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

(I) **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.

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-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.

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