THE SINGARENI COLLIERIES COMPANY LTD

(A Government Company)

SINGARENI THERMAL POWER PROJECT STAGE-II (1 X 800 MW)

TECHNICAL SPECIFICATION

FOR

EPC PACKAGE

PART – B

(BOOK 5 OF 5 :QUALITY ASSURANCE)

SECTION - VI

BIDDING DOCUMENT NO.: CW-CM-11159-C-O-M-001

PART – B
QA SPECIFICATION

SUB-SECTION– E-00
INTRODUCTION TO QUALITY ASSURANCE SPECIFICATION

Introduction to the Quality assurance specification

For fulfilment of the relevant clauses (Test and inspection) of the General Conditions of Contract and General Technical Requirements of Contract, the Quality Assurance Specification acts as a part of the Technical Specification and is included in the Contract.

This part of the Technical Specification shall be read in conjunction with other parts of the technical specifications, General Technical Requirements and Erection Conditions of the Contract.

This document specifies the quality requirements, to be detailed in terms of Tests/Checks/Procedures at the times of manufacturing, Testing, Inspection and also during installation of various Equipment / Components at the place of manufacturer and / or on the site.

Various standards referred in this document shall be the latest revisions.

The quality requirements are spelt out in the following ways;

1) Through description

2) In the form of tables

In either of the above two forms the test /checks / procedures are mentioned against particular item/ equipment/ component/ system etc.

This specification also contains the Indicative vendor list (with disclaimer) mentioned against particular item/ equipment/ component/ system etc.

The quality requirements specified in this document and also the vendor list are only indicative and not exhaustive.

SUB-SECTION– E-01
STEAM GENERATOR AND AUXILIARIES

STEAM GENERATOR AND AUXILIARIES

1.00.00 SHOP TESTS FOR STEAM GENERATOR

1.01.00 Pressure parts

The material which can be identified against mill sheet or manufacturer test certificate only shall be used in the manufacture of pressure parts. Material shall meet all the mandatory requirements (and supplementary checks if asked for) of specified specification.

All Plates above 40mm & all bar stock / forgings above 40 mm dia shall be ultrasonically tested. For pressure parts, plates of thickness equal to or above 25 mm shall be ultrasonically tested. Each plate shall be subjected to a 100% normal ultrasonic at the mill to meet the minimum requirements of EN 10160:1999 / equivalent ASTM standards

1.01.01 Drum / Separator/ Storage Tank

(a) Each plate shall be subjected to a 100% normal ultrasonic at the mill to meet the minimum requirements of EN 10160:1999 / equivalent ASTM standards. Elevated temperature tensile tests shall also be carried out on plate material for each heat.

(b) After cutting to size and removal of cut outs, the plates shall be subjected to magnetic particle test along the edges of the plate and on areas adjacent to the cut outs.

(c) All forged connections shall be examined by 100% UT before machining.

(d) Fully machined connecting pieces of internal diameter 100 mm and above, shall be subjected to magnetic particle examination / liquid penetrant examination

(e) Mechanical tests shall be carried out on specimens prepared from the production control test plates of the longitudinal welds.

(f) Mechanical tests shall be conducted on the specimens from manhole cutouts of dished ends.

(g) On completion of welding, the entire Drum / Separator / Storage Tank shall be subjected to stress relieving in the furnace.

(h) All butt welds shall be subjected to 100% ultrasonic testing/radiography/PAUT+TOFD and magnetic particle examination after stress relief.

(i) All full penetration welds shall be subjected to ultrasonic examination after stress relief.

(j) After stress relieving (SR) all welds, internal and external shall be examined by MPI methods depending on size and accessibility and all butt welds shall be subjected to 100% radiography.

(k) All connecting tubes & pipes shall be subjected to UT prior to fabrication as per BS 3602 or equivalent with longitudinal calibration notch of depth 5% of wall thickness (0.3 mm min. and 1.5 mm max.)

Note: PT can be carried out in inaccessible areas where MPI cannot be done

(l) **Hydraulic Test and Pneumatic Test:**

Complete Drum / Separator/ storage tank/ Mixing Sphere etc. shall be subjected to hydraulic pressure test and all compensating pads to be pneumatically tested.

1.01.02 Headers

(a) Raw material for headers shall be subjected to UT prior to fabrication as per EN10246:7 1996 or equivalent with longitudinal calibration notch of depth 5% of wall thickness (0.3 mm min. and 1.5 mm max.) shall be adhered to.

(b) All butt welds shall be subjected to RT/PAUT+TOFD examination. Also MPI after SR.

(c) All full penetration nozzle and attachment welds shall be subjected to UT prior to stress relieving.

(d) All nozzles, branches, stubs and load bearing attachment shall be examined by MPI techniques after the toes of the weld have been ground smooth and stress relieved.

(e) Non-load bearing welds shall be examined by MPI techniques after the toes of the welds have been ground smooth and stress relieved.

(f) Headers shall be subjected to hydraulic pressure tests and all compensating pads to be pneumatically tested.

(g) All weld joints in alloy steel headers of P 91, X20 and X22 & other material of P15E group and above shall be checked for Hardness. 3% hardness check shall be carried out on welds of other alloy steel Headers.

(h) Boroscopy examination shall be carried out for those header which will be interconnected with other headers by welding.

Note: PT can be carried out in inaccessible areas where MPI cannot be done

1.01.03 Tubes & Tube Elements

(a) Raw material of pipes/ tubes for water wall, superheater, reheater, Economizer, riser, supply and connecting tubes including nozzle/stubs, connections for drum, headers, Pipe work etc. shall be subjected to 100% UT prior to fabrication as per EN10246:7 1996 or equivalent with longitudinal calibration notch of depth 5% of wall thickness (0.3 mm min. and 1.5mm max.) shall be adhered to.

(b) All bent tubes/stubs shall be checked for ovality and thinning by ultrasonic method on first off and random checks on subsequent pieces. Critical bends, where PWHT is required after bending, shall be subjected to LPI/MPI. For FOT area reduction shall be calculated

(c) All tubes/panels/coils shall be checked for clearance by steel ball test and for cleanliness by sponge passage.

(d) i) SHOP WELDS: Finished butt welds shall be subjected to RT or UT. Wherever the code/standard/process specifies random sampling, the same shall be minimum 20%.

(ii) FIELD WELDS: a) Finished butt welds shall be subjected to RT or UT. Wherever the code/standard/process specifies random sampling, the same shall be minimum 20%. b) Finished butt welds not covered under random sampling for RT/UT, referred above at point(a) shall be subjected to RT or UT or PAUT.

(e) Minimum 10 % of the fillet joints shall be subjected to MPI/ LPI.

However, Fillet welds of material grades P15E and above or any other new material grade subject to the acceptance by NTPC shall be subjected to 100% MPI / LPI.

(f) Tubes and fabricated panels/coils shall be subjected to hydraulic pressure test including water wall panels, burner panels, preheaters, super heaters & economizers.

(g) 10% hardness survey on butt welds of P15E material group and above. 10% Hardness checks shall also be carried out on welds of T23 material grade. 3% Hardness checks shall also be carried out on welds of T22 material grade used in water wall panels.

(h) In case of RT of tube welds with DWDI (elliptical view) number of exposure shall be as per relevant code / plant standard and will not be less than two exposures for each weld wherever there is no limitation in carrying out two RT shots.

(i) Panel /Coils:

In case of spiral water wall design, trial assembly of complete wall of each side including hopper shall be carried out.

1.01.04 Boiler Piping

(a) All raw materials used shall have co-related mill test certificate meeting material specification.

(b) All pipe lengths shall be subjected to 100 % ultrasonic examination as per BS 3602 or equivalent with longitudinal calibration notch of depth 5% of wall thickness (0.3mm min. and 1.5mm max.) shall be adhered to.

(c) All bent pipes shall be checked for ovality and thinning by UT on first off lot & on random samples for subsequent pieces. Outer surface of bends shall be subjected to MPI/LPI.

(d) The edge preparation for shop and site welds in stainless steel /alloy steel shall be subjected to dye penetrant check. Non-destructive examination of welds shall be carried out after post weld heat treatment, if any.

(e) All butt welds in alloy steel piping of P91, X20 and X 22 shall be checked for RT/ UT and MPI after SR. UT shall be of Digital Recordable Type.

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(f) All weld joints in alloy steel piping of P 91, X20 and X22 & other material of P15E group and above shall be checked for Hardness. For PWHT Induction Heating shall be deployed. However PWHT can be done in furnace also. 3% hardness check shall be carried out on welds of other alloy steel piping.

(g) All load bearing attachment welds shall be subjected to MPI after SR.

(h) Non-destructive examination of welds shall be carried out in accordance with the relevant design/manufacturing codes. However, as a minimum, the following requirements shall be met. Further, statutory requirement, wherever applicable, shall also be complied with.

(1) Temperature > 400 Deg, C or pressure exceeding 71 bar.

(i) 100% RT/UT on butt welds and full penetration branch welds.
(ii) 100% MPE.

(2) Temperature > 175 Deg, C upto 400 Deg. C or pressure exceeding 17 bar and upto 71 bar.

(i) 100% RT/UT on butt welds and full penetration branch welds for pipe dia more than 100 NB.

(ii) 10% RT/UT on butt welds and full penetration branch for pipe dia upto 100NB.

(iii) 100% MPE.

(3) For all other pipes not covered above, shall be subjected 100% MPE/ DPT in case of under ground pipes and 10% MPE/DPT in case of piping above the ground. Further, 10% of butt welds of underground piping shall be subjected to RT.

(i) Wherever SR/PWHT is envisaged for alloy steel, above NDTs shall be after SR/PWHT.

1.01.05 Fittings:

(a) Raw material of all forged fitting shall be ultrasonically tested. All mother pipes used for formed fitting shall be ultrasonically tested as per BS 3602 or equivalent with longitudinal calibration notch of depth 5% of wall thickness (0.3mm min. and 1.5mm max.) shall be adhered to.

(b) Fittings shall be subjected to suitable NDT as per applicable standards. However following minimum NDE requirement shall also be applicable / met.

(i) For fittings X20, P-91, P-92 and material group P15E & above

- 100% MPI &
- 10% hardness check &
- For fittings of 200 NB & above 100% UT/RT

(ii) 100% UT/RT for fittings of 200 NB & above for boiler feed discharge, recirculation and spray piping of boiler feed system.

(iii) 100% UT/RT for fittings of all other piping of size OD 508mm & above

1.01.06 Valves:

(a) Pressure retaining parts of valves shall be subjected to (min.) NDT as per Table 1.

(b) Hardened/stellitted valve disc and seat are to be subjected to LPI and hardness check.

(c) Color matching of valve disc/plug and seat shall be carried out to ensure min. 80% contact and no through passage.

(d) Hydraulic pressure test and seat leak test shall be carried out as per ANSI 16.34/ IBR.

(e) Air seat leak test shall be carried out as per applicable Standards/Codes.

(f) Functional testing shall be carried out on each valve to check the following as per the approved valve data sheet
(1) Smooth operation
(2) Valve travel, closing and opening time.
(3) Current drawn by actuators.

(g) Springs for safety valves shall be tested with suitable NDT and for spring rate.

(h) Safety and safety relief valves shall be tested for performance.

(i) All forgings rounds above diameter 40 mm shall be ultrasonically tested.

(j) All critical valve components shall be tested for mechanical and chemical properties.

TABLE-1

Valve size NB in mm	**ANSI Class upto 300**	**ANSI Class above 300 upto 600**	**ANSI Class above 600 below 900**	**ANSI Class 900 & above & below 4500**
Less than 50	Visual	Visual	Visual	MPI
50 & above but below 100	Visual	Visual	MPI	MPI & RT (on 10% of valves on 100% area)
100 & above but less than 300	Visual	MPI	MPI & RT (on 10% of valves on change of section & weld ends)	MPI & RT (on 100% area)
300 and above	MPI	MPI	MPI & RT (on change of sections & weld ends)	MPI, RT on100% area)

Note:

For body and bonnet forgings, UT with MPI may be adopted in place of RT.
For austenitic steel MPI may be replaced by LPI.

1.01.07 Non Pressure Bearing Attachments

Load bearing welds shall be subjected to examination by ultrasonic testing (UT) and magnetic particle inspection (MPI) techniques after stress relief (SR). No load bearing welds shall be subjected to MPI after stress relief. The toes of the welds adjoining the drum / separator shall be ground smooth prior to stress relieving before carrying out this examination.
Note: LPI can be carried out in inaccessible areas in place of MPI

1.01.08 Steam coil Air Preheater and Fuel Oil Heater

Hydraulic pressure test shall be carried out on the heating coils. All pipes, valves steam traps and mountings shall be subjected to hydraulic test as called for under IBR, BS or other approved codes.

1.01.09 Soot Blowers

(a) Butt weld between nozzle and lance tube shall be subjected to 20 % radiography tests.

(b) Hydraulic test on valve body

(c) Soot blower shall be subjected to operational checks as below:

(1) Smooth operation

(2) Long Tube travel, closing and opening time.

(3) Current drawn.

1.01.10 Steam Generator Startup Drain Recirculation Pump

(a) Raw material for casing, shaft and impeller shall be tested for high temperature physical properties, apart from mandatory & supplementary check of material specification.

(b) All forging and castings shall be subjected to 100% UT/RT and MPI/DP check.

(c) Static and dynamic balancing of the rotary parts shall be carried out.

(d) Hydraulic pressure test shall be conducted on pumps casing at min. 1.5 times the Design Pressure.

(e) Interchangeability shall be maintained and checked.

(f) Each pump shall be subjected to a performance test at the manufacturer's works under as near actual site conditions as possible.

(g) Following test shall be carried out on assembled units: -

Type Test:

i) Tests to establish unit functioning of pump at temp and pressure.

(ii) Hot standstill and start up tests.

Routine Test:

(i) NPSH test

(ii) Temperature rise test.

(iii) Under voltage test.

(iv) Quality assurance proof test.

(v) Hydrostatic test of complete unit.

(vi) Over speed test.

(vii) Tests to determine unit characteristics

(viii) Pump performance.

(ix) Unit run at rated voltage

(x) Starting current at rated voltage.

(xi) Cold start up test.

(xii) Endurance test of motor windings, joints and terminal seals

(xiii) Noise level.

(xiv) Inspection of dismantled unit.

(xv) High voltage test.

(h) For heat exchanger for these pumps, butt welds on pressure parts shall be tested with RT/UT and all other welds shall be tested with MPI/LPI. Hydraulic test shall be carried out both on tube side as well as shell side at min. 1.5 times the design pressure.

1.01.11 Condensate Transfer Pump

a) Static and dynamic balancing of the rotary parts shall be carried out.
b) Hydraulic pressure test shall be conducted on pumps casing at min. 1.5 times the Design Pressure.
c) Each pump shall be subjected to a performance test at the manufacturer's works under as near actual site conditions as possible.

1.01.12 Hydraulic Test

(a) The drum and all components which are to be subjected to fluid pressure shall be tested to minimum of 150% of the design pressure. In determining the value of the maximum attainable pressure for any component the contractor shall take in to account all relevant factors (e.g. safety valve blow off pressure, fluid surges, etc.), which may cause an elevation in the pressure. The contractor shall furnish details of the basis of the calculation of maximum attainable pressure tests. The duration of the pressure tests shall be sufficient, as approved by the Engineer, to show any leakage paths and to permit a through examination of the component whilst under pressure.

(b) The temperature of the fluid used for the pressure test shall be such as to avoid any possibility of brittle fracture at a low temperature and the same to be modified and submitted to the Engineer for approval, before commencing the test.

(c) The fluid used shall be of sufficient purity and where relevant, inhibits to avoid excessive corrosion and /or damage to temporary parts either during the test or prior to drying and cleaning.

1.01.13 Pneumatic Test of Compensating Pads:

All compensating pads shall be provided with two-threaded weep holes to test welds at 0.5 Kg/sq. cm. (g) with soap solution and “no leakage” shall be ensured

1.02.00 ROTATING AND OTHER EQUIPMENTS/ITEMS FOR STEAM GENERATOR

1.02.01 (a) The material which can be identified against mill sheet or manufacturer test certificate only shall be used in the manufacture of pressure parts. Material shall meet all the mandatory requirements (and supplementary checks if asked for) of specified specification.

(b) For sleeve bearing, UT shall be carried out on the babbitting of bearing. Dye penetrant check shall be done on edges.

(c) Blue matching is to be performed between components.

1.02.02 Air Preheater

(a) Forged shafts coming under air preheater like stub shaft, main rotor forging, housing hub shall be subjected to 100% UT at mill and magnetic particle inspection after machining.

(b) For non-modular design trial assembly is to be carried out at shop prior to dispatch to site.

(c) Critical welds of rotor post shall be subjected to radiographic examination.

(d) Sector Plates shall be machined to ensure the proper flatness.

(e) Trail run of Air preheater rotor drive assembly with Gear box, Pinion, Elect motor, air motor needs to be carried out at shop.

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(d) Sector Plates shall be machined to ensure the proper flatness.

(e) Trail run of Air preheater rotor drive assembly with Gear box, Pinion, Elect motor, air motor needs to be carried out at shop.

1.02.03 Fans: Induced Draft, Forced Draft and Primary Air fans and GR fans

(a) Rotor components shall be subjected to ultrasonic test at mill and magnetic particle inspection / liquid penetrant examination after rough machining.

(b) Butt welds in rotor components shall be subjected to 100% RT and all welds shall be magnetic particle/dye penetrant tested after stress relieving.

(c) All rotating components and assemblies of fan shall be balanced dynamically to quality grade 2.5 of ISO 1940.

(d) Full range performance test shall be carried out on one fan of each type and size as per BS 848, Part-1.

(e) Test for Natural Frequency of Fans shall be carried out as given in respective subsection of Technical Requirements of Steam Generator & Auxiliaries.

Fans: Seal air Fan, Scanner air fans

(a) Rotor components i.e. shaft and hub shall be subjected to ultrasonic test at mill and magnetic particle examination after rough machining.

(b) 10% of Butt and fillet welds both in rotor and static components of the fan shall be subjected to MPI / DPT after stress relieving.

(c) Fan impeller shall be balanced dynamically to quality grade 2.5 of ISO 1940.

1.02.04 Coal Mills, PF Piping and Burners

(a) Raw material for shaft, coupling, gears and pinions, top and bottom races and other rotating components shall be subjected to UT. MPI/LPI shall be carried out to check surface soundness.

(b) Wear-resistant parts shall be UT/ RT tested to check soundness after suitable heat treatment. Check for chemical composition, hardness and microstructure shall be carried out. For ceramic materials check for various properties including hardness, density, wear rate and composition shall be carried out.

(c) Butt welds in the tube/ separator /body casing of the mill shall be tested by UT / RT and MPI. All other welds in main tube/separator shall be tested by MPI/LPI for acceptance. The tube shall be statically balanced.

(d) All gearboxes shall be run tested for adequate duration to check rise in oil temperature, noise level and vibration. Check for leak tightness of gear case also shall be performed.

(e) Trail assembly (stacking) of at least one Mill complete with all major components needs to be carried out at shop.

(f) Fabricated pipe welds should be examined by MPI.

(g Ceramic/basalt lined piping/bends shall be checked for proper layout.

(h) Weldments on burner components shall be checked with suitable NDT. The burner assembles shall be tested for operation at shop.

1.02.05 Coal Feeders

(a) Any welds in the casing/ pulley fabrication shall be checked with MPI.

(b) Type tests including degree of protection and routine tests shall be done as per relevant Indian Standards or equivalent International Standards.

(c) All major items like plates for casings, head pulley, tail pulley, Pulley shaft and major castings shall be procured with respective material test certificates.

(d) Leak tightness test shall be done on individual feeder casing. Functional test for load cell shall be carried out.

(e) Test for weighing accuracy, calibration and repeatability shall be carried out at various speeds by a coal flow on one feeder.

(f) Calibration check shall be carried out on all feeder cabinet/ assemblies prior to dispatch.

1.02.06 **Fuel Oil Pumps**

(a) Bar stock/forging above 40 mm diameter shall be subjected to UT. Impeller and rotor shall be dynamically balanced.

(b) Pump assemblies shall be subjected to hydraulic test.

(c) All pumps including spare cartridges shall be subjected to performance test at the manufacturer's works under as near site conditions as possible and strip down examination after the test.

1.02.07 **EOT CRANES**

1.0 HOOKS

1.01 All Tests including Proof Load Test as per relevant IS shall be carried out.

1.02 MPI/DPT shall be carried out after proof load test.

2.0 STEEL CASTING

2.01 DPT on machined surface shall be carried out.

3.0 GIRDERS, END CARRIAGE, CRAB, GEAR BOX AND ROPE DRUM

3.01 The plates of thickness 25mm and above shall be ultrasonically tested.

3.02 NDT requirements on weldments shall be as follows:

(a)	BUTT WELDS IN TENSION	:- 100% RT AND 100% DPT
(b)	BUTT WELDS IN COMPRESSION	:- 10% RT AND 100% DPT
(c)	BUTT WELDS IN ROPE DRUM	:- 100% RT AND 100% DPT
(d)	FILLET WELDS	:- RANDOM 10% DPT

4.0 FORGINGS (wheel, gears, pinions, axle, hooks & hook trunnion)

4.01 All forgings greater than or equal to 50 mm diameter or thickness shall be subjected to Ultrasonic test.

4.02 DPT/MPI shall be done after hard-facing and machining.

5.0 Wire rope shall be tested as per relevant standard.

6.0 Reduction gears shall be tested for reduction ratio, backlash & contact pattern. Gear box shall be subjected to no load run test to check for oil leakage, temperature rise, noise and vibration.

7.0 The cranes shall be completely assembled at shop for final testing. All tests for dimension, deflection, load, overload, hoisting motion, cross travel etc. as per IS-3177 shall be carried out at shop.

8.0 All electric hoists shall be tested as per IS-3938 and chain pulley blocks shall be tested as per IS-3832.

1.02.08 Lube Oil systems/ Hydraulic Power Pack

Lube Oil system/ hydraulic power packs shall be tested for performance.

1.02.09 Fans & pumps which are not mentioned in other clauses above shall be dynamically balanced and functionally tested at Manufacturer's works. Complete performance tests shall be carried out on first pump/fan of each type and capacity to verify its output against total head, power input, efficiency, vibration and noise level. Head/volume, efficiency and power input curves corrected for site conditions shall be furnished.

1.02.10 Dampers

(a) All the dampers shall be subjected to operational test/checks.
(b) Leak tightness of test of Dampers / Gates shall be carried out as given in respective subsection of Technical Requirements of Steam Generator & Auxiliaries.
(c) All dampers shall be checked for sealing dimensions to establish guaranteed tightness.

1.02.11 Steel Structure of Boiler, Mill Bunker building including Coal bunkers, Coal transfer points. Coal conveyor galleries and supporting trestles, Ducts, Hoppers, etc.

(a) Only material which has been identified against mill sheet or test certificates shall be used for construction. All plates above 40mm thickness shall be 100% ultrasonically tested.

(b) Visual inspection of all welds shall be performed in accordance with AWS D.1.1.

(c) NDT requirements of structural steel welds (other than Coal Bunkers) shall be as under:-

(i) 100% RT/UT on butt-welds of plate thickness $\geq$ 32 mm.

(ii) For plates of 25mm < thickness < 32mm - 10% RT/UT and 100% MPI

(iii) For plates of thickness < 25mm - 10% MPI/LPI.

(iv) All fillet welds of built up plate girders shall be inspected 100% by MPI.

(d) (Edge for field weld shall be examined by MPI for plate thickness > 32mm. Edge for field weld for ceiling girders shall be examined by UT for 100mm from the edge).

(e) Ceiling girders/columns, ducts hoppers & tunnels shall be trial assembled and match marked prior to dispatch/erection. At least two consecutive girders along with cross member shall be assembled at a time..

(f) Production test coupons for Butt and Fillet welds of main columns and Ceiling girders shall be carried out.

(g) **Coal Bunkers / Bins (If applicable)**

i) 10% DPT after back gouging.

ii) 5 % spot radiography test on butt welds. Where access not available, UT shall be carried with prior approval of NTPC.

(iii) Full penetration welds (other than butt welds) shall be subjected to 10% Ultrasonic testing.

1.02.12 Drum Sling Rods (Required only with Boiler Drum)

(a) Sling rods forging shall be subjected to ultrasonic examination.

(b) Welds shall be examined by UT and MPI after stress relief.

(c) Trial fitment of the rods with the drum shell shall be carried out to ensure proper contact.

(d) Screw thread of the rods shall be suitably protected to avoid damage during handling and transport.

1.02.13 Hangers & Supports:

(a) All raw materials used shall have co-related mill test certificate meeting mandatory checks of material specification.

(b) Completed springs shall be tested for Scragging Test & Load vs Deflection Test and for dia. > 25mm MPI shall be carried out.

(c) Butt Welds shall be tested for UT and fillet welds shall be tested for MPI.

(d) Turn buckle/ pipe clamps/ Hangers of thickness > 25mm shall be checked by MPI/DPT on bent portion.

(e) Assembled Hangers shall be checked for Variation in deflection and Travel vs Load test and shall meet the requirements of NTPC data sheet.

1.02.14 Thermal Insulation, Lagging & Cladding:

(a) **Lightly resin bonded mineral wool:**

LRB mattresses/sections of Rockwool/ Glass wool shall conform to & tested as per relevant clauses of Indian Standards and shall meet the requirements of NTPC data sheet. Type tests except Thermal Conductivity shall be regularly carried out once in three months, Thermal Conductivity Type Test shall be carried out minimum once in twelve months by the manufacturer. Requirements of various components like Binding wires, Lacing wires, Wire mesh, etc. shall be as per NTPC approved data sheet / as given in respective Sub-Section of Technical Requirements of Steam Generator & Auxiliaries.

(b) **Castable Refractory:**

Fire Bricks / Castable Refractory confirming to & tested as per relevant clauses of Indian Standards and shall meet the requirements of NTPC data sheet. Castable Refractory shall have proper identification, supplier name, customer name, Batch No., Date, material name & Net weight in Kgs. with proper instructions for handling.

(c) **Lagging & Cladding:**

All insulation shall be protected by means of an outer covering of Aluminum sheeting confirming to ASTM B-209-1060 temper H14 from reputed manufacturer meeting the requirements of NTPC data sheet.

1.02.15 **Metallic expansion Joint for piping (if applicable)**

(a) Hydraulic pressure test shall be carried out on each pipe and expansion bellow.

(b) Longitudinal butt weld on bellow shall be subjected to suitable NDT examination before forming, and after forming MPE / DP test shall be carried out.

(c) All welds shall be subjected to 100% magnetic particle/dye penetrant check and butt welds shall be subjected to 100% radiographic testing.

(d) All the bellows subjected to vacuum service shall be subjected to vacuum test.

(e) The bellows shall be subjected to movement test to establish suitability to perform satisfactorily in site conditions. During this test spring rate shall also be measured.

(f) The testing of MEJ shall be as per Expansion joint Manufacturer Association (EJMA) standard.

1.02.16 Quick erect Scaffolding structure (vertical)

(a) Critical components shall be tested for Mechanical & Chemical properties and Dimensional conformity.

(b) Partial Trial assembly.

(c) Load test of platform & Scaffolding structure (vertical).

2.00.00 **FIELD /ERECTION CHECKS FOR STEAM GENERATOR & AUX.**

2.01.00 (1) Raw Material, In process and Non Destructive Testing indicated during manufacture shall be applicable for site fabrication/erection of the respective item.

(a) All rotary equipments shall be checked for its direction of rotation and free movement after placing it on the foundation.

(b) All Valves shall be checked for its direction of flow.

(c) Insulation shall be carried out only after satisfactory inspection of leak test.

(d) Erection checks, tolerance limits and Quantum of NDE are indicated in respective Drawing, Field Quality plan and Field Welding Schedule.

2.02.00 **Hydraulic Tests of Pressure Parts**

2.02.01 On completion of erection of Steam Generator, Piping and Auxiliaries, the unit with its fittings and mountings in position shall be subjected to hydraulic pressure test in accordance with requirements of Indian Boiler Regulations & NTPC Technical Specification.

SUB-SECTION– E-02
ELECTROSTATIC PRECIPITATOR

ELECTROSTATIC PRECIPITATORS

1.00.00 DISCHARGE AND COLLECTING ELECTRODES

1.01.01 1) Work tests for Discharge electrodes include the following (for the wire type electrodes)

(a.) Chemical and tensile tests.

(b.) Metallographic examination-longitudinal and transverse (250X)

(c.) Surface finish and surface purity from chloride ions.

(d.) Spring back and surface finish after coiling (applicable to helical discharge electrodes

For all other type of electrodes, testing to be carried out as per the applicable standards.

(2) Work tests for collecting electrodes and rigid discharges electrode include the Following:

(a) Chemical and mechanical properties.

(b) Check for profile and straightness.

(c) Check for surface finish and dimensional accuracy.

(d) Cupping test for deep drawn sheets as per IS 513.

1.02.00 Thermal insulation shall be subjected to all tests as per IS: 8183.

LRB mattresses/sections of Rockwool / Glass wool confirming to & tested as per relevant clauses of Indian Standards and shall meet the requirements of NTPC data sheet. Type tests except Thermal Conductivity shall be regularly carried out once in three months, Thermal Conductivity Type Test shall be carried out minimum once in twelve months by the manufacturer. Wire mesh of diameter 0.71mm (min.) or as per approved data sheet shall only be used. Requirements of various components like Binding wires, Lacing wires, Wire mesh, etc. shall be as per NTPC approved data sheet / as given in (Technical Requirements of Electrostatic precipitator).

1.03.00 ESP Structure

(a) Only material which has been identified against mill sheet or test certificates shall be used for construction. All plates above 40mm thickness shall be 100% ultrasonically tested.

(b) Visual inspection of all welds shall be performed in accordance with AWS D.1.1.

(c) NDT requirements of structural steel welds shall be as under:-

(i) 100% RT/UT on butt-welds of plate thickness $\geq$ 32 mm.

(ii) For plates of 25mm $\leq$ thickness < 32mm - 10% RT/UT and 100% MPI.

(iii) For plates of thickness < 25mm - 10% MPI/LPI.

(iv) All fillet welds of structural members shall be inspected 100% by MPI.

(d) Edge for shop & field weld shall be examined by MPI for plate thickness $\geq$ 32mm.

SUB-SECTION– E-03
SCR/HYBRID SYSTEM

SUB-SECTION-E-03
SCR/HYBRID (SCR+ SNCR) System

(NOT APPLICABLE)

SUB-SECTION– E-04
FGD SYSTEM

FLUE GAS DESULPHURISATION SYSTEM

1.00.0	**FLUE GAS DESULPHURISATION SYSTEM**
1.01.0	**Mills:**
1.01.01	Raw material for shaft, coupling, gears and pinions, top and bottom races and other rotating components shall be subjected to UT. MPI/LPI shall be carried out to check surface soundness.
1.01.02	Wear-resistant metallic parts, if applicable shall be UT/RT tested to check soundness after suitable heat treatment. Check for chemical composition, hardness and microstructure shall be carried out.
1.01.03	Butt welds in the tube/body/shell casing of the mill shall be tested by RT and MPI. All other welds in main tube/ body casing shall be tested by MPI/LPI for acceptance.
1.01.04	All gearboxes shall be run tested for adequate duration to check rise in oil temperature, noise level and vibration. Check for leak tightness of gear case also shall be performed.
1.01.05	No load run test of the assembly shall be demonstrated at shop/site depending upon its design/feasibility.
1.02.0	**Feeders:**
1.02.01	Any welds in the casing/pulley fabrication shall be checked with MPI.
1.02.02	Routine tests shall be done as per relevant Indian Standards or equivalent International Standards.
1.02.03	All major items like plates for casing, head pulley, tail pulley, pulley shaft and major castings shall be procured with respective material test certificates.
1.02.04	Calibration check shall be carried out on all feeders.
1.03.0	**Dampers:**
1.03.01	All the dampers shall be subjected to operational test/checks with the job actuator.
1.03.02	Gas tight Dampers shall be subjected to shop leakage test to demonstrate the guaranteed tightness as per NTPC Tech Specification.
1.04.0	**PIPING, VALVE AND SPECIALITIES:**
1.04.01	All pipes and fittings shall be tested as per applicable code.
1.04.02	All valves shall be hydraulically/Air tested for body, seat and back-seat (if applicable) as per relevant standard.
1.04.03	NDT on valves shall be as per relevant standard.
1.04.04	Valves shall be offered for hydro test in unpainted conditions.
1.04.05	Functional checks of the valves for smooth opening and closing shall also be done.

1.05.00 **TANKS / VESSELS:**

1.05.01 **Atmospheric tanks:**

i) All welds joints shall be DP tested and tanks shall be water fill tested up to liquid level as per construction Code.

ii) All atmospheric storage tanks fabricated and erected at site shall be subjected to tests (NDT and Vacuum) according to design code/standard as applicable.

iii) Lining of the tanks/vessels shall be tested for hardness and spark test etc, as per applicable standard.

1.05.02 **Pressure vessels:**

1) NDT on weld joint shall be as per respective code requirements or the minimum as specified as below:

   i) 100% DPT on root run of butt weld, nozzle welds and finished fillet welds.
   ii) 10% DPT on all finished butt welds.
   iii) 10% RT (covering all 'T'/cross joints) of butt welds.

2) Butt welds of dished ends shall be stress relieved and subjected to 100% RT.

3) Each finished vessels shall be hydraulically tested to 150% of the design pressure for a duration of 30 minutes.

1.06.00 **HEAT EXCHANGER/HEATER:**

1.06.01 All material shall be tested for chemical and mechanical properties and NDT as per relevant standard.

1.06.02 NDT on welds and other checks shall be as per relevant code.

1.06.03 Air heaters shall be subjected to dimensional and clearance checks as per standard practice

1.06.04 Lube. oil system, drive system, soot blowing system etc. of Air heaters shall be checked suitably as per standard practice

1.07.00 **PUMPS:**

1.07.01 UT on shaft forgings (greater or equal to 40mm) and MPI/DPT shall be done on shafts and impeller to ensure freedom from defects.

1.07.02 The pump casing shall be hydraulically tested at 200% of pump rated head or at 150% of shut off head, whichever is higher. The test pressure shall be maintained for at least half an hour.

1.07.03 The pump rotating parts shall be subjected to static and dynamic balancing.

1.07.04 All pumps shall be tested at shop for capacity, head efficiency and brake horse power as per relevant/applicable standard.

1.07.05 Noise and vibration shall be measured during the performance testing at shop.

1.08.00	**STRUCTURES , DUCTS, HOPPERS:**
1.08.01	All materials shall be tested for chemical and mechanical properties as per relevant standard. All plates above 40mm shall be 100% ultrasonically tested.
1.08.02	Visual inspection of all welds shall be performed in accordance with AWSD1.1.
1.08.03	NDT requirements of structural steel welds shall be as under: i) 100% RT/UT on butt-welds of plate thickness>= 32mm. ii) For plates of 25mm<=thickness<32mm-10% RT/UT and 100% MPI. iii) For plates of thickness <25mm-10% MPI/LPI.
1.08.04	Edge for shop and field weld shall be examined by MPI for plate thickness >= 32mm.
1.08.05	Cladding material and its application on the ducts shall be tested as per applicable standard.
1.09.00	**VACUUM BELT FILTER SYSTEM:**
1.09.01	Impeller, casing and shaft of vacuum pumps shall be tested for chemical and mechanical properties as per relevant standard. All plates above 40mm shall be 100% ultrasonically tested.
1.09.02	UT on shaft (if greater or equal to 40mm) and impeller shall be carried out.
1.09.03	All vacuum pumps shall be tested at shop for capacity, power, pressure, efficiency, noise and vibration etc.
1.09.04	Filter cloths and belts shall be tested for physical properties as per relevant standard
1.09.05	Hydro cyclones shall be checked by visual, dimensional etc.
1.10.00	**SPRAY NOZZLES:**
1.10.01	Spray nozzles shall be tested for physical properties
1.10.02	Spray nozzles also shall be subjected to performance test.
1.11.00	**AGITATORS:**
1.11.01	Lining of the agitator shall be tested for hardness and spark test etc. as per applicable standard.
1.11.02	Impellers shall be tested for dimensional and balancing check. All impeller welds shall be tested by PT / MT.
1.11.03	Gear Boxes shall be tested for run test as per standard practice
1.12.00	**FANS:**
1.12.01	Impeller, casing, blades and shafts of fans shall be tested for chemical and mechanical properties as per relevant standard. All plates above 40mm shall be 100% ultrasonically tested.

1.12.02	Rotor components shall be subjected to ultrasonic test at mill and magnetic particle inspection / liquid penetrant examination after rough machining.
1.12.03	Butt welds in rotor components shall be subjected to 100% RT and all welds shall be magnetic particle/dye penetrant tested after stress relieving. Due to design of the rotor in case RT is not feasible then in lieu of RT, UT shall be performed.
1.12.04	All rotating components and assemblies of fan shall be balanced dynamically
1.12.05	Performance test shall be carried out on fans as per Technical specification/ Relevant standard
1.12.06	Test for Natural Frequency and hardness of Fans blades shall be carried out as per Technical specification/ relevant standard.
1.13.0	**OXIDATION BLOWER**
1.13.01	Impeller, casing, gears and shafts of oxidation blowers shall be tested for chemical and mechanical properties as per relevant standard. All plates above 40mm shall be 100% ultrasonically tested.
1.13.02	Butt welds in rotor components shall be subjected to 100% RT and all welds shall be magnetic particle/dye penetrant tested after stress relieving (if applicable).
1.13.03	All rotating components and assemblies of blower shall be balanced dynamically.
1.13.04	Performance test shall be carried out on blowers as per Technical specification/ relevant standard.
1.14.00	**ABSORBER**
1.14.01	All weld joints shall be tested to suitable NDT techniques as applicable to the materials being welded, joint design , weld profile and corrosion protection requirement etc. according to design code/ standard as applicable. Tanks shall be water fill tested up to liquid level as per construction Code. Vacuum test according to design code/standard as applicable.
1.14.02	Cladding / Bonding material and its application shall be tested as per applicable standard. Corrosion test on Corrosion Resistant Alloy shall be performed as per ASTM G48/applicable relevant standard for C276 Gr material. For Ti Cladding Material shall meet the NTPC Datasheet and shall be tested as per relevant applicable Indian/International standard as applicable.
1.14.03	Absorber fabricated and erected at site shall be subjected to all tests according to design code/ standard as applicable.

1.15.00 **Thermal Insulation, Lagging & Cladding:**

(a) **Lightly resin bonded mineral wool:**

LRB mattresses/sections of Rockwool/ Glass wool shall conform to & tested as per relevant clauses of Indian Standards and shall meet the requirements of NTPC data sheet. Type tests except Thermal Conductivity shall be regularly carried out once in three months, Thermal Conductivity Type Test shall be carried out minimum once in twelve months by the manufacturer. Requirements of various components like Binding wires, Lacing wires, Wire mesh, etc. shall be as per NTPC approved data sheet / as given in respective Sub-Section of Technical Requirements of Steam Generator & Auxiliaries.

(b) **Lagging & Cladding:**

All insulation shall be protected by means of an outer covering of Aluminum sheeting confirming to ASTM B-209-1060 temper H14 from reputed manufacturer meeting the requirements of NTPC data sheet.

1.16.00 **OTHER CRITICAL EQUIPMENTS:**

1.16.01 Checks/ NDTs shall be done as per relevant Indian Standards or equivalent International Standards.

1.17.00 **BOROSILICATE LINING:**

Borosilicate block shall conforms to NTPC data sheet and to be tested as per Relevant applicable standard

SUB-SECTION– E-05
LOW PRESSURE PIPING

LOW PRESSURE PIPING

PIPES, FITTINGS, BENDS, VALVES, COATING-WRAPPING, STRAINERS EXPANSION, JOINTS, TANKS, FASTENERS, LINING ETC.

	Tests/Check / Items / Components	Material Test	DPT/MPI / RT	Ultrasonic Test	WPS/ WQS/PQR	Hydraulic / Water Fill Test	Pneumatic Test	Assembly Fit up	Dimensions	Functional/operational Test	Other Tests	All Tests as per relevant Std	REMARKS
1	Pipes & Pipe Fittings	Y[a]	Y[b]			Y1			Y			Y	
2	Diaphragm Valves	Y[a]				Y[5]			Y		Y[6]		
3A	Cast Butterfly Valves (Low Pressure)					Y		Y	Y	Y	Y[7]		
	Body	Y[a]	Y[b]										
	Disc	Y[a]	Y[b]										
	Shaft	Y[a]	Y	Y[c]									
3B	Fabricated Butterfly Valves	**REFER NOTE 14**											
4	Gate/ Globe/Swing Check / Ball Valves	Y[a]	Y[b]	Y[c]		Y[5]	Y	Y	Y	Y	Y[8]		
5	Dual Plate Check Valves	Y[a]	Y[b]	Y[c]		Y	Y	Y	Y	Y	Y[4]		
6	Rolled & Welded Pipes and Mitre Bends	Y[a]	Y[3]		Y	Y[3]			Y		Y[3&15]	Y	
7	Coating & Wrapping of Pipes	Y[2]									Y[2]		
8	Tanks & Vessels	Y[a]	Y[b]		Y	Y			Y		Y[16]		
9	Strainers	Y[a]	Y[b]		Y #	Y					Y[11]		#For Fabricated Strainer
10	Rubber Expansion Joints	Y[a]				Y[12]		Y	Y		Y[13]		
11	Internal Lining of Pipes	Y[a]							Y		Y[9]		
12	Site Welding		Y[10]		Y	Y							

NOTES (MEANING OF SUPERSCRIPTS)

a	One per heat/heat treatment batch/lot.
b	On machined surfaces only for castings and on butt welds.
c	For shaft/spindles > or = 40 mm
1	100% Hydraulic test shall be carried out. Weld joints not subjected to hydraulic test due to some unavoidable reasons, shall be subjected to 100% RT/PAUT.
2	Spark Test, Adhesion Test and Material Test for primer and enameled & Coal Tar Tapes as per AWWA-C-203-91/ IS-10221 & IS 15337 as applicable.
3	Followings are the testing requirements for fabrication of pipes at site

TESTS	QUANTUM OF CHECKS
WPS, PQR, Welder Qualification Test	100% Welders and WPS shall be qualified as per ASME- section IX
DPT on root run	100% for pipes up to 1200 mm diameter
DPT after back gauging	100% for pipes above 1200 mm diameter
RT / UT by (TOFD/PAUT) Technique	5% (100% of T Joints)
DPT on finished butt weld joints	10%

	Hydraulic Test	100%, 1.5 times the design pressure or 2 times the working-pressure whichever is higher.
4	Dry Cycle Test on Dual Plate Check valve spring for one lakh Cycles shall be carried out as a type test. If Dry Cycle test carried out earlier for same material & diameter, Test report shall be reviewed.	
5	Seat Leakage Test for Actuator Operated Valves, shall be done with by closing the valves with actuator.	
6	Tests on rubber parts shall be conducted per batch of rubber mix for tensile, Elongation, hardness, adhesion, spark test, bleed resistance test. In addition, type test for 50,000 cycles of each type of diaphragm shall also be conducted.	
7	Hydraulic Test of Body, Seat and disc-strength shall be carried out in accordance with governing design standard in presence of owner / owner's representatives. Actuator operated valves shall be checked for Seat Leakage by closing the valves with actuator. For Proof of Design Test refer respective chapters of engineering portion in the technical specification.	
8	Blue matching, wear travel for gates, valves, pneumatic seat leakage, and 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. Fire safe test for ball valve shall be done wherever specified. In case of already carried out, the test report shall be submitted for review and acceptance by owner / owner's representatives. Valves shall be offered for hydro test in unpainted condition.	
9	Tensile, Elongation, Hardness, Specific Gravity, Lining Thickness, Humidity Check, Pipe temperature check, Adhesion Test and Holiday Detection Test etc as per applicable standard shall be done for all lining material and application.	
10	10% of welds (Root and finished welds) shall be subjected to DPT. (100% DPT for compressed air line and boiler & deaerator fill line.).	
11	Pressure drop across the strainer for each type and size as a special test shall be carried out. In case of already carried out, the test report shall be submitted for review and acceptance by owner / owner's representatives.	
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/IS 3400 Part 20 aging test and adhesion strength of rubber to fabric, rubber to metal adhesion shall be carried out.	
14	In addition of all tests as indicated for Cast Butterfly valve being applicable for fabricated butterfly valves, following test shall be done for Fabricated Butterfly Valve: a. UT as per ASTM A-435/IS 11630 & IS 4225 on plate material for body and disc shall be carried out for plate thickness 25mm and above. b. 100% RT and DPT as per ASTM, Section-VIII, Division-I, on butt joins of body and disc. 10% DPT on other welds shall be done. c. Post weld heat treatment as per ASME, Section-VIII, Division-I on butt joints of body and disc. d. Welders and WPS shall be qualified as per ASME- section IX	
15	Maximum number of segments in segmental flanges shall be four (04) only. All butt weld joints in the segmental flanges shall be examined by RT/UT. Segmental flanges exceeding 37.5 mm thickness shall be stress relieved as per norms of ASME Section VIII after welding.	
16	For pressure vessel welds RT shall be done as per design code requirements.	

All Valves shall be offered for inspection in unpainted condition.

No repair welding is permitted on Cast Iron / Alloy Cast Iron Castings.

SUB-SECTION– E-06
POWER CYCLE PIPING

POWER CYCLE PIPING

1.00.00 H.P. PIPING FOR STEAM GENERATOR AND TURBINE GENERATOR & AUX.

1.01.00 **Piping:**

(a) All raw materials used shall have co-related mill test certificate meeting material specification.

All tests, as given in respective material code (other than supplementary requirements), shall be carried out as minimum. This includes the tests wherein it is specified in the ASTM code that "the test is to be carried out when specified by the purchaser" or any such indication, in the code

(b) All pipe lengths under this package, including piping where alloy steel is used shall be subjected to 100 % ultrasonic examination as per material specification standard with acceptable notch depth of 5% of the selected wall thickness (1.5mm maximum) except for the following piping system:

DOWN STREAM OF AUX. PRDS (where carbon steel is used) and aux. steam piping system (station HDR, unit HDR, interconnection) where notch depth of 12.5% of the selected wall thickness (1.5mm maximum) will be adhered to.

(c) The edge preparation for shop and site welds in stainless steel /alloy steel shall be subjected to a dye penetrate check.

(d) Pipe bend shall be checked for ovality and thinning by ultrasonic or other acceptable methods on first off lot & on random samples for subsequent pieces for high pressure applications. Outer surface of bends shall be subjected to magnetic particle examination/LPI.

(e) Non-destructive examination of welds shall be carried out after post weld heat treatment, if any.

(f) All butt welds in alloy steel piping of P-91, X -20, X-22 & material P15E group & above shall be checked for RT/ UT/PAUT+TOFD & MPI after SR.

(g) For welds in P91, X20 & X22 and material P15E group & above Materials requiring heat treatment, induction type of heating shall be deployed for post weld heat treatment, or heat treatment can be carried out in furnace.

(h) Non-destructive examination of welds shall be carried out in accordance with the relevant design/manufacturing codes. However, as a minimum, the following requirements shall be met. Further statutory requirement, wherever applicable shall also be complied with.

(1) Temperature > 400 Deg, C or pressure exceeding 71 bar.

(i) 100% RT/UT on butt welds and full penetration branch welds.

(ii) 100% MPE.

(2) Temperature > 175 Deg, C upto 400 Deg. C or pressure exceeding 17 bar and upto 71 bar.

(i) 100% RT/UT on butt welds and full penetration branch welds for pipe dia. more than 100 NB.

(ii) 10% RT/UT on butt welds and full penetration branch for pipe dia up to 100NB.

(iii) 100% MPE.

(3) For all other pipes not covered above, shall be subjected 100% MPE/ DPT in case of underground pipes and 10% MPE/DPT in case of piping above the ground. Further, 10% of butt welds of underground piping shall be subjected to RT.

(i) Wherever SR/PWHT is envisaged for alloy steel, above NDTs shall be after SR/PWHT.

(j) Hardness survey of welds shall be carried out on alloy steel/stainless steel piping (100% Hardness survey of welds on P91, X20 & X22 & above material grade of P15E above piping) and 3% hardness survey on welds of other alloy steel.

1.02.00 **Fittings:**

(a) Raw material of all forged/formed fitting shall be ultrasonically tested. All mother pipes used for fitting shall be ultrasonically tested or hydraulic tested. Forged fitting shall be ultrasonically tested and formed fittings shall be MPI tested.

All tests, as given in respective material code (other than supplementary requirements), shall be carried out as minimum. This includes the tests wherein it is specified in the ASTM code that "the test is to be carried out when specified by the purchaser" or any such indication, in the code

(b) Fittings shall be subjected to suitable NDT as per applicable standards. However following minimum. NDE requirement shall be applicable / met.

(i) For fittings X20, P-91 & P-92 and material group P15E & above

- 100% MPI &
- 10% hardness check.
- Also 100% UT/RT, for fittings of 200 NB & above

(ii) 100% UT/RT for fittings of 200 NB & above for boiler feed discharge, recirculation and spray piping of boiler feed system.

(iii) 100% UT/RT for fittings of all other piping of size OD 508 mm & above.

1.03.00 **Hangers & Supports:**

(a) All raw materials used shall have co-related mill test certificate meeting mandatory checks of material specification.

(b) Completed springs shall be tested for Scragging Test & Load vs Deflection Test and for dia. > 25mm MPI shall be carried out.

(c) Butt Welds shall be tested for UT and fillet welds shall be tested for MPI.

(d) Turn buckle/ pipe clamps/ Hangers of thickness > 25mm shall be checked by MPI/DPT on bent portion.

(e) Assembled Hangers shall be checked for Variation in deflection and Travel vs Load test and shall meet the requirements of NTPC data sheet.

1.04.00 **Thermal Insulation & Lagging, Cladding:**

1.04.01 **Light resign bound mineral wool:**

LRB mattresses of Rockwool / Glass wool confirming to IS-8183, tested as per relevant clauses of IS 3144 and shall meet the requirements of NTPC data sheet. Type tests except Thermal Conductivity shall be regularly carried out once in three months, Thermal Conductivity Type Test shall be carried out minimum once in twelve months by the manufacturer. Requirements of various components like Binding wires, Lacing wires, Wire mesh, etc. shall be as per NTPC approved data sheet / as given in respective Sub-Section of Technical Requirements of Power Cycle system.

1.04.02 **Lagging &Cladding:**

Aluminum sheeting confirming to ASTM B-203-1060 temper H14 from reputed manufacturer meeting the requirements of NTPC data sheet.

1.05.00 **Valves:**

(a) Pressure retaining parts of valves shall be subjected to (min.) NDT as per Table 1.

(b) Hardened/stellitted valve disc and seat are to be subjected to LPI and hardness check.

(c) Color matching of valve disc/plug and seat shall be carried out to ensure min. 80% contact and no through passage.

(d) Hydraulic pressure test and seat leak test shall be carried out as per ANSI 16.34/ IBR.

(e) Air seat leak test shall be carried out as per applicable Standards/Codes.

(f) Functional testing shall be carried out on each valve to check the following as per the approved valve data sheet

(1) Smooth operation

(2) Valve travel, closing and opening time.

(3) Current drawn by actuators.

(g) Springs for safety valves shall be tested with suitable NDT and for spring rate.

(h) Safety and safety relief valves shall be tested for performance.

(i) All forgings rounds above diameter 40 mm shall be ultrasonically tested.

TABLE-1

Valve size NB in mm	ANSI Class up to 300	ANSI Class above 300 up to 600	ANSI Class above 600 below 900	ANSI Class 900 & above & below 4500
Less than 50	Visual	Visual	Visual	MPI
50 & above but below100	Visual	Visual	MPI	MPI & RT (on 10%of valves on 100% area)
100 & above but less than 300	Visual	MPI	MPI & RT (on 10% of valves on change of section & weld ends)	MPI & RT (on 100% area)
300 and above	MPI	MPI	MPI & RT (on change of sections & weld ends)	MPI, RT on100% area)

NOTE: For body and bonnet forgings UT with MPI may be adopted in place of RT
For austenitic steel MPI may be replaced by LPI.

1.06.00 **CHEMICAL DOSING SYSTEM (HP/LP/OXYGENATED)**

(a) Pumps of chemical **dosing** system shall be performance tested as per relevant international codes.

(b) In case of diaphragm type of pumps, the life cycle test shall be done on pumps. If this test is already conducted for same model in earlier projects of NTPC, then TCs for same shall be reviewed.

(c) Dosing skid shall be subjected to leakage test and functional test.

(d) Oxygen cylinders shall be as per relevant standard meeting statutory requirements.

1.07.00 **MEATLLIC EXPANSION JOINT FOR PIPING (IF APPLICABLE)**

(a.) Hydraulic pressure test shall be carried out on each pipe and expansion bellow.

(b.) Longitudinal butt weld on bellow shall be subjected to suitable NDT examination before forming, and after forming MPE / DP test shall be carried out.

(c.) All welds shall be subjected to 100% magnetic particle/dye penetrant check and butt welds shall be subjected to 100% radiographic testing.

(d.) All the bellows subjected to vacuum service shall be subjected to vacuum test.

(e.) The bellows shall be subjected to movement test to establish suitability to perform satisfactorily in site conditions. During this test spring rate shall also be measured.

(f.) The testing of MEJ shall be as per Expansion joint Manufacturer Association (EJMA) standard.

SUB-SECTION– E-07
HYDROGEN GENERATION PLANT

SCOPE & SUPPLY FOR AUXILARY BOILER

(Mechanical portion)

1.00.00 Not Used.

SUB-SECTION– E-08
STEAM TURBINE & AUXILIARIES

STEAM TURBINE & INTEGRAL AUXILIARIES

1.00.00 **GENERAL REQUIREMENTS**

Refer QA & I portion of General Technical conditions of technical specification.

(a) **Shop Tests**

Shop tests shall include all tests to be carried out at Contractor's works, at works of his sub-contractor and at works where raw material is manufactured for equipment. Testing requirement of major equipment over and above the respective code/standard requirements are given for ST & Aux. including Condenser, HP Bypass System & Vibration Isolating System.

(b) **Site Tests**

The Contractor shall prepare and submit detailed field quality plans in the format prescribed by NTPC setting out the quality practice and procedures to be adopted by him for assuring quality for each equipment of material at this specification from the receipt of material at site, during storage erection, pre-commissioning to final commissioning of the plant. However, the bidder may furnish the quality plans in his standard formats provided such quality plans contain the details required as per format enclosed as Annexure-II. These procedures shall necessarily include all checks/tests conducted at site for preservation, assembly, alignment, positioning of the equipment, foundation preparation, welding/bolting heat treatment, non-destructive examination, hydraulic test, running test, performance test etc. The Contractor shall also furnish detailed quality procedure proposed by him for storage, preservation, painting, acid cleaning, alkali boil out, steam blowing, hydraulic test air/gas tightness test etc. to the Employer. The same shall be discussed and finalised with the Employer and six numbers of such finalised copies shall be submitted.

1.01.00 **STEAM TURBINE AND ASSOCIATED EQUIPMENT**

1.01.01 **High Pressure Cast Steel Enclosures:**

High pressure Cast Steel Enclosures (for example High pressure and Intermediate Pressure Inner and Outer Cylinders, Steam Chests and liner, Steam Inlet Pipes, nozzle boxes etc.).

(1) Test pieces fully representative of the material and condition of the casting shall be made available at OEMs works to enable the properties of material to be determined.

Creep requirements:

a) Steels chosen for design metal temperatures less than 400°C are exempt from creep /stress rupture testing.

b) Steels chosen for design metal temperatures between 400°C to 540°C AND having less than 3% chromium, shall require 5 years performance

feed back experience in the absence of which, creep rupture test will be required to be carried out for maximum test duration of 1000 hrs/mutually agreed parameters for NTPC approval.

c) Steels chosen for design metal temperatures above 540°C AND/OR having more than 3% chromium, shall require 10 years performance feed back experience OR adequate stress rupture data, in the absence of which, creep rupture test will be required to be carried out for maximum test duration of 1000 hrs/mutually agreed parameters for NTPC approval.

d) Unspecified alloying elements shall be controlled as per the applicable standard.

(2) Each casting shall be subjected to magnetic particle examination on the entire inner and outer surfaces after heat treatment.

(3) Each casting shall be subjected to a 100% examination for internal flaws by ultrasonic/ radiographic method after heat treatment and suitable preparation.

(4) Cast enclosure shall be subjected to a hydraulic pressure test based on established practice of manufacturer unless there is a geometrical constraint for doing hydro test. Bidder to furnish their practice in this regard for Employer's approval.

(5) Excavated area of all the defects shall be subjected to MPI/DPI to ensure excavation up to sound area. All the areas repaired/upgraded by welding shall be examined by UT, RT (where UT results cannot be analyzed correctly) and MPI. Sketches/reports of location of repair and reports of NDT carried out on repaired areas shall be submitted along with certificates. Hardness survey shall be carried out on the repaired area.

(6) Where stub pipes and transition pieces are welded to the main body of an enclosure the following shall be carried out:

(i) Radiographic examination or Ultrasonic testing and Magnetic particle or dye penetrant examination of weld preparation.

(ii) Magnetic particle examination of finished welds after stress relief.

(iii) Radiographic or ultrasonic examination of finished welds.

(iv) Before despatch to site, the site weld preparations on the stub pipes and transition pieces shall be subjected to 100% RT/UT and magnetic particle examination / Dye penetration test.

(v) Hardness survey on the weld joint, HAZ and parent material.

(7) Wall thickness measurement by ultrasonic for critical and highly stressed zones of the casting shall be carried out.

(8) Colour matching of castings by putting two halves together or feeler gauge tightness check from outside to ensure required contact area and joint tightness shall be carried out.

1.01.02 **Low Pressure Enclosure (Fabricated)**

(a) Where welds are made by chipping and grinding back to the first side weld before completing the weld from second side, a magnetic particle or dye penetrant examination of the chipped area shall be carried out.

(b) Bidder to furnish their practice regarding stress relieving of the fabricated enclosures for Employer's approval.

(c) Bidder to furnish their standard practice regarding NDT on welds for Employer's approval, however following are minimum NDT requirements:

Butt welds	10% RT or UT and 10% MPE/DP test
Fillet welds	10% MPE/DPT
Nozzle welds	10% MPE/DPT
Lifting lug & other load bearing fillet welds	100% MPE/DPT
Site weld edge preparations	10% MPE/DPT

(d) Bidder to furnish his proven practice for hydraulic pressure tests. If it is not their practice, the justification for not carrying out hydraulic test shall be furnished for Employer's approval.

(e) Feeler gauge tightness check from inside and outside to ensure required joint tightness shall be carried out.

1.01.03 **Rotors**

(a) **Forgings**

Rotor forgings (monoblock and/or discs), Impulse Wheel & Nozzle Box and coupling forgings :

(1) Fully representative tangential or radial test pieces shall be provided at each end of the body, at each shaft end and radial test piece from the trepanned core (when a core is trepanned) respectively to determine mechanical properties including impact, brinell hardness etc. and tests for notch toughness i.e. FATT (both transition temperature and room temperature impact values).

(2) Creep requirements:

a) Steels chosen for design metal temperatures less than 400°C are exempt from creep /stress rupture testing.

b) Steels chosen for design metal temperatures between 400°C to 540°C AND having less than 3% chromium, shall require 5 years performance feed back experience in the absence of which, creep rupture test will be required to be carried out for maximum test duration of 1000 hrs/mutually agreed parameters for NTPC approval.

c) Steels chosen for design metal temperatures above 540°C AND/OR having more than 3% chromium, shall require 10 years performance feed back experience OR adequate stress rupture data, in the absence of which, creep rupture test will be required to be carried out for maximum test duration of 1000 hrs/mutually agreed parameters for NTPC approval.

d) Unspecified alloying elements shall be controlled as per the applicable standard.

(3) Heat treatment should be carried out in such a way so as to ensure minimum residual stress in the rotor. Residual stress measurement will be carried out.

(4) Each forging shall be subjected to a 100% ultrasonic examination. Normal probes and angular probes with different probe angles shall be used for thorough examination to ensure complete soundness of the forging. Supplier should furnish the proposal, alongwith scanning plan and probe angles to be used, for Employer's approval.

(5) When a rotor forging is bored, a visual and magnetic particle examination of the bore shall be carried out.

(6) Thermal stability tests shall be carried out on HP and IP rotor forgings to ensure the thermal stability of the rotors in service and at over speed.

(7) Following tests shall be carried out on the rotor welds:

(i) Ultrasonic examination with normal and angular probes of the weld to ensure complete coverage and freedom from harmful defects.

(ii) Run out of rotor before and after welding

(iii) MPE on finish welds.

(iv) Hardness survey on the welds.

(v) Stress relieve annealing.

(vi) Test reports of filler material used.

(vii) Dimensional record of weld preparation.

(8) Dimensional Examination of the rotor blade grooves and other important dimensions to be carried out to ensure the conformance to drawing dimensions, Log sheets/records shall be prepared for all important dimensions.

(b) **Complete Rotors**

(1) Axial & radial run-outs and surface finish checks shall be carried out before and after blading and after over speed tests.

(2) Check for clearance between rotor groove and blade at the root in line with manufacturer's standard and proven practice being followed.

(3) Rotors shall be dynamically balanced at rated speed.

(4) An over speed test shall be carried out during which the rotor shall withstand an over speed of 125% for two continuous minutes. If bidder's practice is different from as stated above, then same shall be furnished to Employer's approval. During this test vibration measurement and analysis shall be carried out.

(5) After blading, rotor stages with free standing blades over 225 mm of active length are to be given standing vibration tests to determine natural frequencies in various vibration modes to ensure that the ranges are outside operating frequencies and to check correct fitment of blades. The modes to be tested are: Bucket group tangentials, wheel axials and group axials.

(6) In case, impulse stage and or blade discs are fitted on the rotor, fit up between such disc and rotor to be checked up before and after over speed.

(7) Lock blade lift after the over speed, if applicable based on manufacturer's standard design & practice shall be checked and record for same shall be maintained.

1.01.04 **Stator & Rotor Blades and Shroud Bands**

(a) Fully representative test pieces shall be made available at OEMs works to enable mechanical properties of the material to be determined. In case of blades machined from bar stock, mechanical tests shall be carried out on the hardest and softest specimens of each heat treatment batch. Hardness test will be carried out on 100% basis.

(b) Creep requirements shall be similar as applicable for High Pressure cast steel enclosures.

(c) Each bar stock for machining blades and forging shall be subjected to 100% ultrasonic examination.

(d) When erosion shielded, the erosion shield and blade joint shall be radiographed. In case of flame and laser hardening MPI shall be done.

(e) Dye penetrant checks shall be made on the erosion shield and blade joint in manufacture prior to fitting to the wheel and after over speed tests.

(f) Magnetic particle inspection or dye-penetrant examination (when MPI is not applicable) shall be carried out on finish machined blade profile, roots and shrouds.

(g) All moving blades of over 225mm active length are to be moment weighed and assembled on shaft in a prescribed sequence to ensure optimum balancing of rotor.

(h) Natural frequencies of the L.P Turbine blades shall be determined before mounting on rotors to ensure that the same are outside operating frequency range.

(i) Shroud bands after punching and after riveting shall be subjected to 100% DPT to ensure freedom from harmful surface defects.

(j) In case of cast blades, following testing shall be done:-

(1) Chemical analysis/Mechanical testing per heat/heat treatment batch.

(2) Rough machined/finish machined blade surface shall be subjected to MPI/DPT respectively.

(3) -RT/UT on blades as per supplier standard practice.

(4) Before starting mass productions, following technological tests shall be carried out on the first lot of 10 to 15 blades:-

(i) 100% radiography and 100% MPI on blades

(ii) 100% hardness testing.

(iii) Mechanical testing and metallurgical testing.

(iv) Weld repair shall not be permitted unless prior approval of Employer is obtained.

In case of repair is allowed, manufacturer shall submit WPS/PQR and defectogram for Employer's approval before welding. After weld repair, RT shall be carried out on repaired area.

1.01.05 **Diaphragms**

(a) Welded and fabricated Diaphragms

(1) Concentricity checks shall be carried out on finally machined diaphragms to ensure that there are no negative overlaps between guide and moving blades.

(2) 10% Ultrasonic examination and 10% magnetic particle examination / dye penetration examination shall be carried out on finished, stress relieved and machined welds

(b) Cast/Forged/Machined Diaphragms

(1) Details of the results of the tests conducted to determine mechanical properties together with chemical analysis, metallographic/ metallurgical examination, and heat treatment procedures recommended and actually followed shall be recorded on certificates.

(2) Concentricity, flatness, blade drop and area checks shall be carried out on finally machined diaphragms to ensure that there are no negative overlaps between guide and moving blades and port wall. Finish shall be to Project Manager's approval.

(3) A 100% ultrasonic examination shall be carried out on diaphragm materials. Blade junction areas with the side walls shall be checked by magnetic particle or dye penetrant testing.

(c) Colour matching of all the diaphragms by putting two halves together or feeler gauge tightness check shall be carried out.

1.01.06 **Stop, Control and bypass valves, actuators/servo-motors and steam strainers**

(a) Test pieces shall be made available at OEMs works to enable the mechanical properties of valve bodies, bonnets, valve disc and seat, and valve spindle material to be determined.

Test Creep requirements:

i. Steels chosen for design metal temperatures less than 400°C are exempt from creep /stress rupture testing.

ii. Steels chosen for design metal temperatures between 400°C to 540°C AND having less than 3% chromium, shall require 5 years performance feed back experience in the absence of which, creep rupture test will be required to be carried out for maximum test duration of 1000 hrs/ mutually agreed parameters for NTPC approval.

iii. Steels chosen for design metal temperatures above 540°C AND/OR having more than 3% chromium, shall require 10 years performance feed back experience OR adequate stress rupture data, in the absence of which, creep rupture test will be required to be carried out for maximum test duration of 1000 hrs/mutually agreed parameters for NTPC approval.

Unspecified alloying elements shall be controlled as per the applicable standard.

(b) Dye penetrant checks shall be carried out on stellited components in finish ground or honed condition. For nitrided areas DPT will be carried out in case

of doubt during visual inspection. Hardness check shall be carried out to ensure required hardness on test sample.

(c) Valve body and bonnet castings/forgings shall be subjected to 100% radiography or 100% ultrasonic examination. Body and bonnet shall also be subjected to 100% magnetic particle examination on entire surface. All pressure containing welds in body and bonnet shall be subjected to 100% RT/UT and MPI examination.

(d) Wall thickness of the body and bonnet after finish machining shall be measured by ultrasonic method and valve seat bore shall be checked for size and concentricity.

(e) Bar stock for valve stem shall be subjected to ultrasonic examination and finish machined stem shall be subjected to magnetic particle/Dye penetrant examination.

(f) Each valve body and bonnet shall be hydraulically tested at minimum 1.5 times the maximum working pressure after applying temperature corrections.

(g) All the actuating cylinders/servomotors shall be performance tested.

(h) Performance testing shall be carried out on valve operators/ actuators to check functional requirements like trip closing and opening time, valve lift and hysteresis.

(i) Colour matching of the valve disc and seat to ensure the required contact area is to be carried out.

1.01.07 Cast and Forged Steel Components such as LP casing, in case of cast design, inlet & extraction/exhaust connections, shaft seal covers and rings, governor shaft, breach nut, threaded ring, angle ring, U-ring, servomotor parts such as body, piston, cover, yokes; turning gear casing and other items which are not specifically covered elsewhere

(a) Results of tests conducted to determine mechanical properties, chemical analysis, metallurgical/ metallographic examination for nodular cast iron, if any and heat treatment procedures recommended and actually followed shall be recorded on certificates.

(b) Each pressure containing enclosure shall be subjected to a hydraulic pressure test at 1.5 times the design pressure.

(c) Each casting/forging shall be subjected to suitable non-destructive examination by Radiographic or ultrasonic and magnetic particle or dye penetrant examination methods to ensure freedom from harmful defects.

1.01.08 **Bolts and nuts for pressure Retaining enclosures and Rotor Couplings**

(a) Bar stock greater than or equal to 50 mm in diameter for bolts shall be subjected to ultra- sonic examination.

(b) Finish machined bolts (Joint Bolts & Coupling Bolts) shall be subjected to magnetic particle examination /DPT for surface defect examination.

(c) Coupling bolts and nuts shall be suitably identified after weight control checks.

1.01.09 **Governing and Protection System Equipment such as Electro-hydraulic Controller, Hydraulic Amplifier, Hydraulic Controller, Electro hydraulic Convertors, Hydraulic Convertors, Hydraulic Speed Governor, Trip Devices etc.**

(a) All pressure retaining parts shall be subjected to hydraulic testing.

(b) All the major castings/forgings shall be subjected to suitable NDT methods depending upon their application and criticality to ensure the freedom from harmful defects.

(c) All the main assemblies and sub-assemblies shall be subjected to functional test.

(d) All butt welds shall be subjected to minimum 10% RT/UT and all fillet and corner welds shall be subjected to MPI/DPT.

(e) All control equipment shall be subjected to rig testing, if it is not possible to test it on the steam turbine light run. The purpose of rig testing shall be as far as practical to prove that the functioning of the control equipment is in accordance with the approved design.

(f) Nitrided and stellited components will be subjected to DPT and hardness check shall be carried out on test sample.

1.01.10 **Inspection of Completed Turbine**

The steam turbine shall be assembled in the manufacturer's works to such an extent that a thorough inspection can be carried out. The purpose of this inspection will be to ensure that the fit between mating components is correct and that all clearances are in accordance with the design requirement. Contractor will prepare the checklist in this regard and submit the same for Employer's approval. However, minimum clearances which are required to be checked and records to be maintained during assembly of Inner Casing - Rotor, Inner Casing - Outer Casing, Rotor - Outer Casing, Gland Steam Housing - Shaft - Casing etc. and shroud diameters, axial distances for shroud bands for casings, clearance between shaft seal casings and shaft seal rings, radial and axial blade clearance in blading section, axial and radial alignment of rotor in respect of shaft seals, alignment of overspeed governor etc. by actual assembly. However, if the Bidder’s standard practice provides for verifying the clearances by any other method, such as, computer aided assembly, the same is acceptable, in case the bidder is having experience for similar or higher rating turbine. This is indicative check only. However, the details shall be finalised during QP finalisation stage.

These check lists shall be designed so that a comparison can be made between the design clearances, the clearances measured during works assembly, and those measured during the site turbine build. The vendor shall state, in his proposal, whether or not it is his practice to carry out no load works running tests on the steam turbine. If not carried out, the vendor shall give details of their normal works practice

in order to verify compliance with the design of the steam turbine control and emergency control equipment.

1.02.00 **AUXILIARIES OF STEAM TURBINE**

1.02.01 **Bearing Pedestals and Bearings**

(a) **Cast Pedestals & Housing**

Leakage tests shall be conducted on pedestals.

(b) **Fabricated Pedestals & Housing**

(1) Leakage test shall be conducted on pedestals.
(2) 10% weld shall be checked after stress relieving by magnetic particle test or DPT and minimum 10% of the butt welds will be checked by RT or UT.

(c) **Bearings shell**

(1) The shell and castings\forgings shall be subjected to suitable non destructive examination like RT\UT & MPI as applicable.

(2) Colour matching of the shells by putting two halves together or feeler gauge tightness checks from inside and outside to ensure required contact area and joint tightness shall be carried out.

(3) The fabricated /cast shell shall be subjected to hydraulic pressure test / water fill test as applicable.

(4) Chemical analysis of white metal shall be carried out. The effectiveness of the white metal adhesion shall be checked by ultrasonic or other approved method and the exposed edges of the white metal shall be subjected to a dye penetrant examination.

1.02.02 **Cross around pipes**

(a) Weld edge preparation of shop and site welds shall be checked by magnetic particle examination or dye penetration test.

(b) All butt welds shall be subjected to 100% Radiographic examination/Ultrasonic examination depending on thickness.

(c) Magnetic particle examination shall be carried out on un-machined welds. In case, welded area is machined then DPT shall be carried out.

1.02.03 **LUBRICATING OIL, JACKING OIL AND CONTROL OIL SYSTEMS**

(a) **Pumps**

(1) Main oil pump shaft shall be subjected to ultrasonic examination. Butt welds shall be subjected to RT/UT.

(2) Pump impeller shall be subjected to suitable NDT method like MPI/DPT for surface defect examination. Impeller of turbine shaft mounted main oil pumps shall also be subjected to an over speed test as per the guide lines followed for HP rotor.

(3) Pump casing shall be subjected to hydraulic pressure test at 1.5 times the design pressure or meeting any national / international standard.

(4) All pumps shall be performance tested at the manufacturer's works. Test shall include check for vibration and noise levels also. Procedure for performance testing shall be submitted to Employer for approval.

(b) **Oil purifiers.**

(1) All pressure parts will be subjected to hydraulic pressure test.

(2) Components/parts of the equipment shall be subjected to suitable NDT depending upon the criticality of the application to ensure freedom from surface and sub surface defects.

(3) All rotating parts like bowl assembly etc., shall be subjected to static and dynamic balancing test. In case of coalescer type oil purifier balancing test is not applicable.

(4) The complete purifier shall be tested at manufacturer's works for capacity, mechanical running sequential operation and interlocks, moisture content(if not covered under Type Test clause of technical specification), vapour tightness, vibration, noise level, quality improvements etc.

(c) REFER RELEVANT CLAUSES OF THE SPECIFICATION FOR OTHER ITEMS SUCH AS PIPING, HEAT EXCHANGERS, VALVES, FILTERS, BLOWERS / EXHAUSTERS ETC IN THIS SYSTEM.

1.03.00 **CONDENSERS FOR MAIN TURBINE AND DRIVE TURBINE:-**

1.03.01 **WATER COOLED CONDENSERS FOR MAIN TURBINE AND DRIVE TURBINE (IF OFFERED)**

(A) SHELL, HOTWELL, WATER BOXES, DOORS AND TUBESHEETS

(a) All welds shall be visually examined. Radiographic examination of 10% of butt welds shall be carried out. However, for vacuum containing welds, R.T. on at least 10% of each butt weld shall be carried out. Surface defect examination by magnetic particle inspection or equivalent test method shall be carried out for minimum 10% weldments. This shall apply to site welds also.

(b) All edge preparations shall be examined for surface defects. Edge preparation for welds to be carried out at site shall be checked by magnetic particle inspection/Dye penetrant examination method before despatch.

(c) In case of fabricated flanges, welds shall be checked by 100% radiographic/ultrasonic and 100% magnetic particle inspection methods to ensure freedom from internal and surface defects.

(d) To ensure dimensional control of condenser, parts\sub assemblies shall be trial assembled at shop. BIDDER shall furnish his proposal in this regard, which will be subject to Employer's approval. The extent/need for trial Assembly of various parts of Condenser / sub assemblies like Water Box, Water Chamber, Hotwell, Main Tube plate and support plate, its alignment and trial insertion of few tubes etc. shall be as per Manufacturers standard established practices. Such established practices shall be furnished to NTPC during finalization of quality plan.

(e) Bidder to furnish his practice regarding stress relieving of the water boxes and water chambers.

(B) TUBES

Condenser Tubes shall be tested as per the requirements of relevant codes and standards.

1.03.02 **AIR COOLED CONDENSERS FOR MAIN TURBINE AND DRIVE TURBINE (IF OFFERED)**

(A) FABRICATION OF CONDENSER AND ACCESSORIES

(a) All welds shall be visually examined. Radiographic examination of 10% of butt welds shall be carried out. However, for vacuum containing welds, R.T on at least 10% of each butt weld shall be carried out. Surface defect examination by magnetic particle inspection or equivalent test method shall be carried out for minimum 10% weldments. This shall apply to site welds also.

(b) All edge preparations shall be examined for surface defects. Edge preparation for welds to be carried out at site shall be checked by magnetic particle inspection/Dye penetrant examination method before despatch.

(c) In case of fabricated flanges, welds shall be checked by 100% radiographic/ultrasonic and 100% magnetic particle inspection methods to ensure freedom from internal and surface defects.

(B) FAN

(a) Ultrasonic Test shall be carried out on shaft material diameter ≥ 40 mm.

(b) Fan hub and fan blade shall be tested as per relevant material code requirement and shall be tested for internal defects as per relevant code.

(c) Moment weight test on blades, blade track variation, tip clearance shall be checked.

(d) In case of fabrication of hub and blades by welding, the weld joint shall be tested by RT.

(e) Assembly fit up and balancing shall be checked.

(C) GEAR BOX

(a) Gear box shall be tested as per relevant standard for performance, noise, vibration etc.

(b) Gear box shall be tested for no load run test for 4 hours.

(D) MOTOR

The respective specification covered elsewhere is to be referred.

(E) PIPING

(a) All piping joint shall be tested for 10% RT/UT. IBR code regulations 1950 shall be ensured for IBR piping and relevant original IBR certificates shall be furnished.

(F) TUBES

(a) Condenser tubes/finned tubes shall be tested as per the requirements of relevant codes and standards.

1.03.03 **Steam Throw Off Device (If Offered)**

(a) Edge preparations shall be examined for surface defects by MPI/DPT. 10% radiographic or ultrasonic examination shall be carried out for all weldments.

(b) Welds shall be subjected to surface defect examination by 10% magnetic particle/dye penetrant examination.

1.03.04 **SPRING ASSEMBLY (If Offered)**

(a) Static load testing of the springs shall be carried out and spring characteristics shall be drawn and verified.

(b) Surface defect test shall be carried out on all the springs after coiling and heat treatment.

(c) Surface cleaning shall be checked prior to painting and check for thickness of painting shall be carried out.

1.04.00 **Condenser Air Evacuation System For Main Turbine Condenser And Drive Turbine Condenser**

1.04.01 **Pumps**

(a) Vacuum pump shafts shall be subjected to ultrasonic test. After finish machining, shaft shall be subjected to magnetic particle examination/dye penetration test.

(b) Pump casings and impellers shall be subjected to magnetic particle/dye penetration test. Finished pump rotor shall be subjected to dynamic balancing.

(c) Pump casings shall be subjected to hydraulic test at 1.5 times the shut off pressure or twice the maximum operating pressure, whichever is higher.

(d) Each pump shall be tested at supplier's works at full speed and load conditions to demonstrate successful operation and performance in accordance with the design requirements.

(e) Supplier shall demonstrate by carrying out visual cavitation test that pump will be operating under all operating condition including blank off condition without cavitation.

(f) REFER RELEVANT CLAUSES OF THE SPECIFICATION FOR OTHER ITEMS SUCH AS HEAT EXCHANGERS, FILTERS, PIPING, VALVES, ETC. IN THIS SYSTEM.

1.04.02 The complete package shall be subjected to hydraulic pressure and leakage test and shop tested to check interlocks and functional requirements. The one complete unit shall also be subjected to demonstrate successful operation and performance testing, with saturated air conditions at condenser design vacuum point as well as vacuum pump design point with total minimum three points. The test should be conducted with the respective motors to be supplied. The test shall include check for vibration and noise level.

1.05.00 **FEED WATER HEATERS, DRAIN COOLERS, GLAND STEAM CONDNSER, HEAT EXCHANGERS & PRESSURE VESSELS/ STORAGE TANKS**

1.05.01 All raw materials used shall have co-related mill test certificate meeting mandatory and supplementary checks of material specification.

1.05.02 Material for Tube plates shall be ultrasonically tested. Finished plates shall be subjected to suitable NDT. For cladded plates, bonding shall be checked by UT. Vendor shall furnish their practice regarding manufacturing & NDT for supply of cladded plates for Employer's review. Drilled Tube plates shall be checked for ovality of holes, ligaments, surface finish etc.

1.05.03 Dished ends shall be subjected to 100% MPI and RT/UT on welded joints. Knuckle portion shall be checked by MPI for surface defects and thinning shall be checked by UT.

1.05.04 Butt Welded / Full penetration joints shall be checked by suitable RT / UT. Fillet welds shall be checked by MPI / DPT.

1.05.05 Tubes shall be tested as per the relevant codes / specification / standards.

1.05.06 Before tubes expansion in the tube sheets, the mock-up test for expansions shall be carried out, in case not done earlier. Torque setting of expander shall be based on mock up tests. Joints shall be checked for tube thinning.

1.05.07 Completed assemblies shall be pressure tested with working-fluid/ hydraulically/ pneumatically. The heat exchangers shall be tested on both tube side and shell side. After hydro test, the heat exchangers shall be suitably dried and nitrogen capped. Atmospheric tanks shall be tested for leakage by water fill test for at least 12 hrs.

1.06.00 **PIPING, BELLOWS AND THERMAL INSULATION FOR TURBINE & AUX SYSTEMS**

1.06.01 **Piping and Fittings**

(a) All raw materials used shall have co-related mill test certificate meeting mandatory and supplementary checks (as required to meet statutory

requirement and elsewhere asked in the specification) of material specification.

(b) All pipe lengths shall be subjected to 100% ultrasonic examination or hydraulic tests and UT/RT on longitudinal welds at the tube mill.

(c) All mother pipes used for fittings shall be subjected to a hydraulic test or an ultrasonic test at the tube mill. Raw material of all forged fittings shall be ultrasonically tested. Forged fittings shall be ultrasonically tested.

(d) Welded and cast fittings, if any, shall be subjected to suitable NDT as per applicable standards. However, as a minimum 100% RT shall be carried out on all alloy steel fittings and on carbon steel fittings for use above 71 bar design conditions.

(e) The edge preparation for shop and site welds shall be checked by MPI/LPI however edge preparation in stainless steel alloy/ steel shall be subjected to a Dye penetrant check.

(f) Thickness of pipe bends shall be checked by ultrasonic or other acceptable methods on sample basis for high pressure applications. Outer surface of bends shall be subjected to magnetic particle examination / LPI.

(g) Non-destructive examination of welds shall be carried out after post weld heat treatment, if any.

(h) Non-Destructive Examination of welds shall be carried out in accordance with the relevant design/manufacturing codes. However, as a minimum, the following requirements shall be met (except for oil piping). Further statutory requirement, wherever applicable shall also be complied with.

(1) **Temperature > 400^{0}C And / Or pressure exceeding 71 bar.**

(i) 100% RT/UT on butt welds and full penetration branch welds.

(ii) 100% MPE.

(2) **Temperature > 175^{0}C up to 400^{0}C AND / OR pressure exceeding 17 bar and up to 71 bar.**

(i) 100% RT / UT on butt welds and full penetration branch welds for pipe dia more than 100 NB.

(ii) 10% RT / UT on butt welds and full penetration branch welds for pipe dia up to 100 NB.

(iii) 100% MPE.

(3) Wherever SR/PWHT is envisaged, above NDTs shall be after SR/PWHT.

(4) For all other pipes not covered above (except oil piping), shall be subjected 100% MPE / DPT in case of under ground pipes and 10% MPE/DPT in case

of piping above the ground. Further, 10% of butt welds of underground piping shall be subjected to RT.

(5) Hardness survey of welds shall be carried out on alloy steel/stainless steel piping. (100% Hardness survey of welds on P91, X20 & X22 material grade pipings).

(6) For welds in P91, X20 & X22 materials, only induction type of heating shall be deployed for heat treatment.

(i) Oil piping shall be subjected to following NDT.

(1) Butt welds of Oil piping shall be subjected to 10% RT and 10% DP Test. For Jacking oil lines 100% RT & 100% DPT shall be carried out on butt welds.

(2) Fillet welds with load transfer shall be subjected to 100% MPE/DPT and fillet welds without load transfer shall be subjected to 10% MPE/DPT.

(j) Rubber lined pipes shall be hydraulically tested before rubber lining. All rubber lining is to be subjected to following tests as per IS-4682 part-I or acceptable equivalent:

(1) Adhesion test

(2) Check for resistance to bleeding

(3) Measurement of thickness

(4) Shore hardness test

(5) Visual examination and spark test at 5 KV/mm of thickness.

1.06.02 **Metallic Expansion Bellows**

(a) Hydraulic pressure test shall be carried out on each pipe and expansion bellow.

(b) Longitudinal butt weld on bellow shall be subjected to suitable NDT examination before forming, and after forming MPE / DP test shall be carried out.

(c) All welds shall be subjected to 100% magnetic particle/dye penetrant check and butt welds shall be subjected to 100% radiographic testing.

(d) All the bellows subjected to vacuum service shall be subjected to vacuum test.

(e) The bellows shall be subjected to movement test to establish suitability to perform satisfactorily in site conditions. During this test spring rate shall also be measured.

(f) Life cycle test, meridional yield rupture test and squirm test to be carried out on a prototype/expansion bellow as per Sec.D clause 3.2 of standards of Expansion joint Manufacturer Association (EJMA). In case these tests have already been accepted by NTPC on a prototype expansion bellow, as defined in Sec.D Clause 3.2 of Expansion Joints Manufacturers Association (EJMA) test reports may be furnished by manufacturer for consideration and approval of Employer.

1.06.03 **Rubber Expansion Joint**

(a) Rubber compound test slab after vulcanising shall be tested for tensile strength, elongation and shore hardness. Tests on rubber compound shall also include hydro stability test as per ASTM D-3137 and ozone resistance test as per ASTM D- 380.

(b) Fabric strength of synthetic fibre for reinforcement shall be checked, and test for rubber to fabric adhesion as per IS: 3400/ASTM D- 413, rubber to metal adhesion as per IS 3100/ASTM D-429 shall be carried out.

(c) All expansion joints in assembled condition shall be subjected to vacuum test at 730 mm Hg below atmospheric pressure under conditions to ensure its suitability to withstand deflection in each axial transverse and longitudinal direction. Duration of test shall be of minimum 10 minutes.

(d) All bare bellows shall be subjected to hydraulic pressure test in normal condition at 1.5 times the design pressure for duration of 30 minutes. Additionally, all bare bellows shall be subjected to deflection tests under pressure, pressure being raised from zero to the design value in regular steps and deflection measured at each step.

(e) All expansion joints in assembled condition along with control rod assembly shall be subjected to deflection test under design pressure. The details of test procedure shall be subjected to approval by Project Manager.

(f) Either during the hydraulic test or during the vacuum test, change in circumference at the top position of the arch shall not exceed 1.5% of measured circumference at normal position.

(g) Twenty Four (24) hours after the above tests, the permanent set (variation in dimensions with respect to its original dimension) shall be measured and recorded. The permanent set shall not be more than 0.5%.

(h) Life cycle test shall be carried out on bellows of each type, design and size. In case these tests have already been accepted by NTPC in earlier projects for the same type / size /design, test certificate for the same may be furnished for approval of Employer.

1.06.04 **THERMAL INSULATION**

(a) For mineral wool insulation, testing shall be carried out as per relevant standard.

(b) For sprayed mineral wool, testing shall be carried out as per relevant standard.

(c) Thermal conductivity (k value) shall generally be measured in line with relevant standard.

1.06.05 **Hangers and Supports**

(a) Forged components such as clevis, turnbuckle, eye- bolts, coupling etc. will be subjected to material testing, hardness, MPE, proof load test etc.

(b) Dampers with viscous fluids will be checked for viscosity of liquid used, damping resistance of the damper, stiffness of the damper etc.

(c) Springs used for variable constant load and spring hangers shall be checked for chemical, mechanical and spring rate tests.

(d) Complete variable and constant load spring cage will be subjected to performance test and load/deflection test. Calibration of spring cages shall be done at shop.

1.07.00 **VALVES**

1.07.01 Inspection and testing requirements for valves other than extraction line valves and butterfly valves shall be as follows:-

(a) Pressure retaining parts of valves shall be subjected to NDT as per Table 1.

(b) Bar stock/forging above 40mm diameter for valve trim shall be subjected to UT.

(c) Hardened/stellitted valve disc and seat are to be subjected to LPI and hardness check (on test sample).

(d) Colour matching of valve disc/plug and seat shall be carried out to ensure contact.

(e) Hydraulic pressure test and seat leak test shall be carried out as per ANSI 16.34.

(f) Air seat leak test shall be carried out as per applicable Standards/Codes.

(g) Functional testing shall be carried out on each valve to check the following as per the approved valve data sheet:

(1) Smooth operation
(2) Valve travel, closing and opening time.
(3) Current drawn by actuators..

(h) Springs for safety valves shall be tested with suitable NDT and for spring rate.

(i) Safety and safety relief valves shall be tested for performance.

TABLE-1
NDT REQUIREMENTS FOR PRESSURE RETAINING COMPONENTS OF VALVES

Valve size NB in mm	ANSI Class upto 300	ANSI Class above 300 upto 600	ANSI Class above 600 below 900	ANSI Class 900 & above & below 4500
Less than 50	Visual	Visual	Visual	MPI
50 & above but below 100	Visual	Visual	MPI	MPI & RT (on 10% of valves on 100% area)
100 & above but less than 300	Visual	MPI	MPI & RT (on 10% of valves on change of section & weld ends)	MPI & RT (on 100% area)
300 and above	MPI	MPI	MPI & RT (on change of sections & weld ends)	MPI, RT (on 100% area)

Note:

(i) For body and bonnet forgings UT with MPI may be adopted in place of RT. For austenitic steel MPI may be replaced by LPI.

(ii) Weld Edge Preparation shall be subjected to MPI/LPI

1.07.02 **Extraction Line Valves**

(a) Surface crack examination and hardness check (on test sample) shall be carried out on all hard faced/stellieted surfaces, if any.

(b) As a minimum requirement of castings for all valves on cold reheat and extraction lines shall be subjected to 100% MPI on all areas and RT on Butt Weld ends and change of Section. For forgings minimum requirement shall be 100% UT and 100% MPI.

(c) Bar stock for valves stem shall be subjected to UT. Finish machined valve stem shall be subjected to magnetic particle examination/dye penetration test.

(d) Wall thickness measurement by ultrasonic for critical and highly stressed zones of the casting/forging shall be carried out.

(e) Colour matching of the valve disc and seat to ensure required contact area shall be carried out.

(f) Hydraulic pressure tests shall be carried out on each valve to check body and bonnet strength. Seat leakage and back seat leakage test (wherever

applicable) shall be carried out. Air seat leakage test shall also be carried out. Minimum test requirements of pressure shall be as per ANSI B 16.34.

(g) Functional testing shall be carried out on each valve to check for freedom of movement, adherence to clearance, opening/ closing etc.

1.07.03 **Butterfly valves**

(a) Valve disc shall be checked for surface and sub-surface defects by magnetic particle examination.

(b) Stubs and driving shafts shall be tested for internal defects by ultrasonic method.

(c) Dye penetration test shall be carried out on shafts, seat rings etc.

(d) Test samples for rubber seal shall be subjected to tensile and hardness test for vulcanising and after ageing. Hydraulic stability test and ozone crack resistance tests also be carried out.

(e) Valve shall be subjected to hydraulic pressure test for body and air seat leakage tests as per AWWA-C504/IS 13095.

(f) Proof of design tests for valves and actuator shall be carried out as per AWWA-C504/IS 13095. In case the test has already been carried out on previous supplies, the contractor may submit the test certification of same for approval of Project Manager.

(g) After complete assembly each valve with actuator will be subjected to performance test by opening and closing the valve from fully closed to fully open position and the reverse, under no flow for at least 25 cycles to check.

(1) Smooth uninterrupted movement of valve.

(2) Closing and opening time.

(3) Current drawn by actuator.

(4) Operation of tripping switch and position indicator.

(h) After assembly, one valve of each size with respective actuator shall be shop operated over the full range of movement in both the directions, with the body subjected to the full hydrostatic pressure conditions, to demonstrate that the unit is in working order without any leakage through the joints and torque switches/clutches, limit switches are operating satisfactorily. During the test, hand wheel operation, opening/closing time and current drawn shall also be checked.

1.08.00 **MISC. ITEMS / EQUIPMENTS**

1.08.01 **FILTERS / STRAINERS**

(a) Filters / strainers shall be tested as per the requirements of relevant codes / standards.

(b) Filters / strainer shall be performance tested for pressure drop, flow, particle size. If performance test is earlier established, then records shall be reviewed.

1.08.02 **BLOWERS/ EXHAUSTERS**

(a) Rotors shall be dynamically balanced. Leakage tests (if applicable) shall be carried out.

(b) Performance tests including noise and vibration tests shall be carried out as per relevant standards / codes.

1.08.03 **LP CHEMICAL DOSING SYSTEM**

(a) Pumps of chemical doing system shall be performance tested as per relevant international codes.

(b) In case of diaphragm type of pumps, the life cycle test shall be done on pumps. If this test is already conducted for same model in earlier projects of NTPC, then TCs for same shall be reviewed.

(c) Dosing skid shall be subjected to leakage test and functional test.

1.09.00 **Electrical and Control & Instrumentation:**

Refer Electrical and Control & Instrumentation Sections of QA&I specification.

1.10.00 **SITE TEST:**

Quality requirements for site activities shall be as a minimum, those specified for corresponding shop activities.

1.10.01 **Hydraulic Test of Pressure Parts:**

On completion of erection of pressure parts of each steam turbine generator, the unit with its fittings and mountings in position coming under purview of IBR shall be subjected to hydraulic test pressure in accordance with requirement of Indian Boiler Regulations. Water used for hydraulic test shall be made alkaline by addition of suitable chemical. After the test, all parts shall be drained and suitably preserved.

1.10.02 **Condenser Assembly- Water Cooled (If Offered):**

(a) If the condenser sections calls for site assembly, care shall be taken in assembly of sections and correctness of alignment and fit up shall be checked. Site welding shall be carried out as per the procedure approved by the Project Manager.

(b) All weld seams shall be subjected to DPT/MPI. At least 10% of butt welds shall be subjected to radiographic examination.

(c) All welds between condenser neck and LP turbine shall be subjected to 100% radiographic and magnetic particle examination.

(d) Condenser tubes shall be visually examined for dents, mechanical damages or any other defects prior to insertion. Both tube ends shall be thoroughly cleaned to a length of 100mm to remove oil, grease etc. and shall be checked for freedom from burrs prior to insertion.

(e) Tube expansion shall be carried out by electronic automatic torque control expanding unit, which shall be calibrated before use. Tube wall thinning and length of expansion shall be controlled and recorded.

(f) Hydrostatic testing of condenser steam space shall be carried out after connecting all the pipes with the condenser along with condenser vacuum systems by filling the steam space with water 300mm above final joint of condenser exhaust neck to the turbine. The level of hydraulic test shall be selected such that all the field welding joints are covered in the test. Any leakage detected shall be rectified immediately.

(g) Condenser water boxes shall be tested hydraulically at a minimum test pressure of 1.3 times the design pressure.

1.10.03 **Condenser Assembly-Air Cooled (If Offered):**

(a) If the condenser sections calls for site assembly, care shall be taken in assembly of sections and correctness of alignment and fit up shall be checked. Site welding shall be carried out as per the procedure approved by the Project Manager.

(b) All weld seams shall be subjected to DPT/MPI. At least 10% of butt welds shall be subjected to radiographic examination.

(c) All welds between condenser hot box and LP turbine shall be subjected to 100% radiographic and magnetic particle examination.

(d) Condenser tube bundles shall be visually examined for dents, mechanical damages or any other defects prior to insertion. Both tube ends shall be thoroughly cleaned to a length of 100mm to remove oil, grease etc. and shall be checked for freedom from burrs prior to insertion.

(e) Water Fill test / Hydrostatic testing / pneumatic test as applicable for condenser hot box space, tube bundle with header and associated parts of ACC shall be carried out after connecting all the pipes along with condenser vacuum systems such that all the field welding joints are covered in the test. Any leakage detected shall be rectified immediately.

(f) Performance test (including flow, pressure, noise, vibration and alignment etc.) of Fan/Compressor as applicable shall be tested at site.

1.10.04 **TURBINE ASSEMBLY**

Bidder shall clearly indicate the extent of assembly to be carried out at site. Accordingly, bidder shall submit elaborate erection and assembly inspection programme of turbine for Employer's approval

SUB-SECTION– E-09
CONDENSER ONLINE TUBE CLEANING SYSTEM

1.00.00 **CONDENSER ON LOAD TUBE CLEANING SYSTEM/DEBRIS FILTER FOR MAIN TURBINE CONDENSER AND DRIVE TURBINE CONDENSER (IF OFFERED)**

1.01.00 **General Requirements**

Refer QA & I portion of General Technical conditions of technical specification.

1.01.01 **Ball Recirculation Pump**

(a) All rotating parts shall be dynamically balanced.

(b) Pump casing shall be subjected to hydraulic test at 1.5 times the shut off head or twice the maximum working pressure whichever is higher.

(c) Complete pump assembly shall be subjected to shop performance test at supplier's works.

1.01.02 **Ball Sorter / Fabricated Body (housing)**

(a) In the case of fabricated design, all butt welds shall be subjected to 10% radiographic/ultrasonic examination. All welds shall be examined by 10% magnetic particle testing method to ensure freedom from surface and sub-surface defects.

(b) Body shall be subjected to hydraulic pressure test at 1.5 times the design pressure.

(c) Performance test shall be carried out on ball sorter assembly.

1.01.03 **Strainer**

(a) Strainer mesh shall be checked for chemical composition and mesh size.

(b) Strainer body shall be subjected to hydraulic pressure test at 1.5 times the design pressure.

(c) Strainer assembly shall be checked for its function.

1.01.04 The complete system and the individual equipment shall be subjected to performance testing at Site to demonstrate successful operation and performance to meet the design conditions. The tests shall also include hydraulic test, function test, check for interlocks and sequential operation. Site test shall also include test to establish pressure drop across the strainer section, proper functioning of DELTA-P system.

1.01.05 **Piping and Fittings**

Piping and fabricated fittings shall be subjected to following NDT.

(a) Butt welds of piping shall be subjected to 10% RT and 10% DP Test. Butt welds of Segmental flanges shall be checked by 100% RT and DPT.

(b) Fillet welds with load transfer shall be subjected to 100% MPE/DPT and fillet welds without load transfer shall be subjected to 10% MPE/DPT.

Wrought/ forged fittings shall be tested as per relevant code/ specification/ standard.

1.01.06 **Coating / lining**

1.01.07 Coating shall be checked for DFT and adhesion. Further, Contractor shall furnish his practice for testing of coating to ensure the uniformity and freedom from pinholes.

1.01.08 Rubber lined items shall be hydraulically tested before rubber lining. All rubber lining is to be subjected to following tests as per IS-4682 part-I or acceptable equivalent:

(a) Adhesion test

(b) Check for resistance to bleeding

(c) Measurement of thickness

(d) Shore hardness test

(e) Visual examination and spark test at 5 kv/mm of thickness.

1.01.09 **VALVES**

Conventional gate/ globe/ check/ ball valves shall be tested as per relevant standard.

1.02.00 **ELECTRICAL AND CONTROL & INSTRUMENTATION: Refer Electrical and Control & Instrumentation Sections of QA&I specification.**

SITE TEST: Quality requirements for site activities shall be as a minimum, those specified for corresponding shop activities.

SUB-SECTION– E-10
CONDENSATE EXTRACTION PUMPS

CONDENSATE EXTRACTION PUMP

1.00.0 CONDENSATE EXTRACTION PUMPS

	INPROCESS TESTS												FINAL TESTS				
Tests / Item/ Description	Chemical Analysis	Mechanical Prop.	Heat Treatment	Run out	U.T.	R.T.	D.P.T.	M.P.I.	Balancing	Hyd. Test	Inclusion Rating	Pressure Drop	Performance Test	NPSH Test	Vibration	Noise	Strip Down Test
	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12	13.	14.	15.	16.	17.
Pump Casing	Y	Y①	-	-	-	-	Y	-	-	Y	-						
Suction Bell	Y	Y①	-	-	-	-	Y	-	-	-	-						
Shaft	Y	Y①	Y	Y	Y	-	Y9	Y9	-	-	Y						
Impeller	Y	Y①	Y	-	-	-	Y	-	Y	-	-						
Rotor	-	-	-	Y	-	-	-	-		-	-						
Fabricated Items	Y	Y①	-	-	-	Y②	Y	-	-	Y③	-						
Strainer																	
a) Body	Y	Y	-	-	-	-	Y*	-	-	Y	-	-					
b)Assembly	-	-	-	-	-	-	-	-	-	-	-	Y**					
CEP													Y④	Y⑤	Y⑥	Y⑦	Y⑧
Elect Items													Tests as per relevant portion of specification				

(1) Chemical/ Mechanical shall be one per heat/HT batch.

(2) 10% Random on Butt Welds

(3) Pressure Containing Parts.

(4) Performance Test on each Condensate Extraction Pump to determine the characteristic curve (Head, Capacity, Efficiency & Power) at Design Speed and to ensure Compliance with design requirements specified in the specification. Measurements shall be carried out at 0%, 25%, 50%, 65%, 80%, 100% and 125% of design flow with cold water.

(5) NPSH (R) test shall be carried out on one Condensate Extraction Pump using cold water at pump flows of 25%, 50%, 80%, 100% and 125% of Design Flow at Design Speed. This shall be done at 3% head break by Suction Throttling Procedure / varying suction pressure.

(6) Vibration on all Condensate Extraction Pumps shall be measured in transverse, Horizontal and Vertical Direction at all measuring points.

(7) Noise Level on each Condensate Extraction pump shall be measured at a distance of 1.5 meter above floor level in elevation and 1 mtr horizontally from the nearest surface of the equipment as per HIS. The measurement shall be taken at six points around the equipment for each flow condition.

(8) One Condensate Extraction Pump shall be dismantled for visual inspection after completion of performance test and NPSH Test. For other Pumps strip down test shall be conducted only in case abnormal performance such as Excessive Vibration, High noise, high bearing temperature etc. is observed during performance test.

(9) DPT / MPI shall be carried out on Shaft.

CONDENSATE EXTRACTION PUMPS

Notes:

1) Quantum of In-Process Checks/ Tests is 100% until & unless specified otherwise.

2) Shop tests shall be conducted with soften Quality Water.

3) Bidder shall furnish details of proposed test procedures including test lay out, type and level of accuracy of instruments, sample calculation etc.

4) Tests shall be done in accordance with latest edition of Hydraulic Institute standard.

5) Tested Pump parameters shall be within following tolerances.

At design head : + 10% of design capacity

At design capacity: + 5% of design head (Under 152.4 meter)

+3 % of design head (for 152.4meter and above)

* In case of fabricated construction.

** One per type and size.

Results must show no minus tolerance with regard to flow and head.

No minus tolerance on efficiency or positive tolerance on power input at motor terminals shall be allowed.

SUB-SECTION– E-11
POWER CYCLE HEATERS & DEAERATOR

POWER CYCLE HEATERS & DE-AERATOR

1.00.00 DEAERATORS:

	Components / Activity \ Tests/ Checks	Chemical Analysis	Mech. Properties	Impact	Hardness	Flattening	Flaring	UT	RT	MPI	DPT	Eddy Current	Air Leak Test	SR	HT	Hydraulic	Pneumatic	Dimensions	WPS/PQR/WQR/App. Performance test	Mock up Test
1	Shell & Dished End	Y	Y	Y				Y[a]		Y[g]				Y[a]				Y[e]		
2	Fabrication/ Welding													Y				Y		
a)	Edge Preparation/ Fillet Weld									Y[b]	Y[b]									
b)	Butt Joints/ Branch Welding							Y[c]	Y[c]	Y	Y			Y				Y[d]	Y	
3	Complete Deaerator															Y		Y		
4	Safety & Safety Relief Valve & other valves	Y	Y					Y[f]	Y[f]	Y[f]	Y[f]					Y		Y[h]		

2.00.00 HEATERS:

Components / Activity \ Tests/ Checks			Chemical Analysis	Mech. Properties	Impact	Hardness	Flattening	Flaring	UT	RT	MPI	DPT	Eddy Current	Air Leak Test	SR	HT	Hydraulic	Pneumatic	Dimension	WPS/PQR/WQR/App. Performance test	Mock up Test
1	**Tube Sheet**																				Y
	a	Forging	Y	Y					Y		Y					Y			Y[i]		
	b	Plates	Y	Y	Y				Y			Y							Y[i]		
	c	Cladding							Y			Y			Y				Y[j]		
2	Shell Plates		Y	Y	Y				Y												
3	Feed Nozzle Manhole forging		Y	Y			Y[k]		Y[l]				Y[k]		Y[i]				Y		
4	**Welding / Fabrication**																				
	a	Weld Edge Preparation									Y[b]	Y[b]									
	b	Back Chipping									Y[b]	Y[b]									
	c	**Weld Joints**																			
		(i) Butt							Y[c]	Y[c]	Y	Y				Y			Y	Y	
		(ii) Fillet									Y	Y				Y			Y	Y	
		(iii) Nozzle / Branch							Y[c]	Y[c]	Y	Y				Y			Y	Y	
		(iv) Tube to tube sheet										Y		Y			Y				
5	Dished End & Hemi Head		Y	Y	Y				Y[a]		Y[b]	Y[b]			Y				Y[e]		
6	Tubes		Y	Y			Y[q]	Y[q]					Y			Y[n]	Y		Y		
7	Tube expansion in tube sheet																		Y[o]		
8	Complete Heater																Y[p]		Y		

CLAUSE NO.	QUALITY ASSURANCE

3.00.00 REMARKS FOR DEAERATORS AND HEATERS:

(a) After forming of plates. For dished end and Hemi head.

(b) DPT may be used as an alternate to MPI.

(c) UT/RT to be decided according to configuration/accessibility.

(d) (i) For plates

(ii) For welding

(iii) For wall thickness

(e) Including wall thickness

(f) (i) 100% RT/UT shall be carried out on bodies, bonnets, nozzle and stem of valves of HP heater.

(ii) 100% DPT/MPI on machined surfaces of valve body, bonnet, stem, disc & springs.

(g) Outer surface (Dished end Knuckle Portion)

(h) Including – Seat leakage

– Relieving

Capacity-popping test at set and blow down pressure

(i) Include ovality of holes, surface finish and size of holes.

(j) For cladding bond and clading thickness during bond check and after drilling

(k) For feed nozzle (pipes)

(l) For forgings

(n) After bending also

(o) Dimension to include wall thinning

(p) Both tube and shell side. After Hydro test drying and nitrogen filling to be done.

(q) As per the code.

For HP Heaters & Gland steam coolers the statutory requirements (if applicable) to be ensured as per IBR latest regulations and the certificates in original to be furnished as per IBR regulations.

Note :

(1) Sampling plan shall be as per relevant Governing/plant standard and shall be subject to mutual agreement during MQP finalization.

(2) Chem./Mech. shall be One/ per heat or HT batch.

SUB-SECTION– E-12
BOILER FEED PUMPS

BOILER FEED PUMP

1.00.00 BOILER FEED PUMPS

INPROCESS TESTS

Tests / Item/ Description	Chemical Analysis	Mechanical Prop.	Heat Treatment	Run out	U.T.	R.T.	D.P.T.	M.P.I.	Balancing	F.A.T.T.	Hyd. Test	Inclusion Rating	Pr. Drop	Dimensions	Remarks
	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	
(A) BFP + BOOSTER PUMP															
i.) Barrel Casing	Y	Y①	Y	-	Y	-	-	Y	-	-	Y	-	-	-	
ii.) Discharge Branch	Y	Y①	Y	-	Y	-	-	Y	-	-	Y	-	-	-	
iii.) Casing Cover	Y	Y①	Y	-	Y	-	-	Y	-	-	Y	-	-	-	
iv.) Suction Branch	Y	Y①	Y	-	-	-	Y	-	-	-	Y	-	-	-	
v.) Diffuser	Y	Y①	Y	-	-	-	Y	-	-	-	-	-	-	-	
vi.) Ring Section	Y	Y①	Y	-	Y	-	Y	-	-	-	-	-	-	-	
vii.) Impeller	Y	Y①	Y	-	-	Y#	Y	-	Y	-	-	-	-	-	
viii.) Shaft	Y	Y①	Y	-	Y	-	Y	Y	-	-	-	Y	-	Y	
ix.) Rotor	-	-	-	Y	-	-	-	-	Y	-	-	-	-	-	
(B) STRAINER															
i.) Body	Y	Y	-	-	-	-	Y***	-	-	-	Y	-	-	-	
ii.) Assembly	-	-	-	-	-	-	-	-	-	-	-	-	Y②	-	
(C) Gear Box AND Hydraulic coupling															
i.) Gear	Y	Y①	Y	-	Y	-	Y9	Y9	-	-	-	-	-	-	
ii.) Pinions	Y	Y①	Y	-	Y	-	Y9	Y9	-	-	-	-	-	-	
iii.) Shaft	Y	Y①	Y	-	Y	-	Y9	Y9	-	-	-	-	-	-	
iv.) Casing	Y	Y①	-	-	-	-	-	-	-	-	Y	-	-	-	
v.) Wheels	Y	Y①	Y	-	Y	-	Y9	Y9	-	-	-	-	-	-	
vi.) Assembled Rotating Component	-	-	-	-	-	-	-	-	Y	-	-	-	-	Y	
(D) RECIRCULA-TION VALVE	Y	Y①	Y	-	Y+	-	Y+	Y+	-	-	Y++	-	-	Y	

① Chemical/ Mechanical shall be one per heat/HT batch

\# On BFP Impeller as per ASTME 446 Level 2

*** In case of Fabricated Construction

② One per type and size.

\+ Type of NDE & quantum of check shall be as per relevant code & pressure class

++ Include body & seat leakage test and functional test

Note: Quantum of Checks/ Tests is 100% untill & unless specified otherwise.

FINAL TESTS

Item/ Description \ Tests	Performance Test	NPSH Test	Vibration	Noise	Pressure Pulsation	Axial thrust	Dry Running	Visual Cavitation	Strip Down Test	Mech. Run test	Other Tests		REMARKS
	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.		
BFP	① Y	② Y	③(a) Y	③(b) Y	③(c) Y	③(c) Y	④ Y	⑤ Y	⑥ Y	Y	Y		
Booster Pump	① Y	② Y	③(a) Y	③(b) Y	-	-	④ Y	-	⑥ Y	-	Y		
Gear Box	⑦ Y	-	Y	Y	-	-	-	-	-	⑧ Y			
HYD Coupling	-	-	-	-	-	-	-	-	-	⑧ Y	Y		
Drive turbine	Tests as per relevant portion of specification including Note-6												

① (a) Performance Tests on each Boiler Feed Pump to determine the characteristic curve (Head, Capacity, Efficiency & Power) at Design Speed and to ensure compliance with design requirements specified in the specification. Measurement shall be carried out at 10%, 25%, 50%, 65%,80%, 100% & 125% of Design Flow with loop water at design temperature. Performance Test at other specified Conditions shall be carried out on all Boiler Feed Pumps at their respective Speeds at design temperature.

(b) Performance Test on each Booster Pump to determine the characteristic curve (Head, Capacity, Efficiency & Power) at Design Speed and to ensure Compliance with design requirements specified in the specification. Measurements shall be carried out at 0%,25%, 50%,65%,80%, 100% and 125% of design flow with cold water.

② NPSH (R) test shall be carried out on one Boiler Feed Pump and one booster pump using cold water at pump flows of 25%, 50%, 80%, 100% and 125% of Design Flow at Design Speed. This shall be done at 3% head break by Suction Throttling Procedure.

③ (a) Vibration on all Boiler Feed Pumps and Booster Pumps shall be measured in transverse, Horizontal and Vertical Direction at all measuring points.

(b) Noise Level on each Boiler Feed Pump and Booster Pump shall be measured at a distance of 1.5 meter above floor level in elevation and 1 mtr horizontally from the nearest surface of the equipment as per HIS. The measurement shall be taken at six points around the equipment for each flow condition.

(c) Pressure Pulsation and Axial Thrust Measurement shall be carried out on one Boiler Feed Pump at all measuring points. Pressure Pulsation shall be measured at suction as well as at discharge in the operating range.

④ Dry running withstand capability shall be demonstrated and established on one Boiler Feed Pump and its corresponding booster pump. Feed pump shall be capable of

accepting complete loss of water and must be capable of being shut down in a controlled manner and brought down to rest after being tripped from design condition with simultaneous closure of suction valve. To demonstrate the capability during shop testing, suction valve actuation should be fast in order to ensure operation during vapour phase. Pump shall then be restarted and bring it back to design condition.

⑤ Deleted

⑥ Complete Strip Down of Boiler Feed Pump which under goes Performance Test, NPSH Test, Dry Run Test, etc. shall be done in order to check problems like Internal Rubbing Damage, Excessive Wear etc. One Booster Pump shall be dismantled for visual inspection after completion of performance test and NPSH Test. For other Pumps strip down test shall be conducted only in case abnormal performance such as Excessive Vibration, High noise, high bearing temperature etc. is observed during performance test.

⑦ Full load full speed/back to back locked rotor torque test for one gearbox.

⑧ Smooth operation, vibration, noise and temperature rise check on all equipment.

(9) BFP + Booster Pump , Gear Box AND Hydraulic coupling (In Process Tests): DPT /MPI shall be carried out on Gear, Pinion, Shaft & Wheel.

Note:

1) Shop tests shall be conducted with soften Quality Water.

2) Bidder shall furnish details of proposed test procedures including test lay out, type and level of accuracy of instruments, sample calculation etc.

3) Tests shall be done in accordance with latest edition of Hydraulic Institute Standard, USA.

4) Tested Pump parameters shall be within following tolerances.

At design head: + 10% of design capacity

At design capacity : + 5% of design head (Under 152.4meter)

+ 3% of design head (for 152.4 meter and above)

Results must show no minus tolerance with regard to flow and head.

No minus tolerance on efficiency or positive tolerance on power input at motor terminals shall be allowed.

5) It is preferred to carry out performance, NPSH(R) and Dry Running tests of the Boiler Feed Pump at design speed. However, in case of any constraint of manufacturer to carry out the above tests at design speed, the testing of pump at reduced speed as per HIS guidelines may be proposed to Owner for review and approval.

6) No Load Mechanical Run Test shall be carried out as per API-612.
In case MRT is not the standard practice of the bidder, the following tests are to be carried out at shop to establish that the Drive Turbine is in compliance with the design:

a) Run out checking of the complete Rotor before & after over speed test.

b) High Speed Balancing at rated speed of the complete rotor.

c) Over speed Test as per manufacturer's proven practice, however the

minimum over speed shall be 1% more than that of tripping value of the drive turbine.

d) The vibrations measured during high speed balancing and over speed shall be within the range of operating values as per manufacturer's standard.

e) The bladed rotor shall be run continuously at the maximum continuous speed for duration as per manufacturer's standard.

f) Visual inspection of the Bladed Rotor after over speeding for any abnormality.

g) Verification of radial & axial clearances between moving parts (Bladed Rotor) and stationary parts (Casing) by actual placement of Rotor in the Casing.

SUB-SECTION– E-13
RAW WATER SYSTEM

PUMPS

Items / Components \ Tests/Check		Material Test	DPT/MPI	Ultrasonic test	RT	Balancing	Hydraulic / Water Fill test	Pneumatic Test	Assembly/ fit up	Dimensions	Functional/operational Test	Performance Test	Other Test	All Test as per relevant Std/ Approved Data Sheets	Remarks
A.	**PUMPS:**								Y[1]	Y		Y[2]			
1	Shaft	Y[a]	Y[b]	Y[c]		Y				Y					
2	Impeller	Y[a]	Y[b]		Y[3]	Y							Y[d]		
3	Suction Bell / Bowl Castings/ Inserts	Y[a]	Y[b]				Y			Y			Y[6]		
4	Discharge Head / Column Pipes / Distance Piece/Base Plate	Y[a]	Y[b]	Y[c]	Y[4]		Y		Y						
5	Companion Flanges	Y[a]	Y[b]	Y[c]	Y[5]				Y						
5	Thrust Bearing (Tilting Pad type)	Y[a]	Y	Y					Y	Y				Y	

Notes:

a	One per Heat/ Heat Treatment Batch/ Lot.
b	On machined surfaces only for Castings / Forgings and on Welds of Fabricated Components.
c	For Shaft diameter ≥ 40 mm and for plate thickness ≥ 25 mm
d	Inter Grannular Corrosion (IGC) Test shall be carried out on SS Castings.
1	Trial assembly of all Vertical Turbine Pump components with Column Pipes, Discharge Head, and Motor Stool shall be carried at shop.
2	Performance testing of Pumps shall be carried out at shop, as per HIS standard to determine Head & Flow Characteristics.
3	If applicable as per Engineering specification or relevant standard
4	Random 10% RT to be conducted on butt welds for Thk ≥ 10 mm & ≤ 25 mm and 100% RT to be conducted on butt welds for Thk > 25 mm (RT may be replaced by Ultrasonic Test due to constraint if any.) Stress relieving shall be carried out as per norms of ASME Section VIII.
5	Segmental Flanges exceeding 37.5 mm thickness shall be stress relieved after welding. All butt weld joints in segmental flange shall be examined by Radiographic Test. (RT may be replaced by Ultrasonic Test due to constraint if any.) Maximum number of segments shall be 4 only.

No repair welding is permitted on Cast Iron / Alloy Cast Iron Castings.

CRANES AND HOISTS

HOOKS

All Tests including Proof Load Test as per relevant IS shall be carried out. MPI / DPT shall be done after proof load test.

STEEL CASTINGS

DPT on machined surface shall be carried out.

GIRDERS, END CARRIAGE, CRAB, GEAR BOX AND ROPE DRUM

UT shall be carried out on plates of thickness 25 mm and above as per ASTM A 435

NDT requirements on weldments shall be as follows

i.	Butt Welds in Tension	100% RT & 100% DPT
ii.	Butt Welds in Compression	10% RT & 100% DPT
iii.	Butt Welds in Rope Drum	100% RT & 100% DPT
iv.	Fillet Welds	10% DPT

FORGINGS (Wheels, Gears, Pinions, Axles, Hooks, & Hooks Trunion)

All forgings greater than or equal to 40 mm diameter or thickness shall be subjected to ultrasonic testing (UT).

DPT / MPI shall be carried out after hard-facing and machining. Hardness and Case depth shall be measured

WIRE ROPES

Wire ropes shall be tested as per relevant standard.

REDUCTION GEARS

Reduction Gears shall be tested for reduction ratio, backlash and contact pattern. Gearbox shall be subjected to No load run test for 4 hours to check for oil leakage, temperature rise, noise and vibration.

Chemical and Mechanical test of all components as per relevant material specification shall be carried out.

COMPLETE CRANE

The crane shall be completely assembled at shop for final testing. All tests as per IS 3177 shall be carried out at shop.

HOISTS

All Electric Hoist shall be tested as per IS 3938 and chain pulley blocks shall be tested as per IS 3832.

PIPES, VALVES, FITTINGS AND SPECIALITIES

	Tests/Check / Items / Components	Material Test	DPT/MPI / RT	Ultrasonic Test	WPS/ WQS/PQR	Hydraulic / Water Fill Test	Pneumatic Test	Assembly Fit up	Dimensions	Functional/operational Test	Other Tests	All Tests as per relevant Std	REMARKS
1	Pipes & Pipe Fittings	Y[a]	Y[b]			Y[1]			Y			Y	
2	Diaphragm Valves	Y[a]				Y[5]			Y		Y[6]		
3A	Cast Butterfly Valves					Y		Y	Y	Y	Y[7]		
	Body	Y[a]	Y[b]										
	Disc	Y[a]	Y[b]										
	Shaft	Y[a]	Y	Y[c]									
	EH Actuators	Y[a]	Y				Y	Y	Y		Y		
3B	Fabricated Butterfly Valves	REFER NOTE 14											
4	Gate/ Globe/Swing Check / Ball Valves	Y[a]	Y[b]	Y[c]		Y[5]	Y	Y	Y	Y	Y[8]		
5	Dual Plate Check Valves	Y[a]	Y[b]	Y[c]		Y	Y	Y	Y	Y	Y[4]		
6	Rolled & Welded Pipes and Mitre Bends	Y[a]	Y[3]		Y	Y[3]			Y		Y[3&15]	Y	
7	Coating & Wrapping of Pipes	Y[2]									Y[2]		
8	Tanks & Vessels	Y[a]	Y[b]		Y	Y			Y		Y[16]		
9	Strainers	Y[a]	Y[b]		Y#	Y					Y[11]		#For Fabricated
10	Rubber Expansion Joints	Y[a]				Y[12]		Y	Y		Y[13]		
11	Internal Lining of Pipes	Y[a]							Y		Y[9]		
12	Site Welding		Y [10]		Y	Y					Y17		
13	Flexible Hoses	Test shall be carried out as per relevant standard.											

	NOTES (MEANING OF SUPERSCRIPTS)
a	One per heat/heat treatment batch/lot.
b	On machined surfaces only for castings and on butt welds.
c	For shaft/spindles > or = 40 mm
1	100% Hydraulic test shall be carried out. Weld joints not subjected to hydraulic test due to some unavoidable reasons, shall be subjected to 100% RT/PAUT.
2	Spark Test, Adhesion Test and Material Test for primer and enameled & Coal Tar Tapes as per AWWA-C-203-91/ IS-10221 & IS 15337 as applicable.
3	Followings are the testing requirements for fabrication of pipes at site

	TESTS	**TESTS**
	WPS, PQR, Welder Qualification Test	WPS, PQR, Welder Qualification Test
	DPT on root run	DPT on root run
	DPT after back gauging	DPT after back gauging
	RT / UT by TIME OF FLIGHT DEFRACTION (TOFD)/PAUT Technique	RT / UT by TIME OF FLIGHT DEFRACTION (TOFD)/PAUT Technique

	DPT on finished butt weld joints	10%
	Hydraulic Test	100%, 1.5 times the design pressure or 2 times the working-pressure whichever is higher
4	Dry Cycle Test on Dual Plate Check valve spring for one lakh Cycles shall be carried out as a type test. If Dry Cycle test carried out earlier for same material & diameter, Test report shall be submitted for review as applicable.	
5	Seat Leakage Test for Actuator Operated Valves, shall be done with by closing the valves with actuator.	
6	Tests on rubber parts shall be conducted per batch of rubber mix for tensile, Elongation, hardness, adhesion, spark test, bleed resistance test. In addition, type test for 50,000 cycles of each type of diaphragm shall also be conducted.	
7	Hydraulic Test of Body, Seat and Disc strength shall be carried out in accordance with latest edition of AWWA C-504. Actuator operated Valves shall be checked for Seat Leakage by closing the Valve with Job Actuator. Seat Leakage test shall be carried out in both directions. For Proof of Design Test refer respective chapters of engineering portion in the technical specification.	
8	Blue matching, wear travel for gates, valves, pneumatic seat leakage, and 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. Fire safe test for ball valve shall be done wherever specified. In case of already carried out, the test report shall be submitted for review as applicable. Functional checks of the valves for smooth opening and closing shall also be done. Valves shall be offered for hydro test in unpainted condition. Anti-corrosive protection shall be tested as per applicable code.	
9	Tensile, Elongation, Hardness, Specific Gravity, Lining Thickness, Humidity Check, Pipe temperature check, Adhesion Test and Holiday Detection Test etc as per applicable standard shall be done for all lining material and application.	
10	10% of welds (Root and finished welds) shall be subjected to DPT. (100% DPT for compressed air line and boiler & deaerator fill line.)	
11	All fabricated strainers shall be subjected to Welding Checks & NDT checks as per design standard requirements. Pressure drop across the strainer for each type and size as a special test shall be carried out. In case of already carried out, the test report shall be submitted for review as applicable.	
12	During Hydraulic & Vacuum test at 30 mm Hg absolute in 3 different positions, the change in Circumference of the Arch should not be more than 1.5%. Permanent Set, after 24 hours of the test, should not exceed 0.5% of Arch.	
13	Tests on rubber for tensile, elongation, hardness, hydraulic stability check as per ASTM D 471, ozone resistance test as per ASTM D 1149/IS 3400 Part 20 aging test and adhesion strength of rubber to fabric, rubber to metal adhesion shall be carried out.	
14	In addition of all tests as indicated for Cast Butterfly valve being applicable for fabricated butterfly valves, following test shall be done for Fabricated Butterfly Valve: a. UT as per ASTM A-435/IS 11630 & IS 4225 on plate material for body and disc shall be carried out for plate thickness 25mm and above. b. 100% RT and DPT as per ASTM, Section-VIII, Division-I, on butt joins of thickness 20mm & above of body and disc. 10% DPT on other welds shall be done. c. Post weld heat treatment as per ASME, Section-VIII, Division-I on butt joints of body and disc. d. Welders and WPS shall be qualified as per ASME- section IX	
15	Maximum number of segments in segmental flanges shall be four (04) only. All butt weld joints in the segmental flanges shall be examined by RT/UT. Segmental flanges exceeding 37.5 mm thickness shall be stress relieved as per norms of ASME Section VIII after welding	
16	For pressure vessel welds, RT shall be done as per design code requirements.	

All Valves shall be offered for inspection in unpainted condition.

No repair welding is permitted on Cast Iron / Alloy Cast Iron Castings.

LAYING/ERECTION OF PIPES

(1) Followings are the Quality Assurance Requirements for laying of 3 LPE Coated MS Pipes

A RECEIPT OF ITEMS AT SITE

Check for completeness of supply and visual check for damage of followings after receipt at site:

i. 3 LPE Coated MS Pipes, fittings, flanges, couplings, bolts and nuts, fasteners, plugs, sleeves etc.

ii. Welding electrodes, filler rods & wires, gases like oxygen, acetylene, argon, carbon di-oxide, propane etc.

iii. X-ray & gamma ray equipment, dye penetrants, RT films,

iv Epoxy Primer, Paint, Heat Shrinkable Sleeve, Coating and wrapping material

B STORAGE

Check for proper storage of following items as per manufacturer recommendations / storage guideline

i. 3 LPE Coated MS Pipes, fittings, flanges, couplings, bolts and nuts, fasteners, plugs, sleeves etc.

ii. Welding electrodes, filler rods & wires, gases like oxygen, acetylene, argon, carbon di-oxide, propane etc.

iii. X-ray & gamma ray equipment, dye penetrants, RT films.

iv. Epoxy Primer, Paint, Heat Shrinkable Sleeve, Coating and wrapping material

C Following checks shall be carried out during Laying of 3LPE Pipes

i. Ensure proper alignment & fit up

ii. Ensure correct joining of pipes

iii. Ensure installation of supports (as applicable)

iv. Hydraulic Test of section and complete pipeline as per Engg technical specification requirements.

D JOINING OF 3 LPE COATED MS PIPES AT SITE BY WELDING

Following checks shall be carried out during joining of 3 LPE coated MS pipes at site by welding

i. Dimensional conformity

ii. Tolerance OD/ Ovality

iii. Ensure proper alignment of pipes, Edge preparation and joint fit up

iv. Ensure Tack weld by qualified welder and provision of internal bracing to keep in proper shape

v. WPS, PQR & WPQ (welder performance qualification) tests prior to welding

vi. Check for surface defects after welding (visual)

vii. 100% DPT on root run/ after back gauging/ grinding of butt weld as applicable

viii. 10% DPT on fillet weld

ix. 10% DPT on finished butt welds

x. 5% RT/ 5% UT by TOFD/PAUT techniques on those butt weld joints which can be 100% hydro tested.

xi. 100% RT / 100% UT by TOFD/PAUT technique of the butt weld joints of pipeline shall be carried out which cannot be Hydro tested.

E WRAPPING & COATING OF HEAT SHRINKABLE SLEEVE, PROCEDURE QUALIFICATION TEST

Following checks shall be carried out during Procedure Qualification Test (PQT) of application (wrapping and coating) of Heat Shrinkable Sleeve as well as during regular work (Wrapping & Coating) of Heat Shrinkable Sleeve after PQT

i. Before start of work, ensure followings

a. Use of correct raw material i.e. epoxy primer, wrap around heat shrinkable sleeve of NTPC acceptable make & grade.

b. The applicator agency deployed for the work shall have adequate experience and approved by NTPC.

c. All the butt weld joints shall have acceptable NDT (RT/UT & DPT) and Hydraulic test records.

ii. Ensure proper cleaning and Surface preparation of butt weld joints & adjoining pipe surface as per approved procedure complying with relevant clauses of Specification.

iii. Finished Surface - Visual Examination, Measurement of Surface Roughness, Profile, dust contamination

iv. Ensure compliance of correct time interval between blasts cleaned ready pipe & coating.

v. Ensure use of correct size of Wrap around heat shrinkable sleeve on each joint

vi. Ensure adequate pre – heating of pipe

vii. Ensure application of correct epoxy primer (check make, grade, date of manufacturing, date of expiry) immediately after preheating

viii. Visual Examination & Wet film thickness measurement after epoxy primer coat

ix. Ensure application of wrap around heat shrinkable sleeve entirely around the pipe when the epoxy is still wet.

x. Ensure proper heat duration / temperature during application of heat on wrap around heat shrinkable sleeve

xi. Finished coat

a. Visual examination,

b. Measurement of coat thickness (on pipe body and on weld bead),

c. Holiday Test

d. Peel – off test

e. Overlap Test

(2) Followings are the Quality Assurance Requirements for laying/erection of MS Pipes

A RECEIPT OF ITEMS AT SITE

Check for completeness of supply and visual check for damage of followings after receipt at site:

i. MS Pipes, fittings, flanges, couplings, bolts and nuts, fasteners, plugs, sleeves etc.

ii. Welding electrodes, filler rods & wires, gases like oxygen, acetylene, argon, carbon di-oxide, propane etc.

iii. X-ray & gamma ray equipment, dye penetrants, RT films, Epoxy Primer, Paint, Coating and wrapping material

B STORAGE

Check for proper storage of following items as per manufacturer recommendations / storage guideline

i. MS Pipes, fittings, flanges, couplings, bolts and nuts, fasteners, plugs, sleeves etc.

ii. Welding electrodes, filler rods & wires, gases like oxygen, acetylene, argon, carbon di-oxide, propane etc.

iii. X-ray & gamma ray equipment, dye penetrants, RT films.

iv. Epoxy Primer, Paint, Coating and wrapping material

C Following checks shall be carried out during Laying of MS Pipes

i. Ensure proper alignment & fit up

ii. Ensure correct joining of pipes

iii. Ensure installation of supports (as applicable)

iv. Hydraulic Test of section and complete pipeline as per Engg technical specification requirements.

D JOINING OF MS PIPES AT SITE BY WELDING

Following checks shall be carried out during joining of MS pipes at site by welding

i. Dimensional conformity

ii. Tolerance OD/ Ovality

iii. Ensure proper alignment of pipes, Edge preparation and joint fit up

iv. Ensure Tack weld by qualified welder and provision of internal bracing to keep in proper shape

v. WPS, PQR & WPQ (welder performance qualification) tests prior to welding

vi. Check for surface defects after welding (visual)

vii. 100% DPT on root run/ after back gauging/ grinding of butt weld as applicable.

viii. 10% DPT on fillet weld

ix. 10% DPT on finished butt welds

x. 5% RT/ 5% UT by TOFD/PAUT techniques on those butt weld joints which can be 100% hydro tested.

xi. 100% RT / 100% UT by TOFD/PAUT technique of the butt weld joints of pipeline shall be carried out which cannot be Hydro tested.

E CHECKS ON PAINTING OF OVERGROUND MS PIPES

i. Before start of work, ensure followings

a. Use of correct raw material i.e. primer, paint of NTPC acceptable make & grade.

b. All the butt weld joints shall have acceptable NDT (RT/UT & DPT) and Hydraulic test records.

ii. Ensure proper cleaning and Surface preparation of butt weld joints & complete pipe surface as per approved procedure complying to relevant clauses of Specification.

iii. Finished Surface - Visual Examination, Measurement of Surface Roughness, Profile, dust contamination

iv. Ensure compliance of correct time interval between blast cleaned ready pipe & coating / painting

v. Ensure application of correct primer, paint (check make, grade, date of manufacturing, date of expiry)

xii. Visual Examination & Wet film thickness measurement after primer coat, paint coats

xiii. Finished coat

a. Visual examination,

b. Measurement of coat thickness (on pipe body and on weld bead),

(3) Followings are the Quality Assurance Requirements for laying of DI pipes

A RECEIPT OF ITEMS AT SITE

Check for completeness of supply and visual check for damage of followings after receipt at site:

DI Pipes, DI Pipes fittings, flanges, couplings, bolts and nuts, fasteners, plugs, sleeves etc.

B STORAGE

Check for proper storage of following items as per manufacturer recommendations / storage manual

DI Pipes, DI Pipes fittings, flanges, couplings, bolts and nuts, fasteners, plugs, sleeves etc.

C LAYING OF DI PIPES

Following checks shall be carried out during Laying of DI Pipes

v. Ensure proper alignment & fit up

vi. Ensure correct joining of pipes

vii. Ensure installation of supports (as applicable)

viii. Hydraulic Test of section and complete pipeline as per Engg technical specification requirements.

SUB-SECTION– E-14
PT PLANT, LETP, DM PLANT, CW TREATMENT AND CLO2 SYSTEM

Items / Components \ Test/Check	Material Test	WPS/PQR/Welder	DPT/MPI	Assembly Fit up	Dimension	RT	Hydraulic test / Pneumatic test / Vacuum test	Performance Test	Test as per relevant Std / Appd. Data Sheets	Other Tests	Remarks
COMMON ITEMS:											
1. Horizontal Centrifugal Pumps				Y	Y			Y^1	Y		
1.1. Casing	Y^a		Y^b		Y		Y				
1.2. Impeller	Y^a		Y^b		Y					Y^d	
1.3. Shaft	Y^a		Y		Y					Y^c	
2. Vertical Pumps				Y	Y			Y^1	Y		
2.1. Casing	Y^a		Y^b		Y		Y				
2.2. Impeller	Y^a		Y^b		Y					Y^d	
2.3. Shaft	Y^a		Y		Y					Y^c	
2.4. Fabricated Parts	Y^a	Y	Y^b		Y	Y^2	Y				
3. Dosing/ Metering Pumps	Y^a				Y		Y	Y^1	Y		
4. Gate/ Globe/ Check Valves	Y^a		Y^b		Y		Y	Y	Y	Y^3, Y^6	
5. Dual Plate Check Valves	Y^a		Y^b		Y		Y	Y	Y	Y^6, Y^{12}	
6. Diaphragm Valves	Y^a				Y		Y		Y	Y^4, Y^3	
7. Butterfly Valves (Low Pr.)				Y	Y		Y	Y	Y	Y^3	
7.1 Body & Disc (Cast	Y^a		Y^b		Y						
7.2 Body and Disc (Fabricated)	Y^a	Y	Y^b		Y				Y	Y^2	
7.3 Shaft	Y^a		Y^b		Y					Y^c	
8. Plug/ Ball Valves (Low Pr.)	Y^a		Y^b	Y	Y		Y	Y	Y	Y^3	
9. Blowers/ Compressors	Y^a		Y^b	Y	Y			Y	Y	Y^c, Y^d	

LEGENDS: Applicable tests are identified by 'Y'.

Y^a : One per Heat / Heat Treatment batch / Lot.

Y^b : On machined surfaces only. Also 100% on Butt Welds & 10% on Fillet Welds.

Y^c : UT shall be done for shafts with Dia 50 mm or above & Plates of Thickness 25 mm or above.

Y^d :Dynamic Balancing per IS: 21940, Grade 6.3 minimum shall be conducted for rotating assy.

Y^1 : As per Pump governing standard. Tolerences as per HIS, USA.

Y^2 : Random 10% RT to be conducted on butt welds for Thk $\geq$10 mm.

Y^3 : Seat Leakage Test for actuator operated valves shall be done by operating the valve with job actuator.

Y^4 : Tests on Rubber Diaphragms shall be conducted per batch of Rubber mix for Tensile, Elongation, Hardness, Thickness, Bleed Resistance. In addition, Type Test for 50,000 cycles for each type of diaphragm shall also be conducted.

Items / Components \ Test/Check	Material Test	WPS/PQR/Welder	DPT/MPI	Assembly Fit up	Dimension	RT	Hydraulic test / Pneumatic test / Vacuum test	Performance Test	Test as per relevant Std / Appd. Data Sheets	Other Tests	Remarks
10. Tanks/ Pressure Vessels	Y[a]	Y	Y[b]	Y	Y	Y[8]	Y		Y	Y[7]	
11. Rubber Lining	Y[a]				Y				Y	Y[9]	
12. Strainers	Y[a]	Y	Y[b]	Y	Y		Y		Y		
13. Pipe & Pipe Fittings	Y[a]	Y	Y		Y	Y[8]	Y		Y		
14. Agitators /Flash Mixer/ Flocculator	Y[a]	Y	Y[b]	Y	Y			Y		Y[10]	
15. Ventilation/Exhaust Fan	Y[a]		Y[b]	Y	Y			Y[11]	Y	Y[c], Y[d]	
16. Hoists & Cranes	Y[a]	Y	Y[b]	Y	Y	Y[8]		Y	Y		
17. Wrapping & Coating Material	Y				Y				Y		
18. Package/ Split AC	Y							Y	Y	Y[14]	
PT & LET PLANT:											
1. Clariflocculator / Reactor Clarifier / Plate or Tube Settler	Y[a]	Y	Y[b]	Y	Y				Y	Y[10]	
2. Pressure / Vacuum Relief valve / Pressure Regulating Valve	Y[a]			Y	Y		Y	Y	Y		
DM PLANT											
1. Resins / Activated Carbon									Y		

Y[6] : Blue Matching, Wear Travel for Gate Valves and reduced pressure test for check valves shall be conducted as per relevant standards.

Y[7] : Heat Treatment of the Tank/Vessel shall be done per fabrication code requirement. Welded dished ends shall be stress relieved. Dished ends manufactured by cold working shall also be stress relieved as per the requirement of code.

Y[8] : RT as per fabrication code requirements. However, dished ends welds, if manufactured by using welded plates shall be subjected to 100% RT.

Y[9] : Rubber Lining Mix shall be subjected to Bleed Resistance Test on mould sample. Adhesion Test, Spark Test and Hardness Test for the Rubber lined jobs shall also be conducted.

Y[10] :Gear Boxes shall be checked for smooth No Load Operation at shop to verify noise and vibration levels. Gear Ratio and Kerosene Leak Test shall also be conducted.

Y[11] :One Fan of each type & size shall be routine performance tested as per corresponding code for air flow, static pressure, total pressure, speed, efficiency, power consumption, noise & temperature rise. Also all Fans shall be subjected to run test of 4 hours during which noise, vibration, temperature rise and current drawn shall be measured.

Y[12] :Dry cycle test on valve spring for 1, 00,000 cycles shall be carried out as

Items / Components \ Test/Check	Material Test	WPS/PQR/Welder	DPT/MPI	Assembly Fit up	Dimension	RT	Hydraulic test / Pneumatic test / Vacuum test	Performance Test	Test as per relevant Std / Appd. Data Sheets	Other Tests	Remarks
2. Filter Membrane					Y				Y		type test, if not carried out earlier, for the similar MOC, size and type of spring. Y^{13}: :Test as per approved supplier practice. Y^{14} : Electronic leak test for condenser & evaporator unit. Note: 1.The complete Piping system along with valves & fittings shall be hydraulically tested at 1.5 times design pressure or 2 times working pressure whichever is higher after erection at site. 2. In case of items other than those identified above, the quality requirements shall be decided based on system design requirements.
3. RO Pressure tube	Y^{a}				Y		Y		Y		

CHLORINE DI-OXIDE PLANT

Test/Check / Items / Components	Material Test	WPS/PQR/Welder	DPT/MPI	Assembly Fit up	Dimension	RT	Hydraulic test / Pneumatic test / Vacuum test	Performance Test	Test as per relevant Std / Appd. Data Sheets	Other Tests	Remarks
1. Horizontal & Vertical Pumps				Y	Y			Y^1	Y		
1.1. Casing	Y^a		Y^b				Y				
1.2. Impeller	Y^a		Y^b							Y^d	
1.3. Shaft	Y^a		Y						Y^c		
2. Dosing/ Metering Pumps	Y^a						Y	Y^1	Y		
3. Rubber lining	Y^a				Y				Y	Y^2	
4. FRP Tank	Y				Y		Y		Y	Y^3	

Note:

1) In case of items other than those identified above, the quality requirements shall be decided based on system design requirements.
2) After erection, the complete Piping system along with valves & fittings shall be hydraulically tested at 1.5 times design pressure or 2 times working pressure whichever is higher.

LEGENDS:

Y Applicable

Y^a One per Heat/Heat Treatment batch./Lot

Y^b On machined surfaces only of castings and forgings. Also 100% after root run/ back gauging for butt welds and 10% after final butt welds and fillet welds.

Y^c UT shall be done for shafts with Dia 50 mm or above & Plates of Thickness 20 mm or above.

Y^d Dynamic Balancing per ISO: 1940, Grade 6.3 minimum.

Y^1 As per HIS, USA/ API 598 (In case of Metering Pump)

Y^2 Rubber Lining Mix shall be subjected to Bleed Resistance Test on mould sample. Adhesion Test, Spark Test and Hardness Test for the Rubber lined jobs shall also be conducted.

Y^3 The test for UV protection shall be carried out and shall be finalized with the approved supplier.

SUB-SECTION– E-15
EQUIPMENT COOLING WATER SYSTEM

	EQUIPMENT COOLING WATER SYSTEM												
	TEST / CHECKS / ITEM / COMPONENTS	Material Test	WPS/PQR/Welder Qualification	DPT/MPI	Assembly Fit Up	Visual & Dimensional Check	UT	RT	Hydraulic / Water Fill	Balancing	Type Test	Performance Test	Other Test
A	**PLATE TYPE HEAT EXCHANGER**		Y	Y[3]	Y	Y			Y				
A.1	Heat Transfer Plates	Y[1]		Y[2]		Y							Y[7]
A.2	Gaskets	Y				Y							
A.3	Cover Plates (Front & Rear)	Y[1]				Y	Y[5]						
A.4	Tie Rods	Y[1]		Y[4]			Y[6]						
B	**HORIZONTAL CENTRIFUGAL PUMP**				Y	Y						Y[10]	
B.1	Casing	Y[1]		Y[4]		Y			Y[8]				
B.2	Impeller	Y[1]		Y[4]		Y				Y[9]			
B.3	Shaft	Y[1]		Y		Y	Y[6]			Y[9]			

NOTES

1 One per heat / HT batch

2 DP Test shall be conducted for 10% of the lot of HT plates. However, in case of any defect, entire lot shall be tested and only defect free plates shall be accepted.

3 100% DP Test shall be conducted on butt welds and 10% DPT on fillet weld after final run.

4 100% DPT shall be carried out on machined surfaces.

5 UT shall be done on plates with thickness >40 mm and for pressure parts plates 25 mm or above.

6 UT shall be done on shaft / tie rod with diameter 40 mm or above.

7 After pressing each HT plate shall be subjected to either of the following tests, as per Manufacturer Practice
a) Light Box Test b) Vacuum Test c) Air Chamber Test

8 All pressure retaining parts shall be hydrostatically tested at 200% of pump rated head or 150% of shut – off head, whichever is higher, for at least 30 minutes. No leakage is allowed.

9 Static and Dynamic Balancing shall be carried out on complete rotor assembly.

10 All pumps shall be tested at rated speed, for head, flow capacity, efficiency and power consumption for the entire operating range i.e. from shut off head to maximum flow. A minimum of 7 readings shall be taken to plot the curve, with one reading at design flow. Testing standard shall be HIS (Hydraulic Institute Standard) of USA.
Performance test shall be carried out with contract motor, wherever Liquidated Damages are to be ascertained based on performance test at shop.

11. For pipes, fittings, valves & RE joints refer QA chapters of LP Piping.

SUB-SECTION– E-16
EOT CRANES AND HOISTS

Shop Test for T.G.Hall EOT Cranes, Other Cranes & Hoist

1.0 HOOKS

1.01 ALL TESTS INCLUDING PROOF LOAD TEST AS PER RELEVANT IS/BS/DIN SHALL BE CARRIED OUT.

1.02 MPI/DPT SHALL BE CARRIED OUT AFTER PROOF LOAD TEST.

2.0 STEEL CASTING

2.01 DPT ON MACHINED SURFACE SHALL BE CARRIED OUT.

3.0 GIRDERS, END CARRIAGE,CRAB, GEAR BOX AND ROPE DRUM

3.01 THE PLATES OF THICKNESS 25MM AND ABOVE SHALL BE ULTRASONICALLY TESTED.

3.02 NDT REQUIREMENTS ON WELDMENTS SHALL BE AS FOLLOWS:

a) BUTT WELDS IN TENSION:- 100% RT AND 100% DPT
b) BUTT WELDS IN COMPRESSION:- 10% RT AND 100% DPT
c) BUTT WELDS IN ROPE DRUM:- 100% RT AND 100% DPT
d) FILLET WELDS:- RANDOM 10% DPT

4.0 FORGING (WHEEL, GEARS, PINIONS, AXLE, HOOKS & HOOK TRUNION)

4.01 ALL FORGINGS GREATER THAN OR EQUAL TO 50 MM DIAMETER OR THICKNESS SHALL BE SUBJECTED TO ULTRASONIC TESTING.

4.02 DPT/MPI SHALL BE DONE AFTER HARDFACING AND MACHINING.

5.0 WIRE ROPE SHALL BE TESTED AS PER RELEVANT STANDARD.

6.0 REDUCTION GEARS SHALL BE TESTED FOR REDUCTION RATIO, BACKLASH & CONTACT PATTERN. GEAR BOX SHALL BE SUBJECTED TO NO-LOAD RUN TEST TO CHECK FOR OIL LEAKAGE, TEMPERATURE RISE, NOISE AND VIBRATION.

7.0 THE CRANES SHALL BE COMPLETELY ASSEMBLED AT SHOP FOR FINAL TESTING. ALL TESTS FOR DIMENSION, DEFLECTION, LOAD, OVERLOAD, HOISTING MOTION, CROSS TRAVEL ETC. AS PER IS-3177 SHALL BE CARRIED OUT AT SHOP.

8.0 ALL ELECTRIC HOISTS SHALL BE TESTED AS PER IS-3938 AND CHAIN PULLEY BLOCKS SHALL BE TESTED AS PER IS-3832.

9.0 <u>LIFTING BEAM</u>:

9.01 THE PLATES OF THICKNESS 25MM AND ABOVE SHALL BE ULTRASONICALLY TESTED.

9.02 NDT REQUIREMENTS ON WELDMENTS SHALL BE AS FOLLOWS:

e) BUTT WELDS IN TENSION:- 100% RT AND 100% DPT
f) BUTT WELDS IN COMPRESSION:- 10% RT AND 100% DPT
g) FILLET WELDS:- RANDOM 10% DPT

9.03 ALL FORGINGS GREATER THAN OR EQUAL TO 50 MM DIAMETER OR THICKNESS SHALL BE SUBJECTED TO ULTRASONIC TESTING.

9.04 DPT/MPI SHALL BE DONE AFTER MACHINING.

9.05 Lifting Beam will be subjected to overload testing at @1.25 X SWL of Lifting Beam at manufacturer works.

SUB-SECTION– E-17
AIR CONDITIONING & VENTILATION SYSTEM

AIR CONDITIONINGAND VENTILATION SYSTEM

1.00.00	**CHILLING UNIT**
1.01.00	**Refrigerant Compressor (Screw/Scroll)**
1.01.01	Hydraulic/Pneumatic test of castings of casings shall be carried out. No leakage shall be permitted.
1.01.02	DPT of screw, impeller, shaft, vanes, casing etc. after machining shall be carried out.
1.01.03	All rotating parts of screw and centrifugal compressor shall be dynamically balanced to ISO 1940 Gr. 6.3/IS 21940.
1.01.04	Leak tightness & vacuum check for chilling units / compressor in assembled condition shall be carried out. No leakage shall be permitted.
1.01.05	Performance test of assembled compressor and Chiller assembly shall be done to check for following : i) No load air run (free run) test of all types of compressor to check FAD (Free air delivery), Noise, Vibration & Temp. rise of bearing & body. ii) Functional run test for Chiller assembly shall be carried out.
1.02.00	**CONDENSER & EVAPORATOR**
1.02.01	DPT shall be carried out on welds if applicable.
1.02.02	10% RT of butt weld joint on shell shall be carried out if applicable.
1.02.03	Dimensional check including tube hole dia, ligament, pitch etc. shall be carried out.
1.02.04	Mock-up test of tubes to tube sheet expansion shall be carried out.In case such test is already carried out for similar tube/tube sheet thickness and materials, records for the same shall be furnished for NTPC review.
1.02.05	Hydraulic/Pneumatic test of Shell Side and Tube Side of condenser and evaporator as applicable shall be carried out. 'No leakage' shall be permitted.
2.00.00	**AIR HANDLING UNIT**
2.01.00	For Fans refer tests as mentioned at 4.00.00
2.02.00	One per type of assembled AHU (AHU casing and fan assembly) shall be subjected to free run test. Noise, Vibration and Temp. Rise of bearing shall be measured during run test.
2.01.00	All cooling coil shall be pneumatically tested and no leakage shall be permitted.
3.00.00	**CENTRIFUGAL PUMP**
3.01.00	UT on pump shaft (dia equal to or above 40 mm) and MPI/DPT on pump shaft and impeller after machining shall be carried out.
3.02.00	All rotating components of the pumps shall be dynamically balanced to ISO-1940 Gr. 6.3/IS 21940.
3.03.00	A standard hydrostatic test shall be conducted on the pump casing with water at 1.5 times the shut off pressure on the head characteristics curve or twice the rated pressure whichever is higher, for a minimum duration of 30 minutes.
3.04.00	Standard Running Test

	i) All pumps shall be tested in the manufacturer's works preferably with contract motor (or as specified in Engg Tech spec) for capacity, efficiency, head and brake horse power. Pump shall be given running test over the entire operating range covering from the shut-off head to the maximum flow. The duration of test shall be minimum one (1) hr. A minimum of seven readings approximately equidistant shall be taken for plotting the curves with one point at design flow. Testing of pumps shall be in accordance with stipulations of Hydraulic Institute Standard (HIS) and/or as per applicable Indian Standard or equivalent. Acceptance norms shall be as per approved datasheet & HIS standard and/or as per applicable Indian Standard or equivalent only.
	ii) Noise and vibration shall be measured at shop for reference purpose only.
	iii) Pumps shall be subjected to strip down examination visually to check for mechanical damages after testing at shop in case abnormal noise level and/or excessive vibration are observed during the shop test.
	iv) NPSH test shall be conducted with water as the medium, if required as per approved data sheets.
4.00.00	**FANS:**
4.01.00	20% DPT of welding on fan hub, blades, casing and impeller as applicable shall be carried out.
4.02.00	DPT of fan shafts shall be carried out after machining.
4.03.00	UT of fan shafts (dia equal to or above 40mm) shall be carried out.
4.04.00	Rotating components of all fans shall be dynamically balanced to ISO-1940 Gr. 6.3/IS 21490
4.05.00	All Fans shall be subjected to run test for 4 hrs. or till temperature stabilization is reached. Vibration, Noise level, Temp. rise and current drawn shall be measured during the run test.
4.06.0	One fan of each type and size will be performance tested as per corresponding BIS code/ AMCA for Air flow, Static Pressure, Speed, Efficiency, Power Consumption, Noise, Vibration and Temp. Rise.
5.00.00	**LOW PRESSURE AIR DISTRIBUTION SYSTEM**
5.01.00	Functional test for fire damper along with solenoid shall be done.
5.02.00	Prototype tests report of fire damper (duly approved/accepted by ENGG) for each type and size as per UL-555 for fire rating shall be furnished.
5.03.00	Site Test- After completion, all ducting system shall be checked/tested for air leakages/tightness (smoke test) at site.
6.00.00	**INSULATION:**
6.01.00	Insulation material shall be tested for all mandatory tests only as per relevant code/standard.
6.02.00	Resin bonded mineral wool/Glass wool: Thermal conductivity tests (for thermal insulation only) shall be done the same density of material as applicable as per IS:3346 or equivalent standard//Engg spec.
6.03.00	XLPE/Nitrile Rubber: Thermal conductivity tests (for thermal insulation only) shall be done as per relevant code for the same density and thickness of material and validity of test shall be as per relevant standard/Engg spec.
7.00.00	**COOLING TOWER**
7.01.00	UT of fan shaft and drive shaft (dia equal to or above 40mm) shall be carried out.

7.02.00	DPT of fan hub and shafts shall be carried out after machining.
7.03.00	Color of fills shall be as per approved data sheet.
7.04.00	Fan assembly shall be statically/dynamically balanced.
7.05.00	Cooling Towers being supplied to site in assembled condition shall be subjected to run test at shop to measure FAD, Noise & Vibration. For Cooling Towers being supplied in knocked-down condition, these tests shall be done at site
8.00.00	**AIR FILTERS:**
	Pre/Fine filters shall be tested for initial and final pressure drop Vs flow, efficiency and average synthetic dust weight arrestance as per the requirement of BS 6540/ASHARE-52-76/EN779. HEPA (Absolute) filters shall be tested as per applicable code.
9.00.00	**PIPES & FITTINGS:**
9.01.00	All pipes and fittings shall be tested as per applicable codes / standard.
9.02.00	Site test- Pipes shall be tested at site hydraulically/pneumatically as per application requirement
10.00.00	**VALVES & SPECIALTIES**
10.01.00	Visual and dimensional check of valves as per relevant codes and approved drawing.
10.02.0	All the water line valves shall be hydraulically tested for body, seat and back seat (wherever provided) as per the relevant standard to which these valves are supplied irrespective of the working pressure for which these valves are selected. Check valves shall also be tested for leak tightness test at 25% of the specified seat test pressure.
10.03.0	Refrigerant line valves shall be pneumatically tested for body and seat leakage test.
10.04.00	Valves shall be offered for hydro test and pneumatic test in unpainted condition.
10.05.0	Functional check of the valves for smooth opening and closing shall be done.
10.06.0	Performance test to check pressure drop Vs flow shall be carried out for one valve of each type, size and rating for 'Balancing Valve'/Globe Valves with orifice.
11.00.00	**SPLIT, CASSETTE, WINDOW, PRECISION/PACKAGED AC (PAC) & CONDENSING UNITS**
11.01.00	Split/Cassette/ Window AC/PAC will be accepted on the basis of Manufacturer Standard Guarantee and Warrantee certificate.
11.02.00	PAC/Condensing unit: Each Unit shall be subjected to production routine Test as per relevant standard.
11.03.00	Capacity, noise level and vibration of PAC/ Condensing unit shall be demonstrated as per relevant standard on one unit of each type and rating.
12.00.00	**Air Washer and Unitary Air Filter (UAF)**
12.01.00	Random 10% DPT on weld joints shall be carried out.
12.02.00	Hydraulic test of pressure parts at 1.5 times the design or 2 times of working pressure whichever is higher. Pressure and water fill test of tanks shall be carried out.
12.03.00	Trial assembly of Air washer/UAF for one of each size shall be done in shop.
12.04.00	Performance test to check pressure drop Vs flow shall be carried out for one Nozzle of each type, size and rating.

SUB-SECTION– E-18
LIMESTONE AND GYPSUM HANDLING SYSTEM

Lime & Gypsum Handling (Mechanical)

1.01.0 For following Items, Coal Handling Package (Mechanical) Specification shall be referred.:

I] Brakes and Clamps.
II] Monorails and Hoists
III] Belt Conveyor System
IV} Idlers
V] Belting
VI] Belt Vulcanizing Machine
VII] Pulleys
VIII] Pull Chord & Belt Sway Switches
IX] Zero Speed Switch, Under Belt Switch and Chute Blockage Switch
X] Drive Equipment's
- 1] Gear Boxes
- 2] Flexible Coupling
- 3] Fluid Coupling

XI] Dust Control & Miscellaneous Systems (Dust Suppression & Dry Fog Dust Suppression System).
XII] Pumps.
XIII] Valves & Specialties.
XIV] Pipes and Fittings.
XV] Air Compressor.
XVI] Air Receiver.
XVII] Belt Scales.
XVIII] Package Air Conditioner.
XIX] Steel Structure.
XX] In-Line Magnetic Separators.
XXI] Metal Detector

1.02.00 Hoppers & Liners

1.02.01 Rack & Pinion Gates/Flap Gates/Rod Gates

a) MPI/DP test shall be conducted on rack and pinion / rod / weld joint
b) Functional checks on the gates shall be carried out along with respective actuator, if applicable.

1.03.00 Storage Silo

1.03.01 All material shall be tested for Chemical & Mechanical properties as per relevant standard. MPI/DP test on welding shall be carried out. Fit up assembly checks shall be carried out at shop for all dispatchable segments

1.03.02 Bag Filters: Leakage test shall be carried out for pressure parts. Pulsing and sequential test on bag filter shall be done.

1.04.0 Dust Extraction and Ventilation System

1.04.01 Fan

(a) All materials should be of tested quality and test certificates should be provided.
(b) Dynamic balancing of the fan impellers to be carried out.
(c) Shop run test shall be conducted on all centrifugal fans including check for noise and vibration level.
(d) Performance test shall be conducted on one fan of each type at shop for capacity, pressure, efficiency and power consumption.

1.04.02 Valves and Specialties

Refer 1.01.0 above

1.04.03 Pipes and Fittings

Refer 1.01.0 above

1.05.00 Crushers

The details of the checks to be carried out for various components are to be submitted by the Contractor for Owner's approval. However, some indicative checks on different items are given below which should necessarily form part of the Quality Assurance Plan to be agreed with the Owner.
(a) All plates equal to or above 25mm thickness shall be ultrasonically tested.
(b) Shaft forgings and suspension bars to be checked for ultrasonic testing in addition to check for chemical, mechanical, hardness, microstructure etc. as per applicable material specification.
(c) Following minimum NDT requirements to be ensured for welds:
i) Butt welds - 10% UT/RT and 100% MPI/DPT.
ii) Fillet Welds - 10% MPI/DPT.
(d) Crusher rotor to be dynamically balanced. Procedure to be submitted for approval.
(e) No-load trial run test to be carried out at shop to check for speed (RPM), temperature rise, noise level and vibration.

1.06.0 Mobile Trippers

(a) Shaft and wheel forgings – Ultrasonic test in addition to check for chemical, mechanical, hardness, microstructure etc. as per applicable material specification shall be conducted.
(b) Following minimum NDT requirements to be ensured for welds:
i) Butt welds - 10% UT/RT and 100% MPI/DPT.
ii) Fillet Welds - 10% MPI/DPT.
(c) Shop trial run test shall be carried out and shall include check for noise level and vibration.

1.07.00 Sampling Units

(a) Free carriage and cutter movement, speed of cutter and dust door closing and sealing shall be tested for samplers.
(b) "No load test" shall be carried out for crushers.

1.08.00 Bucket Elevator

1.08.01 All plates equal to or above 25 mm thickness shall be ultrasonically tested.

1.08.02 Castings and forgings, forged/rolled bar/section shall be subjected to ultrasonically test in addition to check for chemical, mechanical, hardness, microstructure etc. as per applicable material specification.

1.08.03 Machined and hard-faced surface of casting/forging and other hardened, stellited parts shall be subjected to DPT/MPI in addition to check for case depth, hardness as applicable for chain/sprocket/gear reducer/rollers/wheel/pan etc.

1.08.04 Following minimum NDT requirements shall be followed for welds:

i) Butt Welds in Tension- 100% UT/RT and 100% MPI/DPT.
ii) Butt Welds in Compression- 10% UT/RT and 10% MPI/DPT.
iii) Fillet Welds - 10% MPI/DPT.

1.08.05 For other items like drive system, motor, pulley, belt etc relevant portion of specification shall be applicable.

1.09.00 Elevators (Rack and Pinion Type)

The details of the checks to be carried out in the various equipments are to be submitted by the contractor for owner's approval. However, some indicative checks on different items are given below which should necessarily form part of the quality assurance plan to be agreed with the owner.

1.09.01 All forgings shall be subjected to ultrasonic test to ensure free from internal defects in addition to check for chemical and mechanical properties.

1.09.02 10% of the welds selected at random shall be subject to DP test.

1.09.03 All forged components shall be subjected to DPI/MPI after machining.

1.09.04 Gear Reducer shall be checked for gear ratio, backlash, contact pattern. No load shop trial run shall be conducted on gear boxes to check for oil leakage, temperature rise, noise and vibration.

1.09.05 Buffer springs shall be subjected to load test as per relevant specifications. Material certificates for springs shall also be furnished.

1.09.06 All components prior to assembly shall be checked for dimensions.

1.09.07 Function test of Elevator assembly shall be carried out.

1.09.08 All electrical equipments shall be of proven quality.

1.09.09 Galvanized components/parts shall be checked for weight of Zn coating, thickness of coating, uniformity of coating and adhesion test and visual examination as per IS 2633 and IS 2629.

1.10.00 **Paddle feeder**

1.10.01 Shaft and wheel forgings – Chemical, Mechanical, Hardness and Ultrasonic Test shall be conducted.

1.10.02 Following minimum NDT on Weld Joint shall be carried out
(a) Butt Welds - 10% UT/RT & 100% MPI/DPT
(b) Fillet Welds - 10% MPI/DPT

1.10.03 Shop trial run shall be conducted to check for movement and RPM of Paddle wheel & Travel wheel, function of P/F in locked rotor condition, noise and

vibration etc.

1.11.00 **Vibrating Screen Feeders/Vibrating Feeder**

(a) Shaft forgings to be checked for ultrasonic testing in addition to check for chemical, mechanical, hardness, microstructure etc. as per applicable material specification

(b) Following minimum NDT requirements to be ensured for welds:

i) Butt welds - 10% UT/RT and 100% MPI/DPT.

ii) Fillet Welds - 10% MPI/DPT.

(c) Shop trial run test shall be conducted to checks for speed (RPM), amplitude (stroke), temperature rise and noise level.

1.12.00 Apron Feeder/Surface Feeder/Box Feeder

1.12.01 All plates equal to or above 25 mm thickness shall be ultrasonically tested.

1.12.02 Castings and forgings, forged/rolled bar/section shall be subjected to ultrasonically test in addition to check for chemical, mechanical, hardness, microstructure etc. as per applicable material specification.

1.12.03 Machined and hard-faced surface of casting/forging and other hardened, stellited parts shall be subjected to DPT/MPI in addition to check for case depth, hardness as applicable for chain/sprocket/gear reducer/rollers/wheel/pan etc.

1.12.04 Suitable check for lifetime sealing of rollers for protection from dust and water shall be done.

1.12.05 Following minimum NDT requirements shall be followed for welds:

i) Butt Welds in Tension- 100% UT/RT and 100% MPI/DPT.

ii) Butt Welds in Compression- 10% UT/RT and 10% MPI/DPT.

iii) Fillet Welds - 10% MPI/DPT.

1.12.06 For other items like drive system, motor, pulley, belt relevant portion of specification shall be applicable

1.12.07 No load trial run test shall be carried out at shop on completely assembled apron feeder to check for trouble free operation, temperature rise, Noise & vibration.

SUB-SECTION– E-19
ASH HANDLING PLANT

1.01.00	**BOTTOM ASH HOPPERS**
1.01.01	All material shall be tested for Chemical & Mechanical properties as per relevant standard. MPI/DPI tests as applicable shall be done on welds to ensure freedom from defects. RT shall be done on load bearing weld/weld under tension as per relevant codes and standard
1.01.02	Fit up assembly checks shall be carried out at shop for at least critical segments of bottom ash hopper before dispatch to site.
1.02.00	**BA HOPPER DISCHARGE GATES**
1.02.01	All material shall be tested for Chemical & Mechanical properties as per relevant standard
1.02.02	Barrel/ casing of Hydraulic/pneumatic Cylinder shall be hydro tested. UT at proof machined condition (for dia/thickness >= 40 mm) shall be done on shafts. Assembled cylinders shall be tested for port leakage
1.02.03	MPI/DPT shall be carried out on welds of BA hopper discharge gates
1.02.04	Functional checks of the BD hopper discharge gate along with actuator shall be carried out to check for smooth opening and closing.
1.03.00	**CLINKER GRINDER/ASH CRUSHER**
1.03.01	All material shall be tested for Chemical & Mechanical properties as per relevant standard. Grinding rolls/elements shall be checked for hardness at manufacturer's works.
1.03.02	UT at proof machined condition (for dia/thickness >= 40 mm) and MPI/DPT after machining shall be done on shafts. MPI/DPT shall be carried out on welds
1.03.03	No load run test for minimum 2 hours continuous operation of clinker grinder shall be done to ensure trouble free operation.
1.04.00	**BOTTOM ASH HANDLING SYSTEM**
1.04.01	Specialized equipment for bottom ash handling system shall be tested as per manufacturer's standard practice and relevant material standard.
1.04.02	Fabricated items, valves and welding checks shall be done as per QA tables and relevant section of technical specification.
1.05.00	**ACI FITTINGS AND BASALT LINED PIPES & FITTINGS**
1.05.01	All material shall be tested for Chemical & Mechanical properties as per relevant standard.
1.05.02	Basalt liners shall be tested for chemical and mechanical properties. Basalt liners shall be examined visually for detection of cracks and defects. Level difference between two basalt liner shall be minimum. No loose piece is allowed.
1.05.03	DPT of welds shall be carried out on root and finished welds of fabricated fittings.
1.05.04	Fittings shall be hydraulically tested as at twice the operating pressure or 1.5 times the design pressure whichever is higher for 30 min duration.
1.06.00	**FLUSHING BOXES & TROUGH TYPE EXPANSION JOINTS**
1.06.01	All material shall be tested for Chemical & Mechanical properties as per relevant standard. MPI/DP tests shall be done on welds to ensure freedom from defects. Water fill test on assembly shall be carried out.
1.07.00	**GEAR BOX**
1.07.01	In addition to checks for physical, chemical, hardness, microstructure as per relevant standard, the shaft and gear/pinion forgings shall be subjected to ultrasonic testing.
1.07.02	MPI to be carried out on Gears/Pinions after machining. Case depth, hardness and MPI after hard-facing shall be checked to ensure freedom from defects.
1.07.03	Gear boxes shall be checked for reduction ratio, backlash and contact pattern. No load shop trial run to be conducted on gear boxes to check for oil leakage, temperature rise, noise level and vibration.
1.08.00	**METALLIC EXPANSION JOINTS**
1.08.01	All material shall be tested for Chemical & Mechanical properties as per relevant standard. Leak test shall be carried out 1.1 times design pressure in case of vacuum application.

1.08.02	DPT shall be carried out on welds before and after forming to check cracks. Spring rate shall also be measured.
1.08.03	Proof of design test shall be carried out on one of the expansion joint as per (EJMA) relevant standards. In case the bidder have already carried out the same on the expansion joint of the type and rating being offered, the test certificate shall be submitted for review.
1.09.00	**FLY ASH BRANCH SEGREGATION VALVES , FLY ASH FEED VALVES, VACUUM BRAKER, AIR INTAKE VALVE AND KNIFE GATE VALVE FOR HOPPER ISOLATION**
1.09.01	All material shall be tested for Chemical & Mechanical properties as per relevant standard. Functional checks of the valves for smooth opening and closing shall also be done. Valves shall also be tested for allowable leakage rate, as applicable. Actuator operated valves shall be tested alongwith actuators
1.10.00	**AIR LOCK/PUMP TANK**
1.10.01	All material shall be tested for Chemical & Mechanical properties as per relevant standard. Air lock/pump tanks shall be tested hydraulically for 1.5 times the design pressure or 2 times working pressure, whichever is higher, for 30 min duration at manufacturer's works. NDT on welds shall be as per requirement of design code/standard.
1.11.00	**BAG FILTERS**
1.11.01	All material shall be tested for Chemical & Mechanical properties as per relevant standard. Leakage test shall be carried out for casing and other pressure parts. Pulsing and sequential test on bag filter shall be done.
1.12.00	**HCSD SILO, DRY FLY ASH STORAGE SILO, DRY BOTTOM ASH STORAGE SILO, BUFFER HOPPER, BA OVERFLOW TANK AND SETTLING/SURGE TANK**
1.12.01	All material shall be tested for Chemical & Mechanical properties as per relevant standard. MPI/DP test on welding shall be carried out. Fit up assembly checks shall be carried out at shop for all despatchable segments.
1.13.00	**ASH SLURRY SUMP ISOLATION PLUG VALVES, SUMP/TRENCH LINERS AND TRENCH JETTING/AGITATING NOZZLES**
1.13.01	All material shall be tested for chemical and mechanical properties as per relevant standard. Sump/Trench Liners and Nozzle Tip shall be checked for hardness.
1.13.02	Sump isolation Plug valves shall be water-fill tested
1.14.00	**FLUID COUPLING:**
1.14.01	All material shall be tested for Chemical & Mechanical properties as per relevant standard. Static and dynamic balancing shall be carried out for all rotating parts. Check for leak tightness of the coupling shall be carried out
1.14.02	Functional test on fusible plug for each type of coupling shall be conducted at shop. All couplings to be run tested at shop.
1.14.03	Check for temperature rise, torque speed, torque slip characteristics and over speed test on one coupling of each size and type during load test (preferably at Full load) at shop.
1.15.00	**SLURRY DISPOSAL LINE VALVES (AT DYKE END)**
1.15.01	**All material shall be tested for Chemical & Mechanical properties as per relevant standard. All valves shall be hydraulically tested for body and seat leakage test at shop.**
1.16.00	**ELECTRIC HOIST & OVERHEAD TRAVELLING CRANE:**REFER QA CHAPTERS OF CRANES AND HOIST
1.17.00	**PACKAGE AIR CONDITIONER:**
1.17.01	Each Unit shall be subjected to production routine Test excluding performance test carried out as per relevant standard. Performance test of PAC shall be carried out as per relevant standard on one unit of each type and rating at site to production
1.18.00	**For items/components like pipes, valves, pumps, compressors, specialties etc refer table below**

SN	Tests/Checks / Items / Components	Material Test	WPS/ WQS/PQR	DPT/MPI	Ultrasonic Test	Radiographic Test	PWHT	Assembly / Fit up	Dimensions	Hydraulic	Pneumatic Test	Balancing	Functional/operational Test	Performance Test	Other Tests	All Tests as per relevant Std
1	Pipes & Fittings	Y[a]							Y	Y[20]						Y
2	Diaphragm Valves	Y[a]							Y	Y[5]			Y		Y[6]	Y
3a	Cast Butterfly Valves (Low Pressure)	Y[a]		Y[3]	Y[b]			Y	Y	Y[5]			Y		Y[7]	Y
3b	Fabricated Butterfly Valves (Low Pressure)	Y[a]	Y	Y[3]	Y[12a]	Y[12b]	Y[12c]	Y	Y	Y[5]			Y		Y[7]	Y
4	Gate/ Globe/ Check Valves	Y[a]		Y[3]	Y[b]			Y	Y	Y[5]	Y		Y		Y[8]	Y
5	Dual Plate Check Valves	Y[a]		Y[3]	Y[b]			Y	Y	Y[5]	Y		Y		Y[4]	Y
6	Plug / Ball Valves	Y[a]		Y[3]	Y[b]			Y	Y	Y[5]	Y		Y			Y
7	Rolled & Welded Pipes / Mitre fittings	Y[a]	Y	Y[3]		Y[1]			Y	Y[20]						
8	Coating & Wrapping of Pipes	Y[a]							Y							Y[2]
9	Strainers	Y[a]		Y[3]					Y	Y[20]					Y[9]	
10	Rubber Expansion Joints	Y[a]						Y	Y	Y[10]					Y[11]	
11	Site Welding		Y	Y[3]		Y[1]				Y[20]						
12	Submersible Pump	Y[a]							Y	Y[17]		Y		Y		Y
13	Horizontal Centrifugal Pumps/ Sump Pumps/ Sludge Pumps/ HCSD Pumps	Y[a]		Y[3]	Y[b]			Y	Y	Y[17]		Y		Y[16]	Y[15]	Y
14	Compressors/ Blowers / vacuum Pumps	Y[a]		Y[3]	Y[b]			Y	Y	Y[20]		Y		Y[18]	Y[19]	Y
15	Atmospheric Storage Tanks/Mixing Tanks	Y[a]	Y	Y[3]				Y	Y	Y[20]					Y[13]	Y
16	Pressure vessels & Heat exchangers	Y[a]	Y	Y[3]		Y[21]	Y[22]	Y	Y	Y[20]					Y[23]	Y
17	Air Drying Plant	Y[a]	Y	Y[3]		Y[21]	Y[22]	Y	Y	Y[20]	Y		Y		Y[24]	
18	Mixers	Y[a]		Y[3]	Y[b]			Y	Y				Y		Y[25]	
19	Fans	Y[a]		Y[3]	Y[b]			Y	Y			Y		Y	Y[14]	Y
	NOTES															
a	One per heat/heat treatment batch/lot.															
b	For shaft/spindles/forgings diameter □ 40 mm															

1	Weld Joints not subjected to hydraulic test shall be subjected to 100% RT.
2	Tests for primer and enamel / Coal Tar Tapes as per AWWA-C-203 / IS 15557
3	On machined surfaces of castings/shaft/spindles/forgings. DPT/MPI on root run (after back gouging/chipping – as applicable) for 100% and on finish butt & fillet welds for 10%.
4	Dry Cycle Test on Dual Plate Check valve spring for one lakh (10^5) Cycles shall be carried out as a type test.
5	Valves shall be tested for Body, seat & back seat leakage as applicable. Hydraulic test pressure shall be as per relevant standard. & shall be done as per relevant standard. Seat Leakage Test for Actuator Operated Valves, shall be done with by closing the valves with actuator. Valves shall be offered for hydro test in unpainted condition
6	Tests on rubber diaphragm such as hardness, bleed resistance test, rubber to fabric bond, flex test & type test for 50,000 cycles shall be carried out.
7	In addition to Body & seat hydrotest, disc-strength shall be carried out as per relevant standard
8	Blue matching for metal-seated valves, Wear travel for gate valves, pneumatic seat leakage test & reduced pressure test for check valves shall be done as per relevant standard. Maximum allowable vacuum loss is 0.5 mm of Hg absolute for valves to be tested for vacuum operation for internal pressure 25 mm of Hg absolute for a period of 15 minutes
9	Pressure drop across the strainer for each type and size as a special test shall be carried out
10	During hydraulic and vacuum tests 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%.
11	Tests on rubber for tensile, elongation, hardness, hydraulic stability check as per ASTM D 471, ozone resistance test as per ASTM D 1149, ageing test and adhesion strength of rubber to fabric & rubber to metal shall be carried out.
12	a) For fabricated butterfly valves: UT as per ASTM A-435 on plates for body and disc shall be carried out. b) 100% RT as per ASTM, Section-VIII, Division-I, on butt joins of body and disc c) Post Weld Heat Treatment (PWHT) as per ASME, Section-VIII, Division-I on butt joints of body and disc of thickness above 30mm shall be carried out.
13	Rubber Lining Mix shall be subjected to Bleed Resistance Test on mould sample. Adhesion Test, Spark Test and Hardness Test for the Rubber lined jobs shall also be conducted.
14	All fans shall be subjected to run test and Vibration, noise, temperature rise, and current drawn shall be measured during the run test. Performance test of one fan of each type and size shall be carried out as per applicable standard for air flow, static pressure, speed, Efficiency, power consumption.
15	In case of diaphragm/plunger, only proven material shall be used and certificate in this regard shall be submitted for review.
16	All pumps to be performance tested as per Hydraulic Institute Standard/Relevant standard. Performance test to include check for noise, vibration level and bearing temperature rise. NPSH test shall be carried out for HCSD pumps and other pumps, if applicable.
17	Pumps shall be tested at 200% of pump rated head or at 150% of pump shut-off head whichever is higher for 30 min duration. For Ash slurry pumps the Rated/shut off head for each slurry pump shall be taken after adding the rated/shut off head for all the pumps coming in a series. The testing for each pump shall be done at the above pressure.
18	Performance testing of each compressor/ Blower / Vacuum Pump shall be carried out at shop as per BS-1571/ IS: 5456 /ISO 1217/ Pneurop 6612/ equivalent as applicable. Noise & vibration shall also be measured during performance testing.
19	For Compressors capacity control and operation of safety valves shall be checked during inspection at shop
20	Pressure retaining parts shall be hydraulic tested. Hydraulic test pressure shall be as per applicable std / 1.5 x design pressure or 2 x working pressure whichever is higher for 30 minutes duration. Atmospheric tanks shall be water fill tested
21	RT on weld joints shall be as per respective code requirements. Heat Treatment of the Tank/Vessel shall be done as per fabrication code requirement.
22	Dished ends shall be stress relieved as per relevant code. However, dished ends welds (if manufactured by using welded plates) shall be subjected to 100% RT and stress relieved.
23	Tube to tube sheet joints of heat exchanger shall be subject to mock up test. Coolers/heat exchanger shall be hydro tested on tube side and shell side
24	Refrigerant compressors shall be tested as per relevant std and certification from manufacturer for the same shall be submitted. Due point measurement & function of auto drain trap shall also be carried out.
25	Concentricity/ centering & Axial Run out Shall also be measured

SUB-SECTION– E-20
COAL HANDLING PLANT

Coal Handling Plant (Mechanical)

1.01.00 Brakes and Clamps

1.01.01 Final testing of brakes shall include load, HV/IR & heat run tests.

1.02.00 Monorails and Hoists

1.02.01 All electric hoist shall be tested as per IS 3938 and chain pulley block shall be tested as per IS 3832.

1.03.00 Chute

1.03.01 Flap Gates

a) MPI/DP test shall be conducted on rack and pinion / rod / weld joint

b) Functional checks on the gates shall be carried out along with respective actuator, if applicable.

1.04.00 Belt Conveyor System

The details of the checks to be carried out in the various equipments are to be submitted by the Contractor for Owner's approval. However, some indicative checks on different items are given below which should necessarily form a part of the Quality Assurance Plan to be agreed with the Owner.

1.04.01 Idlers

a) Check for run out and free movement shall be carried out on idlers. Run out shall be restricted as per IS:8598

b) Test for dust proofness, water proofness and dynamic friction factor of the Idlers shall be conducted at shop. The detailed procedures for the same shall be submitted for review and approval.

1.04.02 Belting

(a) Rubber cover of finished belt shall be checked for tensile strength and elongation at break before and after ageing. Rubber cover shall also be checked for abrasion, tear strength and hardness.

(b) For finished belts, checks for elongation at 10% nominal tensile strength, tensile and elongation at break in longitudinal (warp) direction and tensile in transverse (weft) direction shall be carried out.

(c) Adhesion test between ply to ply and cover to ply shall be carried out.

(d) Trough-ability test and Test for fire resistance shall be carried out.

(e) Test for procedure qualification for belt vulcanizing joint (at site) shall be done. Procedure for belt vulcanizing joint shall be discussed and finalized during FQP finalization.

(f) There will be a limitation on the no. of repairs allowed on the belts. Following will be the acceptance norm for the cover repairs.

i) The maximum size of a repair shall be limited to a size equivalent to one fifth the belt width. No single dimension shall exceed one fifth (1/5) of belt width.

ii) Small local repair by dough filling of size 25mm x 25mm to a limited extent shall not be counted of repairs. However, in case of cluster of repairs, same shall be counted as a patch repair.

iii) The maximum number of patch repair shall not exceed 5 per 100 mts. However, the total number of patch and dough filling repairs shall not exceed 10 per 100 meters.

(g) In addition to above, Steel Cord belt shall also be tested for following.

i. Cord dia and breaking strength
ii. Finished belt shall be tested for cord pull-out strength before and after ageing, peeling resistance.
iii. Dynamic cord pull out test
iv. Cord dia, pitch and number of cords

(h) In no case shall the cover thickness or the width of belt be less than that given in specification.

(i) For testing purpose, belt sample shall be taken from anywhere of the belt roll length offered

1.04.03 Belt Vulcanizing Machine

a) Check for tensile strength shall be carried out on a sample vulcanized belt joint for each type of belt in shop. However, if such test has been done earlier, the report for same shall be submitted for verification.

b) Complete assembly shall be tested at shop for temp. and pressure developed

1.04.04 Pulleys

a) In addition to chemical, mechanical, hardness, microstructure as per applicable material specification, pulleys shaft forgings shall be subjected to ultrasonic testing.

b) 100% MPI/DPT on all welds shall be conducted and 10% RT/UT on butt welds shall be conducted.

c) Static balancing of pulleys shall be carried out after rubber lagging.

d) Checks on rubber lagging to include abrasion loss, shore hardness test, peel-off strength test and physical properties. Peel-off strength shall be 10 Kg/Cm, Abrasion loss shall be less than 250 cubic mm when tested as per DIN 53516.

1.04.05 Pull Chord & Belt Sway Switches

a. Acceptance tests

i) Over all dimension and functional test.

ii) HV & IR test

iii) Degree of protection test report.

1.04.06 Zero Speed Switch, Under Belt Switch and Chute Blockage Switch

a Acceptance test

i) Burn in test at 50 degree C for 48 hours shall be done for electronic switches.
ii) Over all dimension and functional test shall be carried out.
iii) HV & IR
iv) Degree of protection test

1.05.00 Drive Equipment:

1.05.01 Gear Boxes:

(a) In addition to checks for physical, chemical, hardness, microstructure as per relevant standard, the shaft and gear/pinion forgings shall be subjected to ultrasonic testing.

(b) MPI to be carried out on Gears/Pinions after machining. Case depth, hardness and MPI after hard-facing shall be checked to ensure freedom from defects.

(c) Gear reducer shall be checked for reduction ratio, backlash and contact pattern. No load shop trial run to be conducted on gear boxes to check for oil leakage, temperature rise, noise level and vibration.

1.05.02 Flexible Coupling

(a) Ultrasonic testing shall be conducted on forgings for gear sleeve and gear hub, if gear coupling is provided.

(b) MPI shall be carried out after machining to ensure freedom from cracks.

1.05.03 Fluid Coupling

(a) Dynamic balancing shall be carried out for the rotating parts.

(b) Check for leak tightness of the coupling shall be carried out.

(c) Functional test on fusible plug for each type of coupling shall be conducted at shop.

(d) All couplings to be run tested at shop on no load

(e) Check for temperature rise, torque-speed, torque-slip characteristics and over speed test shall be included during performance test of one coupling of each type preferably at full load.

1.06.00 Dust Control & Miscellaneous Systems (Dust Suppression & Dry Fog Dust Suppression System)

The details of the checks to be carried out on the various equipments are to be submitted by the Contractor for Owners approval. However some indicative checks on different items are given below which should necessarily form a part of the Quality Assurance Plan to be agreed with by the Owner.

1.06.01 Pumps

(a) All materials should be of tested quality and test certificates to be provided.

(b) DPT of machined shaft and impeller shall be done.

(c) Shaft forgings to be also subjected to ultrasonic testing.

(d) Impellers to be dynamically balanced to ISO 1940 Gr.6.3

(e) All pressure parts shall be hydraulically tested at 150% of the shut-off head or 200% of rated head, whichever is higher for 30 minutes. No leakage is allowed.

(f) All pumps to be performance tested as per Hydraulic Institute Standard/Indian Standard. Performance test to include check for noise, vibration level and temperature rise.

1.06.02 Valves & Specialties

(a) Valves and Specialties shall be tested as per relevant standards / codes.

(b) Seat Leakage and hydraulic test to be carried out as per relevant standards / codes.

1.06.03 Pipes and Fittings

Pipes and fittings shall be tested as per relevant standards / codes.

1.06.04 Air Compressor

a) All pressure parts shall be hydraulically tested at not less than 150% of design pressure for duration of 30 minutes prior to painting.

b) All other parts including inter-connecting piping shall be hydraulically tested wherever possible, as per relevant codes.

c) Ultrasonic testing shall be carried out on all forgings and rotor for dia 50mm and above. MPI/DPT shall be done on machined area of the components.

d) During assembly all clearances and alignments shall also be checked and recorded

e) Rotor shall be statically and dynamically balanced

f) Performance Test (Shop Test)
   i. Performance test on the compressor shall be carried out in accordance with ISO:1217/Eq. The test shall also include demonstration of loading and unloading mechanism (Capacity control) and operation of safety valve
   ii. Vibration and Noise level measurement shall be done during shop performance test.

1.06.05 Air Receiver

a) Each finished vessel shall be hydraulically tested at 150% of the design pressure for a duration of 30 minutes

b) NDT on weld joints shall be as per respective code requirements or the minimum as specified below

   i. 100% DPT on root run of butt welds

   ii. 100% DPT on all finished butt welds and fillet welds

   iii. 10% RT on butt welds which shall include all T-Joints

1.07.00 Ventilation Systems

1.07.01 Fan

(a) All materials should be of tested quality and test certificates should be provided.

(b) Dynamic balancing of the fan impellers to be carried out.

(c) Shop run test shall be conducted on all centrifugal fans including check for noise and vibration level.

(d) Performance test shall be conducted on one fan of each type at shop for capacity, pressure, efficiency and power consumption.

1.07.02 Valves and Specialties

Refer 1.06.02 above

1.07.03 Pipes and Fittings

Refer 1.06.03 above

1.08.00 Travelling Trippers & Bunker Sealing Arrangement

Mobile Trippers

(a) Shaft and wheel forgings – Ultrasonic test in addition to check for chemical, mechanical, hardness, microstructure etc. as per applicable material specification shall be conducted.

(b) Following minimum NDT requirements to be ensured for welds:

i) Butt welds - 10% UT/RT and 100% MPI/DPT.

ii) Fillet Welds - 10% MPI/DPT.

(c) Shop trial run test shall be carried out and shall include check for noise level and vibration.

1.09.0 Steel Structure

1.09.01 Only material which has been identified against mill sheet or test certificates shall be used for construction. Check testing shall be carried out in the absence of MTC. Correlation shall be maintained by Manufacturer. All plates above 40mm thickness shall be 100% ultrasonically tested.

1.09.02 Visual inspection of all welds shall be performed in accordance with AWS D.1.1.

1.09.03 NDT requirements of structural steel welds shall be as under:

a) 100% RT/UT on butt-welds of plate thickness >= 32 mm. Edge for field weld shall be examined by MPI for plate thickness >= 32mm.

b) For Plates of 10 mm < thickness < 32 mm - 10% RT On butt welds.

c) 10% Ultrasonic testing shall be carried out on full penetration welds (other than butt welds)

d) DP Test on Welds:

- 100% on Root Run & 10% on Final Welds of all butt welds
- At random 5% on fillet of built-up plate girders.

1.09.04 Girders/columns/Beams etc shall be trial assembled and match marked prior to dispatch. Trial assembly procedure at shop shall be submitted for NTPC review and approval.

1.10.00 Belt Scales

The details of the checks to be carried out in the various equipment's are to be submitted by the Contractor for Employer's approval. However, some indicative checks are given below which should necessarily form a part of the quality assurance plan to be agreed with the Employer.

1.10.01 Mounting arrangement/Overall dimensional check shall be carried out on the Belt Scales.

1.10.02 Belt scale shall be calibrated with test weight/test chain in static at works and with test weight for dynamic condition at site.

1.10.03 All electronic modules shall be subjected to burn in test at 50 Degree C for 48 hours.

1.10.04 General check for load cell shall be carried out.

1.10.05 Test report for degree of protection on enclosure shall be furnished.

1.10.06 Accuracy/performance check shall be demonstrated at site.

1.11.00 Package Air-Conditioner

Each Unit shall be subjected to production routine Test excluding performance test carried out as per relevant standard. Performance test of PAC shall be carried out as per relevant standard on one unit of each type and rating at site.

1.12.00 Vibrating Grizzly Feeders and Vibrating Feeders

(a) Shaft forgings to be checked for ultrasonic testing in addition to check for chemical, mechanical, hardness, microstructure etc. as per applicable material specification

(b) Following minimum NDT requirements to be ensured for welds:

i) Butt welds - 10% UT/RT and 100% MPI/DPT.

ii) Fillet Welds - 10% MPI/DPT.

(c) Shop trial run test shall be conducted to checks for speed (RPM), amplitude (stroke), temperature rise and noise level.

1.13.00 Crushers (Ring Granulators)

The details of the checks to be carried out for various components are to be submitted by the Contractor for Owner's approval. However, some indicative checks on different items are given below which should necessarily form part of the Quality Assurance Plan to be agreed with the Owner.

(b) All plates equal to or above 25mm thickness shall be ultrasonically tested.

(c) Shaft forgings and suspension bars to be checked for ultrasonic testing in addition to check for chemical, mechanical, hardness, microstructure etc. as per applicable material specification.

(d) Following minimum NDT requirements to be ensured for welds:

i) Butt welds - 10% UT/RT and 100% MPI/DPT.
ii) Fillet Welds - 10% MPI/DPT.

(e) Crusher rotor to be dynamically balanced. Procedure to be submitted for approval.

(f) No-load trial run test to be carried out at shop to check for speed (RPM), temperature rise, noise level and vibration.

1.14.00 In-Line Magnetic Separators

i) Overall Dimensional, Visual check along with control panel.

ii) HV & IR.

iii) Operation, temperature rise, lifting capacity, force index and gauss strength.

1.15.00 Metal Detectors

i) Functional test including sensitivity, Burn in test, operation of liquid spray marker, detection of smallest piece of different materials as specified.

ii) Test report for Degree of protection test to be furnished.

1.16.00 Coal Sampling Units

(a) Free carriage and cutter movement, speed of cutter and dust door closing, and sealing shall be tested for samplers.

(b) "No load test" shall be carried out for crushers.

1.17.0 Reversible Stacker Cum Reclaimer/Reclaimer

1.17.01 All plates equal to or above 25mm thickness shall be ultrasonically tested.

1.17.02 Forgings/Castings for Shaft, Gears/Pinion, Axles, Rail Wheels, Bucket Hub/Teeth/Blade etc., shall be subject to ultrasonic testing in addition to check for chemical, mechanical, hardness and microstructure as per applicable material specification

1.17.03 MPI/DPT shall be carried out on forgings/casting after machining/hard facing if applicable.

1.17.04 Following minimum NDT requirements shall be followed for welds:

i) Butt Welds in Tension- 100% UT/RT and 100% MPI/DPT.
ii) Butt Welds in Compression- 10% UT/RT and 10% MPI/DPT.
iii) Fillet Welds - 10% MPI/DPT.

1.17.05 Trial assembly of Stacker/Reclaimer, Sub-assemblies shall be carried out at shop. Manufacturer shall furnish detail procedure for various sub assemblies such as wheel bogies, base frame, slew deck, bucket wheel, boom, bucket wheel with shaft and sample bucket etc. for NTPC approval.

1.18.00 WAGON TIPPLER ALONGWITH SIDE ARM CHARGER

1.18.01 All plates equal to or above 25 mm thickness shall be ultrasonically tested.

1.18.02 Casting and forgings/bars (Shafts, Racks, Pinion wheels, Arm etc.) shall be subjected to ultrasonically test in addition to check for chemical, mechanical, hardness, microstructure etc. as per applicable material specification.

1.18.03 Machined and hard faced surface of casting/forging shall be subjected to DPT/MPI.

1.18.04 Following minimum NDT requirements shall be followed for welds:

i) Butt Welds in Tension- 100% UT/RT and 100% MPI/DPT.
ii) Butt Welds in Compression- 10% UT/RT and 10% MPI/DPT.
iii) Fillet Welds - 10% MPI/DPT.

1.18.05 Trial assembly of various sub-assemblies of Wagon Tippler along with Side Arm Charger shall be carried out in shop. Manufacturer shall furnish detail procedure for the same for NTPC approval.

1.19.00 APRON FEEDER

1.19.01 All plates equal to or above 25 mm thickness shall be ultrasonically tested.

1.19.02 Castings and forgings, forged/rolled bar/section shall be subjected to ultrasonically test in addition to check for chemical, mechanical, hardness, microstructure etc. as per applicable material specification.

1.19.03	Machined and hard faced surface of casting/forging and other hardened, stellited parts shall be subjected to DPT/MPI in addition to check for case depth, hardness as applicable for chain/sprocket/gear reducer/rollers/wheel/pan etc.
1.19.04	Suitable check for life time sealing of rollers for protection from dust and water shall be done
1.19.05	Following minimum NDT requirements shall be followed for welds: i) Butt Welds in Tension- 100% UT/RT and 100% MPI/DPT. ii) Butt Welds in Compression- 10% UT/RT and 10% MPI/DPT. iii) Fillet Welds - 10% MPI/DPT.
1.19.06	For other items like drive system, motor, pulley, belt relevant portion of specification shall be applicable
1.19.07	No load trial run test shall be carried out at shop on completely assembled apron feeder to check for trouble free operation, temperature rise, Noise & vibration.
1.20.00	**Paddle Feeders**
1.20.01	Shaft and wheel forgings – Chemical, Mechanical, Hardness and Ultrasonic Test shall be conducted.
1.20.02	Following minimum NDT on Weld Joint shall be carried out (a) Butt Welds - 10% UT/RT & 100% MPI/DPT (b) Fillet Welds - 10% MPI/DPT
1.20.03	Shop trial run shall be conducted to check for movement and RPM of Paddle wheel & Travel wheel, function of P/F in locked rotor condition, noise and vibration etc.

Bio Mass Handling Plant (Mechanical)

1.01.00 Brakes and Clamps

1.01.01 Final testing of brakes shall include load, HV/IR & heat run tests.

1.02.00 Monorails and Hoists

1.02.01 All electric hoist shall be tested as per IS 3938 and chain pulley block shall be tested as per IS 3832.

1.03.00 Chute

1.03.01 Flap Gates

a) MPI/DP test shall be conducted on rack and pinion / rod / weld joint

c) Functional checks on the gates shall be carried out along with respective actuator, if applicable.

2.04.00 Belt Conveyor System

The details of the checks to be carried out in the various equipments are to be submitted by the Contractor for Owner's approval. However, some indicative checks on different items are given below which should necessarily form a part of the Quality Assurance Plan to be agreed with the Owner.

1.04.01 Idlers

c) Check for run out and free movement shall be carried out on idlers. Run out shall be restricted as per IS:8598

d) Test for dust proofness, water proofness and dynamic friction factor of the Idlers shall be conducted at shop. The detailed procedures for the same shall be submitted for review and approval.

1.04.02 Belting

(g) Rubber cover of finished belt shall be checked for tensile strength and elongation at break before and after ageing. Rubber cover shall also be checked for abrasion, tear strength and hardness.

(h) For finished belts, checks for elongation at 10% nominal tensile strength, tensile and elongation at break in longitudinal (warp) direction and tensile in transverse (weft) direction shall be carried out.

(i) Adhesion test between ply to ply and cover to ply shall be carried out.

(j) Trough-ability test and Test for fire resistance shall be carried out.

(k) Test for procedure qualification for belt vulcanizing joint (at site) shall be done. Procedure for belt vulcanizing joint shall be discussed and finalized during FQP finalization.

(l) There will be a limitation on the no. of repairs allowed on the belts. Following will be the acceptance norm for the cover repairs.

iv) The maximum size of a repair shall be limited to a size equivalent to one fifth the belt width. No single dimension shall exceed one fifth (1/5) of belt width.

v) Small local repair by dough filling of size 25mm x 25mm to a limited extent shall not be counted of repairs. However, in case of cluster of repairs, same shall be counted as a patch repair.

vi) The maximum number of patch repair shall not exceed 5 per 100 mts. However, the total number of patch and dough filling repairs shall not exceed 10 per 100 meters.

(g) In addition to above, Steel Cord belt shall also be tested for following.

v. Cord dia and breaking strength
vi. Finished belt shall be tested for cord pull-out strength before and after ageing, peeling resistance.
vii. Dynamic cord pull out test
viii. Cord dia, pitch and number of cords

(h) In no case shall the cover thickness or the width of belt be less than that given in specification.

(i) For testing purpose, belt sample shall be taken from anywhere of the belt roll length offered

2.04.03 Belt Vulcanizing Machine

c) Check for tensile strength shall be carried out on a sample vulcanized belt joint for each type of belt in shop. However, if such test has been done earlier, the report for same shall be submitted for verification.

d) Complete assembly shall be tested at shop for temp. and pressure developed

1.04.04 Pulleys

e) In addition to chemical, mechanical, hardness, microstructure as per applicable material specification, pulleys shaft forgings shall be subjected to ultrasonic testing.

f) 100% MPI/DPT on all welds shall be conducted and 10% RT/UT on butt welds shall be conducted.

g) Static balancing of pulleys shall be carried out after rubber lagging.

h) Checks on rubber lagging to include abrasion loss, shore hardness test, peel-off strength test and physical properties. Peel-off strength shall be 10 Kg/Cm, Abrasion loss shall be less than 250 cubic mm when tested as per DIN 53516.

1.04.05 Pull Chord & Belt Sway Switches

a. Acceptance tests

i) Overall dimension and functional test.

ii) HV & IR test

iii) Degree of protection test report.

1.04.06 Zero Speed Switch, Under Belt Switch and Chute Blockage Switch

a Acceptance test

i) Burn in test at 50 degree C for 48 hours shall be done for electronic switches.
ii) Overall dimension and functional test shall be carried out.
iii) HV & IR

iv) Degree of protection test

1.05.00 Drive Equipment:

1.05.01 Gear Boxes:

(d) In addition to checks for physical, chemical, hardness, microstructure as per relevant standard, the shaft and gear/pinion forgings shall be subjected to ultrasonic testing.

(e) MPI to be carried out on Gears/Pinions after machining. Case depth, hardness and MPI after hard-facing shall be checked to ensure freedom from defects.

(f) Gear reducer shall be checked for reduction ratio, backlash and contact pattern. No load shop trial run to be conducted on gear boxes to check for oil leakage, temperature rise, noise level and vibration.

1.05.02 Flexible Coupling

(c) Ultrasonic testing shall be conducted on forgings for gear sleeve and gear hub, if gear coupling is provided.

(d) MPI shall be carried out after machining to ensure freedom from cracks.

1.05.03 Fluid Coupling

(f) Dynamic balancing shall be carried out for the rotating parts.

(g) Check for leak tightness of the coupling shall be carried out.

(h) Functional test on fusible plug for each type of coupling shall be conducted at shop.

(i) All couplings to be run tested at shop on no load

(j) Check for temperature rise, torque-speed, torque-slip characteristics and over speed test shall be included during performance test of one coupling of each type preferably at full load.

1.06.00 Dust Control & Miscellaneous Systems (Dust Suppression & Dry Fog Dust Suppression System)

The details of the checks to be carried out on the various equipments are to be submitted by the Contractor for Owners approval. However some indicative checks on different items are given below which should necessarily form a part of the Quality Assurance Plan to be agreed with by the Owner.

1.06.01 Pumps

(g) All materials should be of tested quality and test certificates to be provided.

(h) DPT of machined shaft and impeller shall be done.

(i) Shaft forgings to be also subjected to ultrasonic testing.

(j) Impellers to be dynamically balanced to ISO 1940 Gr.6.3

(k) All pressure parts shall be hydraulically tested at 150% of the shut-off head or 200% of rated head, whichever is higher for 30 minutes. No leakage is allowed.

(l) All pumps to be performance tested as per Hydraulic Institute Standard/Indian Standard. Performance test to include check for noise, vibration level and temperature rise.

1.06.02 Valves & Specialties

(a) Valves and Specialties shall be tested as per relevant standards / codes.

(b) Seat Leakage and hydraulic test to be carried out as per relevant standards / codes.

1.06.03 **Pipes and Fittings**

Pipes and fittings shall be tested as per relevant standards / codes.

1.06.04 **Air Compressor**

g) All pressure parts shall be hydraulically tested at not less than 150% of design pressure for duration of 30 minutes prior to painting.

h) All other parts including inter-connecting piping shall be hydraulically tested wherever possible, as per relevant codes.

i) Ultrasonic testing shall be carried out on all forgings and rotor for dia 50mm and above. MPI/DPT shall be done on machined area of the components.

j) During assembly all clearances and alignments shall also be checked and recorded

k) Rotor shall be statically and dynamically balanced

l) Performance Test (Shop Test)
   i. Performance test on the compressor shall be carried out in accordance with ISO:1217/Eq. The test shall also include demonstration of loading and unloading mechanism (Capacity control) and operation of safety valve
   ii. Vibration and Noise level measurement shall be done during shop performance test.

1.06.05 **Air Receiver**

c) Each finished vessel shall be hydraulically tested at 150% of the design pressure for a duration of 30 minutes

d) NDT on weld joints shall be as per respective code requirements or the minimum as specified below

   i. 100% DPT on root run of butt welds

   ii. 100% DPT on all finished butt welds and fillet welds

   iii. 10% RT on butt welds which shall include all T-Joints

1.07.00 **Ventilation Systems**

1.07.01 Fan

(e) All materials should be of tested quality and test certificates should be provided.

(f) Dynamic balancing of the fan impellers to be carried out.

(g) Shop run test shall be conducted on all centrifugal fans including check for noise and vibration level.

(h) Performance test shall be conducted on one fan of each type at shop for capacity, pressure, efficiency and power consumption.

1.07.02 Valves and Specialties

Refer 1.06.02 above

1.07.04 Pipes and Fittings

Refer 1.06.03 above

1.08.00 Travelling Trippers & Bunker Sealing Arrangement

Mobile Trippers

(a) Shaft and wheel forgings – Ultrasonic test in addition to check for chemical, mechanical, hardness, microstructure etc. as per applicable material specification shall be conducted.

(b) Following minimum NDT requirements to be ensured for welds:

i) Butt welds - 10% UT/RT and 100% MPI/DPT.

ii) Fillet Welds - 10% MPI/DPT.

(c) Shop trial run test shall be carried out and shall include check for noise level and vibration.

1.10.0 Steel Structure

1.09.01 Only material which has been identified against mill sheet or test certificates shall be used for construction. Check testing shall be carried out in the absence of MTC. Correlation shall be maintained by Manufacturer. All plates above 40mm thickness shall be 100% ultrasonically tested.

1.09.02 Visual inspection of all welds shall be performed in accordance with AWS D.1.1.

1.09.03 NDT requirements of structural steel welds shall be as under:

e) 100% RT/UT on butt-welds of plate thickness >= 32 mm. Edge for field weld shall be examined by MPI for plate thickness >= 32mm.

f) For Plates of 10 mm < thickness < 32 mm - 10% RT On butt welds.

g) 10% Ultrasonic testing shall be carried out on full penetration welds (other than butt welds)

h) DP Test on Welds:
- 100% on Root Run & 10% on Final Welds of all butt welds
- At random 5% on fillet of built-up plate girders.

1.09.04 Girders/columns/Beams etc shall be trial assembled and match marked prior to dispatch. Trial assembly procedure at shop shall be submitted for NTPC review and approval.

1.10.00 Belt Scales

The details of the checks to be carried out in the various equipment's are to be submitted by the Contractor for Employer's approval. However, some indicative checks are given below which should necessarily form a part of the quality assurance plan to be agreed with the Employer.

1.10.01 Mounting arrangement/Overall dimensional check shall be carried out on the Belt Scales.

1.10.02 Belt scale shall be calibrated with test weight/test chain in static at works and with test weight for dynamic condition at site.

1.10.03 All electronic modules shall be subjected to burn in test at 50 Degree C for 48 hours.

1.10.07 General check for load cell shall be carried out.

1.10.08 Test report for degree of protection on enclosure shall be furnished.

1.10.09 Accuracy/performance check shall be demonstrated at site.

1.11.00 Package Air-Conditioner

Each Unit shall be subjected to production routine Test excluding performance test carried out as per relevant standard. Performance test of PAC shall be carried out as per relevant standard on one unit of each type and rating at site.

1.14.00 In-Line Magnetic Separators

iv) Overall Dimensional, Visual check along with control panel.

v) HV & IR.

vi) Operation, temperature rise, lifting capacity, force index and gauss strength.

1.15.00 Metal Detectors

iii) Functional test including sensitivity, Burn in test, operation of liquid spray marker, detection of smallest piece of different materials as specified.

iv) Test report for Degree of protection test to be furnished.

1.16.00 Sampling Units

(c) Free carriage and cutter movement, speed of cutter and dust door closing, and sealing shall be tested for samplers.

(d) "No load test" shall be carried out for crushers.

1.19.00 Feeders

1.19.01 Shaft and wheel forgings – Chemical, Mechanical, Hardness and Ultrasonic Test shall be conducted.

1.19.02 Following minimum NDT on Weld Joint shall be carried out

(a) Butt Welds - 10% UT/RT & 100% MPI/DPT
(b) Fillet Welds - 10% MPI/DPT

1.19.03 Shop trial run shall be conducted to check for movement and RPM of Paddle wheel & Travel wheel, function of P/F in locked rotor condition, noise and vibration etc.

1.21.0 **Silo and Hoppers**

1.21.01 All material shall be tested for Chemical & Mechanical properties as per relevant standard. MPI/DP test on welding shall be carried out. Fit up assembly checks shall be carried out at shop for all dispatchable segments.

1.22.0 **Mobile Trippers**

(a) Shaft and wheel forgings – Ultrasonic test in addition to check for chemical, mechanical, hardness, microstructure etc. as per applicable material specification shall be conducted.
(b) Following minimum NDT requirements to be ensured for welds:
i) Butt welds - 10% UT/RT and 100% MPI/DPT.
ii) Fillet Welds - 10% MPI/DPT.
(c) Shop trial run test shall be carried out and shall include check for noise level and vibration.

1.23.00 Bucket Elevator

1.23.01 All plates equal to or above 25 mm thickness shall be ultrasonically tested.
1.23.02 Castings and forgings, forged/rolled bar/section shall be subjected to ultrasonically test in addition to check for chemical, mechanical, hardness, microstructure etc. as per applicable material specification.
1.23.03 Machined and hard-faced surface of casting/forging and other hardened, stellited parts shall be subjected to DPT/MPI in addition to check for case depth, hardness as applicable for chain/sprocket/gear reducer/rollers/wheel/pan etc.
1.23.04 Following minimum NDT requirements shall be followed

for welds:

i) Butt Welds in Tension- 100% UT/RT and 100% MPI/DPT.
ii) Butt Welds in Compression- 10% UT/RT and 10% MPI/DPT.
iii) Fillet Welds - 10% MPI/DPT.

1.23.05 For other items like drive system, motor, pulley, belt etc relevant portion of specification shall be applicable.

1.24.00 Elevators (Rack and Pinion Type)

The details of the checks to be carried out in the various equipments are to be submitted by the contractor for owner's approval. However, some indicative checks on different items are given below which should necessarily form part of the quality assurance plan to be agreed with the owner.

1.24.01 All forgings shall be subjected to ultrasonic test to ensure free from internal defects in addition to check for chemical and mechanical properties.

1.24.02 10% of the welds selected at random shall be subject to DP test.

1.24.03 All forged components shall be subjected to DPI/MPI after machining.

1.24.04 Gear Reducer shall be checked for gear ratio, backlash, contact pattern. No load shop trial run shall be conducted on gear boxes to check for oil leakage, temperature rise, noise and vibration.

1.24.05 Buffer springs shall be subjected to load test as per relevant specifications. Material certificates for springs shall also be furnished.

1.24.06 All components prior to assembly shall be checked for dimensions.

1.24.07 Function test of Elevator assembly shall be carried out.

1.24.08 All electrical equipment's shall be of proven quality.
Galvanized components/parts shall be checked for weight of Zn coating, thickness of coating, uniformity of coating and adhesion test and visual examination as per IS 2633 and IS 2629

SUB-SECTION– E-21
COMPRESSED AIR SYSTEM

1.00.00 **AIR COMPRESSOR SYSTEM**

1.01.00 **AIR COMPRESSORS:**

a) All pressure parts shall be hydraulically tested at not less than 150% of design pressure prior to painting and lining, if applicable. The test pressure will be maintained for 30 minutes.

b) All other parts including inter-connecting piping shall be hydraulically tested wherever possible, as per relevant codes.

c) Ultrasonic testing shall be carried out on all forgings and shafts (if dia.> 40mm). MPI/DP test will be done on machined areas of the above components.

d) Rotor shall be statically and dynamically balanced as per relevant standard.

1.01.01 **PERFORMANCE TEST (SHOP TEST) :**

a) Performance test on the compressors shall be carried out in accordance relevant standard. The test shall also include demonstration of loading and unloading mechanism (Capacity control) and operation of safety valves.

b) Power consumption at motor input terminal at rated capacity as well as at fully unloaded condition of all the compressor shall be measured.

c) Vibration and noise level measurement will be done during shop performance test.

d) Test shall be carried out on all compressors with contract drive motor where power consumption for compressors has been indicated as a guaranteed parameter

1.02.00 **AIR RECEIVER, HEAT EXCHANGERS, MOISTURE SEPERATORS, AIR DRYING PLANT:**

a) Each finished vessel shall be hydraulically tested to 150% of the design pressure for a duration of 30 minutes.

b) NDT on weld joints shall be as per respective code requirements or the minimum as specified below:

(i) 100 % DPT on root run of butt welds.
(ii) 100% DPT on all finished butt welds and fillet welds
(iii) 10% RT on butt welds which shall include all T- joints.

c) Tube to Tube sheet joint of the heat exchangers shall be subject to Mock-up test as per the relevant standards.

d) Reactivation blowers shall be tested for FAD, temp. rise noise & vibration. Rotating parts shall be dynamically balanced.

e) Completely assembled ADP shall be pneumatically tested at design pressure for a duration of 5 minutes. Functional and sequential operation testing of the completely assembled ADP shall be demonstrated at shop. Other accessories shall be tested as per relevant code and sections. Dew point measurement shall be done.

FOR E.O.T. CRANE REFER QA CHAPTER EOT CRANES AND HOISTS, FOR PIPES, FITTINGS, VALVES & RE JOINTS REFER QA CHAPTERS OF LP PIPING.

SUB-SECTION– E-22
CW PUMP

	Tests/Check / Items / Components	Material Test	DPT/MPI	Ultrasonic test	RT	Balancing	Hydraulic / Water Fill test	Pneumatic Test	Assembly/ fit up	Dimensions	Functional/operational Test	Performance Test	Other Test	All Test as per relevant Std/ Approved Data Sheets	Remarks
A.	**CW PUMPS, VT PUMPS & CENTRIFUGAL PUMPS (HORIZONTAL / VERTICAL), SUMP PUMPS, SUBMERSIBLE PUMPS, DRAINAGE PUMP**								Y[1]	Y		Y[2]			
1	Shaft	Y[a]	Y[b]	Y[c]		Y				Y					
2	Impeller	Y[a]	Y[b]		Y[3]	Y							Y[d]		
3	Suction Bell / Bowl Castings/ Inserts	Y[a]	Y[b]				Y			Y			Y[6]		
4	Discharge Head / Column Pipes / Distance Piece/Base Plate	Y[a]	Y[b]	Y[c]	Y[4]		Y		Y						
5	Companion Flanges	Y[a]	Y[b]	Y[c]	Y[5]				Y						
5	Thrust Bearing (Tilting Pad type)	Y[a]	Y	Y					Y	Y				Y	
B.	**BUTTERFLY VALVES**						Y[7]		Y	Y	Y		Y[8]	**Y**	
1	Body & Disc (Cast)	Y[a]	Y[b]												
2	Body & Disc (fabricated)	Y[a]	Y[b]	Y[c]									Y[9]		
3	Shaft	Y[a]	Y[b]	Y[c]											
4	EH Actuators	Y[a]	Y				Y	Y	Y		Y				
C.	**RE JOINTS**	Y[a]					Y[10]		Y	Y			Y[11]		
D.	**R & W PIPES**	Y[a]	**REFER NOTE 13**												
E.	**CRANES & HOISTS**	**REFER BELOW FOR QA CHECKS ON EOT CRANES AND HOISTS**													
F.	**VENTILATION FANS**									Y		Y		Y	

1)	Hub/Blades/Casing /Impeller	Y	Y			Y									
2)	Shaft	Y[a]	Y	Y[c]											
3)	Pre/Fine Filters												Y[14]		
H.	**GATE, GLOBE, CHECK VALVES, PIPINGS, & SPECIALITIES**	Y[a]	Y[b]	Y[c]			Y[15]		Y	Y	Y	Y	Y[15]	Y	

Notes:

a	One per Heat/ Heat Treatment Batch/ Lot.
b	On machined surfaces only for Castings / Forgings and on Welds of Fabricated Components.
c	For Shaft diameter. ≥ 50 mm and for plate thickness ≥ 25 mm
d	Inter Grannular Corrosion (IGC) Test shall be carried out on SS Castings.
1	Trial assembly of all Vertical Turbine Pump components with Column Pipes, Discharge Head, and Motor Stool shall be carried at shop.
2	Performance testing of Pumps shall be carried out at shop, as per HIS standard to determine Head & Flow Characteristics.
3	In case of CW pump impellers, Radiographic Examination shall be conducted as per ASTM E186/446 with Severity Level 2 for Gas porosity, Level 3 for Sand, Slag and Shrinkage. Cracks, Inserts and Mottling are not acceptable. Radiographic Examination should cover Vanes, Vane Junctions, Full Radial depth of Hub & other accessible areas of the rest of the Impeller.
4	Random 10% RT to be conducted on butt welds for Thk ≥ 10 mm & ≤ 25 mm and 100% RT to be conducted on butt welds for Thk > 25 mm (RT may be replaced by Ultrasonic Test due to constraint if any.) Stress relieving shall be carried out as per norms of ASME Section VIII.
5	Segmental Flanges exceeding 37.5 mm thickness shall be stress relieved after welding. All butt weld joints in segmental flange shall be examined by Radiographic Test. (RT may be replaced by Ultrasonic Test due to constraint if any.) Maximum number of segments shall be 4 only.
6	No repair welding is permitted on Cast Iron / Alloy Cast Iron Castings.
7	Hydraulic Test of Body, Seat and Disc strength shall be carried out in accordance with latest edition of AWWA C-504. Actuator operated Valves shall be checked for Seat Leakage by closing the Valve with Job Actuator. Seat Leakage test shall be carried out in both directions.
8	For Proof of Design Test refer respective chapters of engineering portion in the technical specification.
9	For Butterfly Valves of Fabricated construction (Sizes 600mm and above), butt Welds of thickness 20mm & above shall be subjected to 100% Radiography and Components shall undergo stress relieving.
10	During Hydraulic & Vacuum test at 30 mm Hg absolute in 3 different positions, the change in Circumference of the Arch should not be more than 1.5%. Permanent Set, after 24 hours of the test, should not exceed 0.5% of Arch.

11	Tests on Rubber for Tensile, Elongation, Hardness, Hydraulic Stability as per ASTM D-471, Ozone Resistance test as per IS:3400 Part 20, Aging test, Adhesion strength of Rubber to Fabric and Rubber to Metal shall be carried out.	
12	Smooth operation and Leakage test shall be carried out at site.	
13	Followings are the testing requirements for fabrication of pipes at site	
	Tests	**Quantum of Check**
	WPS, PQR, Welder Qualification Test	100%
	DPT on root run	100% for pipes up to 1200 mm diameter
	DPT after back gauging	100% for pipes above 1200 mm diameter
	RT/ UT by TOFD Technique/PAUT	5%
	DPT on finished butt weld joints	10%
	Hydraulic Test	100%, 1.5 times the design pressure or 2 times the working pressure which ever is higher.
	Note:- After erection, the complete piping system shall be tested at 1.5 times, the design pressure or two times the maximum working pressure whichever greater. No leakage/seepage is acceptable. Butt weld joints which would not be hydro-tested shall be subjected to 100% RT test/ 100% UT by TOFD /PAUT Technique.	
14	Type / Routine tests as per requirements of BS-6540/ ASHRAE-52-76 for Dust arrestance shall be carried out.	
15	a. All pipes and fittings shall be tested as per applicable code. b. All strainers shall be subjected to Hydraulic pressure test for leakage. c. All valves shall be hydraulically tested for body, seat and back-seat (if applicable) as per relevant standard. Check valves shall also be tested for leak tightness test at 25% of the specified seat test pressure. d. Valves shall be offered for hydro test in unpainted condition. e. Functional checks of the valves for smooth opening and closing shall also be done. f. Anti-corrosive protection shall be tested as per applicable code.	

EOT CRANES AND HOIST

1.00.00 HOOKS

All Tests including Proof Load Test as per relevant IS shall be carried out. MPI / DPT shall be done after proof load test.

2.00.00 STEEL CASTINGS

DPT on machined surface shall be carried out.

3.00.00 GIRDERS, END CARRIAGE, CRAB, GEAR BOX AND ROPE DRUM

UT shall be carried out on plates of thickness 25 mm and above as per ASTM A 435 /IS:11630 & IS: 4225

NDT requirements on weldments shall be as follows

i.	Butt Welds in Tension	100% RT & 100% DPT
ii.	Butt Welds in Compression	10% RT & 100% DPT
iii.	Butt Welds in Rope Drum	100% RT & 100% DPT
iv.	Fillet Welds	10% DPT

4.00.00 FORGINGS (Wheels, Gears, Pinions, Axles, Hooks, & Hooks Trunion)

All forgings greater than or equal to 50 mm diameter or thickness shall be subjected to ultrasonic testing (UT).

DPT / MPI shall be carried out after hard-facing and machining. Hardness and Case depth shall be measured

5.00.00 WIRE ROPES

Wire ropes shall be tested as per relevant standard.

6.00.00 REDUCTION GEARS

Reduction Gears shall be tested for reduction ratio, backlash and contact pattern. Gear box shall be subjected to No – load run test for 4 hours to check for oil leakage, temperature rise, noise and vibration.

7.00.00 Chemical and Mechanical test of all components as per relevant material specification shall be carried out.

8.00.00 COMPLETE CRANE

The crane shall be completely assembled at shop for final testing. All tests as per IS 3177 shall be carried out at shop.

9.00.00 HOISTS

All Electric Hoist shall be tested as per IS 3938 and chain pulley blocks shall be tested as per IS 3832.

SUB-SECTION– E-23
COOLING TOWER

SN	TESTS/CHECK / ITEMS / COMPONENTS	Material Test	WPS/PQR/Welder Qualification	Ultrasonic test	DPT/MPI	Balancing	Assembly Fit up	Dimension	RT	Hydraulic / Water Fill	Test as per relevant Std/ Approved Data Sheets	Other Tests
1	**GEAR BOX**						Y[1]	Y				Y[2]
1.1	Shaft and gear blanks	Y[a]		Y	Y[b]							
1.2	Gear Box Casing	Y[a]								Y		
2	**FAN ASSEMBLY**					Y	Y	Y				Y[3]
2.1	Fan hub	Y[a]	Y		Y[b]				Y[4]			Y[3]
2,2	Fan blades	Y[a]						Y				Y[3]
3A	**DRIVE SHAFT (SS) FOR FAN**	Y[a]	Y	Y	Y[b]	Y		Y				
3B	**CARBON FIBER DRIVE SHAFT**	SEE NOTE - 15										
4	**PVC FILL & DRIFT ELIMINATOR**	Y[5]					Y	Y			Y	Y[6]
5	**GATE/ GLOBE/ CHECK VALVES**	Y[a]			Y[b]		Y			Y	Y	Y[8]
6	**BUTTERFLY VALVES**				Y		Y	Y		Y	Y	Y[9]
6.1	Body (Cast) , Disc (Cast)	Y[a]			Y[b]			Y				
6.2	Body & Disc both fabricated	Y[a]	Y	Y	Y[b]			Y	Y[10]			
6.3	Shaft	Y[a]		Y[c]	Y[b]			Y				
7	**ROLLED & WELDED PIPES.**	Y[a]	**REFER NOTE – 11 FOR ALL CHECKS**									
8	**WRAPPING & COATING OF PIPES**	Y[12]						Y			Y	Y
9	**HOISTS & CHAIN PULLEY BLOCKS**	Y[a]	Y		Y		Y	Y			Y	Y[13]
10	**VENTILATION FANS**	Y[a]	Y	Y[c]	Y[b]	Y	Y	Y			Y	Y[14]
11	**FRP STRUCTURE**											
11.1	**Fiber Glass- Pultruded Structural Products**	See Note- 16 & 18										
11.2	**Fiber Glass- Reinforced Plastic Panels**	See Note 17 & 18										
11.3	**Fiber Glass- Reinforced Pipes**	The FRP pipes shall conform to CTI-154										

	Legend/ Notes:	
a.	One per Heat/Heat Treatment batch/Lot	
b.	On machined surfaces only of castings and forgings. Also 100% after root run/ back gauging for butt welds and 10% after final butt welds and fillet welds.	
c.	UT shall be done for shafts with Diameter 50 mm or above & Plates of Thickness 25 mm or above.	
1.	Blue Matching and Backlash of the gears shall be checked.	
2.	No load run test for 4 hours to check noise, vibration, oil leakage and temperature rise.	
3.	Proof load test, moment weight test on blades, blade track variation & tip clearances shall be checked. Galvanizing tests as per relevant IS.	
4.	10% RT on Butt welds of Fan Hub only (in case fabricated).	
5.	PVC material shall meet the requirements of CTI Bulletin STD-136. However impact test may be done as per ASTM-D-256 and Flammability test may be done as per ASTM-D-635 with extinguishing type PVC. Density & VICAT softening temperature tests shall also be conducted.	
6.	UV exposure shall be carried out on samples, at reputed third party laboratories as per ASTM -G26 method- C/standard specified in engineering portion of the specification for cooling tower. Impact test before and after UV exposure shall be conducted as per ASTM D-256.	
7.	--NA---.	
8.	Blue matching, Wear travel for Gate valves & reduced pressure test for Check valves shall be conducted as per relevant standards.	
9.	For POD of Butterfly Valves refer respective engineering section of the technical specification.	
10.	In case of fabricated construction of Butterfly Valves and companion flanges, UT on Plates of Thickness 20 mm or above for body and disc, and RT on 100% Butt welds shall also be carried out. Welders and WPS shall be qualified as per ASME section -IX. Stress reliving after complete welding shall be carried out as per ASME Section - IX	
11.	Tests	Quantum of Check
	WPS, PQR, Welder Qualification Test	100%
	DPT on root run	100% on pipes up to 1200 mm diameter
	DPT after back gauging	100% on pipes above 1200 mm diameter
	RT/ UT by TOFD Technique/PAUT	5% (covering 100% of `T'-joints)
	DPT on finished welds	10%

	Hydraulic Test	100%, Test pressure = 1.5 times the design pressure or 2 times the working pressure whichever is higher.
	Note:- After erection, the complete piping system shall be tested at 1.5 times, the design pressure or two times the maximum working pressure whichever greater. No leakage/seepage is acceptable. Butt weld joints which would not be hydro-tested shall be subjected to 100% RT test/ 100% UT by TOFD /PAUT Technique.	
12.	Spark test, adhesion test and material tests for primer & enamel and coal tar tapes as per AWWA-C-203.	
13.	Ropes shall meet relevant Code requirements. All motions & safety features shall be tested at Works. Full load & 25% overload test shall also be conducted at works. At site, Full load test shall be conducted with all motions and safety features.	
14.	One Fan of each type & size will be performance tested as per corresponding Code, for Air Flow, Static pressure, Total pressure, Speed, Efficiency, Power Consumption, Noise, and Vibration & Temperature rise. Also, all fans shall be subjected to run test of 4 hours during which Noise, Vibration, Temperature rise & current drawn shall be measured.	
15.	In case of Carbon Fiber Shaft, following checks are applicable a. Manufacturer Test Certificate for Carbon Fiber and Resin b. Dimensional Check, Run out Test and Dynamic Balancing Test on Finished Shaft c. Torsional Test on Drive Shaft Assembly along with flange as a type test to verify the factor of safety. d. Type test for bonding strength at joint between shaft & shaft flange. In case of proven design, test reports of the previous test conducted shall be reviewed. e. UV test for demonstrating the compliance with respect to requirement of UV ray stabilization. Acceptance criteria of the above tests shall be mutually discussed during pre-award discussions based on proven practices of the manufacturer or relevant standards as available	
16.	The physical and mechanical properties of FRP pultruded sections as specified in CTI- Standard 137 shall be tested. Fire retardant property as specified shall be tested.	
17.	The physical properties of FRP Panels as specified in CTI- Standard 131 shall be tested.	
18.	The UV test on identified samples of FRP Pultruded Sections, FRP Panels and FRP Pipes shall be carried out.	