIENTIFIC DEVICES (BOMBAY) PVT LTD,	
126	145-43000-A	FLOW ELEMENT - ORIFICE	DYNAFLUID VALVES AND FLOW CONTROLS (P) LTD.	
127	145-43000-A	FLOW ELEMENT - ORIFICE	MICRO PRECISION PRODUCTS PVT. LTD.	
128	145-43000-A	FLOW ELEMENT - ORIFICE	INSTRUMENTATION LTD.	
129	145-43000-A	FLOW ELEMENT - ORIFICE	HYDROPNEUMATICS PVT. LTD.	
130	145-43000-A	FLOW ELEMENT - ORIFICE	Flow Star Engineering Pvt. Ltd.,	
131	145-43000-A	FLOW ELEMENT - ORIFICE	CHEMTROLS INDUSTRIES PVT. LTD.	
132	145-43000-A	FLOW ELEMENT - ORIFICE	INSTRUMENTATION ENGINEERS PVT LTD	
133	145-44000-A	FLOW ELEMENT - NOZZLE	DYNAFLUID VALVES AND FLOW CONTROLS (P) LTD.	except P91 material pipes;
134	145-44000-A	FLOW ELEMENT - NOZZLE	MINCO (INDIA) FLOW ELEMENTS PVT. LTD.	
135	145-44000-A	FLOW ELEMENT - NOZZLE	HYDROPNEUMATICS PVT. LTD.	
136	145-44000-A	FLOW ELEMENT - NOZZLE	STAR-MECH CONTROLS (I) PVT.LTD.	
137	145-44000-A	FLOW ELEMENT - NOZZLE	INSTRUMENTATION LTD.	
138	145-44000-A	FLOW ELEMENT - NOZZLE	MICRO PRECISION PRODUCTS PVT. LTD.	
139	145-45000-A	INSTRUMENT FITTINGS	Perfect Instrumentation Control (India) Pvt. Ltd.	
140	145-45000-A	INSTRUMENT FITTINGS	Arya Crafts & Engineering Pvt. Ltd.	
141	145-45000-A	INSTRUMENT FITTINGS	Comfit & Valve Pvt. Ltd.	
142	145-45000-A	INSTRUMENT FITTINGS	HP VALVES & FITTINGS INDIA PVT. LTD.	
143	145-45000-A	INSTRUMENT FITTINGS	AURA INCORPORATED	
144	145-45000-A	INSTRUMENT FITTINGS	PRECISION ENGINEERING INDUSTRIES	
145	145-45000-A	INSTRUMENT FITTINGS	FLUIDFIT ENGINEERS PVT. LTD.	
146	145-45000-A	INSTRUMENT FITTINGS	VIKAS INDUSTRIAL PRODUCTS	
147	145-45000-A	INSTRUMENT FITTINGS	Fluid Controls Pvt. Ltd.	
148	145-45000-A	INSTRUMENT FITTINGS	PANAM ENGINEERS	
149	145-47000-A	ELECTROMAGNETIC FLOW METER	Electronet Equipments Pvt Ltd.	
150	145-47000-A	ELECTROMAGNETIC FLOW METER	Adept Fluidyne Pvt. Ltd.	
151	145-47000-A	ELECTROMAGNETIC FLOW METER	SCIENTIFIC DEVICES (BOMBAY) PVT LTD,	

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	<u>NOTES:</u> i) The above sub-vendor list is tentative & for reference only. However Sub-Vendor List is subject to BHEL/ end user approval without any commercial/ delivery implication. ii) New Sub-Vendor if proposed by Vendor during contract stage shall be subject to BHEL/ end user approval without any commercial/ delivery implication.			



TITLE:
**TECHNICAL SPECIFICATION
COLTCS**

SPECIFIC TECHNICAL REQUIREMENTS

SPEC. NO.: **PE-TS-421-165-N002**

SECTION: **I**

SUB-SECTION: **ID**

REV. NO. **00** DATE **02.01.2018**

SHEET **1** OF **1**

SUB-SECTION – ID

DATASHEET-A



TITLE : STANDARD TECHNICAL SPECIFICATION

DATA SHEET-A

**CONDENSER ON - LOAD TUBE CLEANING
SYSTEM (Sponge Rubber Ball Type)**

SPEC. NO. PE-TS- 421-165-N002

SECTION : I

SUB-SECTION: ID

REV. NO. 01

DATE: 02.01.2018

SL.NO PROJECT :

2 X 660 MW MAITREE BANGLADESH

1	<u>GENERAL</u>		
1.1	Nos. of tube cleaning systems sets required for station	NOS.	Four (04) Nos. for 2 units (i.e. 2 Nos. per unit) viz. One independent set for each half of condenser
1.2	Liquid handled		SEA Water (water analysis enclosed as Annexure-II)
1.3	Size of COLTCS	Nb	2600
1.4	Length of Ball Separator	MM	4000 Note: 1. Scope of Ball Separator counter flange is in Purchaser's scope. (Associated Gaskets, nuts and bolts are in Bidder's Scope) 2. Ball Separator shall be mounted directly on the existing Butterfly valve - Refer Annexure IV. 3. Flap of butterfly valve shall be extended to 1200-1300 mm inside the Ball separator.
2.0	<u>DESIGN</u>		
2.1	Operating pressure at Condenser inlet flange	kg/cm ² (g)	Approx 1.5 to 2.5
2.2	Design Pressure for ball separator	kg/cm ² (g)	5.0 kg/cm ² (g)
2.3	Design Mechanical Temperature	Deg. C	60
2.4	Condenser Details		
	a) Type of condenser		Single pass
	b) No. of Condenser sections	Nos.	Two (2)
	c) No. of passes per condenser section (viz. condenser half)	Nos.	One (1)
	d) No. of tubes per condenser	Nos.	2 x 23452



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2 X 660 MW MAITREE BANGLADESH

	e) Tube Dia. OD x Thickness		
	• Top two rows	mm x mm	27.0 x 1.2446
	• Remaining	mm x mm	27.0 x 1.0
	f) Length of tubes between ends.	mm	13612
	g) Tube material		Welded Ti (SS 338 Gr-2)
	h) Pressure drop across condenser - At Normal flow (between Inlet and Outlet flanges of condenser)	MWC	2 x 2.5 MWC (However the actual value can vary +/-10% of the design value)
2.5	CW flow rate through each ball separator		
	- Normal	cu.m/hr	36600
	- Maximum	cu.m/hr	44000
2.6	Design differential pressure for ball separator strainer/screen	Kg/cm ² (g)	0.30
2.7	Pressure drop across ball separator i.e. between inlet & outlet flanges in clean condition at normal flow.	MWC	0.20
2.8	Pressure drop across ball separator in choked condition when strainer backwashing starts	MWC	Not to exceed 0.30
2.9	No. of balls required for COLTCS per condenser section	Nos.	Minimum 10% of number of condenser tubes
3	<u>CONNECTING PIPE DETAILS</u>		
3.1	Condenser inlet pipe		



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2 X 660 MW MAITREE BANGLADESH

	a) Material		CARBON STEEL AS PER ASTM A671 WITH PU (POLYURETHANE) COATING INTERNALLY WITH MIN. 2MM DFT AS PER AWWA-C-222.
	b) O.D. X Thickness	mm x mm	2632 X 16
3.2	Condenser outlet pipe		
	a) Material	CS	CARBON STEEL AS PER ASTM A671 WITH PU (POLYURETHANE) COATING INTERNALLY WITH MIN. 2MM DFT AS PER AWWA-C-222.
	b) O.D. X Thickness	mm x mm	2632 X 16
3.3	Manhole		Yes, 600 NB size
4.0	<u>MATERIALS OF CONSTRUCTION</u>		
4.1	BALL SEPARATOR		
	a) Body / housing		Carbon Steel to ASTM A36, Rubber lined (Min. 5mm thick) inside (with minimum housing thickness same as connecting pipe thickness)
	b) Screen / Strainer		Duplex SS
	c) Strainer shaft		Duplex SS
	e) Internal Hardware in contact with circulating water including nuts, bolts , etc.		Duplex SS
	f) Site Glass provision		YES
4.2	BALL RECIRCULATING PUMP		Non clog type
	a) Casing		18 % Ni Cl D2 type
	b) Impeller		Duplex SS
	c) Shaft		Duplex SS



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PROJECT :

2 X 660 MW MAITREE BANGLADESH

4.3	BALL COLLECTOR		
	a) Body / housing		Carbon Steel to ASTM A36, Rubber lined (Min. 5mm thick) inside
	b) Screen / Strainer/other internals		Duplex SS
	c) Site Glass Provision		YES
4.4	Differential pressure measuring system		Duplex SS
4.5	Injection nozzle		Duplex SS
4.6	Valves		
4.6.1	Check Valves (65 NB & Above)		For sizes 65 NB and above:- Swing check or dual plate type.
	a) Body & Bonnet		Duplex SS Flanged Ends
	b) Disc for Check Valve		Duplex SS
	c) Stem		Duplex SS
4.6.2	Check Valves (50 NB & Below)		For size 50 NB and below-Piston type
	a) Body & Bonnet		Duplex SS Screwed Ends
	b) Disc for Check Valve		Duplex SS
	c) Stem		Duplex SS
4.6.3	Gate/ Globe Valves 50 Nb & Below		
	Body & Bonnet		Duplex SS Screwed Ends
4.6.4	➤ Gate/ Globe Valves (upto 350 Nb)		



TITLE : STANDARD TECHNICAL SPECIFICATION

DATA SHEET-A

**CONDENSER ON - LOAD TUBE CLEANING
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SPEC. NO. PE-TS- 421-165-N002

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PROJECT :

2 X 660 MW MAITREE BANGLADESH

	➤ Body & Disc		Duplex SS
	➤ Shaft		Duplex SS
	➤ Stem		Duplex SS
	➤ Sealing, Retaining segment & internals		Duplex SS
	➤ Bearings		Self lubricating / Seal Lubricated
	➤ Companion Flange		Same as Connecting Pipe MOC
	C) Ball valves		
	i) Body		Duplex SS
	ii) Ball		Duplex SS
	iii) Stem		Duplex SS
4.7	Interconnecting Piping		By Purchaser
	Material		PIPING UPTO & INCLUDING 50NB SHALL BE OF DUPLEX SS AS PER SCH. 40S, PIPING FROM 65 NB TO 300NB (INCLUDING) SHALL BE OF DUPLEX SS AS PER SCH. 10S, PIPING 400NB(INCLUDING) TO 800 NB (INCLUDING) SHALL BE CARBON STEEL AS PER ASTM A671 WITH RUBBER LINED, FLANGED PIPE.
5	COUNTER FLANGES for Ball Separator		
	a) Flanges		CARBON STEEL AS PER ASTM A53 WITH RUBBER LINED (In purchaser's scope)



TITLE : STANDARD TECHNICAL SPECIFICATION

DATA SHEET-A

CONDENSER ON - LOAD TUBE CLEANING
SYSTEM (Sponge Rubber Ball Type)

SPEC. NO. PE-TS- 421-165-N002

SECTION : I

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PROJECT :

2 X 660 MW MAITREE BANGLADESH

	b) Fasteners		SS 316 L (In Bidder's scope).
	c) Gaskets		Min 4 mm thick rubber (In Bidder's scope).
6	<u>OTHER FLANGES/ COUNTER FLANGES</u> (for interconnecting piping, valves, bends, fittings, distributors, nozzles & support installation materials)		In Bidder's scope
6.1	MATERIALS		
	a) Flanges/ counter flanges		Duplex SS
	b) Fasteners		SS 316L
	c) Gaskets		Min 4 mm thick rubber
7.0	Material of Other components not specified above		1. All Wetted & Non-wetted Fasteners in Bidder's Scope shall be of Duplex SS & SS316L material respectively. 2. Suitable for intended duty and shall be subject to Purchasers approval during detailed engg. In the event of order.
8.0	<u>PAINTING</u>		
8.1	INTERNAL SURFACE (for Applications not in Direct Contact with Sea Water)		
	a) Surface preparation		NA
	b) Primer		NA
	c) Final paint		NA



TITLE : STANDARD TECHNICAL SPECIFICATION

DATA SHEET-A

**CONDENSER ON - LOAD TUBE CLEANING
SYSTEM (Sponge Rubber Ball Type)**

SPEC. NO. PE-TS- 421-165-N002

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2 X 660 MW MAITREE BANGLADESH

8.2	EXTERNAL SURFACE		
	a) Surface preparation		SA - 2.5 of Swedish Specn. SIS-05-59-00-1967
	b) Primer		Two (2) coats of Epoxy resin based zinc phosphate primer
	a) Intermediate		Epoxy based TiO ₂ pigmented coat
	d) Final paint		Synthetic enamel paint to achieve total DFT of 175 to 200 microns. Color code shall be as per IS9404 (Appendix-A)
9.0	Adequate provision for future installation of cathodic protection		YES (Along with Sacrificial type anodic protection by Bidder)
10.0	Flow straightener for streamlining the CW flow in ball collecting strainer		If required as per bidder's design – the same to be incorporated by bidder in its constructional feature.
11.0	The tube cleaning system shall be designed for following operation modes		
	a) Automatic start up initiated by push button		YES
	b) Automatic shut down with ball collection effected by : i. Push button ii. Adjustable timer iii. Ball monitoring system		YES
	c) Automatic backwashing of ball separator with ball collection effected by : a. Push button b. Adjustable timer c. Diff. Pressure measuring system		YES

	TITLE : STANDARD TECHNICAL SPECIFICATION		SPEC. NO. PE-TS- 421-165-N002	
	DATA SHEET-A		SECTION : I	
	CONDENSER ON - LOAD TUBE CLEANING		SUB-SECTION: ID	
	SYSTEM (Sponge Rubber Ball Type)		REV. NO. 01	DATE: 02.01.2018
SL.NO	PROJECT :		2 X 660 MW MAITREE BANGLADESH	

	d) Automatic emergency backwashing of ball separator effected by diff. Pressure measuring system		YES
	e) Automatic ball sorting initiated by push button		YES
	f) Provision for manual operation of complete tube cleaning system in case of control system failure		YES
	g) Whether the contacts for DPG, DPS and DPT are independent		YES
	h) Timer for Backwashing		YES
	i) Whether the ball monitoring system is designed to perform the following functions : i. Continuously counting the balls in circulation and giving an alarm calling for investigation of ball losses when the number of balls falls below a set value ii. Continuously measuring the size of the balls in circulation and initiating the shutdown of the tube cleaning system with alarm calling for replacement of balls when the no. of oversized balls falls below a set value		YES

	TITLE : STANDARD TECHNICAL SPECIFICATION		SPEC. NO. PE-TS- 421-165-N002	
	DATA SHEET-A		SECTION : I	
	CONDENSER ON - LOAD TUBE CLEANING		SUB-SECTION: ID	
	SYSTEM (Sponge Rubber Ball Type)		REV. NO. 01	DATE: 02.01.2018
SL.NO	PROJECT :		2 X 660 MW MAITREE BANGLADESH	

	j) Whether the electronic processor of the ball monitoring system is provided with the following : i. Indicators for required basic ball charge ii. Indicators for recirculating ball quantity iii. Indicators for oversized ball quantity iv. Time counters for total cleaning system operating hours v. Time counters for cleaning system operating hours with sufficient no. of oversized balls vi. Recorders for ball consumption		YES
	k) Whether provision for self-testing and self-calibration are made		YES
12.0	Mandatory Spares to be supplied under this specification.		YES (As indicated below)
12.1	Sponge rubber balls for condenser on-load tube cleaning system (20% Abrasive remaining normal)		50000 nos.
12.2	Ball circulating pumps (set consisting of shaft , rotor, bearings, seals, gland package shafts sleeves for complete replacement in one pump)		1 Set



TITLE : STANDARD TECHNICAL SPECIFICATION

DATA SHEET-A

**CONDENSER ON - LOAD TUBE CLEANING
SYSTEM (Sponge Rubber Ball Type)**

SPEC. NO. PE-TS- 421-165-N002

SECTION : I

SUB-SECTION: ID

REV. NO. 01

DATE: 02.01.2018

SL.NO

PROJECT :

2 X 660 MW MAITREE BANGLADESH

12.3	C&I Spares		As per attached Annexure-1
13.0	Documents enclosed for bidder's reference		
	❖ Water Analysis		Attached as per Annexure-II.
	❖ Counter Flange details		Attached as per Annexure-III
	❖ GA of CW piping in TG hall		Attached as per Annexure-IV

LIST OF BASIC MINIMUM SPARES

	Consumable like filters/light sources	100%
	Calibration gases of all types and ranges.	one year supply
(vi).	*Measuring Instruments	
a)	Electronic Transmitters	
(i)	Transmitters of all type, range and model no. (for the measurement of Pressure, differential pressure flow, level, etc.)	10% or minimum 1 No. which ever is more
(ii)	Electronic cards / PCB's for each type and model of transmitters.	10% of each type
b)	Temperature elements	
(i)	RTD's	10% of each type and length or minimum 1 No. which ever is more
(ii)	Thermocouples	10% of each type and length or minimum 1 No. which ever is more
(iii)	Thermo well for above applications	10% of each type and length or minimum 1 No. which ever is more
(iv)	Temperature Transmitters	10%
*List of Measuring instruments as specified with individual system / sub-system shall be applicable for the respective system. Spare list of measuring Instruments will be governed by this clause, for system/subsystem which are not mentioned/specified exclusively in the list of spares.		
3.	Mandatory spare list AAQMS	
(i)	SO2 analyser	
	SO2 analyser instrument	1 no. complete instrument
	Electronic Card Assemblies of each type	10%
	Sets of Gaskets/"O" rings	2 sets
	Heater Assembly/Thermister.	20%
	Air flow meter.	1 no.
	Consumables like filter elements light sources etc.	100%
	Calibration gases of all types and ranges.	One year supply.

Wateranalysis

SL	Sampling Location	pH Values	Temperature (°C)	NTU	EC μ S/cm	Alkalinity mg/L	p-alkalinity mg/L	m-alkalinity mg/L	Total hardness (mg/l)	TDS (mg/L)	Salinity (ppt)	TSS (mg/l)	DO (mg/l)	PO ₄ (mg/L)	Cl- (mg/L)	F- (mg/L)	NH ₄ (mg/L)	NO ₃ (mg/L)	NO ₂ (mg/L)	SO ₄ (mg/L)	BOD ₅ (mg/L)	COD (mg/L)
1	High tide, Passur River, Mongla, Khulna	8.1	26.9	579	353	131	0	133			170		123		0.89	51	<10	0.30	0.78	<016	12	32
2	Low tide, Passur River, Mongla, Khulna	8.1	26.7	594	409	133	0	135			197		147		1.1	66	0.10	<10	0.83	<016	15	48
	Sampling 16 August 2014																					
3	Sampling April	7.9	31						2550	13190	12.00	54	5.7	2.1					1.3		1360	376
4	Sampling July	7.1	33						175	445	2.20	90	6.8	0.45				0.76			45	28
5	Sampling October	8.1	31								0.00			7.6							4.00	
6	Sampling 23. May 2014; Jetty Side Passur River			77		138										9724						
SL	Sampling Location	Al (mg/L)	Ba (mg/L)	Ca (mg/L)	Fe (mg/L)	Mn (mg/L)	Mg (mg/L)	K (mg/L)	Na (mg/L)	FC (CFU)	TC (CFU)	SiO ₂ (mg/L)	P (mg/L)	TOC (mg/L)	DOC (mg/L)	Oil and Grease (mg/l)						
1	High tide, Passur River, Mongla, Khulna	0.85	0.107	26.75	2.0	<0.5	8.7	3.9	29.11	240	240	460	11.7	1.2	6.25	3.93						
2	Low tide, Passur River, Mongla, Khulna	0.962	0.165	26.94	4.2	<0.5	9.4	6.68	41.77	270	270	520	13.6	2.3	7.91	4.49						
	Sampling 16 August 2014																					
3	Sampling April																					
4	Sampling July																					
5	Sampling October																					
6	Sampling 23. May 2014; Jetty Side Passur River			296	0.51		737	204	8505				14.3									

3 - 5: Sampling location: Left bank of Passur River at Project Site - Jetty

Consultancy Research and Testing Services (CRTS)
Department of Civil Engineering, Khulna University of Engineering & Technology

Test Results on Water Quality and Sedimentation Characteristics of Possur River at Intake Point (BIFPCL, Rampal)

Date	High Tide							Low Tide						
	Time	pH	Tur (NTU)	Elec Con (EC) mS/cm	Sedimentation (ml/L)			Time	pH	Tur (NTU)	Elec Con (EC) mS/cm	Sedimentation (ml/L)		
					30min	60min	120min					30min	60min	120min
17.01.15	1100	7.87	103	5.40	-	-	-	1730	7.78	63.5	5.25	-	-	-
18.01.15	1150	8.03	170	3.28	0.05	0.20	0.35	1830	8.03	49.5	1.80	Nil	Nil	Nil
19.01.15	1245	7.86	315	5.24	-	-	-	750	7.90	323	4.88	-	-	-
20.01.15	1330	7.90	178	5.38	0.10	0.25	0.35	830	7.90	208	4.53	0.15	0.35	0.50
21.01.15	1400	7.84	382	5.64	-	-	-	900	7.90	172	5.00	-	-	-
22.01.15	1450	7.86	337	5.50	0.45	0.60	0.70	940	7.84	239	4.94	0.15	0.25	0.40
23.01.15	1540	7.84	202	5.19	-	-	-	1020	7.84	108	5.14	-	-	-
24.01.15	1630	7.62	504	5.96	-	-	-	1050	7.41	92.7	6.24	-	-	-
25.01.15	1715	7.73	311	5.90	-	-	-	1130	7.78	144	5.85	-	-	-
26.01.15	1810	7.85	633	5.77	-	-	-	1210	7.82	299	5.49	-	-	-
27.01.15	1820	7.81	289	5.35	0.05	1.50	2.00	1300	7.85	635	5.66	1.50	3.50	5.00
28.01.15	720	7.86	332	5.47	-	-	-	1320	7.81	653	5.64	-	-	-
29.01.15	830	7.87	386	5.80	-	-	-	1500	7.86	101	5.67	-	-	-
30.01.15	1000	7.90	360	5.73	-	-	-	1630	7.89	258	11.44	-	-	-
31.01.15	1110	7.94	400	11.54	-	-	-	1745	7.97	132	9.22	-	-	-

WATER ANALYSIS

A water analysis from the area adjacent to the site giving salinity and water quality is shown below:

Location	Date	Temp.	pH	EC	Cl	T. Alkalinity	Turbidity	T S	TDS	SS	DO	BOD	COD	Salinity
		°C		µS/cm	mg/l	mg/l	NTU	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
1	7-Jan	27.4	7.74	3010	879	36	68.7	1565	1510	55	5.1	0.8	55	1.6
2	7-Jan	27.1	7.72	3020	878.8	36	68.5	1570	1510	60	5.1	0.8	55	1.6
3	7-Jan	27.8	7.71	3030	879	36	68.8	1565	1510	55	5.1	0.8	55	1.6
1	11-Feb	29.8	7.66	4380	1262	36	182	2390	2180	210	4.7	1	76	2.3
2	11-Feb	29.2	7.63	4380	1268	36	178	2390	2190	200	4.7	1	76	2.3
3	11-Feb	29.1	7.65	4380	1263	36	179	2380	2180	200	4.7	1	76	2.3
1	9-Mar	32.6	7.56	11780	2944.4	38	176	6080	5890	190	4.7	1.2	76	6.7
2	9-Mar	32.6	7.57	11780	2945.2	38	178	6080	5890	190	4.7	1.2	76	6.7
3	9-Mar	32.1	7.55	11780	2946.4	38	177	6090	5890	200	4.7	1.2	76	6.7
1	17-Apr	32.6	7.59	25300	8273	36	185.6	12950	12700	250	4.6	0.7	136	15.5
2	17-Apr	32.6	7.59	25300	8273	36	186.2	12950	12700	250	4.6	0.7	138	15.5
3	17-Apr	32.6	7.59	25300	8273	36	184.8	12950	12700	250	4.6	0.7	136	15.5
1	5-May	32.6	7.59	29200	9480	36	198.6	14900	14600	300	4.5	1.2	177	17.6
2	5-May	32.9	7.54	29200	9470	36	198.6	14900	14600	300	4.4	1.2	177	17.6

Figure 1 Water quality of the Passur River at Mongla point
(Source: EIA-Report)

Location	Date	Temp.	pH	EC	Cl	T. Alkalinity	Turbidity	TS	TD5	SS	DO	BOD	COD	Salinity
		°C		µS/cm	mg/l	mg/l	NTU	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
3	5-May	33.2	7.57	29200	9470	36	199.6	14900	14600	300	4.5	1.2	177	17.6
1	13-Jun	31.6	7.69	18000	5820	36	112.6	9200	9000	200	4.7	1.1	97	10.8
2	13-Jun	31.6	7.69	18000	5800	36	113.2	9200	9000	200	4.7	1.1	97	10.8
3	13-Jun	31.6	7.69	18000	5810	36	112.4	9200	9000	200	4.7	1.1	97	10.8
1	1-Jul	31.6	7.69	440	32.6	36	76.6	285	220	65	5.2	0.8	26	-
2	1-Jul	31.6	7.69	440	32.6	36	76.6	285	220	65	5.2	0.8	26	-
3	1-Jul	31.6	7.69	440	32.6	36	76.6	285	220	65	5.2	0.8	26	-
1	5-Aug	31.6	7.69	275	16.6	36	68.6	192	137	55	5.3	0.7	22	-
2	5-Aug	31.6	7.69	275	16.6	36	68.6	192	137	55	5.3	0.7	22	-
3	5-Aug	31.6	7.69	275	16.6	36	68.6	192	137	55	5.3	0.7	22	-
1	8-Sep	31.6	7.74	270	15.6	36	65.6	180	135	45	5.5	0.7	22	-
2	8-Sep	31.6	7.76	270	15.6	36	65.6	180	135	45	5.5	0.7	22	-
3	8-Sep	31.6	7.74	270	15.6	36	65.6	180	135	45	5.5	0.7	22	-
1	12-Oct	30.6	7.79	290	26.6	36	62.6	192	145	47	5.6	0.7	22	-
2	12-Oct	30.6	7.78	290	26.6	36	62.6	192	145	47	5.6	0.7	22	-
3	12-Oct	30.6	7.78	290	25.6	36	62.6	192	145	47	5.6	0.7	22	-
1	5-Nov	24.6	7.79	340	38.6	36	56.6	210	170	40	5.6	0.7	22	-
2	5-Nov	26.6	7.79	340	38.6	36	56.6	210	170	40	5.6	0.7	22	-
3	5-Nov	25.6	7.79	340	38.6	36	56.6	210	170	40	5.6	0.7	22	-
1	12-Dec	21.5	7.72	520	62.6	36	72.6	320	260	60	5.1	0.9	25	0.4
2	12-Dec	20.9	7.71	520	62.6	36	73.6	320	260	60	5.1	0.9	25	0.4
3	12-Dec	21.1	7.72	520	62.6	36	71.6	320	260	60	5.1	0.9	25	0.4

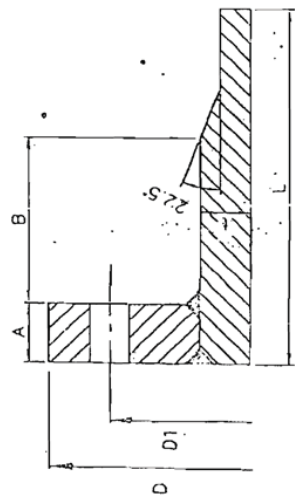
**Figure 2 Water quality of the Passur River at Mongla point
(Source: EIA-Report)**

ANNEXURE-III

ALL DIMENSIONS ARE IN MM

FIRST ANGLE PROJECTION

710M-141-666-DG-3d ON DRAWING



NOTES:-

Flange thicknesses listed are for Design pressure=5Kg/cm²(g) and Flange dimensions as given in the table. Final thickness of the flange is to be checked for actual OD/Bolting PCD/Neck dimensions.

PIPE SIZE	PIPE THK.	FLANGE OD 'D'	BOL PCD 'D1'	WELD NECK FLANGE		SLIP-ON FLANGE THICKNESS
				FLANGE THICK. 'A'	NECK THICK. 'L'	
1200	10-12	1465	1380	40	24	70
1400	14	1675	1590	50	24	70
1600	14	1915	1920	60	32	80
1800	14-16	2115	2020	70	32	90
2200	18	2550	2420	80	36	100
2300	20			90	38	110
2500	20			90	38	110
2700	20			90	38	110
						120
						140
						150
						150

— TENTATIVE

DRAWING FOR BAL. SEPARATOR COUNTER FLANGE

REV.	DATE	ALT	QTD	APPR	JOB NO.	999
STATUS						
DISTRIBUTION						
BIHARAT HEAVY ELECTRICALS LTD PROJECTS ENGINEERING MANAGEMENT PPEL, NOIDA						
TITLE						COUNTER FLANGE DETAILS
DRAWING NO.						PC-DG-999-141-M017
SHEET 01 OF 01						REV 00