

**TITLE:**  
**5X800 MW YADADRI THERMAL POWER  
STATION**

**SPECIFICATION NO. PE-TS-417-155A-A001**

**SECTION : I**

**TECHNICAL SPECIFICATION FOR  
CONDENSATE POLISHING UNIT**

**SUB-SECTION: IA**

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- Schedule of Declaration. (Stamped & Signed)
- Signed and stamped copy of equipment layout of CPU regeneration area.
- Unpriced Price Schedule duly filled as "Quoted". (Stamped & Signed).

Any other documents submitted by bidder except as asked in the bid's specification shall not be evaluated & considered as null & void.

## **21.0 SITE VISIT BEFORE SUBMISSION OF OFFER.**

Bidders shall make Site visit in order to familiarize themselves with existing condition of site before submitting the bid in order to make their offer complete. During detail engineering also, the successful bidder shall be responsible for the correctness of details w.r.t existing facility at site. Customer approval on any drawing having details of existing facility shall not be cited by the successful bidder a valid reason for any shortcoming in the work by them. BHEL shall also not entertain any cost implication for any lack of input data with regard to site during detail ENGINEERING.



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**TECHNICAL DETAILS OF CONDENSATE POLISHING PLANT**

**1.00.00 INTRODUCTION**

For maintaining the feed water purity condensate polishing plant will be provided in the feed water cycle at the downstream of condensate extraction pumps. The function of the CPU will be to purify the condensate effluent from the condenser by removing solids and dissolved salts with the intent of reducing corrosion and depositions in the steam-water cycle. The proposed Condensate Polishing Unit (CPU) shall treat the condensate of the Turbine-Generator (TG) Units of the power station, using deep Mixed Bed Ion Exchange Polisher vessels and an external regeneration system. One (1) number of Condensate Polishing Plants (CPP), for each TG (Turbine-Generator) unit, along with Two sets of common external regeneration system shall be provided alongwith instrumentations, valves and pipings, controls etc. for all 5 sets of TG units.

**2.00.00 SYSTEM DESCRIPTION (GENERAL)**

2.01.00 The proposed Condensate Polishing Plant (CPP) shall treat the condensate of the respective Turbine-Generator (TG) Units of the power station. The system shall be as per tender drawing titled P&ID of Condensate polishing Plant.

2.02.00 The proposed schematic arrangement of the Condensate Polishing Plant has been shown in the relevant Tender Drawing (P&ID). Arrangement of piping and valves shown in them are bare minimum only. The Contractor shall propose the complete system including regeneration facilities as per their standard design and as elaborated in this specifications meeting the basic functional requirements.

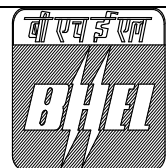
2.03.00 The system should be capable of producing the output characteristics which will be better than or equal to the specified conditions as prescribed by the Boiler Manufacturer or as specified elsewhere in this document whichever is more stringent. The system should be also capable of monitoring and maintaining the characteristics during unit start up, load variations and condenser tube leakage.

2.04.00 The regeneration process offered by the bidder, shall be of proven design and shall essentially be the same process by virtue of which the bidder is qualified and shall give resin-separation compatible with the desired effluent quality. Documentary evidence shall be submitted by the bidder to the Customer/BHEL to establish this requirement during detailed engineering stage if required.

2.05.00 The bidder shall include inert resin in the system if they feel that it helps in better resin separation.

2.06.00 In case, after separation of resins, there are undesired contaminant resins, the bidder shall provide a system either to eliminate this cross contamination of resins or to nullify the detrimental effect of entrapped resins to the effluent quality.

2.07.00 The guaranteed chemical consumption figures must be supported by relevant published data such as performance of the resin system, statistical data on resin losses and actual field performances of Systems using a similar technique, indicating the quantity of chemicals required for regeneration, in particular, besides other parameters. The data on the chemical consumption figures and the calculations furnished by the Bidder shall be the primary basis of checking the guaranteed parameters. The operating exchange capacity and regeneration levels shall be vetted by resin manufacturer and the Bidder must furnish the resin performance curves specially applicable for this project.



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- 2.08.00 The Condensate polishing Plant shall consist of one set of Condensate polishing Units (CPU) for each TG unit inside TG Building and a common external regeneration system (consist of 2 sets of external regeneration facilities) for all 5 TG units. There shall be three service vessels (3X50%) for each 800 MW unit each polishing 50% of the condensate flow corresponding to VWO (valve wide open) condition at 1% make up (Flow through each service vessel indicated in the data sheet) condition.
- 2.09.00 The regeneration system (consist of 2 sets of external regeneration facilities) shall be external and common to the CPU of all the TG units. For regeneration, resin from the exhausted exchanger vessel will be transferred hydraulically/ Hydro-pneumatically to this facility. The exhausted resin charge will be cleaned, separated, regenerated, mixed and rinsed before being stored for the next use.
- 2.10.00 The common influent and effluent headers of each CPU, will be connected to an automatic bypass line (s) to be provided by Bidder. On high pressure signal across the service vessel, the automatic control valve(s) in the bypass line(s) shall open, bypassing the service vessel(s).
- 2.11.00 In the event of a tube failure in the condenser, circulating water will enter the condensate system and will contaminate it. Typical composition for the "START-UP OR CONDENSER LEAK CONDITION" is exhibited elsewhere in the technical specification and the condensate polishing plant shall be designed for such tube leakage condition as mentioned.
- 2.12.00 For arriving water analysis under condenser tube leakage condition. The analysis of the clarified water is exhibited in the Sub-Section IA Annexure VIII of tender specification shall be multiplied with 6.5 COC to derive the circulating water analysis.
- 2.13.00 Polisher mixed bed / service vessels of each 800 MW Unit shall be located in respective TG hall unit. However, the regeneration system shall be common to polisher of all 5 TG units and shall be external consisting of 2sets of external regeneration facility and in building (except bulk acid & alkali storage facility & N-pit which is in open area). The CPU regeneration system will be located near DM plant area (kindly refer plot plan for the same).
- 2.14.00 The equipments kept in open area (Pumps, blowers, motors, tanks, instruments, analysers etc.) have localized shade provisions which is in bidder's scope. All the instruments associated with condensate polishing plant shall be provided with proper enclosures by Bidder. All vessels, pumps & blowers and their drives and other electrical and C&I equipments/accessories of regeneration system shall be suitable for outdoor duty and enclosures class of all the equipments shall be suitably selected by the bidder as per contract specification requirement.

**3.00.00 SALIENT DESIGN DATA**

- 3.01.00 There shall be three service vessels (3X50%) for each 800 MW unit each polishing 50% of the condensate flow corresponding to VWO (valve wide open) condition at 1% make up condition (Flow through each service vessel indicated in the data sheet)
- 3.02.00 The following dissolved solids concentration and conditions shall be used as a basis of design for the condensate polishing system.

(a) NORMAL RUN:

The ionic concentrations indicated below are as such.

| CONTAMINANT                                    | UNIT | INFLUENT | EFFLUENT                |
|------------------------------------------------|------|----------|-------------------------|
| Ammonia                                        | ppb  | 250      | Below detectable limit. |
| Total dissolved solids (TDS, ammonia excluded) | ppb  | 110      | < 25                    |



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|------------------------------------------------------|------------|------------------|----------------------------------------|
| Conductivity (at 25°C) (After removal of all amines) | Micro S/cm | <i>As actual</i> | < 0.1 (after hydrogen column at 25 °C) |
| Silica (as SiO <sub>2</sub> )                        | ppb        | 30               | < 5 (Refer note # 1)                   |
| Total Ferric Iron                                    | ppb        | 50               | < 2                                    |
| Sodium(as Na)                                        | ppb        | 10               | < 2                                    |
| Chloride (as Cl)                                     | ppb        | 20               | < 2                                    |
| pH (polisher runs at 25°C with H/OH mode)            |            | 8.5-9.0          | 6.5-7.5                                |
| Crud (mostly black oxide of iron)                    | ppb        | 50               | < 5                                    |

Note-1: For temperature 50°C and above the silica value in the effluent shall be based on the resin supplier's recommendations.

Under the Normal Condition, each Condensate Polisher Mixed Bed shall be designed to operate in hydrogen cycle for not less than 240 hours of continuous operation, while maintaining the above treated condensate quality.

In addition to the dissolved solids, the influent condensate shall also contain some quantities of suspended solids (crud) derived from the corrosion of water and steam carrying pipelines, turbine condenser, and steam side of the feed water heater. Normally this concentration will not exceed about 50 ppb and the polisher beds shall provide sufficient filtering action to restrict the effluent crud content to less than 5 ppb & same shall be guaranteed.

**(b) START-UP:**

During start up conditions, quality of the influent may deteriorate to:

| CONTAMINANT                                    | UNIT       | INFLUENT         | EFFLUENT                               |
|------------------------------------------------|------------|------------------|----------------------------------------|
| Ammonia                                        | ppb        | 1500             | Below detectable limit.                |
| Total dissolved solids (TDS, ammonia excluded) | ppb        | <i>As actual</i> | < 50                                   |
| Conductivity(at 25°C)                          | Micro S/cm | <i>As actual</i> | < 0.2 (after hydrogen column at 25 °C) |
| Silica (as SiO <sub>2</sub> )                  | ppb        | 500              | < 20 (Refer note # 1)                  |
| Crud (mostly black oxide of iron)              | ppb        | 1000             | < 100                                  |
| pH(polisher runs at 25°C with H/OH mode)       |            | 9.0-9.6          | 6.5-7.5                                |
| Total Ferric Iron                              | ppb        | 1000             | < 10                                   |
| Sodium(as Na)                                  | ppb        | 20               | < 5                                    |
| Chloride (as Cl)                               | ppb        | 100              | < 10                                   |

Note-1: For temperature 50°C and above the silica value in the effluent shall be based on the resin supplier's recommendations.

Useful service run under this condition shall be 48 hours before regeneration.

**(c) CONDENSER TUBE LEAKAGE CONDITION:**

During condenser tube conditions, quality of the influent may deteriorate to:

| CONTAMINANT                                                                                                                    | UNIT | INFLUENT | EFFLUENT |
|--------------------------------------------------------------------------------------------------------------------------------|------|----------|----------|
| Total dissolved solids (TDS, ammonia excluded) (In addition to normal influent contaminants stated in clause 3.02.00 (a) above | ppb  | 2000     | ---      |



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|                               |     |           |                       |
|-------------------------------|-----|-----------|-----------------------|
| Silica (as SiO <sub>2</sub> ) | ppb | As actual | < 20 (Refer note # 1) |
| Sodium(as Na)                 | ppb | As actual | < 20                  |

Note-1: For temperature 50°C and above the silica value in the effluent shall be based on the resin supplier's recommendations.

Useful service run between regeneration under the Startup conditions and under condenser tube leakage condition shall not be less than 48 hours each.

- 3.03.00 Influent water quality as indicated in the above clauses is minimum only. Bidder to check the same and higher values, if felt by them, shall be considered in the design so as to meet the specified effluent quality.
- 3.04.00 The bed cross section in the service vessels shall be such that the average velocity of condensate through it shall not exceed 2 meters/min (120 M3/hr/M2) at the design flow rate for spherical vessel. Internal diameter of the service vessels (excluding the rubber lining) of spherical type shall be selected meeting the above mentioned velocity criteria. The effective depth of mixed bed in condensate polisher service vessel shall be not less than 1100 mm.
- 3.05.00 At the design flow rate, the pressure drop between inlet and outlet flanges of the polisher Condensate Polisher Mixed Beds with clean resin bed shall not exceed 2.0 bar (g). This pressure drop shall include losses due to entrance and exit nozzles, distributors, under drains, resins and the effluent resin traps. Maximum pressure drop under dirty conditions shall be restricted to about 3.5 bar (g) including the pressure drop across effluent resin traps.
- 3.06.00 Cation resins shall be regenerated by technical grade hydrochloric acid to IS: 265 (concentration 30-33% by volume) and anion resins by sodium hydroxide, rayon grade to IS: 252 available as 48% lye. For calculations regeneration temperature should be taken as 25°C. In no case, the regeneration levels cannot be lower than the valves indicated below:
- Cation resin: 125 kg of 100% HCl per cubic meter of resin
  - Anion resin: 160 kg of 100% NaOH per cubic meter of resin.
- 3.07.00 Rinse water outlet headers from condensate-polisher vessels shall be provided with a pressure reducing valve and orifice plate, suitably designed to enable the water entry to the condenser hot well under all operating condition of condenser. The pressure reducing station shall consist of both a pressure reducing valve from design pressure of service vessel to condenser vacuum or a combination of orifice plates to reduce pressure from design pressure of service vessel to 2 kg/cm2 and a pressure reducing valve from 2 kg/cm2 to condenser vacuum.
- 3.08.00 Two (2) nos. Rinse Recirculation Pumps, each complete with electrical drive motor and all other accessories as required for each TG unit.
- 3.08.00 While calculating pump head, 10% margin (minimum) shall be considered of the value of friction losses. Pipe friction loss shall be calculated as per Willam-Hazen formula and "C" value to be adopted shall be as below: -
- Carbon Steel pipe : 100
  - CI pipe/ductile Iron : 100
  - Rubber lines steel pipe : 120
  - Stainless steel pipe : 100
  - PVC/HDPE pipe : 140

For pumps whose discharge pipes shall be running on pipe trestle/ pipe rack and traveling from one area to another area bidder to select 12 m static head while selecting the pump head.



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Pump recirculation with a regulating valve shall be provided for all the pumping system.

**4.00.00 GUARANTEES**

All the design parameters at clause no 3.02.00 of this chapter, i.e. the effluent quality, the design flow, design service length and Pressure drop across the resin bed in clean and dirty condition at rated design flow shall be guaranteed by the Bidder. In addition to that Bidder to refer detail chapter of guarantees as specified in Sub-Section-IA, Annexure -III of this specification for the same.

**5.00.00 SYSTEM REQUIREMENT**

5.01.00 The regeneration process offered by the bidder, shall be of proven design and shall essentially be the same process by virtue of which the bidder is qualified and shall give resin-separation compatible with the desired effluent quality. Documentary evidence shall be submitted by the bidder to the Customer/BHEL to establish this requirement during detailed engineering stage if required.

5.02.00 The bidder shall include inert resin in the system if they feel that it helps in better resin separation.

5.03.00 In case, after separation of resins, there are undesired contaminant resins, the bidder shall provide a system either to eliminate this cross contamination of resins or to nullify the detrimental effect of entrapped resins to the effluent quality.

**5.04.00 EXCHANGE RESINS**

5.04.01 Plant shall include resins for first fill of resins for all condensate polisher mixed beds, Mixed resin storage vessel of all 5 TG units i.e. Twenty (20) complete charges of resin and the same shall be provided by bidder. Further to this Resin for resin injection hoppers charge (150 liters for each resin injection hopper) shall also be provided separately by the bidder. In addition, the above charges bidder to also provide make-up resin for first three years of operation and the same shall be in bidder's scope (Quantity of make-up resins shall be calculated on the basis of 3% and 5% attrition loss per annum for cation and anion resin respectively). Therefore, total resin quantity to be supplied for the project shall include total resin charges for all TG units (20 nos. resin charge) + Two (2) nos. resin injection hopper charge + Make up resin quantity (Make up resin quantity shall be calculated based on the basis of 3% and 5% attrition loss per annum for 3 years for total resin quantity (i.e. 20 charge resins+ 2 resin injection hopper charge) that will be supplied for the plant.

5.04.02 Cation-anion resin ratio shall be 2.0 parts Cation to 1.0 part anion by volume. In case the process requires any non-ionic resin the same shall represent at least 10% of the bed volume, but not less than 15 cm of the bed depth in the resin separation / cation regeneration tank of the external regeneration facility.

5.04.03 After Separation anion resin in the cation resin shall be less than 0.1 % and cation resin in the anion resin shall be less than 0.1%.

5.04.04 Deration factor of 10% for all resins shall be considered while calculating the quantity of resin to be supplied.

5.04.05 The resins used for the Condensate Polishing Unit shall be in the form of spherical beads. Base of the ion-exchange resins shall be a copolymer of styrene and divinyl benzene forming a macro porous or macroreticular structure. Other details are as follows:

Cation : Strong acid, with sulfonic acid functional group.



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Anion : Strong base, with quaternary ammonium (type-I) functional group.  
Inert (if required) : Non-ionic, compatible with the above resin types.

Cation resins shall be supplied in hydrogen form and Anion resins shall be supplied in hydroxide form.

**5.04.06 PHYSICAL PROPERTIES:**

The resin strength and other physical properties shall be suitable to withstand the design pressures in the system.

**5.04.07 CHEMICAL PROPERTIES:**

Total wet volume ion-exchange capacities in equivalents/liter shall be based on resin supplier recommendation and shall be preferably the following:

**Cation in hydrogen form: 1.7**

**Anion in hydroxide form: 0.8**

The resins shall contain a minimum of metallic and organic impurities consistent with good processing. The processing procedure will include rinsing the resins with demineralized water before packing, so that further rinsing will not be required before use. Foreign objects in the resins shall constitute a basis for its rejection.

Cation-Anion resin ratio shall be 2.0 parts cation to 1.0 part anion by volume. In case the bidder's process requires any non-ionic resin the same shall represent at least 10 percent of the bed volume, but not less than 15 cm of the bed depth in the resin separation / cation regeneration vessel of the external regeneration facility. The CPU Grade resin shall be of uniform particle size quality.

The resin charge shall consist of material properly selected, washed, processed and graded to provide the guaranteed capacity and life. The resin shall have adequate abrasion resistance during its guaranteed life.

Manufacturer: The resins selected must have been in use in Condensate Polishing Systems capable of producing water as specified or better, for a period of not less than three (3) years.

The resin shall be suitable for the condensate temperature that may be achieved in all operating regimes of TG cycle. However, the anion resin shall be suitable for a minimum temperature of 60 deg.C.

**5.05.00 CONDENSATE POLISHING UNITS**

5.05.01 Operating pressure for service vessels shall be normal operating pressure of condensate extraction pump. Service vessel design pressure shall be equal to shut off pressure of condensate extractions pump plus 5% margin or as specified in data sheet (A) of this technical specification, whichever is higher.

5.05.02 Design temperature of the service vessel shall take care of all operating regimes including HP-LP bypass operation of TG cycle. Maximum temp. expected during all loads at CEP discharge is 60 Deg C.

**5.05.03 EMERGENCY BYPASS SYSTEM:**

1) Each Condensate polisher service unit shall be provided with an automatic bypass system for the condensate polisher on the condensate inlet and outlet headers of the unit with a set of



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control valve (1X100%) and with its motorized isolation valves (resilient material seated, to ensure bubble-tight shut off) on the upstream and downstream sides of the control valve. The same is applicable and provided for all 5 TG units.

2) In addition to this emergency by pass control valve, one no. flanged motorized On/off type butterfly valve of similar capacity (1X100%) shall be provided in the bypass line of control valve as per P&ID of the Condensate Polishing Unit. Further on the upstream and downstream side of this motorized On/off valve lugged wafer type butterfly isolation valves (resilient material seated, to ensure bubble tight shut off) shall be provided. Isolation valve shall be provided with geared operators for manual operation. The same is applicable and provided for all 5 TG units.

3) In the event of excessive pressure differential (0.35 MPa) between the condensate inlet and outlet headers, this control valve will open automatically to bypass requisite quantity of condensate to prevent this pressure differential from exceeding a preset limit when two vessel/one vessel /no vessel is in operation.

4) When condensate temperature exceeds 50 Deg C the bypass valve shall be 100% opened automatically and the inlet / outlet of the condensate polisher mixed bed shall be closed to protect elements and resins inside the polisher.

5) Bidder to provide 1x100% control valve to achieve proper control under all operating conditions as per Customer/BHEL's approval of Engineering Documents.

6) The control system shall be so designed that the control valve is able to bypass 50 % of rated flow when any of the service vessel is out of service & 100% when both the service vessels are out of service.

7) The isolation valves shall be provided with geared operators for manual operation. The entire system shall be designed for an internal pressure of at least the design pressure of service vessels and for a maximum condensate flow of not less than total design flow of all the working service vessels.

8) Complete instrumentation and controls for this system, including the differential pressure transmitters, panel mounted indicating type controller with provision for remote manual operation, actuator for the control valve with position indicator shall be furnished by the bidder as part of this package. All tubing, wiring, air sets, and other fittings, required to complete the system, shall also be installed by bidder for all 5 TG units.

#### **5.05.04 EXTERNAL REGENERATION FACILITY (REGENERATION PLANT)**

The pressure vessels in the common external regeneration facility shall be provided with adequate freeboards over the top of the settled resins, to minimize resin loss during their use. Minimum freeboards to be are as follows:

|       |                                       |        |
|-------|---------------------------------------|--------|
| (i)   | Mixed resin Storage vessel            | : 100% |
| (ii)  | Resin separation vessel               | : 100% |
| (iii) | Anion and cation regeneration vessels | : 100% |
| (iv)  | Activated carbon filter               | : 75%  |
| (v)   | Resin Injection hopper                | : 80%  |

However, if a vessel is used for more than one service, then the vessel design shall be based on the service which gives maximum freeboard.

5.05.05 Design pressure of the condensate Polisher Service Vessels is indicated elsewhere. For all other Pressure vessels, the design pressure shall be the maximum expected pressure to which the vessel may be subjected plus 5% extra margin, Maximum expected pressure for vessels



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placed in the discharge line of pumps shall be based on the shut-off head of the pumps plus static head at pump suction or 10 kg/cm<sup>2</sup> (g) whichever is maximum.

5.05.06 All equipment for dosing of acid and alkali solutions shall be rated to provide a maximum dosing rate at least 20% in excess of that required from process calculation.

5.05.07 Mill tolerances 0.3 mm shall be considered for determining the thickness of the shells and dished ends of pressure vessels. A minimum thinning allowance of 2 mm shall be considered for the dished ends of pressure vessels. Corrosion allowance for non-rubber lined vessels shall be minimum 2mm.

**5.05.08 HOT WATER TANK (FOR ALKALI)**

Total 2 nos. of hot water tank shall be provided for 2 sets of regeneration system. Each hot water tank for heating of alkali diluent water with (2X60%) electric heating coil, adequately insulated of Mild steel rubber lined construction shall be provided complete with integral pipe works, valves, instrumentation and all other accessories required shall be provided. The capacity of each Hot water tank shall be minimum 20% higher than the maximum water demand. This tank shall be provided with burn out protection, pressure relief valve, level transmitter, temperature indicator etc. The heaters shall be sized for heating the water from a temperature of 15 to 50 deg. C in 5 hours at the outlet of ejector.

**5.05.09 ACTIVATED CARBON FILTER (FOR ALKALI):**

Rated flow of the filter shall not be less than the design capacity of the alkali transfer-cum recirculation pump, and the maximum velocity through the filter for this flow shall not exceed 15 meters/hour. Depth of the filter material shall be as specified in DATASHEET –A of this specification.

The filtering medium shall be granulated activated carbon, meeting following minimum requirements.

|                                  |   |                            |
|----------------------------------|---|----------------------------|
| Total Surface area               | : | Not less than 850 sq.m/gm. |
| Bulk density                     | : | Not less than 400 kg/cu.m. |
| Iodine number                    | : | 850 minimum                |
| Carbon content                   | : | Not less than 90%          |
| Moisture content                 | : | 5% (max)                   |
| Uniformity coefficient           | : | 1.5-1.6                    |
| Effective Size mm                | : | 0.8-0.9 mm                 |
| Particle density wetted in water | : | 1.3-1.4 gm/cc              |
| Abrasion number                  | : | 70 minimum                 |
| Ash Content                      | : | 8% maximum                 |

Mean particle diameter shall be about 1.2-1.4 mm with following size distribution:

|                 |   |               |
|-----------------|---|---------------|
| On 20 mesh      | : | Less than 3%  |
| Through 40 mesh | : | Less than 10% |
| Through 50 mesh | : | Less than 1%  |

The filter shall be provided with all necessary valves and connections for manual backwashing and rinsing with demineralized water. Rate set valves shall be provided with adjustable limit stops for setting backwash and rinse rates.

**5.05.10 DM WATER STORAGE TANKS (NOT IN BIDDER' SCOPE) FOR CONDENSATE POLISHING PLANT**

DM water required for CPU regeneration as well as resin transfer operations shall be drawn from DM Water Storage Tanks (not in bidder's scope). Bidder to consider the piping from common suction line terminal point to CPU regeneration cum resin transfer pumps and recirculation line piping from the



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outlet discharge line of these pumps to common recirculation line along with pneumatic/electric actuated on –off valves, required flanges, counter flanges, fittings to each set of regeneration cum resin transfer pumps (2 sets) and the same shall be in bidder's scope. Further Bidder to consider interlock (trip) of these pumps from the Pressure transmitters provided by bidder in the common suction line of CPU regeneration cum resin transfer pumps. These signals shall be also brought by Bidder to CPU DDCMIS (not in bidder's scope) for tripping and auto operation of the CPU regeneration cum resin transfer pumps for both stage regeneration systems. The arrangement shall be as per Tender P&ID of CPU and same shall be in scope of bidder.

#### **5.05.11 RESIN INJECTION HOPPER**

Two nos. resin injection hopper shall be provided by bidder. The bidder shall provide a hopper type tank for resin make-up, using water slurry, to the condensate polishing systems. This make-up system will constitute a portion of the condensate polishing external regeneration system. The resin hopper shall have a conical bottom and a flat top. The top shall have a piano type hinged port, having a lifting handle, of sufficient size for easy resin loading. The resin shall discharge through a bottom connection to a water ejector for transport. Water shall be added to the hopper to assist in the resin transfer. The ejector discharge shall be to the resin separation-cation regeneration vessel. Demineralized water shall be used throughout for the resin transfer. Piping of the resin make-up system shall be the responsibility of the Bidder as a part of the external resin regeneration system.

a) **Capacity:** The resin make-up hopper tank shall be sized to handle up to 150 liters of as received new resin per single injection.

b) **Material:** The resin make-up hopper tank shall be fabricated of mild carbon steel having a minimum thickness of 6 mm and lined.

#### **5.05.12 PIPING**

1) Bidder shall design, supply and erect the piping between the service units and the common external regeneration facility, for transferring the exhausted and regenerated resins as required.

2) All piping shall be laid above ground and generally laid in pipe trestles including crossing of road/pipe/cable trenches if any. Piping of between chemical tanks area and regeneration area etc. may be laid on pedestals if layout permits.

3) Complete supporting system for the pipeline shall be designed, fabricated and supplied by the Bidder. Inside the building, the overhead portion of the pipeline may be supported from the building structures. In outdoors, the pipeline may run on steel posts. Crossing of the roads shall be on a pipe bridge with a clear height of at least 6.1 meters over the road surface. All the steel structures of the pipe bridge and the supporting posts along with all necessary hanger, clamps, connecting steel, fixing bolts, nuts, etc. shall be supplied and erected by the bidder.

4) Routing of this pipe line shall be developed by the bidder and shall be finalized in coordination with the BHEL/Customer, based on the space available and the final layout.

5) The resin transfer pipeline arrangement shall avoid any sharp bends which cause segregation of the mixed resins, and pockets where the resins can get trapped. Suitable observation ports shall be provided in all critical areas to enable the operator to monitor completeness of the resin transfer operations. All necessary arrangements for venting and draining of the pipeline shall be provided.

6) The resin transfer pipeline shall be sized for a flow velocity of between 2.3 and 3.0 meters/sec.



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7) The condensate pipeline shall be sized for a flow velocity between 3 and 5 m/sec.

8) Remotely operated valves suitably interlocked with the plant operation, shall ensure that the resins get transferred to and from only the particular service vessel which has been selected by the operator.

9) All lined vessel connections and connections in unlined vessels (25 Nb and larger) shall be flanged to ANSI 150 lb class except the polisher service vessels which shall be ANSI 300 lb class (minimum): Flat face flanges shall be used throughout. Nozzle material shall be ASTM-106 Gr.B. Sch.80 pipe for all vessels. All flanged connections shall be supplied complete with matching counter flanges, nuts, bolts and full face gaskets. All the pipeline in service vessels area where pressure may attain same as service vessel shall be designed for 300 lb class (minimum).

10) Bidder to also refer the detailed specification for low pressure piping for piping inside regeneration area & power cycle piping for piping inside service vessel area which is enclosed elsewhere in this specification.

#### **5.05.13 VALVES**

1) All valves shall be designed as per applicable AWWA/IS/BS or equivalent international standard / codes.

2) The isolation valves on the resin transfer line shall be of eccentric plug type/ball valve (full bore type) of stainless steel construction.

3) Emergency bypass control valve shall be of double flanged butterfly type for Each TG units. Lugged wafer type Butterfly motorized Isolation valves (resilient material seated, to ensure bubble-tight shut off) shall be provided on the upstream and downstream sides of the control valve for Each TG units. Isolation valve shall be provided with geared operators for manual operation. The same is applicable and provided for all 5 TG units.

4) In addition to this emergency by pass control valve, one no. flanged motorized On/off type butterfly valve of similar capacity (1X100%) shall be provided in the bypass line of control valve as per P&ID of the Condensate Polishing Unit. Further on the upstream and downstream side of this motorized On/off valve lugged wafer type butterfly isolation valves (resilient material seated, to ensure bubble tight shut off) shall be provided. Isolation valve shall be provided with geared operators for manual operation. The same is applicable and provided for all 5 TG units.

5) Isolation Valves handling Acid, Alkali, Ammonia etc. shall be diaphragm type and MOC and pressure rating shall be as per DATASHEET –A of condensate polishing unit.

6) Isolation Valves handling DM water shall be Butterfly or gate or globe type and shall be SS construction. Isolation valves handling DM water can also be of diaphragm type MOC and pressure rating shall be as per DATASHEET –A of condensate polishing unit.

6) Non-return valves for DM Water & alkali shall be SS construction and for acid non-return valve shall be lined type or as per manufacturer's standard practice.

7) All valves in service vessels area where pressure may attain same as service vessel shall be designed for 300 lb class (minimum).

8) MOC of butterfly valve at inlet of service vessel Body- CS, Disc- SS-316 and outlet of service vessel Body – SS-316, disc- SS-316. Rinse recirculation and Rinse line valve will be of MOC:



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Body – SS-316, disc- SS-316.

**5.05.14 PRESSURE VESSELS, ATMOSPHERIC TANKS & MISCELLANEOUS ITEMS**

1) Design pressure of the condensate Polisher Service Vessels shall be as indicated in the data sheet. For all other pressure vessels, unless otherwise mentioned design pressure shall be the maximum expected pressure to which the vessel may be subjected plus 5% extra margin, Maximum expected pressure for vessels placed in the discharge line of pumps shall be based on the shut-off head of the pumps plus static head at pump suction or 10 kg/cm<sup>2</sup> (g) whichever is maximum).

2) All pressure vessels shall be designed and constructed in strictly in accordance with the ASME code Section VIII Div.-I /IS-2825 or acceptable equivalent international standard.

3) All pressure vessels shall be fabricated from carbon steel plates as per SA-515 Gr. 60/ 70 or SA-516 Gr. 60/ 70 and lined internally.

4) Lining used shall be natural rubber having a shore durometer reading of 65 ± 5 Shore 'A' as per IS 4682 Part I.

5) The lining shall be applied in three layers, resulting in a total thickness of not less than 4.5 mm anywhere on the internal surfaces of the vessels. The lining shall extend over the full face of all flanged connections and shall have a minimum thickness of 3 mm in all such external areas.

6) Design of all vertical cylindrical atmospheric storage tanks containing water, acid, alkali and other chemicals shall conform to IS: 803.

7) Design of all horizontal cylindrical storage tanks containing water, acid, alkali and other chemicals shall conform to BS EN12285-2:2005.

8) Unless otherwise mentioned design temperature of all pressure vessels and storage tanks shall be 10 deg.C higher than the maximum temperature that any part of the vessel/tank is likely to attain during operation.

9) In case, tank is subjected to vacuum, the same shall be taken care in designing the tank.

10) The design of Demineralized water storage tanks (Vertical type) shall conform to IS: 803. Supporting frame where required shall be in accordance with IS: 800. The tank shall be "Non-pressure" fixed roof type with atmospheric vents.

11) CPU service vessels of spherical shape is acceptable only.

12) All vessels/tanks without inside rubber lining shall have a corrosion allowance of minimum 2 mm and mill allowance (minimum 0.3 mm) for shell and dished ends. Thinning allowance of 2 mm (minimum) shall be considered for dished end of all type.

13) All the atmospheric tanks shall have sufficient free board above the "Level High /Normal Level" as the case may be. The overflow level shall be kept at least 30 cm or 10% of vessel height above the "Level High /Normal Level" for all the tank. Further, a minimum 100 mm free board shall be provided above the top of overflow level to the top of tank.

**5.05.15 MATERIAL**

1) All pressure vessels shall be designed and constructed in strict accordance with the ASME code Section VIII or acceptable equivalent international standard. Suitable mill tolerances shall be considered for determining the thickness of the shells and dished ends. A minimum thinning



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allowance of 2 mm shall be considered for the dished ends of torishpherical type.

2) Pressure vessel ends shall be of dished design and constructed by forging, pressing or spinning process. Spherical vessels for CPU service vessels are acceptable. Conical or flat ends shall not be accepted. All the atmospheric vessels shall be at least 6 mm thickness.

3) All pressure vessels shall be fabricated from carbon steel plates as specified in DATASHEET-A and lined internally. The lining shall be of rubber having a hardness of 65 plus/minus 5 shore -A meeting the requirements of IS: 4682, Part-I. The lining shall be applied in three layers, resulting in a total thickness of not less than 4.5 mm anywhere on the internal surfaces of the vessels. The lining shall extend over the full face of all flanged connections and shall have a minimum thickness of 3 mm in all such external areas.

**5.05.16 VESSEL INTERNALS REQUIREMENTS:**

Vessel internal shall meet the following requirements:

1) Inlet water and regenerant distributor: - Hub and internals diffuser splash plate or header and perforated laterals. Material of construction shall be SS-316 except for acid service which will be of suitable material as per process requirement and proven practice.

2) Under drains: The under drain system shall be provided with screened laterals with internal perforated pipes and rubber lined flat bottom. For resin separation/regeneration/mixed resin vessels, it may have fully screened bottom (NEVA - clog type with pora-septanurese screen, fully supported by subway grid or equal) /Fasteners.

3) All internal fasteners shall be of SS-316 and heavy duty locknuts shall be used throughout.

**5.05.17 RESIN TRAP & CARBON TRAP:**

1) Resin Traps: Outlet of each condensate polisher vessel, activated carbon filter and waste effluent header of the common regeneration shall be provided with a resin trap. Pressure drop at design flow through a clean resin trap shall not exceed 0.35 kg/sq.cm. Resin trap housing shall be of rubber lined steel construction for regeneration area & Housing MOC shall be SS316 provided at the outlet of each condensate polisher vessel and for internals (cord & screen) shall be of JOHNSON SCREENS IRELAND or equivalent (SS-316) construction. Resin traps of process effluent line shall have screen opening not exceeding 120 percent of associated process vessel under drain screen opening. Other resin traps shall have screen opening of 60 mesh. In place manual back flushing shall be provided for all resin traps.

2) Carbon Trap (for ACF): Outlet of each Activated Carbon filler on Carbon trap (media trap) shall be provided. MOC of carbon trap Housing shall be SS316 and for internals (cord & screen) MOC shall be SS-316.

**6.00.00 OPERATION & CONTROL PHILOSOPHY OF CPU PLANT**

The regeneration system (consist of 2 sets of external regeneration facility) with interconnection shall be external and common to the polisher of all 5 TG units. Under normal conditions, it will hold a complete charge of freshly regenerated and mixed resin, ready for use, in its storage tank. For regeneration, resin from the exhausted exchanger vessel shall be transferred hydraulically / hydro pneumatically to any one of the available common external regeneration facility.

The empty exchanger vessel will then be filled up with the already regenerated resin which was stored in the any one of the regeneration facility. This exchange vessel shall come into service soon after perquisite condition is satisfied or as and when desired by the operator. In the



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meantime, the exhausted resin shall be cleaned, separated, regenerated, mixed and rinsed before being stored for next use.

The control & operation of regeneration area shall be from DDCMIS based control system located in regeneration area. There shall be provision for remote manual operation also.

Each CP System, shall be operated for service and resin transfer from concerned Service Area - Equipment Control center (ECC) to be located indoor in the vicinity of Condensate Polisher Vessels of each TG unit.

Operation from this ECC can only be undertaken under authorization from Regeneration Area – ECC addressed hereinafter.

**6.01.00 GENERAL**

- 6.01.01 It is not the intent to specify here the complete details of the control system. Basic type of controls required has been specified below. The bidder shall submit with the proposal the complete detail of the system offered by him like the extent of automation offered, operation of the complete system, logic/flow diagrams, type and details of the presentation of information, the type of mimic, hardware details etc. along with detailed circuit descriptions.
- 6.01.02 It shall be possible to operate the regeneration plant in Auto/Semi-Auto /Manual mode. In 'Auto' mode, once the sequence has been initiated, it shall proceed from step to step automatically. In 'Semi-Auto' mode each step shall be performed only after initiation by the operator. In 'Manual' mode complete operation shall be by the operator by operation of the Control switches on the panel. Control for chemical dosing system and alkali preparation facilities shall be provided in it.
- 6.01.03 'Close-Auto-Open' control facility shall be provided from OWS/control panel for solenoid valves. In 'Auto' position, the valves shall receive close / open command from the Control system.
- 6.01.04 'Stop-Auto-Start' Control facility shall be provided from OWS / control panel for the various drives. In 'Auto' position, the drives shall receive stop/start command from the Control system.
- 6.01.05 On control system failure, it shall be possible to operate the valves by means of manual operation of solenoid valves too.
- 6.01.06 The control system shall link the various steps such as closing/opening of different valves, starting/stopping of various pumps etc. which form a sequence. The logic system shall adhere to the correct sequence of operation and predetermined time intervals. The system shall have interlocks so that, criteria necessary for each step are complete prior to proceeding to the next step.
- 6.01.07 It shall be possible to switch mode of operation from one to the other at any moment and the operation shall proceed on the newly selected mode from that time.
- 6.01.08 For steps, which require frequent time adjustment, it shall be possible to change the time setting from the OWS/EWS. For all other steps it shall be possible to adjust the time setting from inside the OWS/EWS.
- 6.01.09 For all sequences, the current step number, set time of the step, elapsed time of the step and the total elapsed time of the sequence shall be indicated in the OWS/OWES.
- 6.01.10 A mimic shall be provided for the CPP scheme and Regeneration system scheme shall be provided. Status of various vessels, drives, valves etc. shall be indicated by on the mimic.

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- 6.01.11 The system shall incorporate the necessary safety features. During automatic sequential operation, if any pre-requisite criterion is not fulfilled or missing for a pre-determined time interval, the steps should not proceed further, and Alarm shall be provided. Missing criteria, sequence, which is under hold up etc., shall be displayed.
- 6.01.12 The safety system for any sequence/step shall check the opening of the required valves and closure of the remaining valves of the plant to avoid mal-operation.
- 6.01.13 Wherever standby equipments are provided, it shall be possible to select each of the drive on 'standby' duty.
- 6.01.14 The detailed logic for the sequence and for each of the drive shall be subject to the BHEL/Customer's approval.
- 6.01.15 Start, progress and stop of each of the sequence shall be annunciated.
- 6.01.16 The status of vessels of Condensate Polishing Plants shall be available in all the CPP panels of all TG units and as well as in the regeneration plant control panel. Similarly, the status of regeneration plant status shall be available in the panels of Condensate Polishing Plants of all TG units.

#### **6.02.00 CONTROL & OPERATION OF THE CONDENSATE POLISHING UNIT**

- 6.02.01 The regeneration system control system shall be linked with TG control system for data transfer through a two-way link for both information and control.
- 6.02.02 It shall be possible to select each of the CPU vessel for any of the following operations or mode:
- Standby (Applicable for where spare service vessel (s) are provided.
  - Service.
  - Isolation from service.
  - Exhausted Resin Transfer from CPU vessel to Regeneration plant.
  - Regenerated Resin Transfer from Regeneration Plant to CPU vessel.
  - Rinse recycle mode.

**Each mode or operation is described as below:**

#### **6.02.03 STANDBY MODE:**

- (1) Among the vessels, any one of the vessels may be selected in this mode.
- (2) Under this mode, the vessel, which was regenerated in previous cycle and filled with regenerated resin, shall be kept ready for next Service cycle.
- (3) The selection of any vessel for Standby mode shall be initiated by operator and there shall be indication about the details such as "Condition of the resin; Whether it is filled with regenerated resin or exhausted resin, whether the standby vessel has undergone rinse cycle or not, date and time of receipt of regenerated resin and completion of rinse cycle etc.

#### **6.02.04 SERVICE MODE:**

- (1) Service flow rate for each polishing vessel shall be monitored by panel mounted flow indicators. During periods of low condensate flow the operator may select to remove one of the



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vessels from service by a manually initiated automatic sequence.

(2) A differential pressure transmitter installed between the influent and effluent headers will on a high signal cause an annunciator alarm and bypass system shall be initiated as described elsewhere in this section.

(3) By observing the individual vessel flow indicators, or conductivity at vessel outlet the operator can determine which vessel is contributing most to the pressure drop and is in need of resin cleaning.

(4) Panel mounted Cation conductivity indicators shall monitor the polishing system influent and effluent streams as well as the discharge of each service vessel. A high influent conductivity annunciator alarm will alert the plant operator that a problem condition such as air or condenser cooling water leakage has occurred. This conductivity analyzer shall also provide contacts for an alarm at the power station main control room. A high effluent header or service vessel conductivity annunciator alarm will alert the operator to the need for regeneration of a polishing vessel.

(5) When the vessel under Service mode is ready for regeneration, the operator shall change the same into "Isolation mode" in the panel. Subsequently the "Standby vessel" shall be selected for "Service mode" from the OWS/control panel. The selection shall follow, required sequences such as pressurization of the vessel, checking of the effluent quality and putting the vessel in service on satisfactory effluent quality.

**6.02.05 ISOLATION FROM SERVICE:**

(1) Normally "Service Vessel" once exhausted shall be isolated from service till the "Resin Transfer" operation is complete. In addition, provision to be kept for isolation of one or all the vessels from service if required by operator from the panel.

(2) The sequence 'Resin Transfer from CPU Vessel to Regeneration plant' and Resin Transfer from Regeneration plant to CPU Vessel' shall be initiated from the condensate polishing unit control panel but shall be controlled by the CPU DDCMIS in the Regeneration Control Panel.

**6.02.06 EXHAUSTED RESIN TRANSFER FROM CPU VESSEL TO REGENERATION PLANT:**

(1) When a vessel in a service mode needs regeneration as stated above, the resin transfer from the particular vessel to the regeneration plant shall be initiated from the panel of the condensate polishing plant.

(2) Manually initiated automatic sequences shall be provided for transferring resin from a Service vessel to the remote common regeneration facility for all 5 TG units for physical cleaning and chemical regeneration.

(3) The transfer of resin from the service vessel shall include operations such as isolation of the service vessel, hydraulic/hydro-pneumatic transfer of the resin to the external regeneration system (resin separation vessel) and the complete drain down of the service vessel to the hotwell.

(4) The sequence of "Resin Transfer" operation from CPU service vessel to regeneration plant and from regeneration plant to CPU vessel shall be initiated from service vessel area as well as regeneration area panel and shall be controlled from Regeneration area panel.

(5) The completion of the operation shall be exhibited in the control panels.



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**6.02.07 RESIN TRANSFER FROM REGENERATION PLANT TO CPU VESSEL:**

(1) When the regeneration is completed in the regeneration plant, the resin shall be transferred to the empty service vessel of Condensate Polishing plant.

(2) This shall be initiated by the operator from the control panel of condensate polishing plant of the unit from which resin was transferred to the regeneration plant in previous service. Provision shall also be kept to transfer the regenerated resin to any of the empty vessel of the CPP of any of the TG unit if required.

(3) The transfer of resin from the regeneration plant shall include operations such as hydraulic/Hydro-pneumatic transfer of the resin and the complete drain down of the water.

(4) The sequence shall be initiated from the panel of CPP and shall be controlled in the regeneration Control Panel.

(5) The completion of resin transfer operation shall be exhibited in both the Control panels.

**6.02.08 RINSE RECYCLE MODE:**

(1) After transfer of regenerated resin from the regeneration plant to the empty condensate polisher vessel, this rinse cycle shall be initiated from the Control system of the respective unit so that the vessel may be rinsed and kept ready for next service cycle.

(2) The rinse recycle shall be manually initiated in full automatic sequence. This sequence shall include the rinse down step using condensate at the desired flow rate until the unit effluent quality is acceptable for boiler feed water. Prior to rinsing, the resin shall be given air scrub by means of air blowers provided near the CPP.

(3) The effluent quality shall be determined by conductivity monitoring of the rinse water outlet, which is returned to the condenser hotwell for recycle.

(4) Panel mounted cation conductivity indicator shall be interlocked to prevent advancing of the automatic sequence until the rinse down is complete.

(5) Cation conductivity values shall be monitored and interlocked to prevent advancing of the automatic sequence until the rinse down is complete.

(6) The completion of rinse operation shall be annunciated in the panel so that the rinsed vessel may be selected for "Standby mode" or "Service mode" as per requirement.

**6.03.00 EXTERNAL REGENERATION CONTROL SYSTEM**

The control for the external regeneration system shall be from the Operation workstation with DDCMIS RTU located in a separate Control Room at Regeneration Area. This shall clearly show the status of each concerned Condensate Polisher Mixed Bed. This Console will provide a manually initiated automatic sequence for physical cleaning and chemical regeneration of the resins and show the status of the cycle at all times. This shall also provide all controls and operation facilities for the acid and alkali solution preparation and dosing system. The Regeneration Area Operation Console shall also control the sequences of Resin Transfer – i.e. to transfer resin from the Condensate Polisher Mixed Bed to the external regeneration facility and to receive freshly regenerated resin from the regeneration facility– this involves depressurization of the Condensate Polisher Mixed Bed, water sluicing of exhausted resins to the regeneration system, draining the Condensate Polisher Mixed Bed to the condenser hot well, receiving a water slurry of fresh resin from the regeneration system and finally completely



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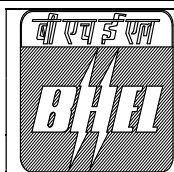
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filling the vessel with condensate.

There shall be 2 common external CPU regeneration system with interconnection shall be provided in CPU regeneration area and nearby service vessel area for all 5 CPU service vessels area (TG units). The system shall be designed so that any of the polisher vessel of anyone of the service vessel area shall be capable of transferring the exhausted resin to any one of the regeneration system which is available for service and shall be capable to transfer the regenerated resin vice –versa in the polisher vessel. The necessary control, logic and interlocks shall be incorporated in control system for CPU. The arrangement of the same shall be shown in P&ID of CPU as well as single line diagram of CPU service vessel and regeneration area.

- 6.03.01 One external regeneration system (consist of 2 sets of external regeneration facility) with interconnection shall be provided to serve the condensate polishing for all 5 TG units. This system shall be designed for physical cleaning and chemical regeneration of the resin system will consist of required number of resin separation and regeneration vessels, a mixed resin storage vessel, the tank for introducing the required regeneration solutions and means for adding make-up resin. It will have acid, alkali, and ammonia (if required) dosing system and alkali preparation facilities.
- 6.03.02 Manually initiated automatic sequences shall be provided for transferring resin from a vessel to the remote common facility for physical cleaning, separation and chemical regeneration and for returning fresh resin to the service vessel(s). Control for chemical dosing system and alkali preparation facility shall also be provided in it.
- 6.03.03 Physical cleaning of the resin shall consist of three steps, drain to level, air scrub and rinse. The air scrub and rinse steps are of short duration, approximately 1 and 2 to 3 minutes respective time. However, the program will allow the operator to increase or decrease the number of times the sequence is repeated to meet the requirements existing at that time.
- 6.03.04 The chemical regeneration is a many step sequence. Regeneration shall include hydraulic reclassification of the resins and the transfer of the resins to the respective regeneration vessels shall be hydraulically/ hydro-pneumatically. The Bidder may include a layer of inert, intermediate density resin to achieve a better separation of the cation and anion resins, improve resin regeneration, and reduce leakage. The separated resins are then back washed, cation & anion resin shall be regenerated with hydrochloric acid and sodium hydroxide solutions respectively and then rinsed. Following the rinse step the resins shall be given an air scrub followed by a good backwash. The resin is then transferred back to the resin separation vessel and the resins are air mixed. The mixed resins after regeneration are given a final rinse with the discharge conductivity being monitored. The quality of this discharge will determine if the regeneration has been effective. If the quality is not satisfactory the regeneration sequence must be repeated. If satisfactory, the mixed resin is transferred to the resin storage vessel.
- 6.03.05 A resin mixing and final rinse may occur in the resin storage vessel provided that the system design will permit direct return of the resins to the resin separation vessel in the event of an unsatisfactory regeneration.
- 6.03.06 Upon satisfactory completion of regeneration, the status shall be annunciated audio-visually in the regeneration system OWS/control panel and as well as in the Main Plant Control System. This repeat annunciation in the CPP OWS/panel shall facilitate the operator to initiate resin transfer operation from the regeneration plant to the desired vessel of the Unit in which the service vessel is empty.
- 6.03.07 Upon resin transfer operation from regeneration plant as described by the operator from the I Control System, the regeneration plant shall be ready to receive next batch of exhausted resin from any of the CPP. The status of regeneration plant (Whether ready to receive resin for



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regeneration or under regeneration etc.) shall be available in the Control System of CPP.

- 6.03.08 Demineralized water shall be used throughout the regeneration process for backwashing, diluting the regenerant, rinsing and resin transfer.
- 6.03.09 A conical bottom hopper having a water ejector will be used for resin make-up.
- 6.03.10 The complete detail of the regeneration system shall be supplier specific and the extent of automation offered, operation of the complete system, logic/flow diagrams, type and details of the presentation of information, the type of mimic, hardware details etc. along with detailed circuit descriptions shall be provided during detail engineering.
- 6.03.11 It shall be possible to operate the Regeneration Plant in Auto/Semi-Auto/Manual mode.
- 6.03.12 In 'Auto' mode, once the sequence has been initiated, it shall proceed from step to step automatically.
- 6.03.13 In 'Semi-auto' mode each step shall be performed only after initiation by the operator.
- 6.03.14 In 'Manual' mode complete operation shall be by the operator.
- 6.03.15 'Close-Auto-Open' control switches shall be provided on the panel for the various drives. In 'Auto' position, the drives shall receive stop/start command from the DDCMIS.
- 6.03.16 'Start-Auto-Start' Control switches shall be provided on the panel from the various drives. In 'Auto' position, the valves shall receive close/open command from the DDCMIS.
- 6.03.17 On CPU DDCMIS failure, it shall be possible to operate the valves by means of manual operation of solenoid valves also.
- 6.03.18 It shall be possible to switch mode of operation from one to the other at any moment and the operation shall proceed on the newly selected mode from that time.
- 6.03.19 For steps which require frequent time adjustment, it shall be possible to change the time setting from the front of the panel. For all other steps it shall be possible to adjust the time.
- 6.03.20 For all sequences, the current step number, set time of the step, elapsed time of the step and the total elapsed time of the sequence shall be indicated on control system.
- 6.03.21 The system shall incorporate the necessary safety features. During automatic sequential operation, if any pre-requisite criteria is not fulfilled or missing for a pre-determined time interval, the steps should not proceed further, the Alarm shall be provided. Missing criteria, sequence which is under hold up etc. shall be displayed.
- 6.03.22 The safety system for any sequence/step shall check the opening of the required valves and closure of the remaining valves of the plant to avoid mal-operation.
- 6.03.23 wherever standby equipments are provided, it shall be possible to select each of the drive on 'standby' duty.
- 6.03.24 Start, progress and stop of each of the sequence shall be annunciated in all the control system.
- 6.03.25 At any time only one of the sequence shall be in progress.
- 6.04.00 INTERLOCKS**

All interlocks for safe operation of the plant shall be provided. The following interlocks as a bare



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minimum requirement of the system shall be provided:

- 6.04.01 Service vessels shall be taken back in service, only after they have been pressurized.
- 6.04.02 Service vessels can be taken up for resin transfer only after they have been completely isolated from the condensate system and depressurized.
- 6.04.03 Resin can be transferred to and from only one service vessel at a time from one set of regeneration system. In view of this control system shall be designed so that simultaneous 2 resin charges shall be transferred to any two service vessels of all 5 TG units and vice-versa to the regeneration system through dedicated resin transfer lines provided for 2 sets of external regeneration system.
- 6.04.04 Resin transfer between the service and the regeneration skids shall be permitted only when the receiving vessel is initially empty.
- 6.04.05 Regeneration sequence can commence, only when the level in the waste neutralization pit is low enough to receive the entire waste quantity of waste water from the regeneration operation.
- 6.04.06 Wherever possible, completion of all timed steps in the regeneration and resin transfer process shall be physically verified by effluent conductivity etc, as applicable. The automatic sequence shall be prevented from advancing to next step, till these required physical conditions are achieved, and at the same time this delay shall be annunciated in the control panel, to draw the attention of the operator. The automatic sequence of operations shall be interruptive at any time by the operator and he shall be able to take over the control to manual from that step onwards. Further operator should be able to override sequence, if required.
- 6.04.07 It shall be possible for the operator to extend the timing of a particular step by isolating the timer for the duration. The timer will restart once the operator puts back the system on 'auto' and the other steps will then follow as programmed.
- 6.04.08 The regeneration sequence shall be prevented from advancing further in the event of tripping of a running motor or other fault condition, which do not permit the various desired parameter of this step to be achieved. A manual override for this shall also be provided.
- 6.04.09 Annunciation logic shall be carefully designed so that the alarms are activated only under abnormal conditions. As for example, low flow of diluent water is only relevant when the chemical dosing is in progress. All other times, when no diluent water flow is required, this annunciation should be blocked. In general, Normal and trouble free operation of the plant shall not activate any of these alarms.
- 6.04.10 adequate diluent water flow shall be established before starting of the ejectors/ dosing pumps for acid and alkali.
- 6.04.11 The immersion heater in the hot water tank can be put on only when there is adequate water level in the tank.
- 6.04.12 CPU service vessel inlet & isolation valves will close automatically in the event of tripping of condensate extraction pump.

Note: Bidder to note that for complete control & operation of the CPU plant bidder to also refer the respective Control & Instrumentation (Sub -Section IC& IIC) & Electrical (Sub-Section IB& IIB).



TITLE:

TECHNICAL SPECIFICATION FOR  
CONDENSATE POLISHING UNIT  
5X800 MW YADADRI THERMAL POWER STATION

SPEC NO: PE-TS-417-155A-A001

SECTION: I

SUB-SECTION: IA

REV NO: 00

DATE:

**ANNEXURE-I****QUALITY PLAN**



TITLE:

**TECHNICAL SPECIFICATION FOR  
CONDENSATE POLISHING UNIT  
5X800 MW YADADRI THERMAL POWER STATION**

SPEC NO: PE-TS-417-155A-A001

SECTION: I

SUB-SECTION: IA

REV NO: 00

DATE:

**CONDENSATE POLISHING PLANT**

| Tests/Check<br>Items /<br>Components             | Material Test  | WPS/PQR/Welder Qualification | DPT/MPI        | Assembly Fit up | Dimension | RT             | Hydraulic / Water Fill | Pneumatic Test | Functional/operational Test | Bleeding resistance tests | Adhesion/ Spark Test | Performance Test | Other Test     | All Test as per relevant Std/ Appd Data Sheets | Dynamic Balancing | Remarks |
|--------------------------------------------------|----------------|------------------------------|----------------|-----------------|-----------|----------------|------------------------|----------------|-----------------------------|---------------------------|----------------------|------------------|----------------|------------------------------------------------|-------------------|---------|
| CPU Service Vessel                               | Y <sup>a</sup> | Y                            | Y              | Y               | Y         | Y              | Y <sub>3</sub>         |                |                             |                           |                      |                  | Y <sup>1</sup> |                                                |                   |         |
| Acid Alkali/Chemical Storage Tanks/ Vessels (LP) | Y <sup>a</sup> | Y                            | Y              | Y               | Y         | Y <sub>4</sub> | Y                      |                |                             |                           |                      |                  |                |                                                |                   |         |
| Resins/Activated Carbon & Internals of CPU       | Y <sup>a</sup> |                              |                |                 | Y         |                |                        |                |                             |                           |                      |                  |                | Y                                              |                   |         |
| Rubber Lining of Vessels/ Tanks/ Pipes etc       | Y <sup>a</sup> |                              |                |                 | Y         |                |                        |                |                             | Y <sup>2</sup>            | Y                    |                  |                | Y                                              |                   |         |
| Dosing Pumps/Metering Pumps                      | Y <sup>a</sup> |                              |                |                 |           |                | Y                      |                |                             |                           |                      | Y <sup>5</sup>   |                | Y                                              |                   |         |
| Diaphragm Valves                                 | Y <sup>a</sup> |                              |                |                 | Y         |                | Y <sub>6</sub>         | Y <sup>6</sup> |                             |                           |                      |                  |                | Y <sup>7</sup>                                 |                   |         |
| Butterfly Valves (Low Pressure)                  |                |                              |                |                 | Y         |                | Y <sub>6</sub>         |                | Y                           |                           |                      |                  | Y <sup>8</sup> |                                                |                   |         |
| 1. Body (Cast)                                   | Y <sup>a</sup> |                              | Y <sup>b</sup> |                 |           |                |                        |                |                             |                           |                      |                  |                |                                                |                   |         |
| 2. Disc (Cast)                                   | Y <sup>a</sup> |                              | Y <sup>b</sup> |                 |           |                |                        |                |                             |                           |                      |                  |                |                                                |                   |         |
| 3. Shaft                                         | Y <sup>a</sup> |                              | Y              |                 |           |                |                        |                |                             |                           |                      |                  | Y <sup>c</sup> |                                                |                   |         |
| High Pressure Ball Valves & Butterfly Valves     | Y <sup>a</sup> |                              |                |                 |           |                | Y                      |                |                             |                           |                      |                  |                | Y                                              |                   |         |
| Horizontal Centrifugal Pumps                     |                |                              |                | Y               | Y         |                |                        |                |                             |                           |                      | Y <sup>5</sup>   |                | Y                                              |                   |         |
| 1. Casing                                        | Y <sup>a</sup> |                              | Y <sup>b</sup> |                 |           |                | Y                      |                |                             |                           |                      |                  |                |                                                |                   |         |
| 2. Impeller                                      | Y <sup>a</sup> |                              | Y <sup>b</sup> |                 |           |                |                        |                |                             |                           |                      |                  |                |                                                | Y                 |         |
| 3. Shaft                                         | Y <sup>a</sup> |                              | Y              |                 |           |                |                        |                |                             |                           |                      |                  | Y <sup>c</sup> |                                                | Y                 |         |
| Rotary Blowers                                   |                |                              |                | Y               | Y         |                |                        |                |                             |                           |                      | Y                |                | Y                                              |                   |         |
| 1. Casing                                        | Y <sup>a</sup> |                              | Y <sup>b</sup> |                 |           |                | Y                      |                |                             |                           |                      |                  |                |                                                |                   |         |
| 2. Rotor                                         | Y <sup>a</sup> |                              | Y              |                 |           |                |                        |                |                             |                           |                      |                  | Y              |                                                | Y                 |         |



TITLE:

**TECHNICAL SPECIFICATION FOR  
CONDENSATE POLISHING UNIT  
5X800 MW YADADRI THERMAL POWER STATION**

SPEC NO: PE-TS-417-155A-A001

SECTION: I

SUB-SECTION: IA

REV NO: 00

DATE:

**Notes:**

1. Heat Treatment shall be done as per ASME code.
2. Bleeding Resistance tests shall be done by keeping the sample in 33% HCl, 48% NaOH and DM Water for 72 Hrs.
3. Hydro Test shall be conducted, before Rubber lining.
4. As per code requirements.
5. As per HIS, USA.
6. Hydro test of body before Rubber lining. Seat Leakage test for Actuator operated valves shall be done by closing the Valves with Job Actuator.
7. Tests on Rubber parts such as Diaphragms shall be done per batch of Rubber mix, such as Tensile, Hardness, Adhesion, Spark Test, Bleed Resistance test and Flex test. Life Cycle test for Diaphragms for 50000 cycles etc shall also be done.
8. Hydro Test of Body, Seat & Disc Strength shall be carried out in accordance with latest edition of AWWA C-504 Standard. Proof of Design Test in accordance with latest edition of AWWA C-504 Standard shall also be carried out, if not carried out earlier. Seat Leakage test for Actuator operated valves shall be done by closing the Valves with Job Actuator. Seat leakage test shall be carried out in both directions.
  - a) One per Heat/Heat Treatment batch/Lot
  - b) On machined surfaces only.
  - c) UT shall be done for shafts with Dia 50 mm or above.
9. For all other Misc. items, refer Table on LP piping.
10. Bidder will perform hydro test at 1.5 times of design pressure of entire Condensate Polishing Plant at site after commissioning of all the equipments in presence of Customer/BHEL. Format of record will be through protocol, subject to BHEL/Customer acceptance.
11. Hydro test will be conducted before rubber lining.
12. Proof of Design (P.O.D.)
  - 12.1 P.O.D. test certificates shall be furnished by the bidder for all applicable size-ranges and classes of Butterfly valves supplied by him in the presence of Customer's representative.
  - 12.2 All valves that are designed and manufactured as per AWWA-C-504 shall be governed by the relevant clauses of P.O.D test in AWWA-C-504. For Butterfly valves designed and manufactured to EN-593 or equivalent, the P.O.D. test methods and procedures shall generally follow the guidelines of AWWA-C-504 in all respect except that Body & seat hydro test and disc-strength test shall be conducted at the pressures specified in EN-593 or the applicable code. Actuators shall also meet requirements of P.O.D. test of AWWA-C-504.

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13.0 Inspection / test / check requirements for pressure vessels other than service vessel are same as for inspection / test / check requirements for service vessel as indicate in table given above.

14.0 For piping, vales, fillings in service vessel area quality requirements please also refer power cycle piping quality plan.

15.0 Quality requirements specified here if contradicting as specified elsewhere in this chapter, then stringent quality requirements shall be followed by the bidder for all items without any price and delivery implications to BHEL/customer.

16.0 The Quality requirements mentioned here in this annexure for different mechanical, electrical & C&I items are bare minimum, if any other quality requirements required for these items as per BHEL & customer during detail engineering the same shall be accepted and provided by bidder without any price and delivery implication to BHEL & customer.

## CONTENT

| CLAUSE NO. | DESCRIPTION                                   |
|------------|-----------------------------------------------|
| 1.00.00    | QUALITY ASSURANCE PROGRAMME                   |
| 2.00.00    | GENERAL REQUIREMENTS QUALITY ASSURANCE        |
| 3.00.00    | QUALITY ASSURANCE DOCUMENTS                   |
| 4.00.00    | INSPECTION, TESTING & INSPECTION CERTIFICATES |

### ATTACHMENTS

|             |                                       |
|-------------|---------------------------------------|
| ANNEXURE-I  | FORMAT OF QUALITY ASSURANCE PROGRAMME |
| ANNEXURE-II | FIELD WELDING SCHEDULE                |

**VOLUME : IIA****SECTION-VII****QUALITY ASSURANCE REQUIREMENTS****1.00.00 QUALITY ASSURANCE PROGRAMME**

**1.01.00** To ensure that the equipment and services under the scope of Contract whether manufactured or performed within the Contractor's works or at his Sub-contractor's premises or at the Owner's site or at any other place or work are in accordance with the specifications, the Contractor shall adopt suitable quality assurance programme to control such activities at all points, as necessary. Such programmes shall be outlined by the Contractor and shall be finally accepted by the Owner/Authorised representative after discussions before the award of contract. A quality assurance programme of the Contractor shall generally cover the following :

- a) His organisation structure for the management and implementation of the proposed quality assurance programme.
- b) Documentation control system.
- c) Qualification data for Bidder's key personnel.
- d) The procedure for purchase of materials, parts, components and selection of Sub-contractor's services including vendor analysis, source inspection, incoming raw-material inspection, verification of materials purchased etc.
- e) System for shop manufacturing and site erection control including process controls and fabrication and assembly controls.
- f) Control of non-conforming items and system for corrective actions.
- g) Inspection and test procedure both for manufacture and all site related works.
- h) Control of calibration and testing of measuring and testing equipments.
- i) System for quality audit.
- j) System for indication and appraisal of inspection status.
- k) System for authorising release of manufactured product to the Owner.
- l) System for handling storage and delivery.
- m) System for maintenance of records.

- n) Furnishing of quality plans for manufacturing and field activities detailing out the specific quality control procedure adopted for controlling the quality characteristics relevant to each item of equipment/component as per format enclosed at Annexure-I to this section for Owners approval
- o) Internal standards, if referred in the quality plans shall generally be compatible with National / International standards and shall be mentioned in the quality plans. Alternatively bidder shall furnish extracts of the internal standards detailing out acceptance norm for the product / material.

## 2.00.00 **GENERAL REQUIREMENTS - QUALITY ASSURANCE**

2.01.00 All materials, components and equipment covered under this specification shall be procured, manufactured, erected, commissioned and tested at all the stages, as per a comprehensive Quality Assurance Programme. An indicative programme of inspection/tests to be carried out by the Contractor for some of the major items is given in the respective technical specification. This is however, not intended to form a comprehensive programme as it is the Contractor's responsibility to draw up and implement such programme duly approved by the Owner/Consultant. The detailed Quality Plans for manufacturing and field activities should be drawn up by the Bidder, separately in the format attached at Annexure-I and will be submitted to Owner/Authorised representative for approval. Schedule of finalisation of such quality plans will be finalised before award.

Contractor shall furnish list of Manufacturing Quality Plans of major equipments indicating proposed inspection categorisation indicating items that will be offered for Owner's inspection etc and the Field Quality Plans

2.02.00 Manufacturing Quality Plan for all the major equipment will detail out their respective important components, their in-process various tests/inspection & final inspection / tests, to be carried out as per the requirements of this specification and standards mentioned therein and quality practices and procedures followed by Contractor's Quality Control organization. The relevant reference documents and standards, acceptance norms, inspection documents raised etc., during all stages of materials procurement, manufacture, assembly and final testing/performance testing are to be comprehensibly documented by Contractor.

Manufacturing Quality Plan for all major equipments/ items will be approved by owner. In these approved quality plans, Owner / Authorised representative shall identify customer hold points (CHP), test / checks which shall be carried out in presence of the Owners Engineer or his authorised representative and beyond which the work shall not proceed without consent of Owner / Authorised representative in writing. Inspection/ Test reports are to be submitted to owner as specified in final approved Manufacturing Quality Plans.

2.03.00 Field Quality Plans / Procedures for all field activities shall be submitted to

owner for review / approval. These Quality Plans / procedures will detail out, for all equipment, the quality practices and procedures etc. to be followed by the Contractor's site Quality Control organisation, during various stages of site activities from receipt of materials/ equipment at site.

- 2.04.00 The Bidder shall also furnish copies of the reference documents/plant standards/acceptance norms/tests and inspection procedure etc., as referred in Quality Plans along with Quality Plans. These Quality plans and reference documents/standards etc. will be subject to Owner's approval without which manufacture shall not proceed. These approved documents shall form a part of the contract. In these approved quality plans, Owner/Authorised representative shall identify customer hold points (CHP), test/checks which shall be carried out in presence of the Owners Engineer or his authorised representative and beyond which the work will not proceed without consent of Owner/Authorised representative in writing. All deviations to this specification, approved quality plans and applicable standards must be documented and major deviations in the form of Non Conformity Report shall be referred to Owner/Authorised representative for approval and dispositioning.
- 2.05.00 No material shall be despatched from the manufacturer's works before the same is accepted subsequent to pre-despatch final inspection including verification of records of all previous tests/inspections by Owner's Engineer/ Authorised representative for "CHP" and "W" points marked in quality plans , and duly authorised for despatch by issuance of Material Despatch Clearance Certificate (MDCC). For items which is not under owner's inspection the contractor shall apply for despatch clearance (MDCC) from owner by submitting their internal inspection reports and quality records
- 2.06.00 All materials used or supplied shall be accompanied by valid and approved materials certificates and tests and inspection report. These certificates and reports shall indicate the sheet serial numbers or other such acceptable identification numbers of the material. The material certified shall also have the identification details stamped on it.
- 2.07.00 Castings and forgings used for construction shall be of tested quality. Details of results of chemical analysis, heat treatment record, mechanical property test results shall be furnished.
- 2.08.00 All welding and brazing shall be carried out as per procedure drawn and qualified in accordance with requirements of ASME Section - IX (latest edition) or other International equivalent standard acceptable to the Owner.

All brazers, welders etc. employed on any part of the contract at Contractor's/ Sub-Contractor's works or at site shall be qualified as per ASME Section-IX (latest edition) or equivalent international standard approved by the Owner. Such qualification tests shall be conducted in presence of Owner / his authorised representative or owner approved Third Party Inspection Agency(TPIA). Previously qualified WPS & PQR shall be acceptable if witnessed by owner's approved TPIA.

For welding of pressure parts and high pressure piping coming under IBR purview, the requirements of IBR shall also be complied with.

- 2.09.00 All non-destructive examination (NDT) shall be carried out in accordance with LIST OF STANDARDS FOR REFERENCE as given below in this section.

The NDT operator shall be qualified as per SNT-TC-IA (of American Society of non-destructive examination). Results of NDT for the list major equipments / items identified for owner's inspection shall be properly recorded and submitted for review and approval. Other items not covered under owner's inspection, contractor shall review and approve the NDT results and such reports shall be submitted to owner in the final documentation of the items / equipments

- 2.10.00 All the sub-vendors proposed by the Contractor for procurement of major bought out items including castings, forgings, semi-finished and finished components/equipment list of which shall be drawn up by the Contractor and finalised with the Owner shall be subject to Owner's approval. Quality Plans of the successful vendors shall be discussed, finalised and approved by the Owner/Authorised representative and form part of the Purchase Order between the Contractor and the Vendor.

- 2.11.00 All the purchase specifications for the major bought-out items, list of which shall be drawn up by the Contractor and finalised with the Owner shall be furnished to the Owner for comments and subsequent approval before orders are placed.

Owner reserves the right to carry out quality audit and quality surveillance of the systems and procedures of the Contractor's or their sub-vendor's quality management and control activities. The Contractor shall provide all necessary assistance to enable the Owner carry out such audit and surveillance.

Quality audit/approval of the results of tests and inspection will not prejudice the right of the Owner to reject equipment not giving the desired performance after erection and shall not in no way limit the liabilities and responsibilities of the Contractor in earning satisfactory performance of equipment as per specification.

- 2.12.00 Quality requirements for main equipment shall equally apply for spares and replacement items.

- 2.13.00 Repair/rectification procedures to be adopted to make any job acceptable shall be subject to the approval of the Owner.

- 2.14.00 For quality assurance of all civil works refer to the specifications for civil works.

### 3.00.00 **QUALITY ASSURANCE DOCUMENTS**

- 3.01.00 The Contractor shall be required to submit two (2) copies and two (2) sets of microfilms / CDs of the following Quality Assurance documents within three (3) weeks after despatch of the equipment:

- a) Material mill test reports on components as specified by the specification.

- b) The inspection plan with verification, inspection plan check points, verification sketches, if used and methods used to verify that the inspection and testing points in the inspection plan were performed satisfactorily.
- c) Non-destructive examination results /reports including radiography interpretation reports.
- d) Factory tests results for testing required as per applicable codes and standards referred in the specification.
- e) Welder identification list listing welder's and welding operator's qualification procedure and welding identification symbols.
- f) Sketches and drawings used for indicating the method of traceability of the radiographs to the location on the equipment.
- g) Stress relief time temperature charts.
- h) Inspection reports duly signed by QA personnel of the Owner and Contractor for the agreed inspection hold points. During the course of inspection, the following will also be recorded :
  - i) When some important repair work is involved to make the job acceptable.
  - ii) The repair work remains part of the accepted product quality.
- i) Letter of conformity certifying that the requirement is in compliance with finalised specification requirements.

#### 4.00.00 **INSPECTION, TESTING AND INSPECTION CERTIFICATES**

4.01.00 The Owner's Engineer, or his duly authorised representative and/or an outside inspection agency acting on behalf of the Owner shall have access inside the workshops, test labs, establishments at all reasonable times to inspect and examine the materials and workmanship of the works during its manufacture or erection and if part of the works is being manufactured or assembled on other premises or works, the Contractor shall obtain for the Owner's Engineer and for his duly authorised representative permission to inspect as if the works were manufactured or assembled on the Contractor's own premises or works.

4.02.00 The Contractor shall give the Owner's Engineer/ Authorized Inspector twenty one (21) days written notice for "CHP" / "W" points of any material being ready for testing by owner' engineer / Authorized inspector. Such tests shall be to the Contractor's account except for the expenses of the Inspector. The Engineer/ Inspector, unless the witnessing of the tests is virtually waived, will attend such tests within fifteen (15) days of the date on which the equipment is notified as being ready for test/inspection. If owner's Engineer / Authorised Inspector fail to attend the inspection, next mutually convenient date for test shall be agreed with Contractor. Contractor shall, in

no case proceed with the test without owner or his authorized inspectors, unless the witnessing is officially waived and advised Contractor to proceed with the test. Contractor shall forthwith forward duly certified completed test report and a product quality certificate in six (6) copies to owner upon completion of such test.

- 4.03.00 The Engineer or Inspector shall within fifteen (15) days from the date of Inspection as defined herein give notice in writing to the Contractor, or any objection to any drawings and all or any equipment and workmanship which is in his opinion not in accordance with the contract / QAP or other approved quality documents. The Contractor shall give due consideration to such objections and shall either make modifications that may be necessary to meet the said objections or shall confirm in writing to the Engineer/Inspector giving reasons therein, that no modifications are necessary to comply with the contract / QAP or other approved quality documents.
- 4.04.00 When the factory tests have been completed at the Contractor's or sub-contractor's works, the Engineer/Inspector shall issue a certificate to this effect fifteen (15) days after completion of tests excluding the test completion date subject to submission of all certified documents related to the test, If the tests are not witnessed by the Engineer/Inspectors, the certificate shall be issued within fifteen (15) days of the receipt of the Contractor's test certificate by the Engineer/Inspector. Failure of the owner's Engineer/Inspector to issue such a certificate shall not prevent the Contractor from proceeding with the works. The completion of these tests, or the issue of the certificates shall not bind the Owner to accept the equipment should it, on further tests after erection be found not to comply with the contract / QAP or other approved quality documents.
- 4.05.00 In all cases where the contract provides for tests whether at the premises or works of the Contractor or any sub-contractor, the Contractor, except where otherwise specified shall provide free of charge such items as labour, materials, electricity, fuel, water, stores, apparatus and instruments as may be reasonably demanded by the owner's Engineer/Inspector or his authorised representatives to carry out effectively such tests on the equipment in accordance with the Contract / QAP or other approved quality documents. Contractor and shall give facilities to the owner's Engineer/ Inspector or to his authorised representative to accomplish testing.
- 4.06.00 To facilitate advance planning of inspection in addition to giving inspection notice as per Clause 4.02.00, the Contractor shall furnish quarterly inspection programme indicating proposed schedule dates of inspection at customer hold point and final inspection stages. Updated quarterly inspection plans will be made for each three consecutive months and shall be furnished before beginning of each calendar month.

**LIST OF STANDARDS FOR REFERENCE**

- a) International Standards Organisation (ISO).
- b) International Electro-technical Commission (IEC).
- c) American Society of Mechanical Engineers(ASME)
- d) American National Standards Institute (ANSI).
- e) American Society for Testing and Materials (ASTM).
- f) American Institute of Steel Construction (AISC).
- g) American Welding Society (AWS).
- h) Architecture Institute of Japan (AIJ).
- i) National Fire Protection Association (NFPA).
- j) National Electrical Manufacturer's Association (NEMA).
- k) Japanese Electro-technical Committee (JEC).
- l) Institute of Electrical and Electronics Engineers (IEEE).
- m) Federal Occupational Safety and Health Regulations (OSHA).
- n) Instrument Society of America (ISA).
- o) National Electric Code (NEC).
- p) Heat Exchanger Institute (HEI).
- q) Tubular Exchanger Manufacturer's Association (TEMA).
- r) Hydraulic Institute (HIS).
- s) International Electro-Technical Commission Publications.
- t) Power Test Code for Steam Turbines (PTC).
- u) Applicable German Standards (DIN).
- v) Applicable British Standards (BS).
- w) Applicable Japanese Standards (JIS).
- x) Electric Power Research Institute (EPRI).
- y) Standards of Manufacturer's Standardization Society (MSS)

- z) Bureau of Indian Standards Institution (BIS).
- aa) Indian Electricity Rules.
- bb) Indian Boiler Regulations (IBR).
- cc) Indian Explosives Act.
- dd) Indian Factories Act.
- ee) Tariff Advisory Committee (TAC) rules.
- ff) Emission regulation of Central Pollution Control Board (CPCB).
- gg) Pollution Control regulations of Dept. of Environment, Govt. of India
- hh) Central Board of Irrigation and Power (CBIP) Publications

**ANNEXURE-I**  
**FORMAT OF QUALITY ASSURANCE PROGRAMME**

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |    |                                             |    |                   |    |                                                |                                                                                                                                                |                    |    |   |   |  |  |                                                                                                                                                                                         |  |  |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|---------------------------------------------|----|-------------------|----|------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|----|---|---|--|--|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|--|
| <b>VENDOR'S LOGO , NAME &amp; ADDRESS</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |    | <b>MANUFACTURING QUALITY ASSURANCE PLAN</b> |    |                   |    | <b>DOC NO:</b>                                 | XXXXX-CAL-QAP-M-0001                                                                                                                           |                    |    |   |   |  |  |                                                                                                                                                                                         |  |  |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |    | <b>ITEM :</b>                               |    |                   |    | <b>REV NO :</b>                                | 0                                                                                                                                              | 1                  | 2  | 3 | 4 |  |  |                                                                                                                                                                                         |  |  |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |    |                                             |    |                   |    | <b>DATE :</b>                                  |                                                                                                                                                |                    |    |   |   |  |  |                                                                                                                                                                                         |  |  |
| <b>CLIENT :</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |    |                                             |    |                   |    | <b>LOCATION :</b>                              |                                                                                                                                                |                    |    |   |   |  |  |                                                                                                                                                                                         |  |  |
| <b>PROJECT :</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |    |                                             |    |                   |    | <b>REFERENCE PURCHASE ORDER NO. &amp; DT :</b> |                                                                                                                                                |                    |    |   |   |  |  |                                                                                                                                                                                         |  |  |
| <b>VENDOR :</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |    |                                             |    |                   |    | <b>REFERENCE APPROVED DATA SHEET :</b>         |                                                                                                                                                |                    |    |   |   |  |  |                                                                                                                                                                                         |  |  |
| <b>SUB VENDOR :</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |    |                                             |    |                   |    | <b>REFERENCE APPROVED DRAWING. NO. :</b>       |                                                                                                                                                |                    |    |   |   |  |  |                                                                                                                                                                                         |  |  |
| <b>ABBREVIATIONS :</b><br><br>QAP - QUALITY ASSURANCE PLAN,<br>CR - CRITICAL,<br>MA - MAJOR,<br>MI - MINOR<br>SPEC - SPECIFICATION,<br>TC - TEST CERTIFICATES<br>P - PERFORM<br>w - WITNESS<br>V - VERIFY<br>CHP - CUSTOMER HOLD POINT                                                                                                                                                                                                                                                                                  |    |                                             |    |                   |    |                                                | <b>AGENCY :</b><br><br>1 - DCPL/PROJECT AUTHORITY<br>2 - SUPPLIER<br>3 - SUB-SUPPLIER<br>4 - MANUFACTURER<br>5 - THIRD PARTY INSPECTION AGENCY |                    |    |   |   |  |  | <b>GENERAL REMARKS</b><br>1 THE ITEMS WHICH ARE FALLING UNDER ANY STATUTORY AUTHORITY'S (LIKE I.B.R. ETC.) SCOPE SHALL BE SUBJECTED TO THAT STATUTORY AUTHORITY'S INSPECTION CLEARENCE. |  |  |
| <b>NOTES:</b><br>1. EXACT MATERIAL / PROCESS / INSPECTION / TESTS FOLLOWED BY THE MANUFACTURER SHALL BE SPECIFIED<br>2. EXACT REFERENCE DOCUMENT/ACCEPTANCE STANDARD SHALL BE SPECIFIED<br>3. IN CASE SPECIFIED ACCEPTANCE STANDARD / NORMS IS OTHER THAN NATIONAL / INTERNATIONAL STANDARDS<br>. STANDARD / COPY OF THE ACCEPTANCE NORMS FOLLOWED BY THE MANUFACTURER SHALL BE SUBMITTED FOR REVIEW RECORD<br>4 FINAL INSPECTION DOSSIER SHALL BE PREPARED BY MANUFACTURER & SHALL BE ENDORSED BY INSPECTIONION AGENCY |    |                                             |    |                   |    |                                                |                                                                                                                                                |                    |    |   |   |  |  |                                                                                                                                                                                         |  |  |
| <b>Prepared by</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |    |                                             |    | <b>Checked by</b> |    |                                                |                                                                                                                                                | <b>Approved By</b> |    |   |   |  |  |                                                                                                                                                                                         |  |  |
| Revision                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | R0 | R1                                          | R2 | R0                | R1 | R2                                             | R0                                                                                                                                             | R1                 | R2 |   |   |  |  |                                                                                                                                                                                         |  |  |
| DATE                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |    |                                             |    |                   |    |                                                |                                                                                                                                                |                    |    |   |   |  |  |                                                                                                                                                                                         |  |  |

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|-------------------------------|-------------|--------|--------|------------|----------|----------|-----------------|------------------|----------|----|----|---------|----|
| VENDOR'S LOGO, NAME & ADDRESS |             |        | ITEM : |            |          |          |                 |                  | DOC NO:  |    |    |         |    |
|                               |             |        |        |            |          |          |                 |                  | REV NO : |    | R0 | R1      | R2 |
|                               |             |        |        |            |          |          |                 |                  | DATE :   |    |    |         |    |
| SL NO.                        | DESCRIPTION | CHECKS |        |            | CATEGORY | REF DOCS | ACCEPTANCE NORM | FORMAT OF RECORD | AGENCY   |    |    | REMARKS |    |
|                               |             | TYPE   | METHOD | QUANTUM    |          |          |                 |                  | P        | W  | V  |         |    |
| 1                             | 2           | 3      | 4      | 5          | 6        | 7        | 8               | 9                | 12       | 13 | 14 | 15      |    |
| 1.00                          |             |        |        |            |          |          |                 |                  |          |    |    |         |    |
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| Notes:                        |             |        |        |            |          |          |                 |                  |          |    |    |         |    |
| Prepared by                   |             |        |        | Checked by |          |          |                 | Approved By      |          |    |    |         |    |
| Revision                      | R0          | R1     | R2     | R0         | R1       | R2       | R0              | R1               |          | R2 |    |         |    |
| DATE                          |             |        |        |            |          |          |                 |                  |          |    |    |         |    |
|                               |             |        |        |            |          |          |                 |                  |          |    |    |         |    |

**ANNEXURE-II****FIELD WELDING SCHEDULE**

PROJECT : FWS NO :  
 CONTRACTOR : REV NO. :  
 PACKAGE : FIELD WELDING CODE :  
 SYSTEM : PAGE NO. :

| Sl No. | Drawing No. for Weld Locations & Identification mark | Description of parts to be welded | Material specification | Dimensions | Process of Welding | Type of Weld | Electrode Filler Specification | WPS No. | Minimum Pre-heat Temperature | Heat Treatment Temperature [Holding Time in secs] | NDT Method Quantum | NDT Specification Number | Acceptance Norm Ref. | Remarks |
|--------|------------------------------------------------------|-----------------------------------|------------------------|------------|--------------------|--------------|--------------------------------|---------|------------------------------|---------------------------------------------------|--------------------|--------------------------|----------------------|---------|
|--------|------------------------------------------------------|-----------------------------------|------------------------|------------|--------------------|--------------|--------------------------------|---------|------------------------------|---------------------------------------------------|--------------------|--------------------------|----------------------|---------|

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The Field Welding Schedule should be submitted for :

- ☐ Pressure Parts
- ☐ Tanks/Vessels
- ☐ Piping
- ☐ Heavy/Important Structural Steel
- ☐ Heat Exchangers
- ☐ Bus Ducts

**16.0. LOW PRESSURE PIPING**

| Sl.No. | Tests/Check<br><br>Items /<br>Components | Material Test  | DPT/MPI        | Ultrasonic Test | WPS/<br>WQS/PQR | Balancing | Hydraulic / Water<br>Fill Test | Pneumatic<br>Test | Assembly Fit<br>up | Dimensions | Functional/operati<br>on al Test | Performance<br>Test | Other tests     | All Tests as per<br>Relevant Std | Adhesion /<br>Spark | Remarks        |
|--------|------------------------------------------|----------------|----------------|-----------------|-----------------|-----------|--------------------------------|-------------------|--------------------|------------|----------------------------------|---------------------|-----------------|----------------------------------|---------------------|----------------|
| 1)     | Pipes & Fittings<br>and<br>Metered Bends | Y <sup>a</sup> | Y <sup>b</sup> |                 | Y               |           | Y                              |                   |                    |            |                                  |                     |                 |                                  |                     |                |
| 2)     | Diaphragm<br>Valves                      | Y <sup>a</sup> |                |                 |                 |           | Y <sup>b</sup>                 |                   |                    | Y          |                                  |                     |                 | Y <sup>b</sup>                   |                     |                |
| 3)     | Butterfly Valves<br>(Low Pressure)       |                |                |                 |                 |           |                                |                   |                    |            |                                  |                     |                 |                                  |                     |                |
| a)     | Casted Butterfly<br>Valves               |                |                |                 |                 |           |                                |                   |                    |            |                                  |                     |                 |                                  |                     |                |
| (i)    | Body (Cast)                              | Y <sup>a</sup> | Y <sup>b</sup> |                 |                 |           | Y                              |                   | Y                  | Y          | Y                                |                     | Y <sup>c</sup>  |                                  |                     |                |
| (ii)   | Disc (Cast)                              | Y <sup>a</sup> | Y <sup>b</sup> |                 |                 |           |                                |                   |                    |            |                                  |                     |                 |                                  |                     |                |
| (iii)  | Shaft                                    | Y <sup>a</sup> | Y              | Y <sup>c</sup>  |                 |           |                                |                   |                    |            |                                  |                     |                 |                                  |                     |                |
| b)     | Fabricated<br>Butterfly<br>Valves        |                |                |                 |                 |           |                                |                   |                    |            |                                  |                     |                 |                                  |                     | Ref.<br>Note14 |
| 4)     | Gate / Globe /<br>Swing Check<br>Valves  | Y <sup>a</sup> | Y <sup>b</sup> | Y <sup>c</sup>  |                 |           | Y <sup>b</sup>                 | Y                 | Y                  |            |                                  |                     | Y <sup>8</sup>  |                                  |                     |                |
| 5)     | Dual Plate Check<br>Valves               | Y <sup>a</sup> | Y <sup>b</sup> | Y <sup>c</sup>  |                 |           | Y                              | Y                 | Y                  |            |                                  |                     | Y <sup>4</sup>  |                                  |                     |                |
| 6)     | Rolled & Welded<br>Pipes                 | Y <sup>a</sup> | Y <sup>3</sup> |                 | Y               |           | Y <sup>1</sup>                 |                   |                    | Y          |                                  |                     |                 |                                  |                     |                |
| 7)     | Coating &<br>Wrapping of<br>Pipes        | Y <sup>2</sup> |                |                 |                 |           |                                |                   |                    |            |                                  |                     | Y <sup>2</sup>  |                                  |                     |                |
| 8)     | Tanks & Vessels                          | Y <sup>a</sup> | Y <sup>b</sup> |                 | Y               |           | Y                              |                   |                    |            |                                  |                     |                 |                                  |                     |                |
| 9)     | Strainers                                | Y <sup>a</sup> | Y <sup>b</sup> |                 |                 |           | Y                              |                   |                    |            |                                  |                     | Y <sup>11</sup> |                                  |                     |                |

| Sl.No. | Tests/Check<br><br>Items /<br>Components | Material Test  | DPT/MPI        | Ultrasonic Test | WPS/<br>WQS/PQR | Balancing | Hydraulic / Water<br>Fill Test | Pneumatic<br>Test | Assembly Fit<br>up | Dimensions | Functional/operati<br>on al Test | Performance<br>Test | Other tests     | All Tests as per<br>Relevant Std | Adhesion /<br>Spark | Remarks |
|--------|------------------------------------------|----------------|----------------|-----------------|-----------------|-----------|--------------------------------|-------------------|--------------------|------------|----------------------------------|---------------------|-----------------|----------------------------------|---------------------|---------|
| 10)    | Rubber<br>Expansion Joints               | Y <sup>a</sup> |                |                 |                 |           | Y <sup>12</sup>                |                   | Y                  |            |                                  |                     | Y <sup>13</sup> |                                  |                     |         |
| 11)    | Rubber Lining of<br>Pipes                | Y <sup>a</sup> | Y <sup>b</sup> |                 | Y               |           | Y                              |                   |                    | Y          |                                  |                     |                 | Y <sup>a</sup>                   | Y                   |         |
| 12)    | Hangers &<br>Supports                    | Y <sup>a</sup> |                |                 |                 |           |                                | Y                 |                    |            |                                  |                     |                 |                                  |                     |         |
| 13)    | Fasteners                                | Y <sup>a</sup> |                | Y <sup>b</sup>  |                 |           |                                | Y                 |                    |            |                                  |                     |                 |                                  |                     |         |
| 14)    | Site Welding                             |                | Y <sup>1</sup> |                 | Y               |           | Y                              |                   |                    |            |                                  |                     |                 |                                  |                     |         |

**Notes:**

1. Weld Joints not subjected to hydraulic test shall be subjected to 100% RT.
2. Spark Test, Adhesion Test and Material Test for primer and enameled & Coal Tar Tapes as per AWWA-C-203-91
3. DPT on route run and after back gouging and on finish welds.
4. Dry Cycle Test (Spring Cycle Test) for one lakh Cycles shall be carried out as a type test..
5. Seat Leakage Test for Actuator Operated Valves, shall be done with by closing the valves with actuator.
6. Tests on rubber parts per batch of rubber mix such as hardness, adhesion, spark test, bleed test and flex test on diaphragm, type test for diaphragm for 50,000 cycles.
7. Hydraulic Test of Body, Seat and disc-strength shall be carried out in accordance with latest edition of AWWA-C-504 in presence of Employer's representatives. Actuator operated valves shall be checked for Seat Leakage by closing the valves with actuator. Seat Leakage Test shall be carried out in both directions.

8. Blue matching, wear travel for gates, valves, pneumatic seat leakage, reduced pressure test for check valves shall be done as per relevant standard. Maximum allowable vacuum loss is 0.5 mm of Hg abs. for valves to be tested for vacuum operation for internal pressure 25 mm of Hg abs. for a period of 15 minutes 9.
9. Hardness, Bleeding Test and Ozone resistance test shall be done on rubber material
10. 2% of welds shall be subjected to DPT.
11. Pressure drop across the strainer for each type and size as a special test shall be carried out
12. During hydraulic and vacuum tests at 25mm Hg abs in 3 positions, the change in the circumference of arch should not be more than 1.5%. 24 hrs after the test permanent set in dimension should not exceed 0.5%.
13. Tests on rubber for tensile, elongation, hardness, hydraulic stability check as per ASTM D 471, ozone resistance test as per ASTM D 1149 aging test and adhesion strength of rubber to fabric, rubber to metal adhesion shall be carried out.
14. For fabricated butterfly valves: UT as per ASTM A-435 on plates material for body and disc. 100% RT as per ASTM, Section-VIII, Division-I, on butt joints of body and disc and post weld heat treatment as per ASME, Section-VIII, Division- I on butt joints of body and disc of thickness above 30mm shall be carried out in addition to other tests indicated for cast butter fly valves.
  - a) One per heat/heat treatment batch/lot.
  - b) On machined surfaces only for castings and on finished butt welds.

For shaft/spindles > or = 50 m

flange. The material of construction of spool pipe shall be the same as that of pumps suction piping. The strainer element shall be of perforated sheet with aperture size of 6 mm and wrapped with AISI-316 stainless steel wire mesh of 500 micron nominal aperture. The clear opening area of the strainer shall be at least 5 times the pipe area.

j) Non-return Valves

- i) All non-return valves shall be of approved type and make and the pressure drop shall be subject to approval. Non-return valves for steam services and on pump discharge sides shall be provided with approved dash pots, where required, and with prior approval.
- ii) The body seat for swing check valves shall be inclined at such an angle as to minimise chatter.
- iii) To enable the internal parts to be examined or removed without removing the valves from the pipeline, the flanged cover should be used. The bodies shall be stamped with an arrow to indicate the correct flow direction.
- iv) Provision shall be made to drain both sides of a horizontal non-return valve where such a valve adjoins an isolating valve for non-return valves mounted on vertical pipe integral by-pass shall be used to facilitate draining as stated earlier.

k) De-super heaters

De-super heaters along with spray water supply and control system shall be provided on the auxiliary steam lines, etc. as required. A de-superheater shall be designed for the design conditions of the piping on its upstream side and shall also take care of its severe condition of working. As far as possible, the de-super heaters shall be mounted on a vertical line to avoid the problem of water accumulation in it. However, if installed horizontally, the inside diameter of the de-superheater shall be the same as that of the pipe on which it is mounted and the pipe shall be provided with drain pocket and trap station.

## 7.00.00 INSPECTION, TESTING AND INSTALLATION

### 7.01.00 Testing of Piping at Works

#### 7.01.01 Material Test and Analysis

All materials shall be furnished in strict accordance with the codes specified and in accordance with the detailed specification. All sources of material shall be disclosed and relevant test certificates for the physical and chemical properties of the material shall be made available to the Owner/Engineer before the final shop inspection.

### 7.01.02 Hydrostatic Test

All piping shall be subjected to the hydrostatic test pressure at shop as required by the IBR or any other applicable standards. Test pressure shall however be not less than the following :

$$\text{Test Pressure} = 1.5 \times \frac{\text{Allowable Stress at Room Temp.}}{\text{Allowable Stress at Design Temp.}} \times \text{Design Pressure}$$

The Contractor shall guarantee his work as capable of withstanding such hydrostatic tests and consent to repair or replace at his expense any item, which fails to pass such tests at site. Hydrostatic test of all pipes coming under IBR shall be offered for witnessing by the representative of the Inspecting Authority recognised by IBR.

### 7.01.03 Wall Thickness Tests

Wall thickness tests shall be made on a length of pipe of each type to determine the actual wall thickness at outer wall of bend on such piping.

The tests shall be done before fabrication on the piping system and results submitted to Owner/Engineer for approval.

### 7.02.00 Capacity Tests for Pipe Supports

Each constant load and spring support shall be tested before delivery to ensure that the variation in support capacity provided through the specified ranges (i.e. the difference in load between hot conditions and cold condition) does not exceed 6 percent for constant load supports and 20 percent for variable spring supports.

All materials shall be of tested quality. Hanger springs shall be properly calibrated.

### 7.03.00 Testing of Valves & Specialties at Works

7.03.01 All materials shall be of tested quality and the contractor shall submit the relevant material test certificate for the approval of Owner/Consultant.

7.03.02 All Valves and Specialties as well as counter flanges to be used in steam service shall have IBR certification marked on them and IBR certificates in appropriate proforma, shall be submitted.

7.03.03 Gate valves shall be subjected to shop tests in accordance with API-598 including the high-pressure closure test. Globe valves shall be tested in accordance with BS-1873 and check valves in accordance with BS-1868.

7.03.04 All gaskets used for test shall be of the same material and design as specified for the finished product.

- 7.03.05 Each relief valve shall be subjected to hydrostatic test, seat pressure test, seat leakage test and test for relieving capacity.

The valve body test pressure shall be at least twice the set pressure.

The seat test pressure should be at least equal to the set pressure. During this test, the valve seat shall be demonstrated to be watertight for a period of at least two (2) minutes.

- 7.03.06 Functional tests : The fully assembled or completed valves including the operators and accessories shall be functionally tested to demonstrate the operability of the valve and the operator. This may be done by cycling typical valves 3 or 4 times from open to close position. The manual operation of the motor operated valves using the manual override to demonstrate freedom from friction shall also be conducted.

#### 7.04.00 **Tests on Strainers and Traps at Works**

- 7.04.01 All strainers shall be subjected to hydrostatic test. The test pressure shall be twice the design pressure.

- 7.04.02 All steam traps shall be subjected to hydrostatic test at twice the design pressure. IBR certification shall be furnished for all steam traps.

- 7.05.00 Test reports and certificates of the mentioned tests and other tests as required to ensure satisfactory operation shall be submitted to Owner/Consultant before despatch of equipment IBR certification as required shall be furnished.

- 7.06.00 All rubber lining should be subjected to tests as per IS:4682 (Part-I).

#### 7.07.00 **Tests at Site**

Contractor shall carry out tests at site to prove to the Owner that the equipment of the plant complies with requirements stipulated and is erected in accordance with requirements. Before the plant is put on trial run the Contractor will be required to conduct tests to demonstrate to the Owner that each item of the plant is capable of correctly performing the functions for which it was specified. These test may be conducted concurrently with those required under commissioning sequence. Tests required shall in general be as follows :

- a) All piping, valves and specialties after installation, will be tested hydraulically at a pressure, one half times that of the maximum attainable pressure in the system or 2 times the design pressure whichever is higher, to check against leak tightness.
- b) All manually operated valves/gates shall be operated throughout 100% of the travel and these should function without any trouble whatsoever.
- c) Visual check on all structural components, welding, painting etc. and if doubt arises these will be tested again.

- d) All test instruments and equipment shall be furnished by the Bidder to the satisfaction of the Owner.
- e) Checks on electrical items as mentioned in relevant electrical specification.

#### 7.08.00 **Pre-Commissioning Testing**

##### 7.08.01 Alignment Test

After completion of erection and before start-up, alignment test shall be carried out by the Contractor to check levelling, clearance, eccentricity etc. Measurement will be witnessed and acceptance will be certified by the Engineer.

##### 7.08.02 Heat Treatment

All necessary preheating, post heating and stress relieving operation of welds/fabricated, items are part of the erection work and shall be supervised by the Contractor in accordance with relevant regulations and standard.

The Bidder shall arrange all required supervising staff for heat treatment and stress relieving works.

Heat treatment may be required to be carried out at any time during day and night to ensure the continuity of the progress. The Contractor shall provide supervising staff accordingly.

All data such as heating temperature, heating rate, sparking time, maximum temperature during heat treatment shall be properly recorded. All the data recorded during heat treatment shall be the property of the Owner.

##### 7.08.03 Radiography Test

The Contractor shall carryout radiography tests of all field-welded joints coming under IBR the acceptability standard of which shall be as per IBR (latest revision). For other field welded joints radiography or other ND testing methods shall be employed as per ASME or equivalent. All radiography shall be carried out in presence of a competent supervisor of the contractor and his certificate of identification of the films of the radiographs shall be given invariably in all cases.

The repair work shall be suggested by the Contractor immediately after detection of the defective zone to the complete satisfaction of the Engineer. Regarding acceptance of the joints, decision of the Engineer shall be final.

All X-ray films of joints radiographed at site shall become the property of the Owner.

Contractor shall carryout the following optional non-destructive tests after completion of erection of all piping and equipment.

Ultrasonic test per weld joint.

Hardness test for 10% weld joints for each system of piping and/or as specified in the approved Field Quality Plan (FQP).

#### 7.08.04 Hydrotest

Hydrotesting shall be conducted for all pressure parts after installation at required pressure irrespective of carrying out 100% radiography of field welded joints. All necessary blanking arrangement required for such hydrotesting shall be furnished by the Contractor. The hydro testing of piping coming under the I.B.R. shall meet the requirements of I.B.R. and all necessary test pump, temporary piping etc. shall be supplied by the Erection Contractor, irrespective of carrying out radiography on 100% basis of the field welded joints.

After the hydrostatic test, the Erection Contractor shall carry out thorough flushing of all lines with water to ensure removal of foreign materials like welding rods, metal chips etc. to the satisfaction of Engineer. After the flushing of the lines, all the water shall be drained and the piping shall be blown with air for drying the cleaned surface and the lines shall be air blasted to ensure proper cleaning of line to the satisfaction of engineer.

As a rule, hydro test shall be performed after all eventual pipe branching have been completed and valves installed. Should it be required to hasten erection work, hydrotest may be performed in sections.

All safety valves coming under purview of Indian Boiler Regulation shall be set and other tests shall be conducted to the satisfaction of concerned Boiler Inspector. All other safety valves shall also be set and sealed to the satisfaction of the Engineer.

All instruments necessary for the tests shall be supplied by the Contractor and calibrated before test as per relevant code.

The Contractor shall make necessary changes and corrections without any extra cost as may be felt by the Owner/Engineer to meet the guarantee and other technical particulars.

#### 7.09.00 **Installation**

7.09.01 For all steam blown lines temporary strainers shall be installed at the equipment terminals so as to prevent any inflow of particles where that may cause any damage or harmful effect. For example, such strainers shall be placed on main steam and hot reheat line terminals at turbine end unless the turbine stop valves/interceptor valves have integral strainers suitable for the purpose. The temporary strainers shall be kept on line for sometime after the plant starts normal operation, as per the discretion of the Engineer. So, the design of strainers shall be based on the design conditions of the pipes on which they are installed. Where flow meters are to be installed in pipes requiring steam blowing, initially the pipes shall be erected with the flow meter branch pipes replaced by temporary spool pieces. After the end of steam blowing operation the temporary spool pieces shall be removed and the flow

meter branch pieces shall be erected in position. In case such a pipe has also to be subject to cold pull-up, temporary anchoring of the main pipe on either ends of the temporary spool piece shall be done before replacing it by the flow-meter branch pipe.

All piping shall be installed in a manner such that expansion will take place in the direction desired and so that vibrations will be minimised. The contractor shall be responsible for the expansion provisions and flexibility of all field run piping. No piping shall be cold-sprung or cold-pulled unless there remains absolutely no other means to bring down the hot stress or terminal forces/moments within acceptable limit. All such cold pull up shall be shown in the piping drawings, along with a write-up describing clearly the method adopted for cold-pulling. All necessary attachments for cold-pulling, along with temporary anchors, as and wherever required, shall be provided.

The forces and moments on the temporary anchors and attachments shall be submitted. The cold pull-ups and all the above-mentioned documents shall be subject to the approval of the Owner.

- 7.09.02 All expansion bellows shall be installed with a minimum of two tie rods or bolts across each bellows to prevent the bellows from opening under pressure. The connection of the tie rods or bolts to the pipe shall make adequate provision for angular movement of the pipe and bellows.

Pump suction pipes shall be installed in such a manner that no air can be trapped in the suction piping. Suction pipes shall be supported in such a manner that there will be no high spots where air can be trapped. The in trades of suction branch lines shall be in no place lower than the in trades of the manifold at the point where the branch line connects to the manifold.

Standard "Factory Made" fittings shall be used in all piping. Shop or site fabricated mitred fittings shall not be used unless accepted by the Owner.

- 7.09.03 During erection no weights must be lifted by means of tackle fastened to the beams or slabs of the floor or roof except where provision has been specifically made for this purpose.

Supporting straps around flanges of pipes or valves or around welded joints will not be accepted. Anchors shall be attached to pipe by approved means. All supports should be shop fabricated and should be positioned before erection of the piping takes place and near to joints & valves wherever possible.

- 7.09.04 The Contractor shall provide all the necessary wall boxes and collars where pipes pass through walls, floors and roofs, also the necessary supports for any trenched pipes. Roof collars shall be fitted with a high sealing to prevent water falling through the holes.

The wall boxes and floor collars shall be constructed so that they can if necessary be erected after the pipes are in position. Pipes passing through roof collars shall be provided with an approved pipe sleeves, weather hood and cowl which shall be fixed by the Bidder. Floor collars shall extend to an approved height above the floor level and the pipes shall be fitted with hoods where required.

7.09.05 Drainpipe work shall be designed as per ANSI B31.1.

High pressure drains (above 40 kg/sq.cm) shall have two valves in series and that near the condenser or flash box shall be motor operated arranged to open and close to ensure minimum wear on one valve.

High-pressure drains shall have a screw-down non-return valve at the point of discharge near the manifold of the Flash tank to prevent backflow of flashed steam.

Low-pressure drains shall have steam traps of an approved design complete with strainers, isolating valves and by-pass valves.

Low-pressure drains shall have an isolating valve at the point of take-off from the pipe or vessel to be drained or as near as possible for convenient operation.

Pipe wall thickness shall be as per international standard approved by Owner/Engineer during detailed engineering.

Drain pockets of an approved size and construction shall be provided for all steam lines.

Arrangement of valves in the drain line shall be as shown in the Bidder's P & I Diagram.

7.09.06 All electrical actuators and pneumatic/hydraulic actuator shall be erected, aligned, adjusted and finally set to the satisfaction of the Owner. This includes adjustment and setting of torque and limit switches.

8.00.00 **DRAWINGS, DATA, INFORMATION & MANUALS**

8.01.00 **Drawings, data, Information to be furnished by the Bidder along with the Bid**

8.01.01 A complete list of all piping systems and corresponding materials included in the scope of work.

8.01.02 A complete list of all valves with their quantities and ratings.

8.01.03 Manufacturer's catalogue indicating design and construction of spring hangers, valves, specialties offered.

8.01.04 Manufacturer's catalogue indicating complete range of available size and rating of pipes and fittings.

8.02.00 **After Award of Contract**

8.02.01 Layout drawings as well as Isometric drawings (for line sizes NB 50 mm and larger) showing the routing of various piping and location of hangers, restraints, anchors, valves etc.

|                                                                                   |                                                                                                          |                                                                                                                  |                                                             |                                                    |                    |                                                                                                        |                                                 |                                               |      |                          |     |   |                                                                                                                      |
|-----------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------|----------------------------------------------------|--------------------|--------------------------------------------------------------------------------------------------------|-------------------------------------------------|-----------------------------------------------|------|--------------------------|-----|---|----------------------------------------------------------------------------------------------------------------------|
|  |                                                                                                          | MANUFACTURERS NAME & ADDRESS                                                                                     |                                                             | STANDARD QUALITY PLAN                              |                    |                                                                                                        |                                                 | PROJECT                                       |      | 5X800 MW YADRADRI TPS    |     |   |                                                                                                                      |
|                                                                                   |                                                                                                          | AS PER APPROVED VENDOR LIST                                                                                      |                                                             | ITEM:                                              | ELECTRIC WIRE ROPE | QP NO                                                                                                  |                                                 | PACKAGE                                       |      | WIRE ROPE ELECTRIC HOIST |     |   |                                                                                                                      |
|                                                                                   |                                                                                                          |                                                                                                                  |                                                             | REV                                                |                    | 0                                                                                                      | CONTRACT No                                     |                                               |      |                          |     |   |                                                                                                                      |
|                                                                                   |                                                                                                          |                                                                                                                  |                                                             | DATE                                               |                    |                                                                                                        | CONTRACTOR                                      |                                               | BHEL |                          |     |   |                                                                                                                      |
|                                                                                   |                                                                                                          |                                                                                                                  |                                                             | PAGE                                               |                    | 1 of 4                                                                                                 |                                                 |                                               |      |                          |     |   |                                                                                                                      |
| SL.No                                                                             | COMPONENT & OPERATIONS                                                                                   | CHARACTERISTICS                                                                                                  | CATEGORY                                                    | TYPE OF CHECK                                      | EXTENT OF CHECK    | REFERENCE DOCUMENT                                                                                     | ACCEPTANCE NORMS                                | FORMAT OF RECORD                              | D*   | M                        | C   | N | REMARKS                                                                                                              |
| 1                                                                                 | 2                                                                                                        | 3                                                                                                                | 4                                                           | 5                                                  | 6                  | 7                                                                                                      | 8                                               | 9                                             |      | **                       | 10  |   | 11                                                                                                                   |
| 1.0                                                                               | <b>RAW-MATERIALS</b>                                                                                     |                                                                                                                  |                                                             |                                                    |                    |                                                                                                        |                                                 |                                               |      |                          |     |   |                                                                                                                      |
| 1.1                                                                               | a) STRUCTURAL MATERIAL<br>b) RAW MATERIAL FOR HOIST AND GEAR BOX HOUSEING, TROLLEY PLATE (AS APPLICABLE) | MECH. , CHEM. PROPS                                                                                              | MA                                                          | CHEMICAL COMPOSITION AND TENSILE STRENGTH          | 1 / lot            | APPD. DRG. / DATA SHEET                                                                                | APPD. DRG. / DATA SHEET                         | Mill.s TC                                     | √    | V                        | V   | V | Test shall be carried out in absence of mill TC                                                                      |
| 1.2                                                                               | GEARS, SHAFT/AXLES, WHEELS                                                                               | MECH , CHEM. PROPS                                                                                               | MA                                                          | CHEMICAL COMPOSITION, HARDNESS (DURING IN-PROCESS) | 1 / LOT            | APPD. DRG. / DATA SHEET                                                                                | APPD. DRG. / DATA SHEET / IS:3938               | LAB. REPORT / MANUFACTURER'S TEST CERTIFICATE | √    | P                        | V   | V | In case the items are not manufactured in-house, the manufacturer's test certificate shall be submitted for chemical |
|                                                                                   |                                                                                                          | U.T FOR DIA/THK > 50mm                                                                                           | CR                                                          | NDT                                                | 100%               | ASTM A 388                                                                                             | NOTE 4                                          | INSPN. REPORT                                 | √    | P                        | V   | V |                                                                                                                      |
| 1.3                                                                               | WIRE ROPE                                                                                                | Dimensional CHECK                                                                                                | MI                                                          | Dia.                                               | 100%               | APPD. DRG. / DATA SHEET                                                                                | APPD. DRG. / DATA SHEET                         | MFERS' TEST CERT.                             | √    | P                        | V   | V |                                                                                                                      |
|                                                                                   |                                                                                                          | BREAKING LOAD CAPACITY                                                                                           | CR                                                          | BREAKING LOAD                                      | 100%               | APPROVED DRG/DATA SHEET / IS:3938 / IS: 2266                                                           | APPROVED DRG/DATA SHEET AND / IS:3938 / IS:2266 | MFERS' TEST CERT.                             | √    | P                        | V   | V |                                                                                                                      |
| 1.4                                                                               | HOOKS                                                                                                    | PHYS./ MECH. , CHEM. PROPS.                                                                                      | MA                                                          | CHEMICAL COMPOSITION, HARDNESS                     | 1 / LOT            | APPROVED DRG/DATA SHEET / IS:3938 / IS:15560                                                           | APPROVED DRG/DATA SHEET / IS:3938 / IS:15560    | MFERS' TEST CERT.                             | √    | P                        | V   | V |                                                                                                                      |
|                                                                                   |                                                                                                          | U.T IF SHANK DIA > 50mm                                                                                          | CR                                                          | NDT                                                | 100%               | ASTM A 388                                                                                             | NOTE 1                                          | INSPN. REPORT                                 | √    | P                        | W   | V | <b>SHANK PORTION ONLY</b>                                                                                            |
|                                                                                   |                                                                                                          | PROOF LOAD CAPACITY                                                                                              | CR                                                          | PROOF LOAD TEST                                    | 100%               | APPROVED DRG/DATA SHEET / IS:3938 / IS:15560                                                           | APPROVED DRG/DATA SHEET / IS:3938 / IS:15560    | INSPN. REPORT                                 | √    | P                        | W   | V |                                                                                                                      |
|                                                                                   |                                                                                                          | DP AFTER PROOF LOAD                                                                                              | CR                                                          | NDT                                                | 100%               | ASTM E-165                                                                                             | NO CRACKS                                       | INSPN. REPORT                                 | √    | P                        | V/W | V |                                                                                                                      |
| 2.0                                                                               | <b>IN-PROCESS</b>                                                                                        |                                                                                                                  |                                                             |                                                    |                    |                                                                                                        |                                                 |                                               |      |                          |     |   |                                                                                                                      |
| 2.1*                                                                              | WELDING PROCEDURE SPECIFICATION                                                                          | CORRECTNESS                                                                                                      | MA                                                          | SCRUTINY                                           | 100%               | IS:7307 / ASME SEC IX                                                                                  | IS:7307 / ASME SEC IX                           | FORMAT OF IS / ASME SEC IX                    |      | P                        | V   | V |                                                                                                                      |
| 2.2*                                                                              | PROCEDURE & WELDER QUALIFICATION                                                                         | WEDLING PARAMETRES                                                                                               | MA                                                          | PHYS. TESTS/RT                                     | 100%               | IS:7310 / ASME SEC IX                                                                                  | IS:7310 / ASME SEC IX                           | AS PER ASME SEC IX                            | √    | P                        | W   | W | IN CASE OF LLOYDS / EIL / TPL QUALIFIED WELDERS AVAILABLE, REQUALIFICATION OF WELDER IS NOT REQUIRED                 |
|                                                                                   |                                                                                                          | LEGND                                                                                                            |                                                             |                                                    |                    |                                                                                                        |                                                 |                                               |      |                          |     |   |                                                                                                                      |
|                                                                                   |                                                                                                          |                                                                                                                  |                                                             |                                                    |                    | * RECORDS IDENTIFIED WITH 'TICK' ( √ ) SHALL BE ESSENTIALLY INCLUDED BY CONTRACTOR IN QA DOCUMENTATION |                                                 |                                               |      |                          |     |   |                                                                                                                      |
|                                                                                   |                                                                                                          |                                                                                                                  |                                                             |                                                    |                    | ** M: MANUFACTURER/SUBCONTRACTOR                                                                       |                                                 |                                               |      |                          |     |   |                                                                                                                      |
| MANUFACTURER/ SUB CONTRACTOR                                                      |                                                                                                          | CONTRACTOR                                                                                                       | C: CONTRACTOR NOMINATED INSPECTION AGENCY(BHEL) N: CUSTOMER |                                                    |                    |                                                                                                        |                                                 |                                               |      |                          |     |   |                                                                                                                      |
|                                                                                   |                                                                                                          | INDICATE 'P' PERFORM 'W' WITNESS AND 'V' VERIFICATION AS APPROPRIATE " CHP" CUSTOMER SHALL IDENTIFY IN COLUMN"N" |                                                             |                                                    |                    |                                                                                                        |                                                 |                                               |      |                          |     |   |                                                                                                                      |
| SIGNATURE                                                                         |                                                                                                          |                                                                                                                  |                                                             |                                                    |                    | REVIEWED BY                                                                                            |                                                 | NAME & SIGN OF APPROVING AUTHORITY &SEAL      |      |                          |     |   |                                                                                                                      |
| 2.3*                                                                              | WELD SET UPS                                                                                             | DIMENSIONS                                                                                                       | MA                                                          | MEAS. , VISUAL                                     | 100%               | WPS, APPD. DRG.                                                                                        | WPS, APPD. DRG.                                 | INSPN. REPORT                                 |      | P                        | V   |   |                                                                                                                      |
| 2.4*                                                                              | WELDMENTS –FINAL RUN                                                                                     | SURFACE DEFECTS                                                                                                  | MA                                                          | PT                                                 | 100%               | IS:3658 / ASTM E:165                                                                                   | ASME SEC. VIII DIV. I                           | INSPN. REPORT                                 | √    | P                        | V   | V |                                                                                                                      |
|                                                                                   |                                                                                                          |                                                                                                                  |                                                             |                                                    |                    |                                                                                                        |                                                 |                                               |      |                          |     |   |                                                                                                                      |

|                                                                                   |                                                                              |                                                                                                                                                                                                          |                                                                                                                     |                                          |                          |                                                                                              |                                                                      |                                          |                       |                          |    |    |                                                                                        |
|-----------------------------------------------------------------------------------|------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------|------------------------------------------|--------------------------|----------------------------------------------------------------------------------------------|----------------------------------------------------------------------|------------------------------------------|-----------------------|--------------------------|----|----|----------------------------------------------------------------------------------------|
|  |                                                                              | MANUFACTURERS NAME & ADDRESS                                                                                                                                                                             |                                                                                                                     | STANDARD QUALITY PLAN                    |                          |                                                                                              | PROJECT                                                              |                                          | 5X800 MW YADRADRI TPS |                          |    |    |                                                                                        |
|                                                                                   |                                                                              | AS PER APPROVED VENDOR LIST                                                                                                                                                                              |                                                                                                                     | ITEM:                                    | ELECTRIC<br>WIRE<br>ROPE | QP NO                                                                                        |                                                                      | PACKAGE                                  |                       | WIRE ROPE ELECTRIC HOIST |    |    |                                                                                        |
|                                                                                   |                                                                              |                                                                                                                                                                                                          |                                                                                                                     | REV                                      |                          | 0                                                                                            | CONTRACT No                                                          |                                          |                       |                          |    |    |                                                                                        |
|                                                                                   |                                                                              |                                                                                                                                                                                                          |                                                                                                                     | DATE                                     |                          |                                                                                              | CONTRACTOR                                                           |                                          | BHEL                  |                          |    |    |                                                                                        |
|                                                                                   |                                                                              |                                                                                                                                                                                                          |                                                                                                                     | PAGE                                     |                          | 1 of 4                                                                                       |                                                                      |                                          |                       |                          |    |    |                                                                                        |
| SL.No                                                                             | COMPONENT & OPERATIONS                                                       | CHARACTERISTICS                                                                                                                                                                                          | CATEGORY                                                                                                            | TYPE OF CHECK                            | EXTENT<br>OF CHECK       | REFERENCE DOCUMENT                                                                           | ACCEPTANCE<br>NORMS                                                  | FORMAT OF<br>RECORD                      | D*                    | M                        | C  | N  | REMARKS                                                                                |
| 1                                                                                 | 2                                                                            | 3                                                                                                                                                                                                        | 4                                                                                                                   | 5                                        | 6                        | 7                                                                                            | 8                                                                    | 9                                        | 10                    | 11                       | 12 | 13 | 14                                                                                     |
| 2.5                                                                               | TRUNION / TROLLEY<br>WHEELS, GEARS PINION                                    | SURFACE & INTERNAL<br>FLAWS (FOR DIA. /<br>THICKNESS >50MM)                                                                                                                                              | MA                                                                                                                  | PT / UT                                  | 100%                     | ASTME:165                                                                                    | NO LINEAR<br>DEFECTS / NOTE-<br>4                                    | INSPN.<br>REPORT                         | ✓                     | P                        | W  | V  |                                                                                        |
| 2.6                                                                               | NDT OF LOAD BEARING<br>BUTT WELDS (IF ANY)                                   | WELD QUALITY OF<br>a)Butt weld on tension 100%<br>RT and 100% DPT<br>b)Butt weld oncompression<br>10% RT and 100% DPT<br>c)Butt weld on rope drum<br>100% RT and 100% DPT d)<br>Fillet weld - Random 10% | CR                                                                                                                  | PT & RT                                  | 100%                     | ASME SEC. VIII DIV. I                                                                        | ASME SEC. VIII<br>DIV. 4. CLUW-51<br>FOR RT<br>APPENDIX -8 FOR<br>PT | INSPN.<br>REPORT ND<br>FILM              | ✓                     | P                        | V  | V  | FILMS TO BE REVIEWED<br>BY BHEL & Customer. DPT<br>SHALL BE CHP FOR<br>Customer & BHEL |
| 2.7                                                                               | GEAR BOXES                                                                   |                                                                                                                                                                                                          |                                                                                                                     |                                          |                          |                                                                                              |                                                                      |                                          |                       |                          |    |    |                                                                                        |
|                                                                                   | COMPLETE ASSEMBLY                                                            | OVERALL DIMENSIONS                                                                                                                                                                                       | MA                                                                                                                  | MEAS.                                    | 100%                     | MFG. DRG.                                                                                    | MFG. DRG.                                                            | INSPN.<br>REPORT                         | ✓                     | P                        | V  |    |                                                                                        |
|                                                                                   | Gear shall be checked for<br>reduction ratio, backlash &<br>contact pattern. | CHECK FOR OIL LEAKAGE,<br>VIBRATION, NOISE TEMP.<br>RISE                                                                                                                                                 | MA                                                                                                                  | NO LOAD<br>RUNNING FOR<br>TWO HOURS      | 100%                     | MFG. DRG.                                                                                    | MFG. STD.                                                            | - DO -                                   | ✓                     | P                        | V  | V  |                                                                                        |
| 2.8                                                                               | ELECTRICALS                                                                  |                                                                                                                                                                                                          |                                                                                                                     |                                          |                          |                                                                                              |                                                                      |                                          |                       |                          |    |    |                                                                                        |
| 1                                                                                 | MOTORS                                                                       | TYPE TESTS ( INCLUDING<br>DEGREE OF PROTECTION)                                                                                                                                                          | MA                                                                                                                  | TYPE<br>TESTS                            | 1 / TYPE,<br>100%        | IS:3938                                                                                      | IS:3938                                                              | MFRS' TEST<br>CERT., INSPN<br>REPORT     | ✓                     | P                        | V  | V  |                                                                                        |
|                                                                                   |                                                                              | ROUTINE TESTS                                                                                                                                                                                            |                                                                                                                     | ROUTINE TESTS                            | 100%                     | IS 325                                                                                       | IS 325                                                               | DO                                       | ✓                     | P                        | V  | V  |                                                                                        |
| 2                                                                                 | RESISTANCES (IF<br>APPLICABLE)                                               | TEMPERATURE RISE                                                                                                                                                                                         | MA                                                                                                                  | VERTIFICATION<br>OF MNFRS' TEST<br>CERT. | 100%                     | IS:3938, RELV. ISS                                                                           | IS:3938, RELV.<br>ISS                                                | MFRS' TEST<br>CERT.                      | ✓                     | P                        | V  | V  |                                                                                        |
| 3                                                                                 | CONTROLLER, LIMIT<br>SWITCHES (IF APPLICABLE)                                | ROUTINE TESTS                                                                                                                                                                                            | MA                                                                                                                  | ROUTINE TEST                             | 100%                     | IS:6975/TECH. SPEC.,                                                                         | IS:6875/TECH.<br>SPEC.,                                              | MFRS' TEST<br>CERT.                      | ✓                     | P                        | V  | V  | Rating and make to be<br>verified.                                                     |
| 4                                                                                 | BRAKES                                                                       | ROUTINE TESTS                                                                                                                                                                                            | MA                                                                                                                  | ROUTINE TEST                             | 100%                     | TECH. SPEC. / IS:15560                                                                       | IS:3938/TECH.<br>SPEC.                                               | MFRS' TEST<br>CERT.                      | ✓                     | P                        | V  | V  |                                                                                        |
| 5                                                                                 | BRAKE DRUM (IF<br>APPLICABLE)                                                | VERIFICATION OF HT<br>CHARTS, HARDNESS (IF<br>APPLICABLE)                                                                                                                                                | MA                                                                                                                  | VISUAL,<br>HARDNESS TEST                 | 100%                     | APPD. DRGS./TECH. SPC.                                                                       | APPD.<br>DRGS./TECH.<br>SPEC.                                        | HT. CHART<br>/INSPN.<br>REPORT           | ✓                     | P                        | V  | V  |                                                                                        |
| 6                                                                                 | CONTACTOR                                                                    | ROUTINE TESTS                                                                                                                                                                                            | MA                                                                                                                  | ROUTINE TEST                             | 100%                     | IS:2959 AND TECH. SPEC.,<br>IS:6547 / IS:3938                                                | IS:2959 AND<br>TECH. SPEC.,<br>IS:6547 / IS:3933                     | INSPN.<br>REPORT                         | ✓                     | P                        | V  | V  | Rating and make to be<br>verified.                                                     |
| 7                                                                                 | CONTROL PANEL, PENDANT<br>SWITCH                                             | * FIXING OF<br>COMPONENTS WIRING<br>MARKING CONTINUITY<br>* FUNCTIONAL TEST<br>* IR & H.V. TEST<br>* IP - PROTECTION TEST<br>* PAINT SHADE,<br>THICKNESS, SHEET                                          | MA                                                                                                                  | VISUAL                                   | 100%                     | APPD.DRG. WIRING<br>DIAGRAM,                                                                 | APPD. DRG.<br>WIRING<br>DIAGRAM,                                     | INSPN.<br>REPORT                         | ✓                     | P                        | V  | V  | BOUGHT OUT ITEMS AS<br>PER BHEL / CUSTOMER<br>APPROVAL LIST                            |
|                                                                                   |                                                                              |                                                                                                                                                                                                          | LEGNDS                                                                                                              |                                          |                          |                                                                                              |                                                                      |                                          |                       |                          |    |    |                                                                                        |
|                                                                                   |                                                                              |                                                                                                                                                                                                          | * RECORDS IDENTIFIED WITH 'TICK'( ✓ ) SHALL BE ESSENTIALLY<br>INCLUDED BY CONTRACTOR IN QA DOCUMENTATION            |                                          |                          |                                                                                              |                                                                      |                                          |                       |                          |    |    |                                                                                        |
|                                                                                   |                                                                              |                                                                                                                                                                                                          | ** M: MANUFACTURER/SUBCONTRACTOR                                                                                    |                                          |                          |                                                                                              |                                                                      |                                          |                       |                          |    |    |                                                                                        |
| MANUFACTURER/ SUB<br>CONTRACTOR                                                   |                                                                              | CONTRACTOR                                                                                                                                                                                               | C: CONTRACTOR NOMINATED INSPECTION AGENCY(BHEL) N: CUSTOMER                                                         |                                          |                          |                                                                                              |                                                                      |                                          |                       |                          |    |    |                                                                                        |
|                                                                                   |                                                                              |                                                                                                                                                                                                          | INDICATE 'P' PERFORM 'W' WITNESS AND 'V' VERIFICATION AS<br>APPROPRIATE " CHP" CUSTOMER SHALL IDENTIFY IN COLUMN"N" |                                          |                          |                                                                                              |                                                                      |                                          |                       |                          |    |    |                                                                                        |
| SIGNATURE                                                                         |                                                                              |                                                                                                                                                                                                          |                                                                                                                     |                                          |                          |                                                                                              | REVIEWED BY                                                          | NAME & SIGN OF APPROVING AUTHORITY &SEAL |                       |                          |    |    |                                                                                        |
| 8                                                                                 | CABLES                                                                       | TYPE AND ROUTINE TESTS                                                                                                                                                                                   | MA                                                                                                                  | TYPE & ROUTINE<br>TESTS                  | 100%                     | AS PER TECH. SPEC.<br>IS:1554/IS:9968- PART - I /<br>IS:694 / RELEVANT IS FOR<br>EELS CABLES | AS PER TECH.<br>SPEC.<br>IS:1554/IS:9968-<br>PART - I / IS:694       | MNFRS' TEST<br>CERT.                     | Ö                     | P                        | V  | V  |                                                                                        |

|                                                                                   |                                                                                                                                                                                                                                                             |                                                                                                                                                                                    |                                                                                                                  |                                |                          |                                    |                                    |                                           |      |                          |    |   |         |
|-----------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------|--------------------------------|--------------------------|------------------------------------|------------------------------------|-------------------------------------------|------|--------------------------|----|---|---------|
|  |                                                                                                                                                                                                                                                             | MANUFACTURERS NAME & ADDRESS                                                                                                                                                       |                                                                                                                  | STANDARD QUALITY PLAN          |                          |                                    |                                    | PROJECT                                   |      | 5X800 MW YADRADRI TPS    |    |   |         |
|                                                                                   |                                                                                                                                                                                                                                                             | AS PER APPROVED VENDOR LIST                                                                                                                                                        |                                                                                                                  | ITEM:                          | ELECTRIC<br>WIRE<br>ROPE | QP NO                              |                                    | PACKAGE                                   |      | WIRE ROPE ELECTRIC HOIST |    |   |         |
|                                                                                   |                                                                                                                                                                                                                                                             |                                                                                                                                                                                    |                                                                                                                  | REV                            |                          | 0                                  | CONTRACT No                        |                                           |      |                          |    |   |         |
|                                                                                   |                                                                                                                                                                                                                                                             |                                                                                                                                                                                    |                                                                                                                  | DATE                           |                          |                                    | CONTRACTOR                         |                                           | BHEL |                          |    |   |         |
|                                                                                   |                                                                                                                                                                                                                                                             |                                                                                                                                                                                    |                                                                                                                  | PAGE                           |                          | 1 of 4                             |                                    |                                           |      |                          |    |   |         |
| SL.No                                                                             | COMPONENT & OPERATIONS                                                                                                                                                                                                                                      | CHARACTERISTICS                                                                                                                                                                    | CATEGORY                                                                                                         | TYPE OF CHECK                  | EXTENT OF CHECK          | REFERENCE DOCUMENT                 | ACCEPTANCE NORMS                   | FORMAT OF RECORD                          | D*   | M                        | C  | N | REMARKS |
| 1                                                                                 | 2                                                                                                                                                                                                                                                           | 3                                                                                                                                                                                  | 4                                                                                                                | 5                              | 6                        | 7                                  | 8                                  | 9                                         |      | **                       | 10 |   | 11      |
| 3.0                                                                               | FINAL INSPECTION                                                                                                                                                                                                                                            |                                                                                                                                                                                    |                                                                                                                  |                                |                          |                                    |                                    |                                           |      |                          |    |   |         |
| 3.1                                                                               | COMPLETELY ASSEMBLED HOIST                                                                                                                                                                                                                                  | 1. COMPLETENESS, CORRECTNESS, OVERALL DIMENSIONS.                                                                                                                                  | MA                                                                                                               | VISUAL, MEAS                   | 100%                     | APPD. DRG.                         | APPD. DRG.                         | MNFRS' TEST CERT.                         | √    | P                        | W  | V |         |
| 3.2                                                                               | ASSEMBLED HOIST PERFORMANCE                                                                                                                                                                                                                                 | 1. LOAD TEST                                                                                                                                                                       | CR                                                                                                               | LOAD TEST at SWL               | 100%                     | IS:6547 / IS:3938                  | IS:6547 / IS:3938                  | MNFRS' TEST CERT.                         | √    | P                        | W  | V |         |
|                                                                                   |                                                                                                                                                                                                                                                             | 2. HOISTING & LOWERING SPEED, PERFORMANCE OF CONTROLLERS SWITCHES CONTRACTORS, RELAYS AND OTHER CONTROL DEVICES CORRELATIONS OF CIRCUITS AND INTERLOCKS AND SEQUENCES OF OPERATION | CR                                                                                                               | MEAS & VISUAL                  | 100%                     | IS:6547 / IS:3938, TECH SPEC.      | TECH SPEC.                         | MNFRS' TEST CERT.                         | √    | P                        | W  | V |         |
|                                                                                   |                                                                                                                                                                                                                                                             | 3. OPERATION OF ALL PROTECTIVE DEVICES                                                                                                                                             | CR                                                                                                               | VISUAL                         | 100%                     | TECH SPEC                          | TECH SPEC.                         | MNFRS' TEST CERT.                         | √    | P                        | W  | V |         |
| 3.3                                                                               | OVER LOAD TEST                                                                                                                                                                                                                                              | 1. OVER LOAD                                                                                                                                                                       | CR                                                                                                               | TEST AT 125 % OF-SWL           | 100%                     | IS:6547/IS:3938                    | IS:6547/IS:3938                    | INSPN. REPORT                             | √    | P                        | W  | V |         |
| 4                                                                                 | PAINTING                                                                                                                                                                                                                                                    |                                                                                                                                                                                    |                                                                                                                  |                                |                          |                                    |                                    |                                           |      |                          |    |   |         |
| 1                                                                                 | PRIMER & FINISHING AND SHADE                                                                                                                                                                                                                                | 1. TO RELEVANT IS                                                                                                                                                                  | MI                                                                                                               | CORRECTNESS OF MFG. TEST CERT. | EACH CONSIGNMENT         | DRG. & DATA SHEET & RELV. IS SPEC. | DRG. & DATA SHEET & RELV. IS SPEC. | MNFRS' TEST CERT.                         |      | P                        | V  |   |         |
|                                                                                   |                                                                                                                                                                                                                                                             |                                                                                                                                                                                    |                                                                                                                  |                                |                          |                                    |                                    |                                           |      |                          |    |   |         |
|                                                                                   |                                                                                                                                                                                                                                                             |                                                                                                                                                                                    |                                                                                                                  |                                |                          |                                    |                                    |                                           |      |                          |    |   |         |
|                                                                                   | NOTE:                                                                                                                                                                                                                                                       |                                                                                                                                                                                    |                                                                                                                  |                                |                          |                                    |                                    |                                           |      |                          |    |   |         |
|                                                                                   | * 1.0 Clause from 2.1 to 2.4 shall be applicable for load bearing welded joints.                                                                                                                                                                            |                                                                                                                                                                                    |                                                                                                                  |                                |                          |                                    |                                    |                                           |      |                          |    |   |         |
|                                                                                   | 2.0 Back Wall Echo shall be adjusted to 100% of Full Screen Height in sound (Defect Free) Area. Defect Echo Height more than 20% of Screen Height shall be treated as unacceptable. Back Wall Echo shall not be less than 80% of Screen Height in any case. |                                                                                                                                                                                    |                                                                                                                  |                                |                          |                                    |                                    |                                           |      |                          |    |   |         |
|                                                                                   |                                                                                                                                                                                                                                                             |                                                                                                                                                                                    |                                                                                                                  |                                |                          |                                    |                                    |                                           |      |                          |    |   |         |
|                                                                                   |                                                                                                                                                                                                                                                             |                                                                                                                                                                                    | LEGND                                                                                                            |                                |                          |                                    |                                    |                                           |      |                          |    |   |         |
|                                                                                   |                                                                                                                                                                                                                                                             |                                                                                                                                                                                    | * RECORDS IDENTIFIED WITH 'TICK' (√) SHALL BE ESSENTIALLY INCLUDED BY CONTRACTOR IN QA DOCUMENTATION             |                                |                          |                                    |                                    |                                           |      |                          |    |   |         |
|                                                                                   |                                                                                                                                                                                                                                                             |                                                                                                                                                                                    | ** M: MANUFACTURER/SUBCONTRACTOR                                                                                 |                                |                          |                                    |                                    |                                           |      |                          |    |   |         |
| MANUFACTURER/ SUB CONTRACTOR                                                      |                                                                                                                                                                                                                                                             | CONTRACTOR                                                                                                                                                                         | C: CONTRACTOR NOMINATED INSPECTION AGENCY(BHEL) N: CUSTOMER                                                      |                                |                          |                                    |                                    |                                           |      |                          |    |   |         |
| SIGNATURE                                                                         |                                                                                                                                                                                                                                                             |                                                                                                                                                                                    | INDICATE 'P' PERFORM 'W' WITNESS AND 'V' VERIFICATION AS APPROPRIATE "CHP" CUSTOMER SHALL IDENTIFY IN COLUMN "N" |                                |                          |                                    | REVIEWED BY                        | NAME & SIGN OF APPROVING AUTHORITY & SEAL |      |                          |    |   |         |

|  |                                 |                                                                                                                                                           |                                                                                                         |
|--|---------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------|
|  | MANUFACTURER'S NAME & ADDRESS : | <b><u>MANUFACTURING QUALITY PLAN</u></b><br><b>ITEM : Chain Pulley Block</b><br><b>QP No.: PE-TS-417-155-A001</b><br><b>REV.:0, Date.: , PAGE: 1 OF 4</b> | <b>PROJECT : 5X800 MW YADRADRI TPS</b><br><b>PACKAGE : CHAIN PULLEY BLOCKS</b><br><b>VOL IIB, SEC C</b> |
|--|---------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------|

| Sr. No. | COMPONENT / OPERATION | CHARACTERISTICS | CLASS | TYPE OF CHECK | QUANTU M OF CHECK | REFERENCE DOCUMENT | ACCEPTANCE NORMS | FORMAT OF RECORD | AGENCY |   |   | REMARKS |
|---------|-----------------------|-----------------|-------|---------------|-------------------|--------------------|------------------|------------------|--------|---|---|---------|
|         |                       |                 |       |               |                   |                    |                  |                  | M      | C | N |         |
|         |                       |                 |       |               |                   |                    |                  |                  | 10.    |   |   |         |
| 1.      | 2.                    | 3.              | 4.    | 5.            | 6.                | 7.                 | 8.               | 9.               |        |   |   | 11.     |

|     |                                                  |                                                       |    |               |                    |                                                 |                               |      |   |   |   |   |                                        |
|-----|--------------------------------------------------|-------------------------------------------------------|----|---------------|--------------------|-------------------------------------------------|-------------------------------|------|---|---|---|---|----------------------------------------|
| 1   | RAW MATERIAL & B/OUT ITEMS:                      |                                                       |    |               |                    |                                                 |                               |      |   |   |   |   |                                        |
| 1.1 | HOOKS                                            | DIMENSIONS,                                           | MA |               | One sample         | IS: 15560                                       | IS: 15560                     | MTC  | ✓ | P | V | V | UT FOR SHANK DIA 50MM AND ABOVE        |
|     |                                                  | CHEMICAL COMPOSITION, MECHANICAL, PHYSICAL PROPERTIES | MA | LAB ANALYSIS  | PER LOT            | Material specification as per approved drawings |                               | T.C. | ✓ | P | V | V |                                        |
|     |                                                  | IDENTIFICATION & COMPLIANCE WITH TC.                  | MA | VISUAL        | 100%               | HOOK TC FROM COMPETENT AUTHORITY                |                               | IR   | ✓ | P | V | V |                                        |
|     |                                                  | INTERNAL DEFECTS                                      | MA | UT            | 100%               | ASTM A-388 (REFER NOTE 1)                       |                               | TC   | ✓ | P | V | V |                                        |
|     |                                                  | PROOF LOAD TEST                                       | MA | REVIEW        | 100%               | IS 15560                                        |                               | TC   | ✓ | P | V | V |                                        |
|     |                                                  | NDT AFTER PROOF LOAD                                  | MA | DPT           | 100%               | ASTM E-165                                      | NO RELEVANT IDENTIFICATION    | TC   | ✓ | P | V | V |                                        |
| 1.2 | LOAD CHAIN                                       | - DIMENSIONS                                          | MA | MEASUREMENT   | 100 %              | IS: 6216 & APPD. DRGS.                          | IS: 6216 & APPD. DRGS.        | IR   | ✓ | P | V | V |                                        |
|     |                                                  | - BREAKING STRENGTH                                   | MA | -TENSILE TEST | 1/LOT              |                                                 |                               | MTC  | ✓ | P | V | V |                                        |
|     |                                                  | - PROOF LOAD                                          | MA | -TENSILE TEST | 100%               |                                                 |                               | MTC  | ✓ | P | V | V |                                        |
|     |                                                  | -HEAT TREATMENT                                       | MA | REVIEW        | 100%               |                                                 |                               | HT   | ✓ | P | V | V |                                        |
|     |                                                  | -GRADE                                                | MA | REVIEW        | 1/BATCH            |                                                 |                               | CHA  | ✓ | P | V | V |                                        |
|     |                                                  |                                                       |    |               |                    |                                                 |                               | RT   | ✓ | P | V | V |                                        |
| 1.3 | RAW MATL. FOR GEAR/ RATCHET PAWL / RATCHET WHEEL | CHEMICAL COMPOSITION, MECHANICAL PROPERTIES           | MA | LAB ANALYSIS  | ONE SAMPLE PER LOT | MATERIAL SPECIFICATION AS PER                   | MATERIAL SPECIFICATION AS PER | MTC  | ✓ | P | V | V | TC or inspection report for components |

|                           |                                                                                                                                                                                      |                  |                                           |
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|                           | LEGEND:                                                                                                                                                                              | FOR CUSTOMER USE |                                           |
| MANUFACTURER / CONTRACTOR | <b>** M : MANUFACTURER / SUB-CONTRACTOR</b><br><b>C : BHEL / NOMINATED INSPECTION AGENCY.</b><br><b>N : CUSTOMER</b><br><b>INDICATE "P" PERFORM "W" WITNESS AND "V" VERIFICATION</b> |                  |                                           |
| SUB-CONTRACTOR            |                                                                                                                                                                                      |                  |                                           |
| SIGNATURE                 |                                                                                                                                                                                      | REVIEWED BY      | NAME & SIGN OF APPROVING AUTHORITY & SEAL |

|  |                                 |                                                                                                                                                          |                                                                                                         |
|--|---------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------|
|  | MANUFACTURER'S NAME & ADDRESS : | <b><u>MANUFACTURING QUALITY PLAN</u></b><br><b>ITEM : Chain Pulley Block</b><br><b>QP No.: PE-TS-417-155-A001</b><br><b>REV.:0, Date.:, PAGE: 2 OF 4</b> | <b>PROJECT : 5X800 MW YADRADRI TPS</b><br><b>PACKAGE : CHAIN PULLEY BLOCKS</b><br><b>VOL IIB, SEC C</b> |
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| Sr. No. | COMPONENT / OPERATION | CHARACTERISTICS | CLASS | TYPE OF CHECK | QUANTUM OF CHECK | REFERENCE DOCUMENT | ACCEPTANCE NORMS | FORMAT OF RECORD | AGENCY |   |   | REMARKS |
|---------|-----------------------|-----------------|-------|---------------|------------------|--------------------|------------------|------------------|--------|---|---|---------|
|         |                       |                 |       |               |                  |                    |                  |                  | M      | C | N |         |
|         |                       |                 |       |               |                  |                    |                  |                  | 10.    |   |   |         |
| 1.      | 2.                    | 3.              | 4.    | 5.            | 6.               | 7.                 | 8.               | 9.               |        |   |   | 11.     |

|      |                                       |                                                 |          |                                   |                    |                           |                           |        |   |   |   |   |                 |
|------|---------------------------------------|-------------------------------------------------|----------|-----------------------------------|--------------------|---------------------------|---------------------------|--------|---|---|---|---|-----------------|
|      |                                       |                                                 |          |                                   |                    | APPROVED DRAWING          | APPROVED DRAWING          |        |   |   |   |   | shall be given. |
|      |                                       | INTERNAL DEFECTS                                | MA       | UT                                | 10%                | ASTM A-388 (REFER NOTE 1) |                           | IR     | ✓ | P | V | V |                 |
| 1.4. | LOAD CHAIN WHEELS                     | - CHEMICAL COMPOSITION<br>MECHANICAL PROPERTIES | MA<br>MA | CHEMICAL<br>MECHANICAL PROPERTIES | ONE SAMPLE PER LOT | APPD. DRG.                | APPD. DRG.                | MTC    | ✓ | P | V | V |                 |
| 1.5  | BEARINGS                              | MAKE, TYPE, CATALOGUE NO.                       | MA       | VISUAL                            | RANDOM             | APP DRG / MFR'S CATALOGUE | APP DRG / MFR'S CATALOGUE | IR     | ✓ | P | V | V |                 |
| 1.6  | HAND CHAIN WHEEL                      | CHEMICAL<br>MECHANICAL PROPERTIES               | MA       | CHEMICAL<br>MECHANICAL PROPERTIES | ONE SAMPLE PER LOT | AS PER DRAWING            | AS PER DRAWING            | MTC    | ✓ | P | V | V |                 |
| 1.7  | HAND CHAIN                            | GRADE/ DIMENSION                                | MA       | GRADE<br>DIMENSION                | 100 %              | AS PER DRAWING            | AS PER DRAWING            | MTC    | ✓ | P | V | V |                 |
| 1.8  | TROLLEY GEARS,<br>PINION,WHEELS, AXLE | CHEMICAL & MECHANICAL                           | MA       | LAB ANALYSIS,                     | 100%               | APPVD DRGS                | APPVD DRGS                | IR/T C | ✓ | P | V | V |                 |
| 2    | <b><u>IN PROCESS</u></b>              |                                                 |          |                                   |                    |                           |                           |        |   |   |   |   |                 |
| 2.1  | RATCHET PAWL /<br>RATCHET WHEEL       | -HARDNESS                                       | MA       | HARDNESS                          | 100%               | IS:3832 / APPD DRG.       | IS:3832/<br>APPD. DRG.    | IR     | ✓ | P | V | V |                 |

|                           |                                                                                                                                                                                      |                  |                                           |
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|                           | LEGEND:                                                                                                                                                                              | FOR CUSTOMER USE |                                           |
| MANUFACTURER / CONTRACTOR | <b>** M : MANUFACTURER / SUB-CONTRACTOR</b><br><b>C : BHEL / NOMINATED INSPECTION AGENCY.</b><br><b>N : CUSTOMER</b><br><b>INDICATE "P" PERFORM "W" WITNESS AND "V" VERIFICATION</b> |                  |                                           |
| SUB-CONTRACTOR            |                                                                                                                                                                                      |                  |                                           |
| SIGNATURE                 |                                                                                                                                                                                      | REVIEWED BY      | NAME & SIGN OF APPROVING AUTHORITY & SEAL |