

FICHTNER Consulting Engineers ( India ) Private Limited.

Subject	Doc. No.	Rev.	Vol. / Sec.
BID PACKAGE FOR COMBINED CYCLE CAPTIVE POWER PLANT AT HAZIRA PLANT, GUJARAT	5111168-ME-SPC-100-001	R1	III / 3.18
			Sheet No.
			550

## VOLUME - III

## SUB-SECTION - 3.18

## ELECTRICAL INSTALLATION

## 1.0.0 GENERAL

This specification covers Erection, Testing and Commissioning of the all electrical equipments.

It is not the intent to specify completely herein all details of the equipment, nevertheless, the equipment shall be complete and operative in all respects and shall conform to the highest standard of engineering, design and workmanship.

## 2.0.0 SCOPE OF WORK

The scope of work shall include but not limited to the following:

Installation of Generator, Transformers, Switchgears, Buducts, Motors, Control and Relay Panels, Battery and Chargers, Cables, Push button stations, Cable trays and accessories, DG Set, UPS system, Communication system, Illumination system, Earthing and lightning protection system, GIS etc.

The scope of work shall also include but not limited to the following:

- Cable Trays and Accessories
- Cable termination and jointing kits.
- Cable ties, clamps and markers
- Conduits and accessories.
- Junction boxes.
- 3-phase power Receptacles.
- Cable glands and cable lugs.
- Fire stop cable sealing system.
- Electrical Lab equipments / Components
- List and supply of Maintenance tools and tackles.
- Danger Boards
- Rubber Mats
- 30 nos. first aid charts shall be provided for display in the plant area.
- Minimum 20 nos. first aid boxes shall be provided at various locations in the plant.
- Sufficient quantity of gas masks shall be provided in line with rule no 43 of I E rules.
- Marshalling Boxes (MBs) as required for the power plant shall be supplied as required for marshalling cables of devices located in an area/ equipment.
- Name Plates indicating the identification of all equipments/systems/plants/etc. for entire plant

All accessories, fittings, supports, anchor bolts etc. which form part of the equipment or which are necessary for safe and satisfactory installation and operation of all the equipments/ all electrical system of entire plant shall be furnished.

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Subject	Doc. No.	Rev.	Vol. / Sec.
BID PACKAGE FOR COMBINED CYCLE CAPTIVE POWER PLANT AT HAZIRA PLANT, GUJARAT	5111168-ME-SPC-100-001	R1	III / 3.18
			Sheet No.
			551

**3.0.0 CODES AND STANDARDS****Code No : Description**

- IS: 1255 : Code of practice for installation and maintenance of power cables up to and including 33 kV rating.
- IS:732 : Electrical wiring installation (system voltage not exceeding 650 V).
- IS 10028 : Code of Practice for selection, Installation & maintenance of Transformers.
- IS 10118 : Code of practice for selection, installation & maintenance of Switchgear & control gear.
- IS:5216 : Guide for safety procedures and practices in electrical works.
- IS 2551 : Danger notice plates
- IS 2309 : Code of practice for the protection of buildings and allied structures against lightning
- IS 3043 : Code of practice for earthing

All the items shall conform to latest edition of relevant IEC/IS standards amended up to date. Equivalent ANSI standards are also acceptable.

Bidder shall comply with Indian statutory Regulations.

**4.0.0 INSTALLATION REQUIREMENTS****4.1.0 General**

All electrical installation work are to be carried out in accordance with this tender document and in conformity with the requirement of Indian Electricity Act, and Indian Electricity Rules as amended up to date and relevant standards, codes and statutory regulations. Manufacturers recommendation are also to be followed. The installation shall be carried out by a licensed and approved electrical contractor. The electrical installation must be got approved by the State Electrical inspector.

Site testing of all electrical equipment are to be carried out as per relevant standards and manufacturer's recommendation.

**4.2.0 Switchgears and Control Gears**

- 4.2.1 The foundations shall be designed to carry the dead weight of panels and additional impact loads imposed. The equipment shall be installed correctly and leveled properly. The floor level in front of the equipment shall be such as to facilitate easy drawout of breakers.
- 4.2.2 For storage batteries the floor shall be chemically resistant type and walls shall have chemically resistant tiles upto a suitable height. Alternatively chemical resistant paints are also acceptable.
- 4.2.3 All openings shall be closed to avoid entry of foreign particles.
- 4.2.4 Should the Switchgear or part of it be having a low IR value, the entire switchgear shall be dried up, with special care, to avoid direct local heating of surrounding insulation.

	Subject	Doc. No.	Rev.	Vol. / Sec.
	BID PACKAGE FOR COMBINED CYCLE CAPTIVE POWER PLANT AT HAZIRA PLANT, GUJARAT	5111168-ME-SPC-100-001	R1	III / 3.18
				Sheet No.
				552

**4.3.0 Transformers**

- 4.3.1 The level of the transformer base should be higher than the highest flood and storm water level of that area.
- 4.3.2 High rating transformer shall be placed after grouting channels or rails over concrete foundations, leveled, aligned & checked for free movement on the rails. Other transformers shall be placed directly on concrete beds. Stoppers to wheels shall be clamped immediately to prevent any movement.
- 4.3.3 Adequate clearance shall be maintained on sides and over the highest point of transformers.
- 4.3.4 Fire barrier walls shall be provided as per requirements.
- 4.3.5 Oil soak pit/drain pit of adequate capacity with necessary drain pipes shall be provided for draining of oil, away from the transformer.
- 4.3.6 Fire protection with sprinkler system shall be provided for higher rating of transformers as required.
- 4.3.7 Samples of oil shall be taken from the bottom of the tank and tested for proper dielectric strength and acidity. It should be ensured that the oil is free from dust and moisture during filling-in operation.
- 4.3.8 Drying out of the transformer shall be carried out to attain the required insulation levels as required.

**4.4.0 Busducts**

- 4.4.1 The insulators in busducts shall be inspected for any possible damage during transit and the defective ones shall be replaced. Contact surface of busbars, busbar bolts and nuts shall be thoroughly cleaned. The busduct run shall be properly aligned and leveled and shall be suitably supported.
- 4.4.2 The opening in the wall where the busduct enters OUTSIDE TO INSIDE room shall be completely sealed off so that entry of rain water and foreign materials are prevented. Expansion joints, flexible connectors inspection on openings, shall be checked for proper tightness.
- 4.4.3 The Generator busduct enclosure shall be checked for earth continuity and then properly earthed.

**4.5.0 Illumination Systems**

- 4.5.1 The location of the lighting panels shall be such that the same shall be operated easily.
- 4.5.2 The location of the light fittings, receptacles, switches, etc. shall be such as to avoid interference with piping or other equipment and to avoid objectionable shadows and glare.

Subject	Doc. No.	Rev.	Vol. / Sec.
BID PACKAGE FOR COMBINED CYCLE CAPTIVE POWER PLANT AT HAZIRA PLANT, GUJARAT	5111168-ME-SPC-100-001	R1	III / 3.18
			Sheet No.
			553

4.5.3 Lighting panels shall be suitable for wall / column mounting. Outdoor lighting panel may be floor mounted. Fixtures shall be firmly supported from structures. Clamps may be bolted or welded to the steelworks. In case of concrete structures, fixtures may be fixed with the help of anchor fasteners. In false ceiling areas fixtures shall be supported from the true ceiling.

4.5.4 All hardware shall be galvanized or zinc passivated. Wherever 90° bending on conduit routes are involved inspection elbows or smooth bends shall be used. All wires in conduit shall be colour coded. Each circuit shall have independent phase and neutral wire. Earth wire shall run in all conduits. Conduit size shall be chosen considering 40% maximum fill.

4.5.5 For street lighting, fixtures shall be mounted on steel poles. Each pole shall be grounded by connecting it to the plant ground grid or by using individual 3 m length ground rod.

4.5.6 In false ceiling areas the switchboards and the conduits shall be recess mounted below the false ceiling.

#### 4.6.0 Cables / Conduits

4.6.1 Cable shall be laid above ground in overhead cable trays or shall be laid in cable trays in cable trenches. For interplant cabling separate cable rack/cable duct bank or combined pipe cum cable rack shall be used.

4.6.2 Cable spreader room shall be provided below switchgear rooms and it shall be provided with easy access for inspection and maintenance.

4.6.3 In transformer yard and switchyard cables shall be laid in cable trays in RCC concrete trenches with RCC covers.

4.6.4 Proper slope shall be ensured in the cable trenches for draining of water. Cable entry to the building from cable trench shall preferably be overhead (above plinth level) to avoid water entry into the building. Depth of cable trenches shall be adequate to provide the required bending of the largest sized cable at the terminating ends.

4.6.5 For remote areas of the Plant cable may be buried directly in ground. Method and depth of burying shall be as given in I.S. 1255. Route markers shall be provided at an interval of 30 m and at each change of route direction.

4.6.6 Where a cable route crosses a permanent road/railway line cables shall be drawn through hume pipes or G.I. pipes. Pipes should be laid in a straight configuration. Filling criteria in any pipe shall not be more than 40%.

4.6.7 The cable layout shall be so designed that a fire in one route affecting certain equipment shall have minimum effect on other equipment.

4.6.8 Separate cable trays shall be used for the following:

- HT Power
- LT Power
- Control
- Instrumentation/communication cables
- Fire survival cables

4.6.9 HT Power cables shall be laid with adequate spacing between each cable. For LT Power Cables also spacing between the cables shall be preferably provided. In any case HT and LT Power

Subject	Doc. No.	Rev.	Vol. / Sec.
BID PACKAGE FOR COMBINED CYCLE CAPTIVE POWER PLANT AT HAZIRA PLANT, GUJARAT	5111168-ME-SPC-100-001	R1	III / 3.18
			Sheet No.
			554

Cables shall not be laid in more than one layer. Control and Instrumentation cables shall not be laid in more than two layers.

- 4.6.10 Contractor shall provide necessary embedded steel inserts in wall/floor/ceiling surfaces for supporting cable trays. The cable racks shall be secured to the rack/tray supports by welding to those inserts or other available building steel surfaces. In case of non-availability of embedded steel inserts in certain tray routes, the contractor shall have to secure the supports on wall/floor/ceiling surfaces by providing suitable anchoring system/ steel inserts having adequate load bearing capability.
- 4.6.11 Sufficient spacing not less than 250 mm shall be provided between different tiers of trays to permit adequate access, for installing and maintaining the cables.
- 4.6.12 The cable risers or vertical raceways shall be covered by 2.5 mm thick sheet steel, hot dip galvanized/painted cable tray covers with suitable stiffeners upto 2.5 metres from respective floor for mechanical protection. The sheet cover shall be of removable type.
- 4.6.13 Conduits shall be used for routing of cables (power/control) from cable trays to equipment/ junction boxes. The size of the conduit shall be selected on the basis of maximum 40% fill criteria. Pipe sleeves (Hume/GI) shall be used for routing of cables between floors, road crossing, entry/exit from outside of building etc. All conduits/pipe shall have their ends closed by caps till the cables are pulled. After the cables are pulled, the ends shall be sealed by suitable sealing compound having fire withstand capability.
- 4.6.14 Cable laid on trays and risers shall be neatly dressed and clamped at an interval of 1500 mm. and 900 mm. for horizontal and vertical cable runs respectively.
- 4.6.15 All power cables shall be clamped individually & control cables may be clamped in groups of three or four cables.
- 4.6.16 All single core power cables shall be laid in trefoil formation and suitably clamped with nylon/ FRP trefoil clamps or with other approved means. The nylon/FRP trefoil clamps shall have very high mechanical strength, fire retardant and self extinguishing characteristics. These clamps shall be with necessary fixing hardwares like bolts, nuts, washers etc. which are hot dip galvanized.
- 4.6.17 For direct buried arrangement before the cables are placed, the excavated portion shall be filled with a layer of sand. This sand layer shall be leveled and the cables laid over it. The cables shall then be covered with 150 mm sand on top of the largest diameter cable and sand shall be lightly pressed. A protective covering with 70 mm thick bricks shall then be provided on top. The remaining portion of the excavated trench shall then be back filled with soil, rammed and leveled.
- 4.6.18 Each cable and cable tray shall be tagged with numbers. Cables and conduits shall be tagged at their entrance, at every 30 m and exit from any equipment, junction box. The tags shall be of aluminium or other approved means with the number punched on it and securely attached to the cable. The location of cable joints, if any, shall be clearly indicated with cable marker with an additional inscriptions "Cable-Joint" and "Cable Number".
- 4.6.19 The contractor shall put ferrules on all control cable cores in all junction boxes and at all terminations. The ferrules shall carry terminal numbers as per drawings. All ferrules shall be coloured, plastic & interlocked type.
- 4.6.20 All cable entry points shall be properly sealed and made vermin and dust proof. Unused opening, if any, shall be effectively closed. Sealing work shall be carried out with approved fire sealing compound.

Subject	Doc. No.	Rev.	Vol. / Sec.
BID PACKAGE FOR COMBINED CYCLE CAPTIVE POWER PLANT AT HAZIRA PLANT, GUJARAT	5111168-ME-SPC-100-001	R1	III / 3.18
			Sheet No.
			555

4.6.21 Cables shall be installed without joints as far as practicable. Jointing kits shall be suitable for the type of cable and for the particular type of installation. The contractor shall provide jointing kits complete with insulating materials, stress grading/relieving materials, plastic mould, resin, earthing materials and all other accessories. A suitable loop shall be provided near all joints. Suitable loop shall also be provided for all power cables of 66kV, 11 kV and all LT Power Cables of bigger size at the terminating ends.

4.6.22 Communication cables shall run on instrument trays/ducts. Wherever these are not available, cables shall be taken sufficiently away from power cables. Communication cables shall cross power cables at right angles.

4.6.23 Top trays with exposure to elevated walkways shall be provided with covers for mechanical protection.

#### 4.7.0 Earthing System

4.7.1 All conduits, trays, cable armour and cable end box, electrical equipment such as motors, switchboards, panels, cabinets, hand rails, rails, fence & fence gates, columns, junction boxes, lockout switches, fittings, fixtures, etc. shall be effectively grounded. The grounding of equipment shall be done by GI flat connected to the risers of main ground mat.

4.7.2 For prefabricated cable trays, a separate ground conductor shall run along the entire length of each row of cable tray and suitably clamped on the cable tray.

4.7.3 All ground conductor connections shall be made by electric arc welding/brazing and all equipment earth connections shall be made by bolting with the earthing pads. Ground connections shall be made from nearest available station ground grid risers.

4.7.4 Equipment shall be generally be furnished with two separate ground pads with tapped holes, bolts, nuts and spring washers etc. Equipment ground connections, after being checked and tested shall be coated with anti-corrosive paint. At least two earth connections shall be provided for all electrical equipment as per IE rules. Longer run of cable trays etc. shall be periodically earthed.

4.7.5 Earthing conductors along their run on walls and columns shall be supported by cleating with approved materials/welding at intervals of 750 mm. For system earthing, earthmat consisting of interconnected mesh of mild steel rods buried in the ground under the main plant area and all off site areas, interconnected together by minimum two numbers of parallel conductors.

4.7.6 Each earthing lead from the neutral of the Transformers shall be directly connected to two electrodes in treated earth pits which in turn shall be connected to station earthing grid.

4.7.7 Earthing for Electronic equipment shall be carried out separately through insulated copper cable & shall be grounded with separate earth electrode. All the earth pits of electronic equipment shall be interconnected. The combined earth resistance shall be less than 0.5 ohm.

#### 4.8.0 Lightning protection system

4.8.1 All areas of the power plant shall be provided with lightning protection as per IEC/IS. The lightning protection system for buildings shall consist of Horizontal/Vertical /Galvanised Steel/ Copper air terminations, down conductors, test link and earth electrodes. The installation shall include laying clamping/cleating anchoring/welding of the down conductors on walls/ columns etc. and connection to the earth electrode through a test link.

4.8.2 Every down conductor shall be provided with a test joint at about 1500 mm. above ground level and connected to an individual earth electrode. The earth electrode shall in turn be connected to the main plant earthing grid. All joints in the down conductors shall be of welded type only.

Subject	Doc. No.	Rev.	Vol. / Sec.
BID PACKAGE FOR COMBINED CYCLE CAPTIVE POWER PLANT AT HAZIRA PLANT, GUJARAT	5111168-ME-SPC-100-001	R1	III / 3.18
			Sheet No.
			557

4.11.4 The terminals for junction boxes shall be suitable for terminating two (2) nos. 2.5 mm<sup>2</sup> stranded copper conductors on each side.

#### 4.12.0 Receptacles

##### 4.12.1 Industrial Receptacles

The industrial receptacles shall be heavy duty type rated for 20 A and 32A , 240V AC complete with plug and switch housed in galvanized sheet steel enclosure having degree of protection of IP 55. These shall be of three pin type with the third terminal connected to earth. Receptacles shall be provided in all the indoor and semi indoor areas such that the any point is accessible within 25m of cabling distance from the receptacle. For outdoor area also necessary receptacles shall be provided as per Owner/Owner's representative's requirement to be indicated during detailed engineering. Receptacles shall be provided in all the buildings of auxiliary equipment, GTG area, HRSG area, GIS building area, Transformer yard. The receptacle shall have safety shutters and other safety interlocks for safe operation.

##### 4.12.2 Welding Receptacles

The welding receptacle to be supplied shall be of 63 A and 100A, industrial heavy duty type with 5pin (with earth connection) suitable for 415 V, 3 phase, 50 Hz supply. In every enclosed area, for every 50 m interval, 1 No. receptacle shall be provided. For outdoor area, necessary receptacles shall be provided as per requirement. Receptacles shall be provided in all the buildings of auxiliary equipment, GTG area, HRSG area, ACC area, Transformer yard & switchyard.

The receptacle and switch shall be housed in a sheet steel enclosure complete with gasket, cable glands etc. All receptacle enclosures shall have 2 Nos. earthing terminals.

The enclosure shall be min. 2 mm. thick galvanized sheet steel and shall conform to the degree of protection IP-55 class.

All receptacles shall be provided with matching plug tops.

In hazardous areas, receptacles shall be of flame proof type.

The receptacle and switch shall be interlocked with the plug such that it shall not be possible to remove the plug with the switch in 'ON' position.

##### 4.13.0 Cable Glands & lugs

4.13.1 Cable glands shall be tinned brass, shrouded, double compression type, complete with necessary armour clamp and tapered washers etc. Cable glands shall match with the different cable sizes.

4.13.2 Cable lugs shall be tinned copper lugs suitable for termination of different sizes of HT/LT/ control cables. Lugs for power cables shall be of compression type, whereas lugs for control cables shall be of insulated terminal crimping type.

##### 4.14.0 Fire Stop Cable Sealing System

4.14.1 In order to restrict the propagation of cable fire and spread of toxic smoke, the cable entry below switchgear panels/ control panel, cable penetration through walls and cable shafts on the floors need to be sealed by fire seal system.

4.14.2 Fire stop cable sealing shall have two (2) hours fire rating. The sealing compound shall have special property to allow for thermal expansion of cables both under normal and short circuit conditions. The sealing system shall be proven type and tested as per relevant standard.



Subject	Doc. No.	Rev.	Vol. / Sec.
BID PACKAGE FOR COMBINED CYCLE CAPTIVE POWER PLANT AT HAZIRA PLANT, GUJARAT	5111168-ME-SPC-100-001	R1	III / 3.18
			Sheet No.
			556

4.8.3 The lightning protection system shall not come in direct contact with other equipment/systems such as cables, conduits, electrical equipment, underground metallic ducts etc. All metallic structures within 200 mm. vicinity shall be bonded to the lightning protection system.

4.8.4 All down conductors shall be cleated/welded/brazed to the wall/columns at an interval 1500 mm. All welded/brazed joints shall be coated with anti-corrosive paint for rust protection. The horizontal roof conductors at the top of building/ structures shall be cleated at an interval of 1500 mm. by providing necessary cement mortar sand blocks.

#### 4.9.0 Cable Trays and Cable Tray Supports

4.9.1 Cable trays shall be pre-fabricated ladder type, made of 3 mm thick sheet steel with hot dip galvanized furnished in standard lengths of not less than 2.5 m.

4.9.2 Cable trays shall be complete with all necessary hot dip galvanized sheet steel accessories such as coupler plates, ground continuity connections, nuts, bolts, washers, clamps etc. Also necessary horizontal/ vertical bends, horizontal/vertical Tees, Reducers, Horizontal cross pieces etc. shall be supplied to make the system complete.

4.9.3 Cable tray support system shall be of sheet steel prefabricated and galvanised or of site fabricated and painted type.

4.9.4 Sheet steel covers of minimum 2 mm. thick shall be provided for wall/column mounted vertical raceways and wherever specifically required. The width of the cover shall be same as that of the tray.

4.9.5 Provision shall be made in the cable trenches so that water should not be entered inside any building through cable trenches.

#### 4.10.0 Cable Termination & Jointing Kits

4.10.1 The cable termination and jointing kits shall be either "Heat Shrink" / "Cold Shrink" / Push ON type. The kits shall include all insulation and sealing materials apart from conductor fittings and consumable items. Joints and terminations shall meet test requirements as per IEC/ VDE 0278. The straight through jointing kits shall be suitable for underground buried installation with uncontrolled backfill and possibility of flooding by water or overhead tray installation.

4.10.2 Cable ties & trefoil clamps shall be of special nylon high tensile material. Cable markers shall be of aluminium.


#### 4.11.0 Junction Box

4.11.1 Junction boxes shall be conforming to degree of protection IP55. The boxes shall be of die cast aluminium (LM 6) complete with removable cover plate with gaskets, two earthing terminals, terminal blocks etc.

4.11.2 The boxes shall have provision for wall, column, pole or structure mounting and shall be provided with cable/conduit entry knock outs & terminal blocks.

4.11.3 The terminal blocks shall be mounted securely on brackets welded to the back sheet of the box. The terminals shall be 650 V grade, one piece construction complete with terminals, insulation barriers, galvanised nuts, bolts and washers and provided with identification strips of PVC. The terminals shall be made of copper alloy and shall be of box clamp type.



	Subject	Doc. No.	Rev.	Vol. / Sec.
	<b>BID PACKAGE FOR COMBINED CYCLE CAPTIVE POWER PLANT AT HAZIRA PLANT, GUJARAT</b>	<b>5111168-ME-SPC-100-001</b>	<b>R1</b>	<b>II / 1</b>
				<b>Sheet No.</b>
				<b>55</b>

request shall supply the Owner/Owner's representative's with a copy of drawings and procedures at the time of the test.

All instruments and apparatus required for the inspection or used for the performance of tests shall be subject to the approval of the Owner/Owner's representative at his discretion and shall be calibrated to an agreed standard in approved laboratories. The cost of making such calibrations shall be borne by the Contractor in all cases.

If the Contractor wishes to apply for a concession in respect of a departure from an approved procedure or standard, this shall be made in writing with full information substantiating the technical acceptability of the proposed change. The Owner/Owner's representative's decision shall be final. Concessions granted shall not absolve the Contractor from any of his responsibilities under the Contract.

#### **8.8.0 Testing During Manufacturing**

The minimum testing requirements for mechanical, electrical and C&I equipment testing to be conducted at manufacturer's works are specified in the detailed specifications.

#### **9.0.0 EQUIPMENT ERECTION, SITE TESTING, COMMISSIONING AND PERFORMANCE TEST**

This Specification generally covers the standards, scope of works, documentation, scope of installation, testing and commissioning of various mechanical, electrical, control and instrumentation equipment & system and various requirements to be adhered to during the execution of the works.

Works shall be performed in accordance with this technical specification and various other drawings and schedules submitted and approved by the Owner/Owner's representative during the execution and the instructions from Engineer-in-charge or his authorized representatives during the progress of the work. Consumables required for the job shall be ensured by the Contractor. All necessary equipments and instruments required to carry out the works, recalibration of the instruments required during loop checking and commissioning shall be done by the contractor.


Field quality plans shall be submitted and shall detail out for all the equipments, the quality practices and procedure to be followed by the Contractor's site quality control organization during various stages of site activities including receipt of materials/equipments at site, preservation and storage, pre-assembly, erection, pre-commissioning and commissioning. The Contractor shall provide all necessary means for execution of inspection and testing, according to the requirements.

#### **9.1.0 Erection**

##### **9.1.1 General**

Erection work shall be carried out in the manner and sequence as may be directed by Contractors supervisory Engineers and the Owner/Owner's representative.

All existing structures, piping, conduits, equipment and facilities shall be protected by the Contractor against damage/degrade during erection. Any damage/degradation caused by Contractor shall be rectified at his cost to the satisfaction of the Owner/Owner's representative within short timelines.

	Subject	Doc. No.	Rev.	Vol. / Sec.
	<b>BID PACKAGE FOR COMBINED CYCLE CAPTIVE POWER PLANT AT HAZIRA PLANT, GUJARAT</b>	<b>5111168-ME-SPC-100-001</b>	<b>R1</b>	<b>II / 1</b>
				<b>Sheet No.</b>
				<b>56</b>

As erection proceeds each assembled part before being boxed up with a view to erecting it finally, shall be inspected and approved by the concerned supervisor. Should any defect be found out during such inspection, the Contractor shall make it good as per directives from Owner/Owner's representative.

All materials such as electrodes, gaskets, bolts, nuts shall be of reputed make and conforming to relevant Indian Standards. Prior approval of Owner/Owner's representative will have to be obtained before commencement of work. Manufacturer's test certificate shall have to be provided when called for.

Contractor shall furnish all instruments, isotopes, films for conducting radiography and equip himself fully. Necessary operators of all testing equipment shall be provided by the Contractor. Dark room facilities with air conditioners for storing and processing radiography films and equipment, as necessary, shall have to be arranged by the Contractor. The radiography shall be done on any weld (including welds for repair) only after final heat treatment.

The equipment shall be placed on respective support, levelled and aligned with precision measuring instruments, checked for proper clearance between moving and stationary parts wherever applicable.

The installation of motors shall be carried out along with driven equipment in accordance with manufacturer's instructions and/or as directed by the Owner/Owner's representative.

Wherever the scope includes control panels, all connections in control panels shall be completed, checked and adjusted to ensure safety and satisfactory operation of the equipment.

Particular attention shall be given towards removal of buckles and other forms of distortion.

Holes in plate work to assist in erection should be avoided.

Misalignment in vertical joints shall not exceed 10% of plate thickness or 1.0 mm, whichever is larger.


Misalignment in horizontal joints shall not exceed 15% of upper plate thickness with a maximum of 2 mm for plate thickness above 8 mm and a maximum of 1.0 mm for plate thickness less than 8 mm.

Welding sequence shall be adopted in such a way so as to minimise distortion due to weld shrinkage and shall be got approved from the Owner/Owner's representative prior to commencement of work.

Welding shall not be carried out on wet surfaces and shall be protected from high winds.

### 9.1.2 Erection Program and notification

The Contractor shall furnish a detailed erection programme taking into consideration the constraints likely to be encountered during various phases of work including interfacing with the existing plant. This erection programme shall be strictly adhered. The Contractor shall take appropriate steps as directed by the Owner/Owner's representative to make up for any slippage from this erection programme and no additional compensation shall be allowed on this account.

	Subject	Doc. No.	Rev.	Vol. / Sec.
	<b>BID PACKAGE FOR COMBINED CYCLE CAPTIVE POWER PLANT AT HAZIRA PLANT, GUJARAT</b>	<b>5111168-ME-SPC-100-001</b>	<b>R1</b>	<b>II / 1</b>
				<b>Sheet No.</b>
				<b>57</b>

Before erection commences and not later than three months before start of erection, the Contractor shall submit the proposed erection test program and the commissioning test program with all proposed erection and commissioning tests and checks. Together with the test programs the proposed test procedures have to be submitted.

The test programs should consider:

- that the sequence and duration of the proposed activities are logical, realistic and in accordance with safety and permit regulations in force
- that the commissioning of any item of plant would not interrupt the normal operation of the existing plant.
- that allowance for training the Owner/Owner's representative's operation personnel during this period has been made.

The Contractor has to take care that the test programs are maintained by the erection organization during erection and commissioning.

The Contractor has to mark all stages, which are subject to the Owner/Owner's representative's acceptance and has to notify at least two week's in advance when such inspection for acceptance becomes due.

### 9.1.3 Supervision during Erection

The Contractor shall provide at proper time the necessary supervisory Engineers, Supervisors and other supervisory personnel duly qualified and in sufficient number for transportation, handling, unloading, storage, erection, pre-commissioning and post commissioning, startup, testing and test operation of plants and equipment.


The Contractor shall keep a competent representative who will be resident Engineer-in-charge and shall remain as In-charge of Contractor's work site and also remain answerable to the Owner/Owner's representative for all activities of the Contractor at site. Before his placement at site, the Contractor shall submit his bio-data to the Owner/Owner's representative for his approval.

The Resident Engineer-in-charge shall supervise the work of all men of the Contractor working at site. He shall work in complete harmony and co-operation with Owner/Owner's representative. All statutory rules and labour laws prevailing in the area must be observed by the Contractor. All safety measures against occurrence of accidents must be taken effectively. Resident Engineer-in-charge shall not be withdrawn without written permission of the Owner/Owner's representative. If any of the Contractor's personnel was found unsuitable for the job, the Contractor shall remove him forthwith and a suitable replacement shall be posted to site within a reasonable time. No compensation for withdrawing of unsuitable or unqualified person(s) from site or for posting suitable person(s) to site at any stage of the project shall be allowed by the Owner/Owner's representative.

### 9.1.4 Sequence of Erection Work

All packing cases and packages shall be opened in presence of the Owner/Owner's representative or his authorised representative.

Nails and packing strips should be pulled out with suitable appliances and kept separately in container and not thrown away at random. All timber of packing cases shall have to be sorted out and stored properly at a suitable place as directed by the Owner/Owner's representative.

	Subject	Doc. No.	Rev.	Vol. / Sec.
	<b>BID PACKAGE FOR COMBINED CYCLE CAPTIVE POWER PLANT AT HAZIRA PLANT, GUJARAT</b>	<b>5111168-ME-SPC-100-001</b>	<b>R1</b>	<b>II / 1</b>
				<b>Sheet No.</b>
				<b>58</b>

From time to time packing materials, timber, nails and strips shall be delivered back to the Owner/Owner's representative or otherwise disposed of as directed by the Owner/Owner's representative. All timber and packing materials shall remain the property of the Owner/Owner's representative.

Each material after stripping from boxes or received loose, shall be carefully inspected, checked with shipping list and identified with erection drawing if necessary. Any short supply and/or damaged part shall be reported forthwith to the Owner/Owner's representative in writing. The Contractor shall be completely responsible to make all necessary arrangements, application and follow procedure to process claim on underwriters, obtain replacement repair/rectify and modify as required on all such damaged/defective/lost equipment and material at no extra cost to the Owner/Owner's representative in order to execute the work to satisfaction of the Owner/Owner's representative within the stipulated contract time. Once the materials are inspected, the same shall be preserved properly and adequately protected from theft and deterioration or damage by rain, storm, dust, water, tampering by casual visitors or workers. The Contractor shall prepare and maintain stores, ledgers and bin cards for all materials in his custody.

Carrying out all repairs to damages/degradation that might have occurred during transit and in subsequent storage. Also modifications and rectification work as necessary and replacement of all lost parts, are under the Contractor's scope.

#### 9.1.5 Safety Regulations

Contractor should follow all the safety regulations / norms as imposed by the Law/Authority/factory inspectorate /Owner/Owner's representative. When going to or from place of work in the plant only the prescribed walkways, paths or cross-overs shall be used and required protections, barricades shall be established for the plant area.

Crawling on, over or under movable equipment shall generally be prohibited.

For overhead work, proper signs shall be placed below and, when conditions justify, a watchman shall be stationed to warn employees in the vicinity.

Work on or about crane runways shall not be undertaken without the Owner/Owner's representative's permission. Whenever it is necessary to do any work on or above the crane runways, the Contractor shall furnish a flag man stationed on the floor.

Only scaffolds which meet the requirements of governing laws shall be used in the project.

Work in area of electric wires and cables shall generally be avoided.


All burning and welding equipment shall conform to, and be used in accordance with, regulations governing such equipment. No burning or welding shall be done at any place on the site until location where such work is to be done is approved.

Adequate fire protection shall be available before work preceding the work.

All warning signs shall be observed.

Contractor shall require his employees to wear hard hats at all times when they are inside the plant area.

Goggles shall be worn whenever there is a possibility of flying particles or splashing of corrosive fluid.

	Subject	Doc. No.	Rev.	Vol. / Sec.
	<b>BID PACKAGE FOR COMBINED CYCLE CAPTIVE POWER PLANT AT HAZIRA PLANT, GUJARAT</b>	<b>5111168-ME-SPC-100-001</b>	<b>R1</b>	<b>II / 1</b>
				<b>Sheet No.</b>
				<b>59</b>

While working at site all workmen shall wear necessary safety protective equipment.

When ladders are the means of access to a platform, they shall be firmly secured top and bottom and the ladder rails shall extend at least one meter above the top landing. When a ladder cannot be secured, a man shall be stationed at the base.

Safety belts shall be used by men working in high places when no hand rails or other guards are in place.

All accidents resulting in injury shall be reported to the Owner/Owner's representative promptly. Owner/Owner's representative's safety rules, regulations and directives shall be followed and reports thereon shall be submitted as and when required.

#### 9.1.6 Proper Treatment of Injured

Contractor shall ensure that proper treatment of injuries is immediately available either as such or in the form of constantly available transportation to a source of such treatment.

Contractor shall ensure that stretchers are available near all areas in which their men are working and that the location of stretchers are well marked.

Contractor shall be solely responsible for the dissemination of all safety regulations including those written here, those promulgated by Owner/Owner's representative and those dictated by good practice, and shall ensure that all his employees and those of his Sub-Contractors are conversant with same


#### 9.2.0 Inspection

After completion of erection and/or installations and before start-up the equipment and all its appurtenances shall be thoroughly cleaned and then, inspected in the presence of the Owner/Owner's representative for correctness, soundness and completeness of installation and acceptability for start-up.

All works to be carried out by the Contractor shall be subject to inspection by the / Owner/Owner's representative as applicable. The work shall be carried out as per applicable specifications, codes of practice, drawings and instructions of Owner/Owner's representative . The Contractor shall provide necessary facilities, instruments and personnel for carrying out the inspection as above and shall comply with the instructions given.

A check list in triplicate will be furnished for the approval of Owner/Owner's representative wherein all items to be checked and necessary instructions will be listed. Inspection and checking shall strictly follow this check list. On completion of the joint inspection and checking two (2) copies of the check list will have to be handed over to the Owner/Owner's representative. The check lists after checking will have to be jointly signed by the Contractor's supervisor and the Owner/Owner's representative to ensure that all inspection and checking have been properly carried out. However, such endorsement shall not relieve the Contractor from the responsibility in ensuring proper erection and cleaning.

During inspection all clearance, alignment and important measurements and adjustments as may be directed shall be noted by the Contractor for future reference and guidance. Two (2) copies of such notes shall be delivered to the Owner/Owner's representative.

	Subject	Doc. No.	Rev.	Vol. / Sec.
	<b>BID PACKAGE FOR COMBINED CYCLE CAPTIVE POWER PLANT AT HAZIRA PLANT, GUJARAT</b>	<b>5111168-ME-SPC-100-001</b>	<b>R1</b>	<b>II / 1</b>
				<b>Sheet No.</b>
				<b>60</b>

All reports of radiographic examination in a format approved by the Owner/Owner's representative shall be submitted to the Owner/Owner's representative for his approval and records.

### 9.2.1 Cleaning

The Contractor shall observe strict cleanliness during execution of the work and shall be in possession of vacuum cleaner for cleaning the internals of machinery under installation. They shall check that all the finished surfaces are greased and covered.

Before boxing up, the Contractor shall examine carefully to ensure that no foreign material, such as welding rod ends, welding beads, metal chips, rope, working tools has been left inside any equipment.

In the case of motors, the following procedure shall be observed

- Checking and cleaning of bearings and charging / filling of lubricants, wherever necessary.
- Cleaning of core and winding, drying out and cornicing the winding and measurement of air gap for motor assembled at site.

Wherever the scope includes control panels, all withdrawable components shall be taken out and internals shall be cleaned with vacuum cleaner, if required.

### 9.3.0 Testing and Commissioning

#### 9.3.1 Erection Test

Following the satisfactory completion of inspection, checking and cleaning of a unit, the plant will be placed in test run. During this period, all adjustments and repairs as required shall be made by the Contractor. Protocol shall be made and signature has to be obtained from Owner/Owner's representative. On completion of satisfactory test run, the plant will be placed under trial operation.

Prior to trial operation of any equipment the following shall be checked:


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.

After successful mechanical completion Mechanical 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
- Proper installation of the drive and equipment on the foundation
- Proper alignment of drive and the driven equipment
- Proper connection of supports, hangers, piping, valves, instruments and other fittings.
- Freeness of the rotors of drive and equipment
- Healthiness of lube oil system, changing and filling as necessary.
- Safety audit
- Testing of site welds (non-destructive examinations)



	Subject	Doc. No.	Rev.	Vol. / Sec.
	<b>BID PACKAGE FOR COMBINED CYCLE CAPTIVE POWER PLANT AT HAZIRA PLANT, GUJARAT</b>	<b>5111168-ME-SPC-100-001</b>	<b>R1</b>	<b>II / 1</b>
				<b>Sheet No.</b>
				<b>61</b>

- Pressure/leak/tightness test
- Pipe line and equipment flushing and cleaning
- Chemical protection of piping systems
- Checking of coating
- Testing of cranes and hoists
- Safety signs and warning signs
- Completion of buildings and civil works
- Test of ventilating and air-conditioning units

#### Electrical/instrumentation equipment tests

The following checks and tests measurements shall be made:

- 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
- Verification of neutralization conditions
- Fire-proof partitioning
- Marking, inscription, provision of designation plates
- Voltage checks
- Polarity checks in the case of DC voltages
- Fuses, over current trips, short-circuit trips, time settings, relay settings
- Transformer oil levels
- Setting indicators, revertive (check-back) signals to the central control room.
- Checks on wiring and cabling for conformity with the constructional circuit-drawings and plans
- checking and functionality testing of electrical systems according to IEC standards
- checking and testing of instruments

#### 9.3.2 Pre-Commissioning Testing

After alignment of all equipment, alignment tests shall be carried out by the Contractor to check levelling, clearance, eccentricity. Measurements will be witnessed and acceptance will be certified by the Owner/Owner's representative.


Hydro-test / eddy current test, as applicable will be carried out on equipment as identified in the QAP to be finalized during detailed engineering. . All necessary blanking arrangements for hydro testing shall be furnished by the Contractor. All necessary test pump/temporary piping shall be supplied by the Contractor.

Preconditions for the commissioning are the issue of the Mechanical Completion Certificate and the availability of the accepted commissioning program and the Contractor's commissioning procedures. The Pre-commissioning Checks cover the functional tests of the individual items and their alarm and tripping systems. Following tests shall be included:

#### Mechanical equipment

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



	Subject	Doc. No.	Rev.	Vol. / Sec.
	<b>BID PACKAGE FOR COMBINED CYCLE CAPTIVE POWER PLANT AT HAZIRA PLANT, GUJARAT</b>	<b>5111168-ME-SPC-100-001</b>	<b>R1</b>	<b>II / 1</b>
				<b>Sheet No.</b>
				<b>62</b>

### Chemical Cleaning of Piping Systems and Equipment

Necessary procedure for chemical cleaning of piping and equipment shall be submitted to Owner/Owner's representative for their approval along with pre-commissioning document during detail engineering stage.

Before introducing chemicals, all the piping systems and equipment shall be water flushed. Water flushing will be followed by alkaline cleaning, acid cleaning and passivation or by EDTA (Ethylene Diamene Tetra Acid) and passivation.

However, the Contractor shall submit along with the offer his usual procedures and practices for chemical cleaning of the piping and equipment specified. The Contractor shall submit all schematics, write up, details of chemicals to be used. and detailed procedures he intends to follow. These schematics and procedures shall be subject to the approval of the Owner/Owner's representative.

#### Pre- cleaning procedure:

Prior to starting any phase of cleaning operation the following procedures shall be ensured:

Installation of all temporary piping, valves, pumps and equipments as required for the flushing and chemical cleaning operations. Temporary piping shall be routed at floor level as far as possible and secured in place to prevent movement/ vibration beyond acceptable limits.

Installation of the instruments as required to ensure satisfactory monitoring and control of the cleaning process. The Contractor shall also determine and arrange locations for sampling of the cleaning solution during cleaning.

By passing all regulation/control valves coming in the cleaning circuit or installation of temporary spool pieces.

Installation of special end covers and temporary suction strainers, for boiler feed pumps and condensate pumps. Pump internals shall not be installed.


Installation of plastic seal in the condenser neck to protect the turbine from alkaline fumes.

Blocking and securing of all spring hangers in the steam lines which may be flooded during the cleaning operation.

Hand cleaning of the interiors of all vessels which are included in the cleaning operation.

#### General cleaning procedures:


- Seal water lines to pump shall be flushed by the permanent arrangement provided for the same.
- Where pipeline terminate in spray headers, these headers shall be inspected after each phase of the cleaning operation and cleaned if necessary.
- All strainers shall be observed closely during the cleaning operation by reading differential pressure gauges, and shall be cleaned when the differential pressure exceeds a predetermined value.
- All high points, vents shall be opened periodically to ensure full system flow.

	Subject	Doc. No.	Rev.	Vol. / Sec.
	<b>BID PACKAGE FOR COMBINED CYCLE CAPTIVE POWER PLANT AT HAZIRA PLANT, GUJARAT</b>	<b>5111168-ME-SPC-100-001</b>	<b>R1</b>	<b>II / 1</b>
				<b>Sheet No.</b>
				<b>63</b>

- e) Upon completion of each stage of cleaning, the waste products shall be drained and transferred to the waste treatment basins. The Contractor shall then supply and add the necessary chemicals to the basin to neutralise all waste solutions and rinses generated by the cleaning process, and arrange for its disposal to an area to be indicated by the Owner/Owner's representative.
- f) Strict safety precautions shall be exercised at all times during the chemical cleaning and during storage and handling of the chemicals. The Contractor shall ensure provision of all protective clothing, apparatus and equipment along with necessary first aid kits as required for handling the chemical and for carrying out the cleaning operation.
- g) All Hazardous waste material generated during construction, erection and commissioning shall be disposed by Contractor using authorised waste disposal agency.

#### Steam Blowing of Piping Systems

- i) Steam blowing shall include engineering, supply and installation of all temporary piping, valves, fittings including quick actuating valves (for puffing purposes), supports, blanking plates, spools, target plates, instruments, controls and all other accessories and services required to complete the cleaning process as specified herein
- ii) The detailed schemes and procedure for steam blowing operations shall be prepared and furnished by the contractor and discussed and finalized during the detailed engineering stage.
- iii) Steam blowing shall also include reinstatement of cleaned piping systems; and dismantling/removal of all temporary piping, equipment and materials from site. All temporary piping, valves, equipment and materials shall be taken back by the contractor upon satisfactory completion of cleaning, and shall be removed from the Owner/Owner's representative's premises.
- iv) Engineering involved regarding temporary piping shall include the following:
  - a. Selection of temporary piping including disturbance factor calculation.
  - b. Preparation of layout of temporary piping and performing stress analysis as per ANSI B 31.1.
  - c. Selection of temporary hangers and supports as required.
- v) The following piping systems shall be cleaned through steam blowing operation.
  - a) Main steam, , LP, HP and LP bypass and process steam piping system.
  - b) Auxiliary steam piping system.
- vi) Steam blowing shall be carried out for removal of particles (rust, scales, weld splatter) from various piping systems to avoid damage to turbine bladings. Cleanliness of system shall be checked by means of test plates made of steel, which will be installed in the centre line of the piping system.
- vii) Cleaning shall be achieved by steam purging i.e. by blowing of steam through the piping such that the momentum of flow is greater than that of steam flow during normal operation of unit (at TMCR). The disturbance factor during steam blowing (ratio of momentum of flow during purge to that during TMCR) shall be more than 1.4.
- viii) The blow off shall be done with steam, which is exhausted through adequately sized, open-ended temporary piping. Temporary piping and motor operated valves shall be installed for steam blowing operation. Pressure shall be built up in the boiler and the

	Subject	Doc. No.	Rev.	Vol. / Sec.
	<b>BID PACKAGE FOR COMBINED CYCLE CAPTIVE POWER PLANT AT HAZIRA PLANT, GUJARAT</b>	<b>5111168-ME-SPC-100-001</b>	<b>R1</b>	<b>II / 1</b>
				<b>Sheet No.</b>
				<b>64</b>

pipings warmed before release of steam by quick opening of motor operated valve located on temporary piping. The cycle shall be repeated until steam from the blow out pipe is determined to be clean.

- ix) If the flow nozzles and control valves have already been erected these shall be removed and replaced by spool pieces before steam blowing. The removed flow nozzle and control valves shall be put back after steam blowing.
- x) The motor operated valves used for steam blowing shall have special characteristics like minimum loss of pressure, resistance to wear during severe working conditions (high velocity and carryover of water and solid particles), quick opening time, minimum effort on electric actuator.
- xi) The steam blowing termination criteria shall be as under:
  - a) Acceptable target plate condition
  - b) Measured disturbance factor (DF) more than 1.4 ((to be reviewed and decided during detailed engineering stage depending upon type of cleaning adopted by Contractor Acid/alkali boil-out).

The required values to calculate actual DF will be measured at site. The criteria for acceptable target plate condition shall be finalised during detailed engineering.


#### Electrical equipment

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

- High voltage tests
- trip tests
- Equipment Functional Test

#### Tests on Motors as per IS

- Insulation test of winding by megger, drying out and, if necessary, high potential test.
- Winding resistance measurement on all 3 phases for motors of bigger size.
- Testing the motor for proper direction of rotation and reconnection, if necessary.
- No load test run of the motor for a minimum of eight (8) hours to check out bearing or other associated parts.
- During test run, hourly record of currents on all the three phases shall be maintained and careful watch shall be maintained on the equipment for any abnormal sound, temperature of bearing, vibrations.
- After no load test run of the motor each rotary equipment shall be coupled and shall be subjected to a test run. The duration of this test run shall be mutually agreed.
- The objective of the test run shall be to ascertain that the following are within the permissible limits and the operation is satisfactory.
  - Vibration and noise level
  - Bearing vibration and temperature
  - Performance of the lube oil systems

	Subject	Doc. No.	Rev.	Vol. / Sec.
	<b>BID PACKAGE FOR COMBINED CYCLE CAPTIVE POWER PLANT AT HAZIRA PLANT, GUJARAT</b>	<b>5111168-ME-SPC-100-001</b>	<b>R1</b>	<b>II / 1</b>
				<b>Sheet No.</b>
				<b>65</b>

- Motor winding temperature
- Performance of various control, interlocks and protective elements, wherever applicable.
- Performance of annunciation system and indication, wherever applicable.

#### Tests on transformers

During installation : Checking of complete delivery, checking of core earthing and insulation of active part from tank, H.V. sample tests of transformer Oil in accordance with IEC or equivalent Standards.

During commissioning : Checking of satisfactory operation.

#### Tests on earthing and lightning protection system

Acceptance tests and measurements of the earthing installations in accordance with IEC or IS standards.

#### Tests on lighting system

Proof of the minimum new value of lighting densities, checking of correct operation both electrically and mechanically.

Contractor shall provide the list of site tests to be performed on electrical equipment as part of pre-commissioning activities for Owner/Owner's representative's review.

#### Control Equipment


- Calibration tests of all analog measuring loops including all remote indications and recorders and the input signals used for closed loop control.
- Testing of all plant mounted transmitters.
- Wiring test of all control cabling in the field, control rooms combined with the function tests.
- Testing of all control modules in the control room

Functional testing of remote control of drives, circuit breakers, solenoid valves, actuators etc.

- Testing of open loop devices especially all sequence logic equipment using simulated inputs.

Testing of all interlocks to ensure safe operation.

- Testing of the alarm annunciation and event recorder system in connection with all field and control room devices using simulated inputs.
- Testing of all closed loop controls.
- Testing of insulation between cable screen and ground.

	Subject	Doc. No.	Rev.	Vol. / Sec.
	<b>BID PACKAGE FOR COMBINED CYCLE CAPTIVE POWER PLANT AT HAZIRA PLANT, GUJARAT</b>	<b>5111168-ME-SPC-100-001</b>	<b>R1</b>	<b>II / 1</b>
				<b>Sheet No.</b>
				<b>66</b>

### 9.3.3 Commissioning

Preconditions of the commissioning are the successful completion of the pre-commissioning checks of all items of the whole system.

Commissioning tests shall be performed in accordance with the procedure contained in the commissioning program approved by the Owner/Owner's representative for individual equipment/system and as a plant. Commissioning test shall also include Redundancy and automatic fall back by simulation of fault conditions


On completion of each commissioning activity to the satisfaction of the Owner/Owner's representative, the commissioning schedule shall be signed and dated by the Contractor and countersigned by the Owner/Owner's representative.

Commissioning test shall prove that the plant is prepared and adjusted to ensure the correct functioning of the individual components and of the complete plant.

After successful completion of the commissioning tests "Authorization to Performance Test " shall be signed.

The Commissioning test shall cover at least following tests:

- Protection tests
- operation of protection devices including the following as a minimum
  - fire protection
  - HRSG protection
  - Gas turbine protection
  - steam turbine protection
  - generator protection
  - transformer protection
  - 66kV GIS protection
  - Balance of plant protection
- Method of alarm/trip condition reset for subsequent starting 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
- Protection systems/settings, in accordance with agreed design and the requirements of the transmission system
- Start-up tests
  - Normal automatic start to preset load
  - Staged 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 units and steam generators at various conditions
  - Power unit(s), test partial and full load rejection to demonstrate.

	Subject	Doc. No.	Rev.	Vol. / Sec.
	<b>BID PACKAGE FOR COMBINED CYCLE CAPTIVE POWER PLANT AT HAZIRA PLANT, GUJARAT</b>	<b>5111168-ME-SPC-100-001</b>	<b>R1</b>	<b>II / 1</b>
				<b>Sheet No.</b>
				<b>67</b>

- Full load rejection tests to measure transient maximum speed and steady state speed at normal governor droop setting
- Method of resynchronism to be demonstrated.

- Turbine bypass operation capability
- Demonstration of start up of the plant utilising start up power only from black start DG and demonstration of safe shut down utilising DG for emergency purposes.
- Operating stability when operated in the full range of load conditions with load variations by increasing or decreasing the electric load/steam delivery.
- Demonstration of the capabilities of the Power Units 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
- Verification of vibration and noise emission
- Environmental monitoring equipment, water quality monitoring equipment, functioning tests and verification of guarantees
- 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 shall be as per MPP recommendations.
- Verification of completeness of scope of supply. This shall be carried out along with the punch list.
- Verification of 24 hours uninterrupted MCR operation
- Establish the capability to deliver the specified process steam even at minimum Gas turbine load, without any fresh air for atleast 8 hours on a continuous basis.


#### 9.4.0 Trial Operations

After successful completion of commissioning test and after relevant test protocols have been accepted by the Owner /Owner's representative, the Contractor shall be allowed to prepare the Plant Units for trial operation. The plant will be started up and loaded. During this loading operation all the controls and protections shall be finally set.

After the plant is loaded to the maximum capability rating and the contractor is fully satisfied with its performance he shall offer the unit for Trial Operation by communicating the same to the Owner/Owner's representative in writing. After receipt of such communication the plant will be on trial operation. The trial operation will be for a minimum period of fifteen (15) days continuously at rated full load/part load as made available by the Owner/Owner's representative or as mutually agreed between the contractor & / Owner/Owner's representative to demonstrate the following :-

- Sustained capability of the plant
- Reliability of the equipment and auxiliaries
- Adequacy of the various auxiliaries, ancillaries & systems and controls.
- Capability of each equipment of the plant to correctly perform the functions for which it is specified.
- Safety requirements

This trial operation shall be undertaken jointly with the Owner/Owner's representative. As a part of the trial operation reliability run and guarantee tests of the plant shall be conducted.

	Subject	Doc. No.	Rev.	Vol. / Sec.
	<b>BID PACKAGE FOR COMBINED CYCLE CAPTIVE POWER PLANT AT HAZIRA PLANT, GUJARAT</b>	<b>5111168-ME-SPC-100-001</b>	<b>R1</b>	<b>II / 1</b>
				<b>Sheet No.</b>
				<b>68</b>

### 9.5.0 Reliability Run

Reliability run shall be undertaken jointly with the Owner/Owner's representative as a part of the trial operation and within the trial operation period. Reliability run shall be conducted for seven (7) days uninterrupted at a load as available at prevailing ambient conditions.

In the event of interruptions to the reliability test run, for which the Contractor is responsible, the length of the reliability test run can be extended by a period equal to the total duration of the interruptions. If such an interruption lasts more than 24 hours, the reliability test run shall be restarted, after repairing the defect. The reliability test run may be interrupted on a maximum of three occasions, provided that no interruption exceeds 8 hours and that the Owner/Owner's representative is notified of the interruption in good time.

After the successful completion of reliability run test the Contractor shall offer the Owner/Owner's representative to conduct the guarantee test on prior intimation to the Owner/Owner's representative. The Contractor shall conduct guarantee test as per approved procedures for such test to the satisfaction of the Owner/Owner's representative. Performance and guarantee tests shall be a part of the trial operation and shall be conducted to the requirements of testing stated under the clause Guarantee test.

Essentially the performance tests shall consist of a simultaneous test to establish the capability of the plant when delivering the base load. The gross heat rate of the unit shall be also tested while demonstrating to the Owner/Owner's representative the Gross Power Output and Auxiliary Power Consumption in order to demonstrate that the plant is able to perform within the parameter limits specified in clause 20 below.

A joint log would be maintained to note various performance data, the malfunctions, output deficiency and short comings and would be compiled and furnished at the end of the trial operation along with the performance test results.

### 9.6.0 Guarantee Test

This consists of performance and guarantee tests as a part of the trial operation and within the trial operation period.

#### 9.6.1 Objective of the test

The parameters which have an impact on commercial viability of the station are Gross Power Output & Gross Heat rate of the plant and the Auxiliary Power Consumption for the entire plant.


Performance Guarantee shall be provided for operation at contract specific site reference conditions as specified and the guaranteed performance parameters of the plant shall be proved by the Contractor during the test. Should the results of these tests show any deficiency from the guaranteed value, the Contractor shall modify the equipment as required at no extra cost to enable it to meet the guaranteed parameters.

All heat rates shall be based on Lower Heating value for the fuel.

#### 9.6.2 Test Documents

The procedure for carrying out the above tests shall be submitted to the Owner/Owner's representative for approval six (6) months in advance. The procedure shall highlight the anticipated date for the test, arrangement and form of the tests.



	Subject	Doc. No.	Rev.	Vol. / Sec.
	<b>BID PACKAGE FOR COMBINED CYCLE CAPTIVE POWER PLANT AT HAZIRA PLANT, GUJARAT</b>	<b>5111168-ME-SPC-100-001</b>	<b>R1</b>	<b>II / 1</b>
				<b>Sheet No.</b>
				<b>69</b>

The procedure shall include the following for each test or group of tests:

1. The sequence of the tests to be conducted.
2. The time duration of each test
3. The number of test runs
4. A list of instruments that will be used for each test. The list shall define which instruments are (a) special test instruments, (b) certified, (c) to be calibrated before and after each test, (d) check instruments, (e) station supply instruments (f) Schematic diagram showing all test points and cross referenced to the instrument list and (g) method of data logging. Data logging thro' satellite communication is not permitted.
5. All formulae, calculations, conversion factors, curves, correction curves etc., to be used in the conducting of the tests and the calculations of the test results. All such items shall be to a accuracy level of four decimals.
6. Sample test reports to data sheets and all specific result sheet forms that will be used for the test.
7. Written procedure and description of conducting the test.

#### 9.6.3 Testing Method

The testing shall be carried out as per PTC – 46. The test boundary shall include the entire unit with heat sink.

##### 9.6.3.1 Measurements

The following measurement has to be taken during performance and guarantee test

#### Output


- Gross power out put of the GTG and STG
  - Auxiliary Power Consumption
- Noise level

All the plant, equipment and systems covered under this specification shall perform continuously without exceeding the noise level over the entire range of output and operating frequency.

Noise level measurement shall be carried out using applicable and internationally acceptable standards. The measurement shall be carried out with a calibrated integrated sound level meter meeting the requirement of IEC 651 or BS 5969 or IS 9779.

Sound pressure shall be measured all around the equipment at a distance of 1.0 m horizontally from the nearest surface of any equipment/machine and at a height of 1.5 m above the floor level in elevation.

A minimum of 6 points around each equipment shall be covered for measurement. Additional measurement points shall be considered based on the applicable standards and the size of the equipment. The measurement shall be done with slow response on

	Subject	Doc. No.	Rev.	Vol. / Sec.
	<b>BID PACKAGE FOR COMBINED CYCLE CAPTIVE POWER PLANT AT HAZIRA PLANT, GUJARAT</b>	<b>5111168-ME-SPC-100-001</b>	<b>R1</b>	<b>II / 1</b>
				<b>Sheet No.</b>
				<b>70</b>

the A-weighting scale. The average of A-weighted sound pressure level measurements expressed in decibels to a reference of 0.0002 micro bar shall not exceed 85 dBA.

Corrections for background noise shall be considered in line with the applicable standards. All the necessary data for determining these corrections in line with the applicable standards shall be collected during the tests.

- Emission level

#### Input

- Natural Gas consumption

#### Specific Site Conditions

- Ambient pressure
- Ambient temperature
- Relative humidity
- Grid frequency
- Power factor
- Fuel analysis (Natural Gas)
- Cycle blow down

Correction curves shall be applied only on the above measured specific site conditions to arrive at the Plant Performance Parameters at the contract specified specific site reference conditions.

#### 9.6.3.2 Contract Specific Site Reference Conditions


- Ambient pressure - 1013 mbar
- Ambient temperature- 35°C
- Relative humidity - 70 %
- Grid frequency - 50 Hz
- Power factor – 0.80
- Design NOX – As per GPCB norms
- Design fuel analysis - LHV of the Natural gas fuel as per contract
- Cycle blow down equal to 0 %
- Deterioration due to aging - factors that are to be applied for Gross power output as agreed and stated in the contract.
- Tolerances that are to be applied on corrected Gross Heat Rate and Gross power output parameters as specifically stated in the contract.

#### 9.6.3.3 Specific Conditions of Testing Method

The correction method stated under cl.5.5.2 in PTC 46 shall be applied to correct the performance parameters measured and corrected as per the above stated method. Tolerances are applied over these corrected performance parameters in such case.

#### 9.6.3.4 Test Uncertainties

The test uncertainty (not tolerance) shall be calculated based on the accuracy and number of test instruments utilized. The same shall be done as per PTC 46 and the maximum expected uncertainty shall not exceed 3 % for corrected gross heat rate and 1.2% for corrected Gross

	Subject	Doc. No.	Rev.	Vol. / Sec.
	<b>BID PACKAGE FOR COMBINED CYCLE CAPTIVE POWER PLANT AT HAZIRA PLANT, GUJARAT</b>	<b>5111168-ME-SPC-100-001</b>	<b>R1</b>	<b>II / 1</b>
				<b>Sheet No.</b>
				<b>71</b>

power output to validate the test. Accordingly the Tenderer shall state in the proposal the permitted deviations/fluctuations of design parameters that are permitted during the test for each operating mode testing.

#### 9.6.3.5 **Correction Curves & Tolerance**

The correction curves shall be provided as mathematical equations in addition to the curves to an accuracy of four decimals. The equations supplied shall be utilized to perform the test result calculations.

#### 9.6.4 **Measuring Equipment**

All test instrumentation and test equipment shall be provided by the Contractor. All the instruments shall be calibrated by a certified body before and after the tests. The calibration certificates shall be submitted to the Owner/Owner's representative prior to the tests. The calibration certificates shall be considered valid for a period of not more than six (6) months from the date of its calibration.

The anticipated points of measurement together with necessary isolation during the tests shall be indicated by the Contractor.

#### 10.0.0 **CLEANING, PROTECTIVE COATING AND PAINTING**

Refer Vol III /Section 2/ Sub Section 2.15 Surface Preparation and Painting.

#### 11.0.0 **SPARE PARTS**

The contractor shall also provide a list of recommended spares for two (2) years of normal operation of the plant over and above the mandatory spares.

#### 11.1.0 **List of Mandatory Spares**

Refer Vol IV /Section 8/ Annexure 2

NOTE: All mandatory spares as per OEM declared critical items shall be included in the list.

#### 12.0.0 **SPECIAL TOOLS, TACKLES AND EQUIPMENT**

One set of special tools and tackles required unit for the operation, maintenance, inspection and repair of the individual main equipment and auxiliary equipment shall be supplied by the Contractors in sufficient quantity to equip the shift personnel, maintenance personnel and workshop craftsman for commissioning, testing, calibration, modification and maintenance of the unit, List of such special tools, tackles and equipment shall be submitted in the EPC bid. Special tools and tackles excludes conventional ones and those locally available normally (not those requiring a drawing and considered as those made to order).

The special tools and equipment for maintenance and repair shall be delivered by the Contractor in lockable steel boxes and they shall be marked in an approved manner for identification purposes and a corresponding tool chart shall be supplied with the steel boxes.

The following tools and appliances shall be supplied under this Contract for use by the Owner/Owner's representative:

- two sets of special tools and gauges required for the maintenance of the Plant
- one set of special lifting and handling tackles / appliances required for the maintenance of the Plant.