NTPC Limited

(A Government of India Enterprise)

EPC PACKAGE FOR SETTING UP 700 TPD (2 X 350 TPD)
WASTE TO ENERGY PROJECT AT KAWAS, SURAT

TECHNICAL SPECIFICATION

FOR

EPC PACKAGE

PART – B (CIVIL)

(BOOK 4 OF 5)

SECTION - VI

BID DOC. NO.: CS-2600-001-9

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1.00.0 DESIGN CRITERIA

Unless specified otherwise, all civil, structural and architectural work shall be designed, supplied and constructed as per latest editions of Indian Codes and Standards with addendums and supplements issued by BIS or relevant International Standards. In case of ambiguity between codes, specifications and drawings, the more stringent of them shall govern.

Design of steel structures shall be done by the Working stress method. Design shall be as per provisions of IS:800 :1984 and other relevant IS standards.

Design of RCC structures shall be done as per IS 456. Detailing for ductility shall be followed as per guidelines of IS13920 to be effective against seismic load. Design of liquid retaining structures shall be done as per IS 3370.

All structures and portions thereof shall be analyzed and designed to sustain various loads and combinations thereof, conforming to the latest revision of applicable Indian Standards, specifications, engineering practice and other technical requirements. All structures shall be designed to sustain worst combination of dead loads plus assigned live loads, equipment, wind, seismic, temperature or other loads it is being subjected to.

Stability of structures shall be investigated for loading conditions during construction. However, factors of safety given in relevant Standards and codes shall also be taken care of.

Finished Ground level of the plant area shall be as per the General Layout Plan.

2.00.0 DESIGN LOADS

2.01.0 LOADS

Design loads will comply with the requirements of IS: 875 as a minimum, unless more stringent requirements are specified herein.
The following types of loads will be considered in general for the analysis and design of structures and foundations.

2.01.1 DEAD LOADS (DL)

Dead loads will include the weight of all structural and architectural components and hung loads & other permanently applied external loads. This should also include equipment dead load. Self-weight of materials may be calculated on the basis of unit weights given in IS: 875 (Part 1). Equipment loads should be considered as per the manufacture's specification.

2.01.2 LIVE LOAD (LL)

The following minimum live loads shall be considered for the design of building/ structures.

POWER HOUSE BUILDING(STG & CONTROL ROOM)		
Ground floor	-General	15 kN/m²
	-Unloading bay	20 kN/m²
AC Equipment Room		15 kN/m²
Switchgear floor		10 kN/m²
Control room		10 kN/m²
Auxiliary Cooling Tower		10 kN/m²
Deaerator Platform		5 kN/m²
Roof		1.5 kN/m²
Platform & Stairs		5 kN/m²
Other floors		10 kN/m²

For areas not covered above, the relevant loading furnished in IS: 875 (Part 2) will govern.

2.01.3 **Wind loads (WL)**
Wind load on structures shall be as specified in Annexure-II.

2.01.4 **Seismic load (SL)**
Seismic design shall be done as specified in Annexure-I.

3.00.0 **MATERIALS & JOB SPECIFICATIONS**

All construction materials and practices shall be finalized by the Bidder, considering the design life of the plant unless more stringent requirements are specified herein.

3.01.0 **GRADE OF CONCRETE**

The following minimum grades of concrete will be adopted for the type of structure noted against each. Design mix shall be used for RCC work as per standards.

TYPE OF STRUCTURES	MIN.GRADE OF CONCRETE
Lightly loaded structures, Grade slab, paving etc.	M25
All RCC members in foundation & Substructure	M25
All RCC members in Superstructure	M25
All Water retaining structures, waste pit and Cooling Tower	M30
Foundation & Superstructure of TG Deck	M35
Chimney foundation	M30
Chimney Shell	M30
PCC under all foundations, Screed Concrete & Fill Concrete	M7.5

3.02.0 **Reinforcement**

Reinforcement steel shall be of high strength deformed TMT steel bars conforming to IS 1786. However, minimum elongation shall be 14.5%.

3.03.0 **Clear Cover (Links / stirrups)**

Clear cover shall be as per IS:456 or as per other applicable standard.

3.04.0 **Foundation Bolts**

Material and details of foundation bolts shall conform to IS 5624. Mild steel bars used for the fabrication of bolt assembly shall conform to grade 1of IS432 and/ or grade A of IS 2062. Hexagonal nuts and lock nuts shall conform to IS 1363 & IS1364 upto M36 diameter and IS 5624 for M42 to M150 diameter.

3.05.0 **Structural Steel**

Structural Steel (including embedded Steel) shall be straight, sound, free from twists, cracks, flaw, laminations and all other defects. Structural steel shall comprise of mild steel, medium strength steel and high tensile steel as specified below. Structural Steel sections/plates shall be minimum 6mm thick.

3.05.1 **Mild Steel**

a) Rolled sections shall be of grade designation E250, Quality A/BR, Semi-killed/ killed conforming to IS 2062. All steel plates shall be of Grade designation E250, Quality BR (fully killed), conforming to IS 2062 and shall be tested for impact resistance at room temperature. Plates beyond 12mm thickness and up to 40mm thickness shall be normalized rolled. Plates beyond 40mm thickness shall be vacuum degassed & furnace normalised and shall also be 100% ultrasonically tested as per ASTM –A578 level B-S2.

b) Pipes shall conform to IS: 1161.

c) Chequered plate shall conform to IS 3502 and shall be minimum 6 mm thick excluding projection. Steel for chequered plate shall conform to grade E250A semi killed of IS: 2062 or equivalent grade conforming to ASTM & BS standards only.

3.05.2 **Medium and High Tensile Steel**

Rolled Sections and plates shall be of grade designation E350 or higher, Quality B0 (Fully killed), conforming to IS 2062. Plates beyond 12mm thickness and up to 40mm thickness shall be normalized rolled. Plates beyond 40mm thickness shall be vacuum degassed & furnace normalised and shall also be 100% ultrasonically tested as per ASTM –A578 level B-S2.

3.06.0 **Structural Steel Painting**

3.06.1 **Painting Of Steel Surfaces Embedded In Concrete**

a) For the portion of Steel surfaces embedded in Concrete, the surface shall be prepared by Manual Cleaning and provided with Primer Coat of Chlorinated Rubber based Zinc Phosphate Primer of Minimum 50 Micron Dry Film Thickness (DFT).

b) All threaded and other surfaces of foundation bolts and its materials, insulation pins, Anchor channels, sleeves, etc. shall be coated with temporary rust preventive fluid and during execution of civil works, the dried film of coating shall be removed using organic solvents.

3.06.2 **Painting Of Steel Surfaces (Other Than Those Embedded In Concrete & Roof structure of waste Pit)**

a) All steel surfaces shall be provided with two component moisture curing zinc (ethyl) silicate primer coat (having minimum 80% of metallic Zinc content in dry film, solid by volume minimum 60% ±2%) of minimum 70 micron DFT to be applied over blast cleaned surface conforming to Sa 2 ½ finish of ISO 8501-1 with surface profile 40-60 Micron. The primer coat shall be applied in shop immediately after blast cleaning by airless spray technique. Zinc dust composition and properties shall be Type-II as per ASTM D520-00.

b) Primer coat shall be followed with the application of Intermediate coat of two component polyamide cured epoxy with MIO Content (containing lamellar MIO minimum 30% on pigment, solid by volume minimum 80% ±2%) of minimum 100 micron DFT. This coat shall be applied in shop after an interval of minimum 24 hours (from the application of primer coat) by airless spray technique.

c) Intermediate coat shall be followed with the application of finish coat of two-pack aliphatic Isocyanate cured acrylic finish paint (solid by volume minimum 55% ±2%) with Gloss retention (SSPC Paint Spec No 36, ASTM D 4587, D 2244, D 523) of Level 2 (after minimum 1000 hours exposure, Gloss loss less than 30 and colour change less than 2.0 ΔE) and minimum 70 micron DFT. This coat shall be applied shop after an interval of minimum 10 hours and within six (6) months (from the completion of Intermediate coat), Colour and shade of the coat shall be as approved by the Employer.

3.06.3 **Painting Of Roof Structure of Waste Pit**

The roof Structure of Waste Pit shall be provided with painting system having total 270 microns DFT.

a) All steel surfaces shall be provided with two component epoxy primer coat (having solid by volume minimum 51% ±2%) of minimum 100 micron DFT to be applied over blast cleaned surface conforming to Sa 2½ finish of ISO 8501-1 with surface profile 40-60 Micron. The primer coat shall be applied in shop immediately after blast cleaning by airless spray technique.

b) Primer coat shall be followed with the application of Intermediate coat of epoxy phenolic coating (solid by volume minimum 63%) of minimum 100 micron DFT. This coat shall be applied in shop after an interval of minimum 24 hours (from the application of primer coat) by airless spray technique.

c) Intermediate coat shall be followed with the application of finish coat of two-pack aliphatic Isocyanate cured acrylic finish paint (solid by volume minimum 55% ±2%) with Gloss retention (SSPC Paint Spec No 36, ASTM D 4587, D 2244, D 523) of Level 2 (after minimum 1000 hours exposure, Gloss loss less than 30 and colour change less than 2.0 ΔE) and minimum 70 micron DFT. This coat shall be applied in shop after an interval of minimum 10 hours and within six (6) months (from the completion of Intermediate coat), Colour and shade of the coat shall be as approved by the Employer.

3.07.0 **Painting of RCC Waste Pit Wall/Invert of Base Slab**

a) Internal concrete surfaces of waste pit shall be provided with two component transparent polyamide cured epoxy sealer coating (having solid by volume minimum 40% ±2%) of minimum 50 micron DFT. Surface to be coated shall be absolutely dry, clean and dust free.

b) Sealer coat shall be followed with the application of epoxy phenolic coating (solid by volume minimum 63%±2%) in two (2) coats of 200 microns each (Total minimum 400 micron DFT). The first coat shall be applied after an interval of minimum 24 hours (from the application of primer coat) by airless spray technique.

Minimum and maximum time interval between first and second coat of epoxy phenolic coating as specified above shall be 6 hours and 7 days respectively from the application of first coat.

3.08.0 **Chimney Painting**

(i) All steel parts embedded in concrete like bolts, nuts, washers, pipe sleeves and insert plate shall be galvanized as per IS:4736. The minimum weight for galvanizing shall be 610 g/sq.m and shall comply with relevant IS Codes.

(ii) The inside surface of chimney shell including corbels shall be provided with epoxy phenolic coating system having total 150 microns DFT.

a) All concrete surfaces shall be provided with two component transparent polyamide cured epoxy sealer coating (having solid by volume minimum 40% ±2%) of minimum 50 micron DFT to be applied over cleaned surface in multiple coats. Surface to be coated shall be absolutely dry, clean and dust free.

b) Sealer coat shall be followed with the application of Intermediate coat of epoxy phenolic coating (solid by volume minimum 63%) of minimum 100 micron DFT. This coat shall be applied after an interval of minimum 24 hours (from the application of primer coat) by airless spray technique.

(iii) The top 15m of the external surface of chimney shell shall be provided with epoxy phenolic coating system having total 220 microns DFT in alternate bands of 'signal red' and 'bright white' colours.

a) All concrete surfaces shall be provided with two component transparent polyamide cured epoxy sealer coating (having solid by volume minimum 40% ±2%) of minimum 50 micron DFT to be applied over cleaned surface in multiple coats. Surface to be coated shall be absolutely dry, clean and dust free.

b) Sealer coat shall be followed with the application of Intermediate coat of epoxy phenolic coating (solid by volume minimum 63%) of minimum 100 micron DFT. This coat shall be applied after an interval of minimum 24 hours (from the application of primer coat) by airless spray technique.

c) Intermediate coat shall be followed with the application of finish coat of two-pack aliphatic Isocyanate cured acrylic finish paint (solid by volume minimum 55% ±2%) with Gloss retention (SSPC Paint Spec No 36, ASTM D 4587, D 2244, D 523) of Level 2 (after minimum 1000 hours exposure, Gloss loss less than 30 and colour change less than 2.0 ΔE) and minimum 70 micron DFT. This coat shall be applied after an interval of minimum 10 hours and within six (6) months (from the completion of Intermediate coat), Colour and shade of the coat shall be as approved by the Employer.

(iv) The balance external surfaces of chimney shell shall be provided with aliphatic acrylate system having total 170 microns DFT.

a) All concrete surfaces shall be provided with two component transparent polyamide cured epoxy sealer coating (having solid by volume minimum 40% ±2%) of minimum 100 micron DFT to be applied over cleaned surface in multiple coats. Surface to be coated shall be absolutely dry, clean and dust free.

b) Sealer coat shall be followed with the application of finish coat of two-pack aliphatic Isocyanate cured acrylic finish paint (solid by volume minimum 55% ±2%) with Gloss retention (SSPC Paint Spec No 36, ASTM D 4587, D 2244, D 523) of Level 2 (after minimum 1000 hours exposure, Gloss loss less than 30 and colour change less than 2.0 ΔE) and minimum 70 micron DFT. This coat shall be applied after an interval of minimum 24 hours (from the application of sealer coat), Colour and shade of the coat shall be as approved by the Employer.

3.09.0 Wall Cladding & Roofing Material

Troughed permanently colour coated metal sheet of approved shade and colour shall be used for side cladding and roofing systems. These sheets shall be colour coated with total coating thickness of at least 35 microns (nominal) comprising of silicon modified polyester (SMP with silicon content of 30% to 50%) paint or Super Polyester paint, of minimum 20 microns (nominal) dry film thickness (DFT) on external face over primer coat of minimum 5 microns (nominal) and minimum 5 microns (nominal) SMP or super polyester paint over primer coat of minimum 5 microns (nominal) on internal face. SMP and Super polyester paint systems shall be of industrial finish of product type 4 of AS/NZ2728. Painting to be done over a metallic zinc coating of class Z350 or aluminium-zinc alloy coating to class AZ200 as per relevant standards.

3.10.0 ROAD WORK

All roads shall be of rigid pavements unless otherwise specified. The design of rigid pavement shall be carried out as per IRC: 58. The effects of design wheel load, maximum tyre inflation pressures, tyre contact area for the vehicle, traffic loads, environmental factors such as temperature changes in the pavement, other factors, like impact, load repetitions, etc., are to be taken.

3.11.0 BOUNDARY WALL

Boundary wall all around the plant area as shown in the General Layout Plan shall be provided. The total height of boundary wall shall be 3600mm above formation level (natural ground level in case formation level is less than natural ground level). Upto height of 3000mm it shall be constructed with ash brick masonry and over that for 600mm concertina coil with maximum loop spacing of 250mm shall be provided with Y-shaped MS angle. The RCC cast in situ reinforced concrete columns shall be provided at 3000mm c/c.

The RCC cast in situ reinforced concrete columns and footing shall be minimum 1500mm below finished formation level with suitable foundation designed for horizontal and vertical loads. The RCC cast in situ concrete columns of minimum size 300mmX350mm shall be provided at 3.0m c/c. The grade of concrete for all cast in situ work shall be in M25 grade concrete.

The boundary wall shall be designed as per relevant IS codes and as per standard practices. The same shall be submitted to Owner for approval at the time of detailed engineering stage. The architecture of boundary wall shall be finalized in consultation with owner. The reinforced cement concrete coping with minimum projections of 150mm on each side shall be provided at the top of the brick masonry and RCC columns with suitable provision for MS angle Post for concertina throughout the boundary wall. Opening for gates/drains and for other crossing shall be suitably provided as per the requirement.

All external & internal surface of boundary wall shall be plastered with 1:5 (cement : sand) mortar and finished with Premium Acrylic smooth exterior paint with silicon additive.

3.12.0 Sewage Treatment Plant

Providing and placing, waste water / sewage treatment plant capacity 5000 litres per day (Sintex product model no. NBF-10 or equivalent) complete with all necessary arrangements including excavation, placing, handling, connecting the inlet pipe to sewer line, connecting the outlet pipe to nearest drain, maintenance of twelve months after commissioning etc as per manufacturers specification and complete as per instruction of Engineer.

3.12.0 Architectural General Features

1. All building shall be designed to meet NBC 2016 requirements and local factories act requirements including statutory approval. Overall colour scheme and designs shall be in harmony with each other and surrounding buildings.

2. Brick masonry shall be made using Fly ash bricks as per IS:13757 & IS:12894.

3. Brick masonry work shall have interior and exterior plaster of 12mm and 18mm respectively.

4. Unless otherwise specified, Brick work shall have Acrylic distemper finish on interior face and acrylic exterior paint finish on external face.

5. The Central Control Room shall be located adjacent to the waste pit separated by fully glazed partition with Stainless Steel framing so as to have full view of the Waste Pit. Glazed floor (Laminated Glass consisting minimum 6mm clear toughened glass on top and minimum 8mm thick clear toughened glass on bottom with 1.52mm thick poly vinyl butyral/polyurethane layer. Actual thickness of the grass panel shall be as per the floor loading requirements.) shall be provided at the edge of this partition to ensure the same. The automatic cleaning system shall be provided for this glazed partition.

6. Minimum area of windows shall be 10% of floor area. In Air Conditioned Area, 24 mm thick hermetically sealed glass with 12 mm air gap in between two toughened glasses of 6 mm thickness shall be provided. Inner glass shall be clear glass and outer glass shall be reflective

glass. In non-Air Conditioned Area, 6 mm thick reflective toughened glass on outer face of the building and 6 mm thick clear toughened glass inside the building shall be provided.

7. For natural light, in addition to the windows area as specified above, buildings with height more than 4.0 m shall have continuous fixed glazing of adequate width at regular interval in minimum 2 mm thick polycarbonate sheet.

8. All Air conditioned area, lift lobby and entrance lobby etc. shall have perforated aluminum false celling with acoustic treatment. 50 mm thick mineral wool insulation with aluminum foil cover shall be provided at bottom of roof of air conditioned area.

9. Entrance lobby shall have granite floor finish with granite dado up to false ceiling, and RCC staircase shall have Marble finish with 1.2 high dado of granite. All staircase shall have stainless steel hand rail with adequate toe guard and knee guard. The width of staircase shall be minimum 1500 mm. All cut outs and opening in RCC Floor shall have 1.2 m high stainless steel hand rail all around with adequate toe guard and knee guard.

10. There shall be comprehensive landscape development in the entire plant area to create a pleasant and healthy environment. The scope of work shall include planting of tree, shrubs, grass, benches and two nos. of water bodies (area 30 sqm. minimum) with fountains and lightings.

11. Buildings with flat roof to be designed for Roof Top Solar PV Panels.

4.00.0 SOIL DATA AND FOUNDATION SYSTEM

Geotechnical data and foundation system for the Waste to Energy package at Kawas site project are enclosed at annexure-V. The bore logs of vicinity are enclosed at annexure-IV.

4.01.00 Soil Data

Contractor has to carry out geotechnical investigation in the areas pertaining to this package. The scheme for geotechnical investigation shall be approved by owner before execution. The geotechnical investigation report to be furnished by the Contractor comprising all necessary tests viz. boreholes, laboratory tests, chemical analysis, penetration tests etc. in respect of the sub-strata prevailing at site shall form the basis of engineering and design calculations and shall have to be submitted to the employer along with the design calculations for necessary approval.

4.01.01 The available soil data is of vicinity of proposed structures, therefore, bidder shall carryout his own detailed soil investigation for facilities under this package and shall be as per the scheme approved by owner. The scheme for geotechnical investigation shall be as given at Clause 4.07.00 and shall be approved by owner before execution. Geotechnical investigation work shall got executed by the Contractor through the agencies as mentioned in Clause No. 4.06.03. However, no time extension shall be given on account of soil investigation carried out by the Bidder. The geotechnical investigation report shall be prepared with detailed recommendations regarding type of foundation and allowable bearing pressure for various structures/ facilities and other soil parameters. The report shall be submitted for Owner's approval prior to commencement of design of foundation.

4.01.02 The furnished borelog details are specific to the co-ordinates where the boreholes have been carried out and are provided for bidder's information only. Soil profile in the proposed area may vary with respect to the borelogs enclosed for bidder's information. Bidder has to consider all such variations in his estimation, over the extent of the work to be carried out. The Bidder should note that nothing extra whatsoever on account of variation between soil data collected

by Owner and that found by the Bidder during geotechnical investigation by him or during execution of works, shall be Payable**.**

Finished Ground Level (FGL) generally corresponds to RL (+) 5.5 m for proposed area. Filling of thickness 2.5 to 3.0 m has been done over Natural Ground Level (NGL) to achieve the FGL as indicated in General Layout Plan.

4.01.03 The Bidder shall fully satisfy himself about the nature of the subsoil expected to be encountered including the type of foundation & ground water table, construction method etc. prior to the submission of the bid. Bidder may refer topographical survey drawing for variation in existing ground level.

4.02.00 Foundation System

The requirements for the foundation system to be adopted are as given in subsequent clauses.

4.02.01 General Requirements

(a.) All structures/equipment shall be supported on suitable open foundations (isolated, combined, raft) or pile foundations depending on type of structures/facilities, sub-strata, topography etc.

(b.) The ground floor slabs, trenches, pipe pedestals, channels/drains and staircase foundation with foundation loading intensity less than 4 T / M^2 may be supported on open / shallow foundations resting on virgin / controlled compacted filled up soil.

(c.) No other foundation (other than as mentioned in (b) above) shall rest on the filled up ground / soil.

(d.) No foundation shall rest on the black cotton soil.

(e.) Before execution of work the bidder shall ensure that there is no obstruction to underground/overground facilities like sewer lines, pipe lines etc. Any such damage and remedial/ rectification measures shall be at the contractors cost.

(f.) All foundations shall be designed in accordance with relevant parts of the latest revisions of Indian Standards.

(g.) The water table for design purpose shall be considered at Finished Ground Level.

(h.) A combination of open and pile foundations shall not be permitted under the same equipment / structure / building.

(i.) **Foundation for equipments on ground floor**

For equipments of static weight upto 1.5 T, the equipment may be supported on the ground floor slab by locally thickening the slab. Thickening of the ground floor slab shall be done upto an extent of about 0.6 m beyond the plan area of the equipment on all the sides. Further, the load intensity below the equipment shall be limited to 4T/m2. Other requirements of floor slab and compaction below the floor slab shall be adhered, as specified elsewhere in the specifications.

For equipment's of static weight between 1.5 T and 20 T, the equipment may be supported on compacted sand filling with the load intensity below the equipment limited to 4T/m2. The minimum depth of foundation is 1.0m below FFL. Other requirements of sand compaction below the foundation shall be adhered, as specified elsewhere in the specifications.

For equipment of static weight more than 20 T, the equipment foundation shall be taken to the founding level or shall be built up with PCC from the level as mentioned in the Table 2. The pedestal of equipment foundation or the foundation Block shall be isolated from the adjoining floor slab by providing bitumen impregnated fiber board of minimum 50 mm thick, conforming to IS: 1838 all around the equipment pedestal for the full depth of the floor slab.

4.02.02 **Open Foundations**

In case open foundations are adopted, following shall be adhered to.

(a.) The minimum width of foundation shall be 1.0 m.

(b.) Minimum depth of foundation shall be 1.0m below Ground Level.

(c.) It shall be ensured that all foundations of a particular structure/ buildings/ facility shall rest on one bearing stratum.

(d.) Minimum founding level, bearing capacity and permissible settlements shall be as given in the Annexure - V to this specification.

4.02.03 Pile Foundations –

In case piles are adopted, following shall be adhered to :

i) The pile foundation shall be of RCC, Cast-in-situ bored piles as per IS:2911. Pile boring shall be done using Crawler mounted Rotary Hydraulic Rigs. Two stage flushing of pile bore shall be ensured by airlift technique duly approved by the Employer.

If required, temporary or permanent MS liner may be provided for piling.

ii) The minimum diameter of pile shall be 600 mm. The allowable load capacity of the pile in different modes (vertical compression, lateral and pullout) shall be as per approved geotechnical report & as enclosed at annexure-I.

iii) Only straight shaft piles shall be used. Minimum cast length of pile above cutoff level shall be 1.0 m.

iv) The contractor shall furnish design of piles (in terms of rated capacity, length, diameter, termination criteria to locate the founding level for construction of pile in terms of measurable parameter, reinforcement for job as well as test piles, pile load test arrangement, locations of initial test piles etc.) for Engineer's approval.

v) The piling work shall be carried out in accordance with IS:2911 (Relevant part) and accepted construction methodology. The construction methodology shall be submitted by the Contractor for Engineer's approval.

vi) Number of initial load tests to be performed for each diameter and rated capacity of pile shall be subject to minimum as under.

Vertical

Lateral Minimum of 2 Nos. in each mode.

Uplift

vii) The initial pile load test shall be conducted with test load upto three times the pile capacity. In case of vertical compression test (initial test) the method of loading shall be cyclic as per IS:2911 (relevant part).

viii) Load test shall be conducted at pile Cut-off Level (COL). If the water table is above the COL the test pit shall be kept dry throughout the test period by suitable de-watering methods. Alternatively the vertical load test may be conducted at a level higher than COL. In such a case, an annular space shall be created to remove the effect of skin friction above COL by providing an outer casing of suitable diameter larger than the pile diameter.

ix) Number of routine pile load tests to be performed for each diameter/allowable capacity of pile shall be as under :

i) Vertical : 0.5% of the total number of piles provided.

ii) Lateral : 0.5% of the total number of piles provided.

x) The routine tests on piles shall be conducted upto test load of one and half times the allowable pile capacity. Piles for routine load tests shall be approved by the Employer.

xi) In case, routine pile load test shows that the pile has not achieved the desired capacity or pile(s) have been rejected due to any other reason, then the Contractor shall install additional pile(s) as required and the pile cap design shall accordingly be reviewed and modified, if required.

xii) Testing of piles and interpretation of pile load test results shall be carried out as per IS:2911 (Part-4). Contractor shall ensure that all the measuring equipment and instruments are properly calibrated at a reputed laboratory / institute prior to their use. Settlement / movement of the pile top shall be made by Linear Variable Differential Transducers (LVDT) having a least count of 0.01mm.

xiii) The test load on initial test piles shall be applied by means of reaction from anchor piles / rock anchors alone or combination of anchor piles / rock anchors and kentledge with concrete blocks.

xiv) Low Strain Pile Integrity test shall be conducted on all test piles and job piles. This test shall be used to identify the routine load test and not intended to replace the use of static load test. This test is limited to assess the imperfection of the pile shaft and shall be undertaken by an independent specialist agency to be approved by Engineering department of Owner. The test equipment shall be of TNO or PDI make or equivalent. The process shall confirm to ASTM.

xv) High Strain Dynamic Load Test may be carried out for routine load testing of working piles. However, at least two numbers of static routine vertical load tests shall be carried out on pile on which high strain dynamic load test has already been carried out for establishing the correlation between the two tests. In case of discrepancy if any between dynamic and static vertical load tests, then additional static routine vertical load tests shall be conducted as decided by the Engineer and the results of static routine vertical load shall prevail. Number of routine vertical pile load tests as per clause 4.02.03 (ix) shall be total of static routine vertical load test and high strain dynamic load tests.

The procedure to carry out the test shall be submitted to the Engineer. The test and equipment shall conform to ASTM D4945-00. The test shall be conducted by an experienced independent test agency approved by the owner. Field data shall be submitted to the site engineer and shall include force velocity curves, pile capacity, simulated static load test curve, net and total pile displacement, pile integrity. A (Case pile wave analysis) CAPWAP or equivalent software analysis shall be conducted on the field data for correct capacity estimation and to evaluate end bearing and skin friction components of the pile.

xvi) From load considerations, single pile may be used under a column/tower. In that case, pile shall be connected with tie beams at pile cut off level in both directions.

xvii) Contribution of frictional resistance of filled up soil if any, shall not be considered for computation of frictional resistance of piles.

xviii) Reinforcement for job piles shall be designed as following:

(a) Compression + bending piles: For these piles, the allowable safe pile capacities in compression and bending shall be considered.

(b) Tension + bending piles: For these piles, the actual pile forces to be considered. However, maximum 3 types of combinations for varying percentage of tension capacity + bending case may be designed & adopted by contractor for the entire scope of work under this package.

4.03.00 Special Requirements

Details of treatment for foundations / underground structures required to counteract soil / water chemical environment shall be as per geotechnical investigation to be carried out by contractor. Contractor shall carry out chemical analysis during geotechnical investigation and required treatment shall be provided accordingly. However, cement and reinforcement shall be provided as per special requirement in Annexure-V.

4.04.00 Excavation, Filling and Dewatering

4.04.01 For excavation works, comprehensive dewatering with well point or deep wells arrangement, if required, shall be adopted. Scheme for dewatering and design with all computations and back up data for dewatering shall be submitted for the owner's information. The water table shall be maintained at 0.5m below the founding depth.

4.04.02 Excavation for shallow foundations shall be covered with PCC immediately after reaching the founding level. In case of any local loosening of soil or pockets are encountered at founding level during excavation the same shall be removed and compensated by PCC M 7.5. The final layer of about 300 mm thickness above the founding level shall be excavated by suitable means, so as to avoid disturbance to founding stratum.

4.04.03 Backfilling around foundations, pipes, trenches, sumps, pits, plinths, etc. shall be carried out with approved material in layers not exceeding 300 mm compacted thickness (higher thickness of layers upto 500mm with heavy mechanical compacting equipment) and each layer shall be compacted to 90% of standard proctor density for cohesive soils and to 80% of relative density for non-cohesive soils.

4.04.04 The founding level for trenches/channels shall be decided as per functional requirement. The bottom of excavation shall be properly compacted prior to casting of bottom slab of trenches / channels.

4.04.05 CBR tests for pavement/road design shall be carried out by the Contractor after earth filling (if applicable) has been completed upto the formation level.

4.04.06 Adequate and suitable warning signs shall be put up at conspicuous places at the excavation work to prevent any persons or vehicles falling into the excavation trench. No worker should be allowed to work where he may be stuck or endangered by excavation machinery or collapse of excavations or trenches.

4.05.00 Sheeting & Shoring

The contractor shall ascertain for himself the nature of materials to be excavated and difficulties, if any, likely to be encountered in excavation, executing the work. Sheeting and shoring, bracing and maintaining suitable slopes, draining etc. shall be provided as per requirement and installed by the Contractor, to the satisfaction of the Engineer.

4.06.00 Scheme of geotechnical Investigation

The Contractor shall carry out detailed geotechnical investigation in the areas under his scope for establishing the sub-surface conditions and to decide type of foundations for the structures envisaged, construction methods, any special requirements/treatment called for remedial

measures for sub-soil/ foundations etc. in view of soft sub-soils, aggressive sub-soils and water, expansive/swelling soils etc. prior to commencement of detailed design/drawings. The Contractor shall obtain the approval for the field testing scheme proposed by him from the Owner before undertaking the geotechnical investigation work.

4.06.01.00 Scheme of geotechnical Investigation

4.06.02.01 Field test shall include but not be limited to the following:

Boreholes, Standard Penetration Test (SPT), Dynamic Cone Penetration Test (DCPT), collection of disturbed samples (DS) and undisturbed soil samples (UDS), Trial Pits (TP), Plate Load Tests (PLT), Electrical Resistivity Test (ERT), In situ field permeability tests, collection of water samples, etc.

4.06.02.02 The diameter of borehole shall be minimum 150 mm in soil and 76 mm in rock. The diameter of UDS sampler shall be 100 mm minimum. Core drilling in rock shall be done by using hydraulically feed rotary drill & double tube core barrel with diamond bit.

4.06.02.03 The minimum tests are indicated in Clause No. 1.07.00. Adequate number of tests shall be conducted up to sufficient depth for complete determination of subsoil conditions. The depth of boreholes shall be as specified in Appendix A. SPT shall be carried out in all types of soil deposits and in all rock formations with core recovery up to 20%, met within a borehole. This test shall be conducted at every 3.0 m interval or at change of strata, up to the final depth. SPT 'N' of 100 and above shall be referred as refusal. UDS shall be collected at every 3.0 m interval or at change of strata up to depth of borehole. UDS may be replaced by additional SPT, if SPT'N' value in the strata is above 50.

4.06.02.04 Laboratory tests shall be done as per relevant IS codes. The laboratory tests, not be limited to the following shall be conducted on disturbed and undisturbed soil samples, rock samples & water samples collected during field investigations in sufficient numbers.

Laboratory Tests on Soil Samples

Laboratory tests shall be carried out on disturbed and undisturbed soil samples for Grain Size Analysis, Hydrometer Analysis, Atterberg Limits, Triaxial Shear Tests (UU), Natural Moisture Content, Specific Gravity and Bulk Unit Weight, Consolidation Tests, Unconfined Compression Test, Free swell Index, Shrinkage Limit, Swell Pressure Test, Chemical Analysis test on soil and water samples to determine the carbonates, sulphates, chlorides, nitrates, pH, organic matter and any other chemicals harmful to concrete and reinforcement/ steel.

Laboratory Tests on Rock Samples

Moisture content, porosity & density, Specific Gravity, Hardness, Soundness, Slake durability index, Unconfined compression test (Both at saturated and in-situ water content), Point load strength index and deformability test (Both at saturated and in-situ water content) shall be carried out on rock samples.

4.06.02.05 Geotechnical investigation (field & laboratory) shall be carried out in accordance with the provisions of relevant Indian Standards.

On completion of all field & laboratory work, geotechnical investigation report shall be submitted for Owner's review/approval. The Geotechnical investigation report shall contain geological information of the region, procedure adopted for investigation, field & laboratory observations/ data/ records, analysis of results & recommendations on type of foundation for different type of structures envisaged for all areas of work with supporting calculations. Recommendations on treatment for soil, foundation, based on subsoil characteristics, soft soils, aggressive chemicals, expansive soils, etc.

Recommendations on foundation system and the net allowable bearing pressures and pile capacity shall be based on the conservative values of geotechnical investigation data.

4.06.03.00 Geotechnical investigation work shall be got executed by the Contractor through the following agencies.

1. C.E.TESTING COMPANY Pvt. Ltd, Kolkata
2. Cengrs Geotechnica Pvt. Ltd, New Delhi
3. KCT Consultancy Services, Ahemdabad
4. M.K. Soil Testing Laboratory, Ahemdabad

4.07.00 Geotechnical Investigation Scheme

a) **Boreholes (Minimum)**

S.No	Structure	Spacing/Number of borehole	Depth of borehole	Remarks
1	TG	Minimum 2 Nos under each TG	Depth of boreholes shall be 35m to 40m.	Depth of boreholes shall be as mentioned in column "Depth of Borehole" or 5m continuous in rock with RQD > 25% whichever is earlier.
2	ACC	Minimum 3 Nos.	35 to 40 m	
3	Boiler	Minimum 4 Nos under each boiler	35 to 40 m	
4	Chimney	Minimum 3 Nos under each Chimney	35 to 40 m	
5	Other Structure/Facility	Minimum 2 Nos. boreholes under each area / facility	30 to 35 m	

b) Other Field Tests (Minimum)

1	Trial Pit (TP)	2 Nos.	Depth - 4 m
2	In Situ Permeability Test In Boreholes	In minimum 3 Nos. of boreholes	Tests shall be conducted at depths of 1.0m, 3.0m, 5.0m, 8.0m and 12.0m.
3	ERT	Minimum 10 Nos.	

- Depth and location of Boreholes and other field tests (PLT, ERT, field permeability tests etc.) shall be approved by Owner before execution of geotechnical investigation work.

- Investigation in any other building / structure / facilities / trestles which are not mentioned above shall also be carried out, if required, by the bidder for the facilities under his scope.

Annexure-V

SOIL DATA AND FOUNDATION SYSTEM

a) Employer has carried out geotechnical investigation in vicinity to the proposed area. Logs of representative boreholes solely for bidder's information in the vicinity of proposed area are enclosed at Annexure-IV.

b) The foundation system to be adopted for different structures shall be as given in Table – 1 below

Table – 1: Foundation System

STRUCTURE	TYPE OF FOUNDATION TO BE ADOPTED
Waste to Energy Plant Structures	Open/Piles

c) Bidder is required to carry out geotechnical investigation in this area. During detailed engineering, the Allowable Bearing Pressure shall be adopted after approval of geotechnical investigation report. However, the maximum allowable bearing pressure shall be lower of the two values i.e. as per approved geotechnical report and as per the values furnished in Table-2.

Table – 2: Net Allowable Bearing Pressure

	Founding	Net Allowable Bearing Pressure T/m^2	
		Isolated and combined footings width upto 6.0 m	Rafts (width > 6m)
Waste to Energy Plant Structures	RL 1.50 M*	6	6
	RL (-) 1.50M	10	12

The finished ground level (FGL) corresponds to RL 5.50 M

In case any loose/soft pockets is encountered at founding level, the same shall be removed completely upto the hard strata and filled up with PCC (1:4:8).

* At this founding level, the founding strata shall be prepared by excavating the expansive soil for 1.0 m below founding level and shall be filled with moorum/CNS. Moorum/CNS shall be compacted in layer of 250 mm thick to minimum 95% of standard proctor density.
Moorum/CNS shall also be provided on the sides of the foundation. The thickness of moorum/CNS filling shall be 1.0m (refer annexure III for detail).

The net allowable bearing pressure higher than above mentioned values shall not be permitted. At intermediate levels the bearing capacity shall be same as the net allowable bearing pressure corresponding to the immediate shallower level mentioned above.

d) **Permissible Settlement of Foundations**:

For open foundations, the total permissible settlement and differential settlement shall be governed by IS: 1904 and from functional requirements whichever is more stringent. However, total settlement shall be restricted to the following:

Isolated, Strip & Raft (machine foundation)	25 mm
Isolated & Strip resting in soil	40 mm
Raft (widths greater than 6 m) resting in soil	75 mm

In case the total permissible settlement is to be restricted to less than as above specified from functional requirements, then the net allowable bearing pressure shall be reduced after review in consultation with Engineer.

e) The minimum diameter of pile shall be 600 mm. The allowable load capacity of the pile in different modes (vertical compression, lateral and pullout) shall be least of the three values i.e. as per approved geotechnical report, as per the values furnished in following table and pile capacity achieved in pile load tests.

Pile Diameter (mm)	Minimum length of pile below cut-off level (m)	Safe Load Capacity in		
		Vertical Comp. (MT)	Pullout (MT)	Lateral (MT)
600	26	110.0	40.0	7.0
760	28	190.0	65.0	12.5

- Cut off Level (COL) is assumed at 3.0 m below FGL.
- The finished ground level (FGL) corresponds to RL 5.50 M

f) **Special Requirements:**

The chemicals in ground water are more than permissible limits. Sulphates and chlorides in ground water are 2000 to 7000 ppm & 7000 to 88000 ppm respectively. In view of the presence of chemicals following shall be adopted for all foundations and sub-structures

- Minimum grade of concrete shall be M30.
- Cement shall be Ordinary Portland Cement with C_3A content from 5 to 8 percent / Portland slag cement confirming to IS 455 having more than 50% slag.
- M30 for all foundation works and piles. Minimum cement content for all foundations including piling shall be 400 kg/cum of concrete. Concrete shall be dense and durable for very severe exposure conditions.
- Reinforcement steel (High Strength Deformed steel bars) shall be Corrosion Resistance thermo-mechanically treated (CRS-TMT) bars and shall confirm to grade Fe-500 of IS:1786 (with minimum percentage of elongation of 14.5%).
- For foundations including piling, the minimum cover to reinforcement shall be as per IS 456 for very severe exposure conditions.

- "Very Severe" exposure condition as per IS 456 to be considered for mix design.
- All foundations and surfaces of substructures coming in contact with earth shall be applied with Minimum two coats of hot bitumen of Industrial grade 85/25, conforming to IS: 702 (latest), mixed with 1% anti-stripping compound at the rate 1.7 Kg/Sq.m (for sum of all coats).

5.00.0 FOUNDATIONS & BUILDINGS

The work shall comprise of design and construction of complete civil , structural & Architectural works pertaining to all foundations, buildings as listed in clause 1.00.0 of Part-A and all other facilities required for completion of all systems under the Waste to Energy Plant scope of work complete as per locations indicated on the final layout drawings.

General civil, structural & architectural specifications for all anticipated buildings shall be as per Annexure-VI. For buildings/facilities not covered in Annexure-VI, best industrial practice shall be followed.

NTPC Limited

(A Government of India Enterprise)

EPC PACKAGE FOR SETTING UP 700 TPD (2 X 350 TPD)
WASTE TO ENERGY PROJECT AT KAWAS, SURAT

TECHNICAL SPECIFICATION

FOR

EPC PACKAGE

PART – B (Quality Assurance)

(BOOK 5 OF 5)

SECTION - VI

BID DOC. NO.: CS-2600-001-9

MANUFACTURING CHECKS FOR STEAM GENERATOR & AUX.

(Mechanical portion)

1.00.00 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 of specified specification.

All Plates above 40mm & all bar stock/ forgings above 40mm dia shall be ultrasonically tested. For pressure parts, plates of thickness equal to or above 25mm shall be ultrasonically tested. All weld joints in alloy steel shall be checked for Hardness of 3% joints. Wherever Stress Relieving/PWHT is envisaged, NDT shall be carried out after Stress Relieving/PWHT.

1.01.00 Drum

(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.

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

(c) On completion of welding, the entire drum shall be subjected to stress relieving in the furnace.

(d) All butt welds shall be subjected to 100% radiographic examination and magnetic particle examination after stress relief.

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

1.02.00 Tubes & Tube Elements

a) Raw material of pipes/ tubes for water wall, super heater, Economiser, riser, supply and connecting tubes including nozzle/ stubs, connections for drum, headers, Pipe work etc. shall be subjected to 100% UT.

b) All bent tubes/stubs shall be checked for ovality and thinning by ultrasonic method on first off and random checks on subsequent pieces.

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

d) Finished butt welds shall be subjected to RT. Wherever the code / standard / process specifies random sampling, the same shall be minimum 20%.

e) 10% of fillet welds shall be subjected to MPI/LPI.

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

1.03.00 Headers & pipes

(a) All butt welds shall be subjected to radiographic examination and magnetic particle examination after stress relief.

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

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

1.04.00 Hydraulic Test

(a) The drum and all components which are to be subjected to fluid pressure shall be Hydraulic tested as per applicable standard/Code.

(b) 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.

1.05.00 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.

1.06.00 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 applicable standard.

(b) Fittings shall be subjected to suitable NDT as per applicable standards.

1.07.00 Valves

(a) Pressure retaining parts of valves shall be subjected to NDT as per applicable code/ standard.

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

(c) All Valves shall be tested as per applicable Standards/Codes.

(d) 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.

1.08.00 Steam coil Air Preheater

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.

1.09.00 Soot Blowers

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

(b) Hydraulic test to be carried out on valve body.

1.00.0 FLUE GAS CLEANING 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 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.

1.02.0 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.

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 NDT on valves shall be as per relevant standard.

1.04.03 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 complete tanks shall be water fill tested.
ii) All atmospheric storage tanks fabricated and erected at site shall be subjected to tests (Hydro, NDT and Vacuum) according to design code as applicable.
iii) Rubber lining shall be tested for hardness and spark test, as applicable.

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.

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

1.07.0 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 at rated speed as per relevant/applicable standard.

1.08.0 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 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 and 100% MPI.

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

1.08.03 Edge for shop and field weld shall be examined by MPI for plate thickness >= 32mm.

1.09.0 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.

1.10.0 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.

1.11.0 AGITATORS:

1.11.01 Rubber lining shall be tested for hardness and spark test

1.11.02 Impellers shall be tested for dimensional and balancing check

1.11.03 Gear Boxes shall be tested for run test as per standard practice

1.12.0 FANS:

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

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

1.12.03 All rotating components and assemblies of fan shall be balanced dynamically

1.12.04 Performance test shall be carried out on fans as per Technical specification/ Relevant standard

1.13.0 Thermal Insulation, Lagging & Cladding:

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

LRB mattresses/sections of Rockwool/ Glasswool 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 Aluminium sheeting confirming to ASTM B-209-1060 temper H14 from reputed manufacturer meeting the requirements of NTPC data sheet.

1.14.0 OTHER CRITICAL EQUIPMENTS:

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

1.10.00 **ROTATING EQUIPMENTS/ITEMS**

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.

1.11.00 **Induced Draft, Forced Draft Air & Primary Air fans**

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

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

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

1.12.00 **Lube Oil systems**

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

1.13.00 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.

1.14.00 **Gates & Dampers**

(a) All the gates & dampers shall be subjected to operational test/checks.

(b) Gas tight Dampers shall be subjected to shop leakage test to demonstrate the guaranteed tightness as per NTPC Tech Specification.

1.15.00 **Boiler Structure, Chimney, 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) 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 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) Columns, Chimney etc. shall be trial assembled and match marked prior to dispatch/erection. At least two consecutive members along with cross member shall be assembled at a time.

1.16.00 Hangers & Supports:

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

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

1.17.00 (a) Thermal Insulation Light resin bound mineral wool:

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 six months by the manufacturer. Wire mesh of diameter 0.71mm (min.) or as per approved data sheet shall only be used.

(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 Aluminium sheeting confirming to ASTM B-209-1060 temper H14 from reputed manufacturer meeting the requirements of NTPC data sheet.

1.18.00 Metallic expansion Joint (if applicable)

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

1.19.00 **Quick erect Scaffolding structure (vertical)**

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

1.20.00 **CHEMICAL DOSING SYSTEM (HP/LP)**

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

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

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 equipment 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**

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.

1.00.0 FLUE GAS CLEANING 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 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.

1.02.0 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.

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 NDT on valves shall be as per relevant standard.

1.04.03 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 complete tanks shall be water fill tested.
ii) All atmospheric storage tanks fabricated and erected at site shall be subjected to tests (Hydro, NDT and Vacuum) according to design code as applicable.
iii) Rubber lining shall be tested for hardness and spark test, as applicable.

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.

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

1.07.0 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 at rated speed as per relevant/applicable standard.

1.08.0 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 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 and 100% MPI.

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

1.08.03 Edge for shop and field weld shall be examined by MPI for plate thickness >= 32mm.

1.09.0 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.

1.10.0 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.

1.11.0 AGITATORS:

1.11.01 Rubber lining shall be tested for hardness and spark test

1.11.02 Impellers shall be tested for dimensional and balancing check

1.11.03 Gear Boxes shall be tested for run test as per standard practice

1.12.0 FANS:

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

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

1.12.03 All rotating components and assemblies of fan shall be balanced dynamically

1.12.04 Performance test shall be carried out on fans as per Technical specification/ Relevant standard

1.13.0 Thermal Insulation, Lagging & Cladding:

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

LRB mattresses/sections of Rockwool/ Glasswool 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 Aluminium sheeting confirming to ASTM B-209-1060 temper H14 from reputed manufacturer meeting the requirements of NTPC data sheet.

1.14.0 OTHER CRITICAL EQUIPMENTS:

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

CONDENSATE EXTRACTION PUMP

1.00.00 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 preferably done at 1 % and 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.

TABLE CONT'D ON NEXT PAGE

CONDENSATE EXTRACTION PUMPS

Note:

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.

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 REMARKS FOR DEAERATORS

(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 DEAERATOR/ Gland steam coolers the statutory requirements as per IBR to be ensured and the certificates in original to be furnished as per IBR statutory requirements.

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.

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 REMARKS FOR DEAERATORS

(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 DEAERATOR/ Gland steam coolers the statutory requirements as per IBR to be ensured and the certificates in original to be furnished as per IBR statutory requirements.

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.

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
	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) RECIRCULATION VALVE	Y	Y①	Y	-	Y+	-	Y+	Y+	-	-	Y++	-	-	Y

Remarks

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

Tests / Item/ Description	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,if offered	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 preferably done at 1 % and 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 Visual Cavitation Test on one first stage production impeller of Boiler Feed Pump shall be carried out to demonstrate absence of Cavitation at Design Speed in Cold Water. The test will establish the cavitation characteristic of one production first stage impeller to confirm that the cavity length under dynamically scaled site conditions corresponding to design point will not exceed an agreed size. This test shall be carried out at 25%, 50%,65%,80%,100% and 125% of Design Flow

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.

STEAM TURBINE & 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, Turbine 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. 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 Enclosure:**

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

(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 minimum test duration of 1000 hrs/mutually agreed parameters for NTPC approval.

c) 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)-If Applicable**

(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 minimum test duration of 1000 hrs/mutually agreed parameters for NTPC approval.

c) 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, along with 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. Run out examination will be carried out at blade shrouds also.

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

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

(d) 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.

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

(f) 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.

(g) 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.

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

(i) 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 on blades.

(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 minimum 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 (If Applicable), 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 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 **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 **AIR COOLED CONDENSERS FOR MAIN TURBINE AND DRIVE TURBINE (IF OFFERED)**

1.03.01 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.

© 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.

1.03.02 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.

1.03.03 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.

1.03.04 **MOTOR**

The respective specification covered elsewhere is to be referred.

1.03.05 **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.

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

1.03.06 **Steam Throw Off Device**

(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.

1.03.07 **SPRING ASSEMBLY (IF REQUIRED)**

(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 (if offered)**

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 **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

(f) Proof of design tests for valves and actuator shall be carried out as per AWWA-C504. 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 **ACC Assembly:**

(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.

1.10.03

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.

POWER CYCLE PIPING

1.00.00 **H.P.PIPING FOR 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 P-5B group & above shall be checked for RT/ UT & MPI after SR.

(g) For welds in P91, X20 & X22 and material P5B 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 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.

(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 P5B 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 and material group 5B & 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 / Glasswool 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:**

Aluminium 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 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 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 pentrant 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.

CLAUSE NO.	QUALITY ASSURANCE

	EQUIPMENT COOLING WATER												
	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			Y8				
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.

L P 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 & specialties	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/ 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							

L P PIPING

	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 shall be subjected to 100% RT.	
2	Spark Test, Adhesion Test and Material Test for primer and enameled & Coal Tar Tapes as per AWWA-C-203-91/ 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%
	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 TIME OF FLIGHT DEFRACTION (TOFD) 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 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 governing design standard. Actuator operated valves shall be checked for Seat Leakage by closing the valves with actuator. Seat Leakage test shall be carried out in both directions. 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.	

L P PIPING

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 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 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 Butter Fly Valve: a. UT as per ASTM A-435 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.

CLAUSE NO.	QUALITY ASSURANCE

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.

e. Rotor shall be statically and dynamically balanced.

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.

1.04.00 **E.O.T. CRANE:**

a) Chain pulley Blocks shall be tested as per IS: 3832.

b) Following NDT requirements shall be met:

(i) 100% RT of Butt welds in tension and 10% RT of butt welds in compression.

(ii) DP at random on all weldments.

Deflection, load, overload & travel check on HOT crane assembly Shall be carried out as per IS: 3177.

1.05.00 **PIPINGS, VALVES, AND FITTINGS**

a. All pipes and fittings shall be tested as per applicable code.

b. 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.

c. Valves shall be offered for hydro test in unpainted condition.

d. Functional checks of the valves for smooth opening and closing shall also be done.

All bar stocks/ forgings, dia ≥ 40 mm shall be Ultrasonic Tested irrespective of the type, size & rating of the valve.

AIR CONDITIONING AND VENTILATION SYSTEM

QA MODULE FOR AIR CONDITIONING AND 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
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 :
1.01.05.01	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.
1.01.05.02	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 whole 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 review as applicable.
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	**FANS**
2.01.00	20% DPT of welding on fan hub, blades, casing and impeller as applicable shall be carried out.
2.02.00	DPT of fan shafts shall be carried out after machining.
2.03.00	UT of fan shafts (diameter equal to or above 40mm) shall be carried out.

2.04.00	Rotating components of all fans shall be dynamically balanced to ISO-1940 Gr. 6.3
2.05.00	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.
2.06.00	One fan of each type and size will be performance tested as per corresponding BIS /AMCA for Air flow, Static Pressure, Speed, Efficiency, Power Consumption, Noise, Vibration and Temp. Rise.
3.00.00	**AIR HANDLING UNIT**
3.01.00	For Fans refer tests as mentioned at 2.00.00
3.02.00	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.
3.03.00	All cooling coil shall be pneumatically tested and no leakage shall be permitted.
4.00.00	**CENTRIFUGAL PUMP**
4.01.00	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.
4.02.00	All rotating components of the pumps shall be dynamically balanced to ISO-1940 Gr. 6.3
4.03.00	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.
4.04.00	Standard Running Test
4.05.01	All pumps shall be tested in the manufacturer's works preferably with contract motor 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 only.
4.05.02	Noise and vibration shall be measured at shop for reference purpose only.
4.05.03	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.
4.05.04	NPSH test shall be conducted with water as the medium, if required as per approved data sheets.

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	Thermal conductivity tests (for thermal insulation only) shall be done once in 12 months for insulation material manufactured during 12 months period for the same density and thickness of material as applicable as per IS:3346 or equivalent standard.
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.
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**
8.01.00	Pre/Fine filters shall be tested for initial and final pressure drop Vs flow 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.
10.02.00	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.
10.03.00	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.
10.05.00	Functional check of the valves for smooth opening and closing shall be done.
10.06.00	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 AC/ PAC/PEC**
11.01.00	Split/Cassette/ Window AC will be accepted on the basis of Manufacturer Standard Guarantee and Warrantee certificate.
11.02.00	PAC/PEC: Each Unit shall be subjected to production routine Test excluding performance test carried out as per relevant standard.
11.03.00	Performance test of PAC/PEC shall be carried out as per relevant standard on one unit of each type and rating at site.
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. 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.

CLAUSE NO	Quality Assurance
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(if applicable)**
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 >= 50 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	**SUBMERGED CHAIN CONVEYOR**
1.03.01	Chain shall be tested for following at manufacturer's works: Case depth & hardness test after heat treatment, Proof Load Test, Break Load Test and Dimensional Test
1.03.02	Cast 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-cast basalt shall be minimum.
1.03.03	Trial assembly of submerged scrapper conveyor & various sub-assemblies shall be carried out in shop for which manufacturer shall furnish detail procedure for NTPC approval
1.04.00	**ASH CRUSHER**
1.04.01	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.
1.04.02	UT at proof machined condition (for dia/thickness >= 50 mm) and MPI/DPT after machining shall be done on shafts. MPI/DPT shall be carried out on welds
1.04.03	No load run test for minimum 2 hours continuous operation of clinker grinder shall be done to ensure trouble free operation.
1.05.00	**GEAR BOX**
1.05.01	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.
1.05.02	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.
1.05.03	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.
1.06.00	**METALLIC EXPANSION JOINTS**
1.06.01	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.

1.06.02	DPT shall be carried out on welds before and after forming to check cracks. Spring rate shall also be measured.
1.06.03	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.
1.07.00	**FLY ASH BRANCH SEGREGATION VALVES , FLY ASH FEED VALVES, VACUUM BRAKER, AIR INTAKE VALVE AND KNIFE GATE VALVE FOR HOPPER ISOLATION**
1.07.01	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
1.08.00	**AIR LOCK/PUMP TANK**
1.08.01	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.
1.09.00	**BAG FILTERS**
1.13.01	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.
1.10.00	**DRY FLY ASH STORAGE SILO, BUFFER HOPPER**
1.10.01	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.
1.11.00	**FLUID COUPLING:**
1.11.01	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
1.11.02	Functional test on fusible plug for each type of coupling shall be conducted at shop. All couplings to be run tested at shop.
1.11.03	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.
1.12.00	**ELECTRIC HOIST & OVERHEAD TRAVELLING CRANE(if applicable):**
1.12.01	All material shall be tested for Chemical & Mechanical properties as per relevant standard. UT at proof machined condition (for dia/thickness >= 50 mm) and MPI/DPT after machining shall be done on gear blanks, shafts, pinions and axles
1.12.02	Proof load test on hook as per relevant standard shall be carried out. UT shall be carried out on shank portion of the hook. DPT shall be carried out after proof load test. Wire ropes shall be tested as per relevant standard. Gear box shall be checked for ratio, backlash, Temp. rise, noise and no leakage of oil.

CLAUSE NO	Quality Assurance
1.12.03	All butt welds of rope drum shall be subjected to 100% RT. DP test shall be carried out after stress relieving of rope drums.
1.12.04	100% radiography of weld under tension and 10% radiography of compression butt weld shall be done for girder etc. 100% DP of all butt welds and 10% DPT on fillet shall be carried out.
1.12.05	All tests of completed assembly shall be carried out as per IS-3177 for Overhead Travelling Crane and as per IS 3938 for Electric Hoist. Chain Pulley Blocks shall be tested as per IS -3832.
1.13.00	**PACKAGE AIR CONDITIONER:**
1.13.01	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.
1.14.00	**SCREW CONVEYOR AND METALLIC CONVEYOR**
1.14.01	Material like plates, shafts shall be tested for chemical and mechanical properties as per relevant standard. MPI/DPI tests as applicable shall be done on welds to ensure freedom from defects.
1.14.02	Functional check shall be carried out at shop for smooth operation.
1.15.00	**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(if applicable)	Y[a]							Y	Y[5]			Y		Y[6]	Y
3a	Cast Butterfly Valves (if applicable)	Y[a]		Y[3]	Y[b]			Y	Y	Y[5]			Y		Y[7]	Y
3b	Fabricated Butterfly Valves (if applicable)	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(if applicable)	Y[a]		Y[3]	Y[b]			Y	Y	Y[5]	Y		Y		Y[4]	Y
6	Plug / Ball Valves(if applicable)	Y[a]		Y[3]	Y[b]			Y	Y	Y[5]	Y		Y			Y
7	Rolled & Welded Pipes /Mitre fittings(if applicable)	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(if applicable)	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	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	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	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 ≥ 50 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.
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.
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.

Shop Test for 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 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 LIFTING BEAM:

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.

1.00.00 FIRE DETECTION & PROTECTION SYSTEM

1.01.00 HYDRANT SYSTEM: Shop Tests

1.01.01 Hydrant Valve:

(a.) All valves shall be hydro tested for body and seat.

(b.) Capacity test / flow test shall be done as per relevant standard.

1.01.02 Water Monitor, Hoses, Branch Pipes, Couplings and Nozzles:

(a.) All tests including hydraulic test shall be done as per relevant Indian / International standard.

1.01.03 For Pumps, Diesel Engine, refer the requirements are indicated separately.

1.02.00 HIGH / MEDIUM VELOCITY WATER SPRAY : Shop Tests

1.02.01 For Pipes, Fittings, Valves and specialties, requirements are indicated separately.

1.02.02 Deluge Valves and Spray Nozzles

(a.) All valves shall be hydro tested for body and seat.

(b.) Performance test / functional test of 'Deluge Valves' and 'Spray Nozzles' shall be carried out.

1.02.03 **Detectors:** All 'Detectors' shall be tested as per relevant Indian / International Standards. Detectors shall also meet the requirements of UL / FM / LPC/VDS etc.

1.03.00 INERT GAS EXTINGUISHING SYSTEM(If Applicable):

1.03.01 Shop Tests

(a.) Complete system selection as well as supplier of major items / component shall be listed by UL / FM / LPC etc.

(b.) Storage Cylinders / Containers with all accessories, all piping, valves, fittings and nozzles shall be subjected to all tests as per the design code to which they are supplied and shall also meet the requirements of TAC / UL / LPC / FM / NFPA/VDS etc.

(c.) Storage Containers shall also meet the statutory requirements of approval / acceptance by CCE.

(d.) Test for fill density, weight, leakage etc. shall be done for charged cylinders / containers.

1.04.00 HORIZONTAL CENTRIFUGAL PUMP:

1.04.01 SHOP TESTS

(a.) UT on Pump Shaft (>= 50mm dia) and MPI / DPT on Pump Shaft and Impeller shall be carried out.

(b.) All rotating components of the pumps shall be statically and dynamically balanced as per ISO: 1940 Gr. 6.3 or better.

(c.) Hydraulic test shall be conducted on pump casing with water at 1.5 times the shut off pressure or twice the rated pressure whichever is higher for a minimum duration of 30 minutes.

(d.) Performance test and Standard Running test:

(1.) All the pumps shall be tested in the manufacturer's works for capacity, efficiency, head and brake horsepower. Pump shall be given running test over the entire operating range covering the shut off head to the maximum flow. The duration of test shall be minimum one hour. A minimum of five readings approximately equidistant shall be taken for plotting the curves with one point at design flow. Testing of pump shall be in accordance with stipulations oh Hydraulic Institute Standard (HIS) and / or as per applicable Indian Standard or equivalent. Tolerance of parameters shall be as per HIS.

(2.) The test shall be conducted at the rated speed preferably with the type tested contract drive motor being furnished. However, in case of any limitation test bed motor duly calibrated can also be used.

(3.) Noise and vibration shall be measured.

(4.) Pumps shall be subjected to strip down examination visually to check for mechanical damages after testing at shop in case abnormal noise level / vibration performance are observed during the shop test.

1.05.00 COMPRESSION IGNITION DIESEL ENGINE

1.05.01 Shop Tests:

(a.) All pressure parts shall be subjected to hydraulic pressure tests at 1.5 times the design pressure.

(b.) All Diesel engine shall be performance tests as per relevant IS / equivalent code.

1.05.02 Performance Test :

Performance test of diesel engine shall be carried out as per BS-5514 to determine the rated power and specific fuel consumption and governor's function. Performance test of engine in shop shall be done with actual job accessories for minimum four hours (three hours for full load and one hour for over load at 110% of full load). All the engine parameters like RPM, inlet airs temp and pressure, water inlet and outlet temp. and pressure, lub. Oil pressure, fuel consumption, ambient condition shall be measured and recorded for every half an hour. No positive tolerance shall be allowed on the specific fuel consumption (contractor to specify in the offer.)

1.06.00 STORAGE VESSELS: Shop Test

1.06.01 Atmospheric Tank

(a.) All weld joints shall be DP Tested and complete tanks shall be water fill tested.

(b.) All atmospheric storage tanks fabricated and erected at site shall be subjected to all tests (Hydro, NDT, and Vacuum) according to design code as applicable.

1.07.00 PIPING, VALVE AND SPECIALITIES

1.07.01 SHOP TESTS

(a.) All pipes and fittings shall be tested as per applicable code.

(b.) DPT of pipe welds (in case of rolled and welded pipes only) shall be carried out for root and finished welds.

(c.) All strainers shall be subjected to hydraulic pressure test for leakage and Pressure drop v/s Flow for each type and size.

(d.) 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.

(e.) Valves shall be offered for hydro test in unpainted condition.

(f.) Functional checks of the valves for smooth opening and closing shall also be done.

(g.) Anti-corrosive protection shall be tested as per applicable code.

1.08.00 PORTABLE & MOBILE FIRE EXTINGUISHERS

1.08.01 SHOP TEST

(a.) All fire extinguishers shall be tested as per relevant standard.

(b.) Performance / function test shall be carried out on sampling basis as per relevant code / standard.

1.09.00 **EOT Crane/ Electric Hoist/Chain pulley block**

a) Chain pulley Blocks shall be tested as per IS: 3832.

b) Electrical wire rope hoists shall be tested as per IS : 3938

c) Following NDT requirements shall be met :
   (i) 100% RT of Butt welds in tension and 10% RT of butt welds in compression.
   (ii) DP at random on all weldments.

d) Deflection, load, overload & travel check on EOT crane assembly shall be carried out as per IS: 3177.

1.10.00 **SITE TESTS**:

(a.) Fire Extinguishers: A performance demonstration test at site of five (5) percent or one (1) number, whichever is higher, of each type and capacity of the extinguisher shall be carried out by the contractor. All consumables and replaceable items require for the contractor without any extra cost to employer would supply this test would be supplied by the Contractor without any extra cost to employer.

(b.) Piping Protection:

(1.) Thickness, Holiday by spark test, Adhesion test shall be carried out as per relevant standard.

(2.) Complete piping shall be Hydro pressure tested, at 1.5 X DP or 2 X MWP whichever is higher, before protection.

(c.) Welding of Pipes:

(1.) ERW Black / rolled welded:

100% DPT on root of butt and finish weld of butt and fillet.

RT on 10% randomly selected joints shall be carried out (for underground piping).

(2.) GI Pipes

Welding on GI Pipes in general shall not be done. Welding of GI Pipes, if permitted by design, (butt / socket / fillet weld) shall be done strictly as per approved drawing and procedure approved by NTPC Engineering. For all such welds 100% DP test and random 1% RT shall be done.

Waste Feed Crane & Bottom Ash Crane

1.0 All plates equal to or above 25mm thickness shall be ultrasonically tested.

2.0 Forgings/Castings for Shaft, Gears/Pinion, Axles, Rail Wheels, Grab Bucket etc., shall be subject to ultrasonic testing in addition to check for chemical, mechanical, hardness and micro structure as per applicable material specification

3.0 MPI/DPT shall be carried out on forgings/casting after machining/hard facing if applicable.

4.0 Wire rope shall be tested as per relevant standard

5.0 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.

6.0 Trial assembly of Waste feed crane and Bottom ash crane sub-assemblies (i.e. Hoisting, Trolley movement, Long Travel, Grab and ungrab) shall be carried out at shop. Manufacturer shall furnish detail procedure for various sub-assemblies for NTPC approval. Functional and capacity check of Grab bucket shall be carried out at shop.

INDUCED DRAFT COOLING TOWERS

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	**STOP LOG GATES**	Y[a]	Y		Y[b]			Y			Y	Y[7]
6	**GATE/ GLOBE/ CHECK VALVES**	Y[a]			Y[b]		Y			Y	Y	Y[8]
7	**BUTTERFLY VALVES**				Y		Y	Y		Y	Y	Y[9]
7.1	Body (Cast) , Disc (Cast)	Y[a]			Y[b]			Y				
7.2	Body & Disc both fabricated	Y[a]	Y	Y	Y[b]			Y	Y[10]			
7.3	Shaft	Y[a]		Y[c]	Y[b]			Y				
8	**ROLLED & WELDED PIPES.**	Y[a]	**REFER NOTE – 11 FOR ALL CHECKS**									
9	**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	**Fibre 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										

INDUCED DRAFT COOLING TOWERS

	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 40 mm or above & Plates of Thickness 20 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.	Smooth operation and leak tightness shall be checked at site.	
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	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 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 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.

INDUCED DRAFT COOLING TOWERS

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	**STOP LOG GATES**	Y[a]	Y		Y[b]			Y			Y	Y[7]
6	**GATE/ GLOBE/ CHECK VALVES**	Y[a]			Y[b]		Y			Y	Y	Y[8]
7	**BUTTERFLY VALVES**				Y		Y	Y		Y	Y	Y[9]
7.1	Body (Cast) , Disc (Cast)	Y[a]			Y[b]			Y				
7.2	Body & Disc both fabricated	Y[a]	Y	Y	Y[b]			Y	Y[10]			
7.3	Shaft	Y[a]		Y[c]	Y[b]			Y				
8	**ROLLED & WELDED PIPES.**	Y[a]	**REFER NOTE – 11 FOR ALL CHECKS**									
9	**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	**Fibre 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										

INDUCED DRAFT COOLING TOWERS

	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 40 mm or above & Plates of Thickness 20 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.	Smooth operation and leak tightness shall be checked at site.	
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	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 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 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.

CW SYSTEM EQUIPMENT

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
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.	**STOP LOG GATES**	Y[a]	Y[b]						Y	Y			Y[12]	

CW SYSTEM EQUIPMENT

E.	**R & W PIPES**	Y[a]	**REFER NOTE 13**											
F.	**CRANES & HOISTS**	**REFER SEPARATE TABLE FOR QA CHECKS ON EOT CRANES AND HOISTS**												
G.	**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

Legends/ 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 ASTM D-1149, 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	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:- Butt weld joints which can not be hydraulic (pressure) tested; shall be examined 100% by Radiographic Test (RT)
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 and Pressure drop v/s Flow for each type and size. 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.

CW SYSTEM EQUIPMENT

WATER TREATMENT SYSTEM AND CONDENSATE POLISHING PLANT

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	

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 ISO: 1940, 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.

Y^6 : Blue Matching, Wear Travel for Gate Valves and reduced pressure test

WATER TREATMENT SYSTEM AND CONDENSATE POLISHING PLANT

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
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]	
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 & Coatig 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]	

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 type test, if not carried out earlier, for the similar MOC, size and type of spring.

WATER TREATMENT SYSTEM AND CONDENSATE POLISHING PLANT

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. Chlorine Tonner / Chlorine Evaporator	Y[a]	Y	Y[b]	Y	Y	Y[8]	Y		Y		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. Chlorinator / Ejector	Y[a]			Y	Y		Y	Y	Y		
4. Chlorine Gas Filter	Y[a]			Y	Y		Y		Y		
5. Pressure / Vacuum Relief valve / Pressure Regulating Valve	Y[a]			Y	Y		Y	Y	Y		
DM PLANT & CWT SYSTEM:											
1. Resins / Activated Carbon									Y		
2. Filter Membrane					Y				Y		
3. RO Pressure tube	Y[a]				Y		Y		Y		
CPU SYSTEM:											
1. Butterfly valves / Ball valves (HP)	Y[a]			Y	Y		Y	Y	Y	Y[3]	
2. Resins / Activated Carbon									Y		
STP & SWIMMING POOL FILTERATION PLANT:											

WATER TREATMENT SYSTEM AND CONDENSATE POLISHING PLANT

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
1. Clariflocculator / Reactor Clarifier / Plate or Tube Settler	Y[a]	Y	Y[b]	Y	Y				Y	Y[10]	
2. Centrifuge	Y[a]	Y	Y[b]	Y	Y		Y	Y	Y		
3. MBR/ MBBR/ SBR	Y[a]	Y	Y	Y	Y		Y		Y	Y[13]	
ZLD PLANT:											
1. Clariflocculator / Reactor Clarifier / Plate or Tube Settler	Y[a]	Y	Y[b]	Y	Y				Y	Y[10]	
2. Chlorine Tonner / Chlorine Evaporator	Y[a]	Y	Y[b]	Y	Y	Y[8]	Y		Y		
3. Chlorinator / Ejector	Y[a]			Y	Y		Y	Y	Y		
4. Chlorine Gas Filter	Y[a]			Y	Y		Y		Y		
5. Heat Exchanger	Y[a]	Y	Y[b]	Y	Y		Y		Y		
6. Centrifuge	Y[a]	Y	Y[b]	Y	Y		Y	Y	Y		
7. Filter Membrane					Y				Y		
8. RO Pressure tube	Y[a]				Y		Y		Y		
9. Pressure / Vacuum Relief valve / Pressure Regulating Valve	Y[a]			Y	Y		Y	Y	Y		

WATER TREATMENT SYSTEM AND CONDENSATE POLISHING 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

GENERATORS & AUXILIARIES (up to 20MW)

PROCESS CHECK FOR STATIC PARTS GENERATOR / EXCITOR

TESTS / ITEM/ COMPONENTS /PROCESS	Visual & dimension	Chem. Prop.(raw material)	Heat treatment	Mech.Prop.(raw material as applicable)	Impact.(raw material)	Hydraulic test	Pneumatic test	RT/UT (10% for butt weld)	MPI/DPT(All welds of trinium& base plate, sample on other)	Relative permeability	Ferrite content	DIN 43760, IS 2848,7358	DIN 48124
Sheet and Fabrication – Stator Frame, End Shield, Terminal Box etc.	Y	Y	Y	Y	Y	Y1	Y1	Y	Y				
Bearing	Y	Y		Y				Y2					
Terminal Bushing													Y
RTD/ Thermocouple												Y	
Additional checks for -Non magnetic Components										Y			
-Non magnetic Components welding											Y		

Y-Test applicable, Y1-For Hydrogen cooled machine, Y2-UT on Babbitt for bearing,

Note:

1- This is an indicative list of tests / checks. The manufacturer is to furnish a detailed Quality Plan indicating the practice and procedure along with relevant supporting documents.

2. All generators shall be assembled at works and shall be tested to verify/ensure design and workman ship in accordance with IEC-34, VDE 0530, IEEE 115, IEEE 43. The manufacturer shall submit detailed test procedure which clearly specify test set up, instruments to be used, acceptance norms (wherever applicable) recording of different parameter, interval of recording, precautions etc.

3. Cooler, control panel and other auxiliaries (as applicable) to be suitably tested as per tests covered in the specification.

GENERATORS & AUXILIARIES
PROCESS CHECK FOR CORE GENERATOR/EXCITOR

TESTS / ITEM/ COMPONENTS / PROCESS	Specific loss before and after ageing	Magnetization	Anisotropy of losses	Stacking factor	Burr level	chem., elect., viscosity cure time, solid content, dielectric properties	Dimension & surface (uniformity of varnish coat)	Spot weld check
Core lamination	Y	Y	Y	Y			Y	
After punching Insulated core Laminations					Y		Y	
Check for varnish						Y		
Ventilation Stamping								Y
Core assembly							Y	

TESTS / ITEM/ COMPONENTS / PROCESS	Process check including Heating & pressure application	Insulation test of insulated core tension bolt & core bar	Functional check of ventilation ducts	Hot spot at rated flux density by infra red camera & ELCID *	Location of temp. detectors	Iron loss at rated flux density
CORE assembly (additional Checks for Generator)	Y	Y	Y	Y	Y	Y

Y-Test applicable

*** In case of any constraint of manufacturer to carry out the test at rated flux , testing at reduced flux as per manufacturer guidelines to be proposed to Owner for review & approval.**

GENERATORS & AUXILIARIES

PROCESS CHECK FOR STATOR CONDUCTOR AND WINDING (GENERATOR/ EXCITOR)

TESTS / ITEM/ COMPO-NENTS /PROCESS	Mech. prop (sample)	Chem. prop (sample)	Resistivity/Resistance	Metallography prop.	Insulation adhesion	Flexibility of bending	Dielectric test	Dimension/visual	Electric test	Physical prop.	Brazing procedure	Process check	Check on RTD + location winding
Winding copper and Connecting bus bars	Y	Y	Y	Y									
Insulated conductor					Y	Y	Y	Y					
Insulation material	Y	Y						Y	Y	Y			
Manufacturing Winding bar/coil & phase bar							Y	Y	Y		Y	Y	
Winding laying							Y	Y	Y			Y	Y
Winding support ring		Y						Y		Y			
Connection between bars											Y		

TESTS / ITEM/ COMPONENTS / PROCESS	Tan delta and delta, tan delta Up to 1.2 un	Corona protection resistance	Reactance of stator winding	Dielectric test at elevated And room temp.	Inter strand Insulation test	Slot wedge tightness & radial movement	Type test on two bars for Heating cycle test, Thermal stability test, Voltage endurance test	Support arrangement
Insulated conductor				Y				
Manufacturing Winding bar/coil & phase bar	Y	Y			Y		Y	
Winding laying								Y
Connection between bars/coil					Y1			
wound stator	Y		Y			Y		

Y - Test Applicable, Y1: As applicable.

GENERATORS & AUXILIARIES
PROCESS CHECK FOR ROTOR AND ASSEMBLY (GENERATOR/EXCITOR)

TESTS / ITEM/ COMPONENTS / PROCESS	Rep. sample tensile stress	Rep. sample 0.2 limit	Rep. sample elongation	Hardness on Sample	Impact check on sample	Rep. sample Chem. prop.	NDTT, FATT (as applicable)	Process check including heat treatment (as applicable)	Ultrasonic test/RT (at suppliers works and after preliminary machining)	Sulphur Prints Check(Depending on proveness)	Flux carrying capacity / Magnetic prop *	Boroscopic Examination
Rotor forging & slip ring shaft	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Rotor end retaining ring, locking ring & Slip ring forgings, diode wheel	Y	Y	Y		Y	Y		Y	Y			
Rotor wedges, damper Wedges.	Y		Y			Y		Y	Y			
Rotor winding copper CC-bolts & D-leads	Y		Y			Y		Y				
Rotor slot boxes/ insulating material						Y						
Rotor winding								Y				
Winding connection studs & assembly												
Complete rotor								Y				
Test on completed rotor at various speed up to rated speed												
Test on completed rotor before & after over speed												
Fan hubs/blades						Y		Y	Y			
GENERATOR assembly												
Diode wheel Assembly												
Permanent magnet					Y						Y	
EXCITER assembly												

Y- Test Applicable * Not applicable for slip ring shaft of SEE

GENERATORS & AUXILIARIES

PROCESS CHECK FOR ROTOR AND ASSEMBLY (GENERATOR/EXCITOR)

TESTS / ITEM/ COMPONENTS /PROCESS	MPI/DP/NDT test	Visual/Dimension/Cleanlines	Adhesion, thickness of Coat on silver plating If applicable	Electrical conductivity and Oxygen content	Mech. test on sample	Electrical test (∑)	Resistance measurement	Inter turn test	Dielectric test
Rotor forging & slip ring shaft	Y	Y							
Rotor end retaining ring & cover, locking ring & Slip ring forgings, diode wheel	Y		Y						
Rotor winding copper, rotor wedges, damper Wedges, CC-bolts & D-leads	Y		Y	Y1		Y			
Rotor slot boxes/ insulating material					Y	Y			
Coil manufacture		Y							
Rotor winding	Y	Y				Y		Y	Y
Winding connection studs & assembly	Y				Y				Y
Complete rotor							Y		Y
Test on completed rotor at various speed up to rated speed								Y	Y
Test on completed rotor before & after overspeed		Y					Y	Y	Y
Fan hubs/blades	Y	Y							
GENERATOR assembly		Y							
Diode wheel Assembly		Y							
Permanent magnet		Y			Y				
EXCITOR assembly		Y							

Y-Test Applicable , Y1: Oxygen content applicable for Rotor winding copper & D Lead,
∑ NOTE- Dielectric test & conductivity test etc. as applicable

GENERATORS & AUXILIARIES

PROCESS CHECK FOR ROTOR AND ASSEMBLY (GENERATOR/EXCITOR)

TESTS / ITEM/ COMPONENTS /PROCESS	Insulation Resistance	PI	Radial run out/alignment	Impedance measurement/ RSO (repetitive surge oscillograph)	Dynamic balancing ISO 5406, 2372, 1940	Over speed test (120%) for 2 minute	Axial run out	Metallography examination	Torque on joint bolts	Fitting and locking of Balancing weights	Brazer and brazing procedure
Rotor forging & slip ring shaft								Y			
CC-bolts									Y		
Coil manufacture											Y
Rotor winding											Y
Winding connection studs & assembly	Y										
Complete rotor	Y		Y	Y	Y	Y			Y		
Test on completed rotor at various speed up to rated speed				Y							
Test on completed rotor before & after overspeed	Y		Y	Y							
Fan hubs/blades										Y	
GENERATOR assembly	Y	Y	Y				Y		Y	Y	Y
Diode wheel Assembly			Y				Y		Y	Y	
Permanent magnet											
EXCITOR assembly			Y						Y	Y	

Y-Test applicable

GENERATORS & AUXILIARIES

ADDITIONAL CHECK FOR EXCITOR

TESTS / ITEM/ COMPONENTS /PROCESS	Routine Test as per applicable std	As per IEC-76 / Applicable std	Pole parallelism & polarity	Mech. chem. & Magnetic prop.(as applicable)	Functional check	Insulation resistance	IEEE/ANSI-C37.18 Or IEC 60947-2	As per applicable standards	As per specification	Dimensional and visual
Fuse diode & filter Circuit	Y									Y
Aux. Transformer (if applicable)		Y								
Carbon brush holder & housing				Y	Y				Y	Y
Cable									Y	
PMG & Exciter stator			Y	Y		Y				
Bandaging wire				Y						
Field discharge resistor					Y					
Bearing, exciter armature field, axis coil , RTD						Y				
Excitation Transformer		Y								
Thyristors									Y	
Field breaker					Y		Y			
Bus duct AC/DC								Y		
Voltage Regulator									Y	
Carbon brush				Y	Y				Y	Y

Y - Test applicable

GENERATORS & AUXILIARIES
FINAL ACCEPTANCE TEST GENERATOR / EXCITOR

TESTS / ITEM/ COMPONENTS /PROCESS	Resistance measurement	Rotor impedance at various speeds	Heat run test	Function check	Voltage regulation	OCC	SCC	Record Aux. parameters	Steady state reactance's	Efficiency By separation of losses
Works running test on generator	Y	Y	Y			Y	Y	Y	Y	Y
Without Excitation, Open Circuit & Short Circuit with rated voltage & current for Generator			Y							
Works test on brush less exciter	Y		Y			Y				
PMG works test	Y		Y		Y	Y				
Full load for PMG & convertor assembly			Y							
Convertor assembly for SEE				Y						
Static excitation system				Y						

TESTS / ITEM/ COMPONENTS /PROCESS	Insulation resistance	Polarisation index	Phase seq. voltage balance	Shaft voltage	H.V. test (except electronic circuit)	RTD, BTD Check	Capacitance measurement	Tan delta, delta tan delta	Rotor journal	Bearing oil catcher
Works running on generator	Y	Y	Y	Y	Y	Y	Y	Y		
On total wdg / phases at interval 0.2 Un for Generator							Y	Y		
Condition after dismantling									Y	Y
Works test on brush less exciter	Y				Y					
PMG works test	Y		Y		Y					
convertor assembly for SEE	Y				Y					
Static excitation system	Y				Y					

Y - Test Applicable

GENERATORS & AUXILIARIES

FINAL ACCEPTANCE TEST GENERATOR/EXCITOR

TESTS / ITEM/ COMPONENTS /PROCESS	Seal rings, liners	Winding Overhang	Vibration measurement	No load	Load characteristics	Characteristics of search coil, quad, axis	Ripple content	As per specification	Visual & dimension	Partial discharge
Works running test on generator			Y						Y	Y
Condition after dismantling	Y	Y								
Works test on brush less exciter			Y	Y	Y	Y			Y	
PMG works test				Y	Y					
Static excitation system							Y	Y	Y	

Y - Test Applicable

CABLING, EARTHING, LIGHTNING PROTECTION

ATTRIBUTES / CHARACTERISTICS / ITEMS/COMPONENTS / SUB SYSTEMS	Dimension	Paint shade, paint thickness, adhesion	Pre-treatment of sheet	IP protection	Proof load*	Surface finish	Deflection test*	HV & IR	Galvanise Test (If Applicable)	Functional	Bought out items/Bill of material	Routine tests as per relevant standard & specification	Acceptance tests as per relevant standard & specification	Constructional feature as per NTPC Specification
Wall Mounted-Lighting Panel (IS-513, IS:5, IS:2629, 2633, 6745)	Y	Y	Y	Y		Y		Y		Y	Y	Y	Y	Y
Switch box/junction box/ Receptacles Panel (IS-513, IS:5, IS:2629, 2633, 6745)	Y	Y	Y	Y		Y		Y	Y	Y	Y	Y	Y	Y
Cable glands(BS-6121)	Y													Y
Cable lug	Y													Y
Lighting wire (IS-694)	Y											Y		
Flexible conduits	Y											Y		Y
Conduits (Galvanise & Epoxy) IS-9537 & IS-2629, 2633, 6745	Y		Y						Y			Y		Y
RCC Hume Pipe (IS-458)												Y		
Cable termination & straight through joint (IS 13573)	Y											Y		Y
Cable Trays, bends, tees, crosses, Flexible supports system & accessories IS-513, 2629,2633,6745	Y		Y		Y	Y	Y		Y			Y	Y	Y
Trefoil clamp	Y													Y
GI flats for earthing & lighting protection (IS 2062, 2629, 6745,2633)	Y		Y						Y			Y		Y
GI wire (IS-280)	Y											Y		
Fire Sealing System (BS –476)												Y	Y	Y

.Note:1.This is an indicative list of tests /checks. The manufacturer is to furnish a detailed Quality Plan indicating the practice and procedure along with relevant supporting documents.

2.* Deflection Test on cable trays and Proof Load test on cable trays support system will be as per details given in the NTPC technical specification & approved MQP. The above acceptance tests shall be done only on one sample from each size of offered lot. This test is not applicable on bends, tees & crosses.

3. Make of all items will be subject to NTPC approval.

LEAD ACID BATTERY

ATTRIBUTES / CHARACTERISTICS → ITEMS, COMPONENTS, SUB SYSTEM ASSEMBLY ↓	Dimensions & Finish	Conformance to relevant part drg. & Manufacturer's standards	Chemical composition	Lead Coating Thickness (min. 25 microns, IS: 6848 App.F) & Adhesion Check	Conformance to CPWD Spec. for Teak Wood	Paint Process checks, Paint Shade, Thickness, Adhesion & Finish	Constructional requirements as per NTPC Spec.	Routine & acceptance tests as per relevant standard
Container & Lids (IS : 1146)	Y	Y						
Vent Plugs	Y	Y						
Sealing Compound (IS : 3116)		Y	Y					
Positive & Negative Plates		Y	Y					
Separators (IS : 6071)	Y	Y						
Electrolyte (Water / Sulphuric Acid) (IS : 1069 / 266)		Y	Y					
Inter-cell Connectors & Fasteners	Y	Y		Y				
Battery Stand	Y	Y			Y	Y		
Cell Insulators	Y	Y						
Stack Assembly	Y	Y						
Lead Acid Battery (IS : 1652)	Y						Y	Y

Note: This is an indicative list of tests / checks. The manufacturer is to furnish a detailed Quality Plan indicating the practice and procedure along with relevant supporting documents.

Ni- Cd BATTERY								
ATTRIBUTES / CHARACTERISTICS → **ITEMS, COMPONENTS, SUB SYSTEM ASSEMBLY** ↓	Dimensions & Finish	Impact Strength	Conformance to relevant part drg. & Manufacturer's standards	Resistance to Alkali	Chemical composition	Nickel Plating thickness	Paint Shade, Thickness, Adhesion & Finish	Routine & acceptance tests as per relevant standard
Container & Lids	Y	Y	Y	Y				
Vent Plugs	Y		Y	Y				
Perforated Steel Strips	Y		Y	Y		Y		
Active Material for Positive & Negative Plates			Y		Y			
Separators	Y		Y	Y				
Electrolyte			Y		Y			
Inter-cell Connectors & Fasteners	Y		Y	Y		Y		
Battery Stand	Y			Y			Y	
Cell Insulators	Y		Y	Y				
Stack Assembly	Y		Y					
Ni-Cd Battery (IS : 10918)	Y							Y

Notes:

1. This is an indicative list of tests / checks. The manufacturer is to furnish a detailed Quality Plan indicating the practice and procedure along with relevant supporting documents.
2. Makes of all major Bought Out Items will be subject to NTPC approval.

BATTERY CHARGER

Attributes / Characteristics → Items / Components / Sub- assembly ↓	Make, Model, Type, Rating & Finish	Verification of Routine test reports as per relevant IS	Sheet Steel Pretreatment & Painting process checks	Conform to relevant Standard & NTPC spec	Dimensional check and Paint shade, thickness, adhesion & Finish checks	Complete physical examination for constructional features as per NTPC approved drgs & specification	Temperature Rise Test on one unit of each rating if Type testing is waived off	Ripple Content Test, Load Limiter & AVR Operation Test	Dynamic Response Test	Operational & Functional Checks	HV & IR Test	Burn-In Test at 50^C for 48 hrs in energised condition	Alternating current measurement test	Degree of Protection Test as per NTCP Spec.
Rectifier Transformer and Reactors IS : 4540, 2026)	Y	Y		Y			Y				Y			
Electronic Components including Potentiometer (Vernier Type)	Y			Y		Y								
Electronic Cards	Y			Y								Y		
PCB & racks for electronic cards	Y					Y								
Control & Selector Switches (IS : 6875)	Y			Y						Y				
Indicating Meters (IS : 1248)	Y			Y						Y				
Indicating Lamps (IS: 13947)	Y			Y						Y				
Air Break Switches / Fuses (IS : 13947 / 13703)	Y			Y						Y				
Control Terminal Blocks (IS : 13947)	Y			Y										
Control Transformer (IS : 12021)	Y			Y						Y				
Push Buttons (IS : 4794)	Y			Y						Y				
MCB (IS : 8828)	Y			Y						Y				
PVC insulated Copper control wires (IS : 694)	Y			Y										
Sheet Steel (IS : 513)	Y		Y	Y										
Synthetic Rubber Gaskets	Y			Y										
Annunciator	Y									Y		Y		
Battery Charger	Y				Y	Y	Y	Y	Y	Y	Y	Y	Y	Y

Notes:

1. This is an indicative list of tests / checks. The manufacturer is to furnish a detailed Quality Plan indicating the practice and procedure along with relevant supporting documents.
2. Makes of all major Bought Out Items will be subject to NTPC approval.

BATTERY CHARGER

(of capacity upto 24 V / 48 V , 150 A DC)

Attributes / Characteristics → Items / Components / Sub- assembly ↓	Make, Model, Type, Rating	Dimensional check and Paint shade, thickness, adhesion & Finish checks	Complete physical examination for constructional features as per approved drgs	Ripple Content Test, Load Limiter operation & AVR Operation Test	Operational & Functional Checks of aux. Devices like annunciator, switches, indiactors etc.	HV & IR Test	Burn-In Test	Dynamic response test	AC input current measurement test	Temperature rise test on one unit
Battery Charger	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y

Note

1. This is an indicative list of tests / checks. The manufacturer is to furnish a detailed Quality Plan indicating the practice and procedure along with relevant supporting documents.
2. Makes of all major Bought Out Items will be subject to NTPC approval.

Control Cables

Attributes / Characteristics / Item / Components / Sub System Assembly	Make, Type & T.C as per relevant standard	Dimension/surface finish	Mechanical properties	Chemical Composition	Spark Test(as applicable)	Electrical properties	Lay length & Sequence	Armour coverage, cross over, looseness, gap between two	Sequential marking/ Batch marking/ surface finish/ cable length	T.S & elongation before & after ageing on outer sheath & insulation	Thermal stability	Anti termite coating on wooden	Constructional requirements feature as per NTPC specification	Routine & Acceptance Tests as per relevant standard & NTPC	FRLS Tests
Copper (IS-8130)	Y	Y	Y	Y		Y									
PVC insulation Compound (IS: 5831)	Y		Y			Y				Y	Y				
FRLS PVC Compound (IS-5831, ASTM-D2843, IS10810(Part 58), IEC-60754 Part-1)	Y		Y							Y	Y				Y
Extrusion & curing /Manufacturing of Core		Y			Y						Y				
Core Laying							Y								
Armour wire/strip	Y	Y	Y												
Inner sheath	Y	Y													
Armouring		Y						Y							
Outer Sheathing		Y							Y						
Finished Cable (IS-5831, ASTM-D2843, IS10810(Part 58), IEC-60754 Part-1, IEC 60332 part III cat B)							Y	Y	Y	Y	Y		Y	Y	Y
Wooden drum(IS-10418) /Steel Drum		Y										Y	Y		

Notes:
1. This is an indicative list of tests / checks. The manufacturer is to furnish a detailed Quality Plan indicating the practice and procedure along with relevant supporting documents.
2. Make of all major Bought out items will be subject to NTPC approval.

ROUTINE TESTS	**Following routine tests shall be carried out on each drum of finished cables for all sizes.**	
1)	Conductor Resistance test	
2)	High voltage test	
ACCEPTANCE TESTS	**Following Acceptance tests shall be carried out on each size of cables, in the offered lot.**	
A) For Conductor (as per sampling plan mentioned in IS: 1554)		
	1)	Annealing test (Copper)
	2)	Resistance test
B) For Armour Wires / Formed Wires (If applicable) (as per sampling plan mentioned in IS: 1554)		
	1.	Measurement of Dimensions
	2.	Tensile Tests
	3.	Elongation Test
	4.	Torsion Test For Round wires only
	5.	Wrapping Test
	6.	Resistance Test
	7.	Mass of Zinc coating test For G S wires / Formed wires only
	8.	Uniformity of Zinc coating For G S wires / Formed wires only
	9.	Adhesion test For G S wires / Formed wires only
	10.	Freedom from surface defects
C) For PVC insulation & PVC Sheath (as per sampling plan mentioned in IS: 1554)		
	1)	Test for thickness
	2)	Tensile strength & Elongation before ageing (for tests after ageing see “D”)

D) Following tests will be carried out on completed cables as per IS on each size:		
	1)	Insulation resistance test (Volume resistivity method)
	2)	High voltage test
E) Following tests shall be carried out on only one size of offered lot (comprising of all sizes):		
	1)	Thermal stability test on PVC insulation and outer sheath
	2)	Oxygen index test on outer sheath
	3)	Smoke density rating test on outer sheath
	4)	Acid gas generation test on outer sheath
F) Flammability test as per IEC 60332 - Part- 3 (Category- B) on completed cable will be carried out as per following sampling plan:		
		This test will be carried out using composite sampling i.e. irrespective of size; cables of one particular type (i.e. armoured, unarmoured) will be bunched together, as per calculations in line with the IEC. All sizes of armoured & unarmoured cables shall be covered.
G) Following tests shall be carried on one length of each size (armoured & unarmoured) of offered lot:		
	1)	Constructional / dimensional check, surface finish, length measurement, sequence of cores, armour coverage, Gap between two consecutive armour wires / formed wires, Sequential marking, drum / outer sheath extrusion's batch number marking
	2)	Measurement of Eccentricity & Ovality

LT Power Cables

Attributes / Characteristics / Item / Components / Sub System Assembly	Make, Type & T.C as per relevant standard	Dimension/surface finish	Mechanical properties	Chemical Composition	Spark Test(as applicable)	Electrical properties	Hot Set Test/ Eccentricity & Ovality	Lay length & Sequence	Armour coverage, cross over, looseness, gap between two	Sequential marking/ Batch marking/ surface finish/ cable length	T.S & elongation before & after ageing on outer sheath & insulation	Thermal stability	Anti termite coating on wooden	Constructional requirements feature as per NTPC specification	Routine & Acceptance Tests as per relevant standard & NTPC	FRLS Tests
Aluminum (IS-8130)	Y	Y	Y	Y		Y										
XLPE Compound (IS-7098)	Y		Y			Y	Y				Y					
PVC insulation Compound (IS: 5831)	Y		Y			Y					Y	Y				
FRLS PVC Compound (IS-5831, ASTM-D2843, IS10810(Part 58), IEC-60754 Part-1)	Y		Y								Y	Y				Y
Extrusion & curing /Manufacturing of Core (PVC / XLPE)		Y			Y		Y					Y				
Core Laying								Y								
Armour wire/strip	Y	Y	Y													
Inner sheath	Y	Y														
Armouring		Y							Y							
Outer Sheathing		Y								Y						
Power Cable (Finished) (IS-5831, ASTM-D2843, IS10810(Part 58), IEC-60754 Part-1, IEC 60332 part III cat B)								Y	Y	Y	Y	Y		Y	Y	Y
Wooden drum(IS-10418) /Steel Drum		Y											Y	Y		

Notes:
1. This is an indicative list of tests / checks. The manufacturer is to furnish a detailed Quality Plan indicating the practice and procedure along with relevant supporting documents.
2. Make of all major Bought out items will be subject to NTPC approval.

ROUTINE TESTS	**Following routine tests shall be carried out on each drum of finished cables for all types (PVC / XLPE insulated) & sizes.**	
1)	Conductor Resistance test	
2)	High voltage test	
ACCEPTANCE TESTS	**Following Acceptance tests shall be carried out on each size of each type (PVC / XLPE insulated) of cables, in the offered lot.**	
A) For Conductor (as per sampling plan mentioned in IS: 1554 / 7098)		
	1)	Annealing test (Copper)
	2)	Tensile Test (Aluminum)
	3)	Wrapping Test (Aluminum)
	4)	Resistance test
B) For Armour Wires / Formed Wires (If applicable) (as per sampling plan mentioned in IS: 1554 / 7098)		
	1.	Measurement of Dimensions
	2.	Tensile Tests
	3.	Elongation Test
	4.	Torsion Test For Round wires only
	5.	Wrapping Test
	6.	Resistance Test
	7.	Mass of Zinc coating test For G S wires / Formed wires only
	8.	Uniformity of Zinc coating For G S wires / Formed wires only

	9.	Adhesion test For G S wires / Formed wires only
	10.	Freedom from surface defects
C) For PVC / XLPE insulation & PVC Sheath (as per sampling plan mentioned in IS: 1554 / 7098)		
	1)	Test for thickness
	2)	Tensile strength & Elongation before ageing (for tests after ageing see “D”)
	3)	Hot set test (For XLPE insulation)
D) Following tests will be carried out on completed cables as per IS on each size of each type (PVC / XLPE insulated)		
	1)	Insulation resistance test (Volume resistivity method)
	2)	High voltage test
E) Following tests shall be carried out on only one size of offered lot (comprising of all sizes & types)		
	1)	Thermal stability test on PVC insulation and outer sheath
	2)	Oxygen index test on outer sheath
	3)	Smoke density rating test on outer sheath
	4)	Acid gas generation test on outer sheath
F) Flammability test as per IEC 60332 - Part- 3 (Category- B) on completed cables as per following sampling plan:		
		This test will be carried out using composite sampling i.e. irrespective of size; cables of one particular type (i.e. armoured PVC insulated, unarmoured PVC insulated, armoured XLPE insulated, unarmoured XLPE insulated) will be bunched together, as per calculations in line with the IEC. All sizes of PVC & XLPE insulated, armoured & unarmoured cables shall be covered. For one particular type, cables with OD less than or equal to 30 mm shall be clubbed together in touching formation while cables with OD greater than 30 mm

		shall be clubbed together leaving a gap equal to OD of cable having least diameter. Cable OD shall be taken as nominal overall diameter as per NTPC approved datasheet.
G) Following tests shall be carried on one length of each size of each type (PVC / XLPE insulated) of offered lot:		
	1)	Constructional / dimensional check, surface finish, length measurement, sequence of cores, armour coverage, Gap between two consecutive armour wires / formed wires, Sequential marking, drum / Batch (outer sheath extrusion batch)number marking on sheath
	2)	Measurement of Eccentricity & Ovality

MV (3.3 kV / 6.6. kV / 11 kV / 33 kV) Cables

Attributes / Characteristics / Item / Components / Sub System Assembly	Make, Type & T.C as per relevant standard	Dimension/surface finish	Mechanical properties	Chemical Composition	Spark Test(as applicable)	Electrical properties	Hot Set Test/ Eccentricity &	Lay length & Sequence	Armour coverage, cross over, looseness, gap between two wires	Sequential marking/ Batch marking/ surface finish/ cable length	T.S & elongation before & after ageing on outer sheath & insulation	Thermal stability on outer sheath	Metallic (Cu) Screening (If applicable)	Anti termite coating on wooden drums	Constructional requirements feature as per NTPC specification	Routine & Acceptance Test as per relevant standard & NTPC specification	FRLS Test
Aluminum (IS-8130)	Y	Y	Y	Y		Y											
Semiconducting Compound	Y		Y			Y											
XLPE Compound (IS-7098 Part-II)	Y		Y			Y					Y						
FRLS PVC Compound (IS-5831, ASTM-D2843, IS10810(Part 58) ,IEC-60754 Part-1)	Y		Y								Y	Y					Y
Triple Extrusion & curing /Manufacturing of Core		Y			Y		Y										
Copper Tape	Y	Y	Y			Y											
Polyster tape	Y	Y															
Core Laying								Y									
Armour wire/strip	Y	Y	Y														
Copper tapping	Y	Y											Y				
Inner sheath	Y	Y															
Armouring		Y							Y								
Outer Sheathing		Y								Y							
Power Cable (Finished)								Y	Y	Y	Y	Y			Y	Y	Y
Wooden drum(IS-10418) /Steel Drum		Y												Y	Y		

Notes:
1. This is an indicative list of tests / checks. The manufacturer is to furnish a detailed Quality Plan indicating the practice and procedure along with relevant supporting documents.
2. Make of all major Bought out items will be subject to NTPC approval.

ROUTINE TESTS	**Following routine tests shall be carried out on each drum of finished cables for all types & sizes.**	
1)	Conductor Resistance test	
2)	High voltage test	
3)	Partial discharge test **(for Screened cables only)**	
ACCEPTANCE TESTS	**Following Acceptance tests shall be carried out on each size of each type (voltage rating) of cables, in the offered lot.**	
A) For Conductor (as per sampling plan mentioned in IS: 7098 Part II)		
	1)	Annealing test (Copper)
	2)	Tensile Test (Aluminum)
	3)	Wrapping Test (Aluminum)
	4)	Resistance test
B) For copper tape / Wires (as per sampling plan mentioned in IS: 7098 Part II)		
	1)	Measurement of Dimensions
	2)	Conductivity check
B) For Armour Wires / Formed Wires (If applicable) (as per sampling plan mentioned in IS: 7098 Part II)		
	1.	Measurement of Dimensions
	2.	Tensile Tests
	3.	Elongation Test
	4.	Torsion Test For Round wires only
	5.	Wrapping Test

	6.	Resistance Test
	7.	Mass of Zinc coating test For G S wires / Formed wires only
	8.	Uniformity of Zinc coating For G S wires / Formed wires only
	9.	Adhesion test For G S wires / Formed wires only
	10.	Freedom from surface defects
C) For XLPE insulation & PVC Sheath (as per sampling plan mentioned in IS: 7098 Part II)		
	1)	Test for thickness
	2)	Tensile strength & Elongation before ageing (for tests after ageing see "D")
	3)	Hot set test (For XLPE insulation)

D) Ageing test:

If the compound manufacturer is carrying out Ageing test , test report of compound manufacturer is to be reviewed. If the compound manufacturer is not carrying out ageing test, then cable manufacturer will carry out ageing test & the test report will be reviewed by NTPC (quantum of ageing test sample shall be one sample /batch)

(a) In case of manufacturers / supplier who have supplied cables in the past through Corporate Centre:- Routine Test of manufacturer internal test report are to be verified by NTPC and Main Contractor at the time of final inspection. NTPC and Main Contractor will also witness routine tests on cables on 10% sample basis.

(b) In case of manufacturers / supplier WHO HAVE NOT SUPPLIED cables in the past through Corporate Centre:- Routine Test of manufacturer internal test report are to be verified by NTPC at the time of final inspection. NTPC will witness routine tests on cables for the first order on 10% sample basis and Main Contractor will witness routine tests on cables for the first order on 100% basis.

1. For Smoke Density rating test: if the test result without conditioning is within (-)10% of the maximum specified value, then, retesting is to be carried out with conditioning of samples as per standard and the test results after conditioning shall be final for acceptance/rejection.
2. For Acid Gas Generation test: if the test result without conditioning is within (-)10% of the maximum specified value, then, retesting is to be carried out with conditioning of samples as per standard and the test results after conditioning shall be final for acceptance/rejection.
3. For Oxygen Index test: if the test result without conditioning is within (+)7% of the minimum specified value, then, retesting is to be carried out with conditioning of samples as per standard and the test results after conditioning shall be final for acceptance/rejection.
4. In case the test results without conditioning do not meet the maximum/minimum specified value, the manufacturer may exercise the option of retesting the samples after conditioning as per standard.

E) Following tests will be carried out on completed cables as per IS on each size of each type		
	1)	Insulation resistance test (Volume resistivity method)
	2)	High voltage test
	3)	Partial discharge test (for Screened cables only)
F) Following tests shall be carried out on only one size of offered lot (comprising of all sizes & types)		
	1)	Thermal stability test on outer sheath

	2)	Oxygen index test on outer sheath
	3)	Smoke density rating test on outer sheath
	4)	Acid gas generation test on outer sheath
	5)	Flammability test as per IEC 60332 - Part- 3 (Category- B) on completed cable
G) Following tests shall be carried on one length of each size of each type of offered lot:		
	1)	Constructional / dimensional check, surface finish, length measurement, sequence of cores, armour coverage, Gap between two consecutive armour wires / formed wires, Sequential marking, marking of drum no. / Batch number of outer sheath extrusion
	2)	Measurement of Eccentricity & Ovality

QA TABLE FOR HT SWITCHGEAR

ATTRIBUTES / CHARACTERISTICS → ITEMS, COMPONENTS, SUB-SYSTEM ASSEMBLY ↓	Make, Type, Model, Rating & TC	Electrical Properties	Mechanical properties	Chemical Properties	Dimensions & Finish	Constructional, Functional & Operational Features as per NTPC Spec.	Item to conform to relevant Standards	Pretreatment as per IS 6005	Paint shade, thickness, adhesion & finish	Functional Checks	HV & IR Test	Degree of Protection Routine test as per NTPC spec.	CB Operation timing check	All Routine Tests as per relevant standard
CRCA steel sheet/ Aluzinc*/ Zincalum*/ Galvalum*	Y		Y	Y	Y		Y							
Aluminum Bus bar material (IS : 5082)	Y	Y	Y	Y	Y		Y							
Copper Bus bar material (IS : 613)	Y	Y	Y	Y	Y		Y							
Bus bar Support Insulator	Y	Y	Y		Y		Y				Y			
HT Circuit Breaker (IEC-62271-100)	Y				Y	Y	Y			Y			Y	Y
HT Contactors (IS : 9046 / IEC 60470)	Y				Y	Y	Y			Y				Y
Protection & Auxilliary Relays	Y				Y	Y	Y			Y				Y
HT CT's & PT's (IS : 2705 / 3156)	Y				Y		Y							Y
HT Fuses (IS : 9385)	Y				Y	Y	Y							
Surge Arrester (IEC : 99 –4)	Y				Y		Y							Y
LT Contactors (IS : 13947)	Y				Y	Y	Y			Y				
Control & Selector Switches (IS : 6875)	Y				Y	Y	Y			Y				
Indicating Meters (IS : 1248)	Y				Y	Y	Y			Y				Y
Indicating Lamps (IS : 13947)	Y				Y	Y	Y			Y				
Push Buttons (IS : 4794)	Y				Y	Y	Y			Y				
Control Transformer (IS : 12021)	Y				Y	Y	Y			Y				Y
LT Fuses (IS : 13703)	Y				Y	Y	Y							
Energy Meters (IS : 722)	Y				Y	Y	Y			Y				Y
Transducers (IEC : 60688)	Y				Y	Y	Y			Y				Y
Diodes	Y	Y				Y	Y			Y				
Terminal Blocks	Y	Y				Y	Y							
Synthetic Rubber Gasket (IS : 11149 / 3400)	Y	Y			Y		Y							
Breaker Handling Trolley	Y				Y	Y			Y	Y				
HT Switchgear Panel IEC-62271-200)	Y				Y	Y	Y	Y	Y	Y	Y	Y	Y	Y

Notes:

1. This is an indicative list of tests / checks. The manufacturer is to furnish a detailed Quality Plan indicating the practice and procedure along with relevant supporting documents.
2. Make of all major Bought Out Items will be subject to NTPC approval.
3. Temperature rise test reports for diode plates with actual heat sink will be verified.

*. CRCA Galvanized steel with metal coating composed of Al (55%), Zn (43.4%) & Si (1.6%),

SQE _10

LT SWITCHGEAR

(MCC, PCC, ACDB, DCDB, FUSE BOARDS, LOCAL PUSH BUTTON STATION, LOCAL MOTOR STARTERS)

ATTRIBUTES / CHARACTERIS-TICS → **ITEMS/ COMPONENTS/ SUB SYSTEM ASSEMBLIY ↓**	Make, Model, Type, Rating & TC	Dimensions & Finish	Electrical properties	Mechanical Properties	Chemical properties	Functional & Operational Features as per NTPC Spec.	Item to conform to relevant Standards	Pretreatment as per IS 6005	Paint Shade, Adhesion, Thickness & Finish	Functional Checks	Milli-volt drop Test	IR – HV – IR Test	Degree of Protection Routine test as per NTPC spec	All Routine tests as per NTPC spec. & IS
Sheet Steel (IS : 513)	Y	Y		Y	Y		Y							
Aluminum Bus bar Material (IS : 5082)	Y	Y	Y	Y	Y		Y							
Copper Bus bar Material (IS : 613)	Y	Y	Y	Y	Y		Y							
Support Insulator	Y	Y	Y	Y			Y							
Air Circuit Breaker (IS: 13947)	Y	Y				Y	Y			Y	Y			Y
Energy Meters (IS : 13010, 13779)	Y	Y				Y	Y			Y				Y
Power & Aux. Contactors (IS : 13947)	Y	Y				Y	Y			Y				
Protection & Aux. Relays (IS : 3231) (IEC 60255 / IEC 61850)	Y	Y				Y	Y			Y				Y
Control & Selector Switches (IS : 13947)	Y	Y				Y	Y			Y				
CT's & PT's (IS 2705 / 3156)	Y	Y					Y							Y
MCCB (IS : 13947)	Y	Y					Y			Y				
Indicating Meters (IS : 1248)	Y	Y				Y	Y			Y				Y
Indicating Lamps (IS : 13947)	Y	Y				Y	Y			Y				
Air Break Switches (IS : 13947)	Y	Y				Y	Y			Y				
Control Terminal Blocks	Y	Y				Y	Y							

LT SWITCHGEAR

(MCC, PCC, ACDB, DCDB, FUSE BOARDS, LOCAL PUSH BUTTON STATION, LOCAL MOTOR STARTERS)

ATTRIBUTES / CHARACTERIS-TICS → **ITEMS/ COMPONENTS/ SUB SYSTEM ASSEMBLIY ↓**	Make, Model, Type, Rating & TC	Dimensions & Finish	Electrical properties	Mechanical Properties	Chemical properties	Functional & Operational Features as per NTPC Spec.	Item to conform to relevant Standards	Pretreatment as per IS 6005	Paint Shade, Adhesion, Thickness & Finish	Functional Checks	Milli-volt drop Test	IR – HV – IR Test	Degree of Protection Routine test as per NTPC spec	All Routine tests as per NTPC spec. & IS
Fuse (IS 13703)	Y	Y				Y	Y							
Control Transformer (IS : 12021)	Y	Y				Y	Y			Y				Y
Push Buttons (IS : 4794)	Y	Y				Y	Y			Y				
Transducer (IEC : 60688)	Y	Y				Y	Y			Y				Y
MCB (IS : 8828)	Y	Y				Y	Y			Y				
Breaker Handling Trolley	Y	Y				Y			Y	Y				Y
Synthetic Rubber Gasket (IS : 11149)	Y	Y		Y	Y		Y							
LT SWITCHGEAR (IS : 8623)	Y	Y				Y	Y	Y	Y	Y		Y	Y	Y

Notes:

1. This is an indicative list of tests / checks. The manufacturer is to furnish a detailed Quality Plan indicating the practice and procedure along with relevant supporting documents.
2. Makes of all major Bought Out Items will be subject to NTPC approval.

LT BUSDUCT															
ATTRIBUTES , CHARACTERISTICS → / ITEM, COMPONENTS, SUB SYSTEM ASSEMBLY ↓	Dimension & Surface Finish	Make, Type, Rating & TC	Electrical Properties	Mechanical Properties	Chemical Properties	Item to conform to relevant IS	WPS Approval, Welder Qualification	Weld Quality Check (DP test & x-ray Test)	Paint Shade, Thickness, Adhesion & Finish	Tightness by Torque measurement	Electrical Clearances	Galvanizing Test as per IS 2629/ 2633/ 4759	IR – HV – IR Test	Phase Sequence Check	Degree of Protection routine test as per NTPC spec.
Aluminum Sheets / Plates / Strips / Flexibles / tubes (IS : 5082 / 737)	Y	Y		Y	Y	Y	Y	Y							
CRCA Flats / ISMC (IS 2062)	Y	Y		Y	Y	Y									
Neoprene / Synthetic Rubber Gaskets (IS 11149 / 3400)	Y	Y		Y	Y										
Rubber Bellows (IS : 3400)	Y	Y		Y	Y										
Support Insulator (BS : 2782, IEC : 660, IS : 10912)	Y	Y	Y	Y											
Galvanized Structure & GI Earthing Flat (IS : 2629 / 2633 / 4749)	Y	Y				Y						Y			
Space Heater & Thermostat		Y	Y										Y		
LT Busduct (IS : 8623 PART 2)	Y	Y				Y	Y	Y	Y	Y	Y		Y	Y	Y

Notes:

1. This is an indicative list of tests / checks. The manufacturer is to furnish a detailed Quality Plan indicating the practice and procedure along with relevant supporting documents.
2. Makes of all major Bought Out Items will be subject to NTPC approval.

MOTOR

TESTS/CHECKS / TEMS/COMPONENTS	Visual	Dimensional	Make/Type/Rating /General Physical Inspection	Mech/Chem. Properties	NDT /DP/MPI/UT	Metallography	Electrical Characteristics	Welding/Brazing(WPS/PQR)	Heat Treatment	Magnetic Characteristics	Hydraulic/Leak/Pressure Test	Thermal Characteristics	Run out	Dynamic Balancing	Routine & Acceptance tests as per IS-325/IS-4722 /IS- 9283/IS 2148/IEC60034\IEC 60079-I/ IS-12615	vibration	Over speed	Tan delta, shaft voltage & polarization index test	Paint shade, thickness & adhesion
Plates for stator frame, end shield, spider etc.	Y	Y	Y	Y	Y				Y										
Shaft	Y	Y	Y	Y	Y	Y			Y										
Magnetic Material	Y	Y	Y	Y			Y			Y		Y							
Rotor Copper/Aluminium	Y	Y	Y	Y			Y		Y										
Stator copper	Y	Y	Y	Y			Y		Y			Y							
SC Ring	Y	Y	Y	Y	Y		Y	Y	Y										
Insulating Material	Y		Y	Y			Y					Y							
Tubes, for Cooler	Y	Y	Y	Y	Y				Y		Y								
Sleeve Bearing	Y	Y	Y	Y	Y				Y		Y								
Stator/Rotor, Exciter Coils	Y	Y	Y				Y	Y											
Castings, stator frame, terminal box and bearing housing etc.	Y	Y	Y	Y	Y			Y											
Fabrication & machining of stator, rotor, terminal box	Y	Y			Y			Y	Y										
Wound stator	Y	Y					Y	Y											
Wound Exciter	Y	Y					Y	Y											
Rotor complete	Y	Y					Y						Y	Y					
Exciter, Stator, Rotor, Terminal Box assembly	Y	Y					Y												

Accessories, RTD, BTD,CT, Space heater, antifriction bearing, gaskets etc.	Y	Y	Y																
Complete Motor	Y	Y	Y												Y	Y	Y	Y1	Y

Note: 1. This is an indicative list of tests/checks. The manufacture is to furnish a detailed Quality Plan indicating the practices & Procedure followed along with relevant supporting documents during QP finalization. However, following methodology to be followed for Inspection Categorisation:

a) Up to 50 KW: Cat-III: Acceptance of Motor up to 50 KW is based on COC of the manufacturer & the Main Contractor confirming NTPC's technical specifications.

b.i) Above 50 KW and up to 75KW: Cat-III : For manufacturers who have already supplied this range of motors to NTPC which have been commissioned and no adverse feedbac reported from RIO/project-site AND for skid mounted motor supplied with the driven equipment. Acceptance based on review of Routine Test Inspection report as per IS-325 COC of the Manufacturer and Main Contractor confirming NTPC's technical specifications.

b.ii) Above 50 KW and up to 75KW: Cat-I: For Other Manufacturers, as per NTPC approved Quality Plan

c) Above 75 KW: Cat-I: as per NTPC approved Quality Plan

2. Additional routine tests for Flame proof motors shall be applicable as per relevant standard
3. Makes of major bought out items for HT motors will be subject to NTPC approval.
4. Y1 = for HT Motor / Machines only.

VFD MODULE SQE_28				
ATTRIBUTES / CHARACTERISTICS / **ITEMS/COMPONENTS, SUB SYSTEM ASSEMBLY**	Visual & Dimensional checks	Make / Type / Rating etc.	Final Inspection as ISS / IEC	Remarks
HT Breaker (IEC 56)	Y	Y	Y	
DC Reactor	Y	Y		For details refer table for DC Reactor
Transformer	Y	Y		For details refer table for Transformer
Motor	Y	Y		For details refer separate table for Motor
VFD Panel	Y	Y		For details refer table for VFD

Note : 1) This is an indicative list of tests/checks. The manufacture is to furnish a detailed Quality Plan indicating the practices & Procedure followed alongwith relevant supporting documents during QP finalisation.

2) Make of all major Bought Out Items will be subject to NTPC approval.

DC REACTOR

ATTRIBUTES / CHARACTERISTICS / ITEMS/COMPONENTS, SUB SYSTEM ASSEMBLY	Visual	Dimensional	Mech. & Chem. Property	Electrical Characteristics	Pretreatment by Seven Tank	Painting by Stove Enameling	Final Inspection as per IS-2026	Welding/NDT
Winding Material (Aluminium)	Y	Y	Y	Y				
Insulation Material	Y	Y		Y				
Sheet Steel	Y	Y	Y					
Winding	Y	Y		Y				
Fabrication of Enclosures	Y	Y			Y	Y		Y
Assembly	Y	Y						
Routine Tests	Y	Y					Y	

Note : 1) This is an indicative list of tests/checks. The manufacturer to furnish a detailed Quality Plan indicating their practice & procedure along with relevant supporting documents during QP finalisation for all items.

2) All major Bought Out Items will be subject to NTPC approval.

TRANSFORMER (OIL FILLED)

Attributes / Characteristics / Items/Components Sub Systems	Visual & Dimensional Checks	Mechanical properties	Electrical strength	Thermal properties	Chemical Composition	Compatibility with oil	NDT / DPT / MPI / UT	Ageing Test.	Voltage Ratio, Vector Group & Polarity, Magnetic Balance Test	Make / Type / Rating / Model / TC / General Physical Inspection.	WPS & PQR	Routine Test as per relevant test	Routine Test
Tank, H.V. & L.V. Cable Box / Flange throat	Y	Y					Y						
Conservator / Radiator / Cooler / Pipes	Y	Y					Y						
Copper Conductor (IS:191)	Y	Y	Y		Y								
Insulating Material	Y	Y	Y	Y	Y	Y							
CRGO Lamination & Built Core	Y	Y	Y		Y	Y							
Bushing / Insulator (IS:2544 / 5621)	Y	Y								Y		Y	
Gasket	Y				Y	Y		Y				Y	
Transformer Oil (IS:335 / IEC296)												Y	
Off-Circuit Tap Changer	Y									Y			
Core Coil Assembly & Pre-tanking	Y								Y				
Marshalling Box	Y	Y					Y					Y	
WTI, OTI, MOG, PRD, Breather, Terminal Connector, Bucholz Relay, Globe & Gate Valve,	Y									Y			
Welding (ASME Sect-IX)	Y										Y		
Complete Transformer (IS:2026/ IEC-60076)	Y												Y

Note: 1) This is an indicative list of tests / checks. The manufacturer is to furnish a detailed Quality Plan indicating the practice and procedure along with relevant supporting documents.
2) All major Bought Out Items will be subject to NTPC approval.

DRY TYPE TRANSFORMER

Attributes / Characteristics Items/Components Sub Systems	Visual & Dimensional check	Mechanical properties	Electrical strength	Thermal Properties	Chemical Properties	NDT / DP / MPI	Voltage Ratio, Vector Group & Polarity	Make / Type / Rating / Model /TC / General Physical Inspection	WPS & PQR	Routine Test as per relevant standard	Measurement of capacitance & tan delta between winding	Routine Test
Enclosure door, H.V. & L.V. Cable Box / Flange Throat	Y	Y						Y				
Copper Conductor	Y	Y	Y		Y							
Insulating Material	Y			Y	Y							
CRGO Lamination & Built Core	Y											
Bushing /Insulator (IS:2544 / 5621)	Y							Y		Y		
Gasket	Y							Y		Y		
Off-Circuit Tap Changer	Y							Y				
Core Coil Assembly	Y						Y					
Marshalling Box	Y									Y		
WTI, Thermister, Terminal Connector	Y							Y				
Welding									Y			
Complete Transformer (IS:11171 / IEC 60076)	Y										Y	Y

Notes: 1) This is an indicative List of test/checks. The manufacturer is to furnish a detailed Quality Plan indicating his practice and procedure along with relevant supporting documents during QP finalization for all item.

2) All major Bought out Items will be subject to NTPC approval.

VFD PANEL

Attributes Characteristics **Item Components Sub System Assembly**	Electrical Properties	Mechanical Properties	Chemical Properties	Dimensions / Finish	Type/ Rating/Functional check	HV/IR	Routine test as per relevant std.	Constructional Features	IS:6005 ,Seven tank process	Paint finish/ shade/thickness adhesion	Mountings / BOM/ Make, Completeness / Wiring	Interlock Functional & Operation Testing / Simulation check	Degree of Protection Test	Final testing as per Relevant IS/IEC
Sheet Steel (IS-513)		Y	Y	Y										
Aluminum / Copper Bus-bar(IS-5082/IS-613/IS-1987)	Y	Y	Y	Y										
Support Insulator (BS-2782/IEC-660/IS-10912)	Y	Y	Y	Y										
Control / Selector Switch(IS-6875)					Y	Y	Y							
Contactor/ MCB(IS-13947)					Y	Y	Y							
O/L Protection relays(IS-3231)					Y		Y							
C.T /V.T/ Indicating Meter(IS-2705/3156/1248)					Y	Y	Y							
Fuse/ Fuse carrier(IS-13703)					Y	Y	Y							
Terminals/lugs/pvc wires(IS-13947//IS-694)	Y			Y	Y	Y	Y							
Timers(IS-3231)					Y	Y	Y							
Push Button/ Lamp/ (IS-6875)					Y	Y	Y							
Control Transformer (IS-12021)					Y	Y	Y							
Mimic, Annunciater					Y		Y							
GASKET(IS-11149)		Y	Y	Y	Y		Y							
Fabrication								Y						
Pretreatment & Painting									Y	Y				
VFD panel										Y	Y	Y	Y	Y

NOTE:

1. This is an indicative list of Test/ Checks. The manufacturer to furnish a detailed Quality Plan indicating the practice and procedure along with relevant supporting documents.
2. All major Bought Out Items will be subject to NTPC approval.

AUXILIARY / LT TRANSFORMER

Attributes / Characteristics Items/Components Sub Systems	Visual & Dimensional Checks	Mechanical properties	Electrical strength	Thermal properties	Chemical Composition	Compatibility with oil	NDT / DPT / MPI / UT	Ageing Test.	Voltage Ratio, Vector Group & Polarity, Magnetic Balance Test	Make / Type / Rating / Model / TC / General Physical Inspection.	Functional check	WPS & PQR	Routine Test as per relevant standard / NTPC Specification
Tank, H.V. & L.V. Cable Box / Flange throat	Y	Y					Y					Y	
Conservator / Radiator / Cooler / Pipes	Y	Y					Y						
Copper Conductor (IS:191)	Y	Y	Y		Y								
Insulating Material	Y	Y	Y	Y	Y	Y							
CRGO Lamination & Built Core	Y	Y	Y		Y	Y				Y			
Bushing / Insulator (IS:2544 / 5621)	Y	Y								Y			Y
Gasket	Y	Y			Y	Y		Y		Y			Y
Transformer Oil (IEC296)			Y										Y
OLTC / Off-Circuit Tap Changer	Y									Y			Y
Core Coil Assembly & Pre-tanking	Y								Y	Y			
Marshalling Box	Y									Y	Y		Y
WTI, OTI, MOG, PRD, Breather, Terminal Connector, Bucholz Relay, Valves	Y									Y	Y		
Welding (ASME Sect-IX)	Y						Y					Y	
Complete Transformer (IS:2026/ IEC-60076)	Y												Y

Note: 1) This is an indicative list of tests / checks. The manufacturer is to furnish a detailed Quality Plan indicating the practice and procedure along with relevant supporting documents.

2) All major Bought Out Items will be subject to NTPC approval.

AUXILIARY / LT TRANSFORMER

Attributes / Characteristics Items/Components Sub Systems	Visual & Dimensional Checks	Mechanical properties	Electrical strength	Thermal properties	Chemical Composition	Compatibility with oil	NDT / DPT / MPI / UT	Ageing Test.	Voltage Ratio, Vector Group & Polarity, Magnetic Balance Test	Make / Type / Rating / Model / TC / General Physical Inspection.	Functional check	WPS & PQR	Routine Test as per relevant standard / NTPC Specification
Tank, H.V. & L.V. Cable Box / Flange throat	Y	Y					Y					Y	
Conservator / Radiator / Cooler / Pipes	Y	Y					Y						
Copper Conductor (IS:191)	Y	Y	Y		Y								
Insulating Material	Y	Y	Y	Y	Y	Y							
CRGO Lamination & Built Core	Y	Y	Y		Y	Y				Y			
Bushing / Insulator (IS:2544 / 5621)	Y	Y								Y			Y
Gasket	Y	Y			Y	Y		Y		Y			Y
Transformer Oil (IEC296)			Y										Y
OLTC / Off-Circuit Tap Changer	Y									Y			Y
Core Coil Assembly & Pre-tanking	Y								Y	Y			
Marshalling Box	Y									Y	Y		Y
WTI, OTI, MOG, PRD, Breather, Terminal Connector, Bucholz Relay, Valves	Y									Y	Y		
Welding (ASME Sect-IX)	Y						Y					Y	
Complete Transformer (IS:2026/ IEC-60076)	Y												Y

Note: 1) This is an indicative list of tests / checks. The manufacturer is to furnish a detailed Quality Plan indicating the practice and procedure along with relevant supporting documents.

2) All major Bought Out Items will be subject to NTPC approval.

LT INDOOR TRANSFORMER (DRY TYPE TRANSFORMER)

Attributes / Characteristics / Items/Components Sub Systems	Visual & Dimensional check	Mechanical properties	Electrical strength	Thermal Properties	Chemical Properties	NDT / DP / MPI	Voltage Ratio, Vector Group & Polarity	Make / Type / Rating / Model /TC / General Physical Inspection	Routine Test as per relevant standard / NTPC Specification
Enclosure door, H.V. & L.V. Cable Box / Flange Throat	Y	Y						Y	
Copper Conductor	Y	Y	Y		Y				
Insulating Material	Y			Y	Y				
CRGO Lamination & Built Core	Y							Y	
Porcelain Bushing /Insulator (IS:2544 / 5621)	Y	Y	Y					Y	Y
Gasket (IS 2712)	Y	Y						Y	Y
Off-Circuit Tap Changer	Y							Y	Y
Core Coil Assembly	Y						Y		
Marshalling Box	Y								Y
WTI, Thermistor, Terminal Connector	Y							Y	
Complete Transformer (IS:11171 / IEC 60076)	Y								Y

Notes: 1) This is an indicative List of test/checks. The manufacturer is to furnish a detailed Quality Plan indicating his practice and procedure along with relevant supporting documents during QP finalisation for all item.
2) All major Bought out Items will be subject to NTPC approval.

LT INDOOR TRANSFORMER (DRY TYPE TRANSFORMER)

Attributes / Characteristics / Items/Components Sub Systems	Visual & Dimensional check	Mechanical properties	Electrical strength	Thermal Properties	Chemical Properties	NDT / DP / MPI	Voltage Ratio, Vector Group & Polarity	Make / Type / Rating / Model /TC / General Physical Inspection	Routine Test as per relevant standard / NTPC Specification
Enclosure door, H.V. & L.V. Cable Box / Flange Throat	Y	Y						Y	
Copper Conductor	Y	Y	Y		Y				
Insulating Material	Y			Y	Y				
CRGO Lamination & Built Core	Y							Y	
Porcelain Bushing /Insulator (IS:2544 / 5621)	Y	Y	Y					Y	Y
Gasket (IS 2712)	Y	Y						Y	Y
Off-Circuit Tap Changer	Y							Y	Y
Core Coil Assembly	Y						Y		
Marshalling Box	Y								Y
WTI, Thermistor, Terminal Connector	Y							Y	
Complete Transformer (IS:11171 / IEC 60076)	Y								Y

Notes: 1) This is an indicative List of test/checks. The manufacturer is to furnish a detailed Quality Plan indicating his practice and procedure along with relevant supporting documents during QP finalisation for all item.
2) All major Bought out Items will be subject to NTPC approval.

CONTROL PANEL SQE_25

Attributes Characteristics / Item Components Sub System Assembly	Electrical Properties	Mechanical Properties	Chemical Properties	Dimensions / Finish	Type/ Rating/Functional check	HV/IR	Routine test as per relevant std.	Constructional Features	IS:6005 ,Seven tank process	Paint finish/ shade/thickness adhesion	Mountings / BOM/ Make, Completeness / Wiring	Interlock Functional & Operation Testing / Simulation check	Degree of Protection Test	Specification requirement
Sheet Steel (IS-513)		Y	Y	Y										
Aluminum / Copper Bus-bar(IS-5082/IS-613/IS-1987)	Y	Y	Y	Y										
Support Insulator (BS-2782/IEC-660/IS-10912)	Y	Y	Y	Y										
Control / Selector Switch(IS-6875)					Y	Y	Y							
Contractor/ MCB(IS-13947)					Y	Y	Y							
O/L Protection relays(IS-3231)					Y		Y							
C.T /V.T/ Indicating Meter(IS-2705/3156/1248)					Y	Y	Y							
Fuse/ Fuse carrier(IS-13703)					Y	Y	Y							
Terminals/lugs/pvc wires(IS-13947//IS-694)	Y			Y	Y	Y	Y							
Timers(IS-3231)					Y	Y	Y							
LVS, Mosaics														Y
Push Button/ Lamp/ (IS-6875)					Y	Y	Y							
Control Transformer (IS-12021)					Y	Y	Y							
Mimic, Annunciater					Y		Y							
GASKET(IS-11149)		Y	Y	Y	Y		Y							
Fabrication								Y						
Pretreatment & Painting									Y	Y				
Control panel										Y	Y	Y	Y	Y

NOTE:

1. This is an indicative list of Test/ Checks. The manufacturer to furnish a detailed Quality Plan indicating the practice and procedure along with relevant supporting documents.
2. All major Bought Out Items will be subject to NTPC approval.

STATION LIGHTING

Item Components / Sub System / Assembly — Attributes / Characteristics	Make, Type , Rating/ TC	Dimension	Pre-Treatment of sheat	Paint Shade Thickness Adhesion & Finish	Galvanization Tests	IP Test	Bought Out Items/ Bill of Material	HV & IR	Functional Check as per spec.	Constructional Feature as per NTPC spec.	Routine Test as per relevant std and spec	Acceptance Test as per relevant std and spec	Item to conform to relevant standard
Luminaries (IS-10322 Part-5 Sec.1 (non –LED type)	Y					Y		Y			Y	Y	Y
Electronic Ballast	Y										Y	Y	Y
Lighting Wire (IS-694)	Y										Y		
Fans (IS-374)	Y										Y		
Pole (IS-2713)	Y			Y						Y	Y	Y	
Lamps (IS-9800, IS-9974)	Y										Y	Y	
Lighting Mast (with raise & lower lantern type)	Y	Y			Y					Y	Y	Y	
Wall Mounted Lighting Panel (IS-513, IS-5)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	
Switch Box/ Junction Box/Receptacles/ Local Push Button Station / Lighting Panel (IS-513, 2629, 2633, 4759, 6745)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	
Cable Gland (BS-6121)	Y	Y									Y		
Cable Lug (IS-8309)	Y	Y									Y		
Flexible Conduit	Y										Y		
Lighting Transformer (IS-11171)	Y									Y	Y		
Epoxy & Galvanised Conduit (IS-9537, 2629, 2633, 4759, 6745)	Y	Y									Y		Y

LED Luminaire quality requirements:

1) **LED modules to conform to IS: 16103 part 2.**
2) **Control gear to conform to IS 15885 part 2 section 13. Manufacturer to issue a certificate of compliance for the same.**
3) **LED modules batch test reports as per IS 16103 part 2, to be verified at the time of final inspection.**
4) **LED luminaire to conform to IS 16107 part 2 section 1.**
5) **LED luminaire marking to be as per IS 16107 part 2 section 1.**
6) **Acceptance tests as per IS 16107 part 2 section 1 to be carried out on LED luminaire except long duration tests i.e. a) Chromaticity coordinates & correlated color temperature (CCT); b) Color rendering index (CRI). Manufacturer will submit a COC for above tests i.e. CCT & CRI**
7) **LED driver make, model, type & rating may be as per recommendations of LED module manufacturer**.

Notes:

1. This is an indicative list of tests / checks. The manufacturer is to furnish a detailed Quality Plan indicating the practice and procedure along with relevant supporting documents.
2. Make of all major Bought Out Items will be subject to NTPC approval.

Passenger/ Service Elevators (GEAR TYPE)

TEST/CHECK / ITEM	Material Test	DPI/MPI	Ultrasonic Test	Dimensions/Physical	Functional/ Operational Test/ Run Test	Performance Test	Other Tests	All routine tests as per applicable standard	Plain shade, thickness & adhesion	Assembly/fit up
Shaft/ Rack/Gears	Y	Y	Y	Y						
Plates	Y			Y						
Wire rope				Y			Y5			
Safety device								Y		
Geared Machine					Y					
VVVF Drive					Y		Y3	Y		
Power, Control & Trailing Cables								Y4		
Control Panel				Y					Y	
ARD System					Y			Y		
Electrical motor								Y		
Complete Elevator				Y	Y	Y1	Y2			Y

Y1 –TEST TO BE DONE AT SITE

Y2 - LOAD/OVERLOAD TEST TO BE DONE AT SITE AS APPLICABLE.

Y3 – Burn in test on electronic card

Y4 – Routine tests including FRLS tests as per Tech. Spec.

Y5- Test report as per relevant std.

NOTE: 1. This is an indicative list of tests/checks. The manufacturer is to furnish a detailed quality plan indicating the applicable practices and procedures followed along with relevant supporting documents during QAP finalization.

2. Makes of all bought out items shall be subject to NTPC approval

SWITCHYARD **SQE_20**

Attributes / Characteristics Items/Components Sub Systems	Make, model, Type & Rating, Test Certificate	Routine & Acceptance Test as per IS / IEC	Functional requirements as per NTPC Specification
765 kV GIS (IEC:62271-203)	Y	Y	Y
400 kV GIS (IEC:62271-203)	Y	Y	Y
220 kV GIS (IEC:62271-203)	Y	Y	Y
132 kV GIS (IEC:62271-203)	Y	Y	Y
Circuit Breaker (IEC:62271-100)	Y	Y	Y
Isolator (IEC:62271-102)	Y	Y	Y
Current Transformer (IEC:60044/BS:3938/IS2705/ IEC: 61869)	Y	Y	Y
Capacitor Voltage Transformer (IEC:186A / 358/IS3156/IEC60044/ IEC: 61869)	Y	Y	Y
Potential transformer (IEC 60044 / IS3156)			
Surge Arrestor (AIS) (IEC:99-4/IS:3070)	Y	Y	Y
Wave Trap (IEC:353 / IS:8792 / 8793)	Y	Y	Y
Sub Station Automation system (IEC 61850)	Y	Y	Y
Protection Relays	Y	Y	Y
Energy meter	Y	Y	Y
Bus Post Insulator (IEC:168 / 815 / IS:2544)	Y	Y	Y
Disc, Pin & String Insulator (IEC:383 / IS:731)	Y	Y	Y
Aluminium Tube (IS:5082 / 2673 / 2678)	Y	Y	Y
Conductor (IS:398)	Y	Y	Y
Hardware fittings for Insulator (IS:2486 / BS:3288)	Y	Y	Y
Hollow insulator (IEC:233/ IS:5621)	Y	Y	Y
Spacers, Clamps & Connector (IS:10162 / 5561/ 617)	Y	Y	Y
Galvanised Steel Structures (IS:2062/2629/4759/6745)	Y	Y	Y
Vibration Damper (IS:9708)	Y	Y	Y

Attributes / Characteristics Items/Components Sub Systems	Make, Type Rating, and Model, Test Certificates	Routine & Acceptance Test as per relevant IS/IEC	Functional requirements as per NTPC Specification
Sag Compensating Spring DIN:2089/2096 IS:3195 / 7906	Y	Y	Y
Long rod Insulator	Y	Y	Y
SF6 Gas filling & evacuating plant	Y	Y	Y
SF6 Gas Leak Detector	Y	Y	Y
Leakage Current Analyser	Y	Y	Y
Nitrogen Gas Filling Device	Y	Y	Y
Event Logger	Y	Y	Y
Operation Analyser	Y	Y	Y
Disturbance Recorder	Y	Y	Y
Synchronising Trolly	Y	Y	Y
Relay Test Kit	Y	Y	Y

Notes : 1) This is an indicative list of test/checks. The manufacture is to furnish a detailed Quality Plan indicating the practice and procedure along with relevant supporting documents during QP finalisation for all items.

2) All major Bought Out Items will be subject to NTPC approval.

MEASURING INSTRUMENTS (PRIMARY AND SECONDARY) Page- 1/2

ITEMS \ TESTS	Dimensions (R)	Make, Model, Type, Rating (R)	Process / Electrical connection (R)	Calibration (R)	Test as per standard(R)	Insulation Resistance (R)	IBR Certification (if applicable)(R)	Hydro Test(R)	Material Test certificate (R)	Degree of Protection	Complete Function Test
1. PR Gauge (IS-3624)	Y	Y	Y	Y	Y				Y		
2. Pr./D.P.Switch(BS-6134)	Y	Y	Y	Y	Y	Y				Y	
3. Electronic Transmitter(Pr / DP and DP Based Flow/ Level) (IEC-60770)	Y	Y	Y	Y	Y	Y				Y	
4. Temp. Gauge (BS-5235)	Y	Y	Y	Y	Y				Y		
5. Temp. Switch	Y	Y	Y	Y	Y	Y				Y	
6. Thermocouples (IEC – 60584 / ANSI-MC-96.1/IS-12579)	Y	Y	Y	Y	Y	Y				Y	
7. RTD(IEC-60751)	Y	Y	Y	Y	Y	Y				Y	
8. Thermowell (ASME 19.3)	Y		Y				Y	Y	Y		
9. Temp Transmitter	Y	Y	Y	Y	Y	Y				Y	
10. Level Transmitter(UT/ GWR)	Y	Y	Y	Y		Y				Y	
11. Level Transmitter(3D/ Strain Gauge)	Y	Y	Y			Y				Y	Y
12. Level Switch (Float/Displacer/ Capacitance/RF)	Y	Y	Y	Y	Y		Y	Y	Y	Y	
13. Electrical Metering Instrument (IS-1248)	Y	Y	Y	Y	Y	Y				Y	
14. Transducer (IEC-60688)	Y	Y	Y	Y	Y	Y				Y	
R-Routine Test A- Acceptance Test Y – Test applicable											
: Note: **1)** This is an indicative list of tests/checks. The manufacturer is to furnish a detailed quality plan indicating the Practices and Procedure adopted along with relevant supporting documents.											

MEASURING INSTRUMENTS (PRIMARY AND SECONDARY) Page- 2/2

TESTS / ITEMS	Dimensions (R)	Make, Model, Type, Rating (R)	Process / Electrical connection (R)	Calibration (R)	Test as per standard (R)	WPS approval (A)	Non-destructive testing (R)	Insulation Resistance (R)	IBR Certification as applicable (R)	Hydro test (R)	Material test certificate (A)	Complete Function test
15. Conductivity Type Level Switches (Electrodes /Pressure Vessels /Valves)	Y	Y	Y				Y	Y	Y	Y	Y	Y
16. Flow Switch	Y	Y	Y	Y								Y
17. Orifice plate(ASME PTC 19.5/BS-1042/EN 5167)	Y	Y	Y	Y #	Y		Y		Y	Y **	Y	
18. Flow nozzle(ASME PTC 19.5/BS-1042/EN 5167)	Y	Y	Y	Y #	Y	Y	Y		Y	Y	Y	
19. Impact head type element	Y	Y	Y								Y	
20.Flow Transmitter(Coriolis/ Positive displacement /Electromagnetic /Ultrasonic)	Y	Y	Y	Y				Y		Y **		
21.Densitiy Meter	Y	Y	Y	Y								
22. Wet Analyzers	Y	Y	Y	Y								
23. Gas Analyzers	Y	Y	Y	Y								
24. Sample Handling System for analyzers (If Applicable)	Y	Y				Y	Y		Y	Y	Y	Y

R-Routine Test A- Acceptance Test Y – Test applicable

Note: 1) This is an indicative list of tests/checks. The manufacturer is to furnish a detailed quality plan indicating the Practices and Procedure adopted along with relevant supporting documents.

- Wet Calibration to be carried out on one flow element of each type and size if calibration carried out as type test same shall not be repeated.

** If Applicable

PROCESS, CONNECTION & PIPING FOR C&I SYSTEMS

ITEMS \ TESTS	Visual (R)	GA, BOM, Layout of component & construction feature(R)	Dimension (R)	Paint Shade/thickness (R)	Flattening, flaring, hydro test, hardness check as per ASTM	Component Ratings (R)	Wiring (R)	Make, Model, Type, Rating(R)	IR & HV (R)	Review of TC for instrument/devices (R)	Accessibility of TBs/Devices (R)	Illumination, grounding (R)	Tubing (R)	Leak/Hydro test(A)	Chemical/physical properties of material (A)	Proof pressure test, Dismantling & reassembly test,Hydrulic impulse and vibration test (R)	Tests as per standards & specification
LOCAL INSTRUMENT ENCLOSURE	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y	Y	Y			
LOCAL INSTRUMENTS RACKS	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y	Y	Y			
JUNCTION BOX	Y	Y	Y	Y *		Y		Y	Y								
GAUGE BOARD	Y	Y	Y	Y		Y		Y		Y			Y	Y			
IMPULSE PIPES AND TUBES	Y		Y		Y			Y							Y		
SOCKET WELD FITTINGS ANSI B-16.11	Y		Y					Y							Y		Y
COMPRESSION FITTINGS	Y		Y					Y						Y	Y	Y	
INSTRUMENT VALVES & VALVE MANIFOLDS	Y		Y					Y						Y	Y		
COPPER TUBING ASTM B75	Y							Y									Y

*-applicable for painted junction boxes.

Note: R-Routine Test A- Acceptance Test Y – Test applicable

Note: This is an indicative list of tests/checks. The manufacturer is to furnish a detailed quality plan indicating the Practices and Procedure adopted along with relevant supporting documents.

INSTRUMENTATION CABLE

ITEMS \ TESTS	Conductor Resistance (R) & (A)	High Voltage (R) & (A)	Insulation Resistance (R) & (A)	Constructional detail, dimensions (A)	Outer-Sheathe/core marking, end sealing (A)	Thermal Stability (A) +	Visual, Surface finish (A) +	Electrical Parameters ** (A) +	Persulphate Test (A) +	Overall/Coverage/Continuity (A)	Swedish chimney Test (SS-4241475) (A) ++	FRLS Test * (A) ++	Tensile & Elongation before & after aging (A) ++	Vol. Resistivity.at room & Elevated Temp. (A) ++	Spark test report review (R)
1. Instrument cable twisted and shielded															
Conductor(IS-8130)	Y			Y			Y								
Insulation(VDE-207)				Y	Y	Y	Y						Y		Y
Pairing/Twisting				Y	Y		Y								
Shielding				Y			Y			Y					
Drain wire	Y			Y			Y		Y	Y					
Inner Sheath				Y	Y	Y	Y					Y	Y		
Outer Sheath				Y	Y	Y	Y					Y	Y		
Over all cable	Y	Y	Y	Y	Y		Y	Y			Y			Y	
Cable Drums(IS-10418)				Y			Y								

Note: High Temp. cables shall be subjected to tests as per VDE-207(Part-6) Compensating cables shall be checked for Thermal EMF/Endurance test as per IS 8784.

Note: This is an indicative list of tests/checks. The manufacture is to furnish a detailed Quality Plan indicating his practice & Procedure along with relevant supporting documents during QP finalization for all items.

Note : (R) - Routine Test A - Acceptance Test Y - Test Applicable

Note : Sampling Plan for Acceptance test shall be as per IS 8784 (As applicable)

- * FRLS Tests: Oxygen / Temp Index (ASTM D-2863), Smoke Density Rating (ASTM – D 2843), HCL Emission (IEC-754-1)
- ** Characteristic Impedance, Attenuation, Mutual Capacitance, Cross Talk (As applicable)

\+ Sample size will be One No. of each size/type per lot.

++ Sample size will be One No. sample for complete lot offered irrespective of size/type.

CHARGER/ACDB/DCDB)																	
TESTS / **ITEMS**	Visual/dimension/rating/ Paint Adhesion/ Thickness (R)	General arrangement/BOM/make of components /Mimic (R)	Efficiency ,regulation(R)	Input voltage variation (A)	Output voltage and frequency adj. range(A)	Preliminary light load test(R)	Load transfer retransfer test (R)*	AC input failure and return test (R)	Parallel operation and current division(R)	Relative harmonic content(R)	Restart with PRI A.C and battery (separately)(R)	System transfer and retransfer (R)*	Asynchronous transfer(R)	Ripple content(R)	Load limiter operation (R)	IR/HV(R)	Tests as per standard &specification (R)&(A)
UPS/CONVERTER (IEC-146 PT-4)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
VOLTAGE STABILISER	Y	Y	Y	Y	Y					Y		Y				Y	
LEAD ACID BATTERY(TUBLAR)-IS-1651																	Y
LEAD ACID BATTERY (PLANTE)-IS-1652																	Y
NICKEL CADMIUM BATTERY(IS-10918/IEC-623)																	Y
SMF BATTERY																	Y
ACDB/DCDB	Y	Y														Y	Y
BATTERY CHARGER	Y	Y	Y	Y	Y				Y					Y	Y	Y	Y

R-Routine Test A- Acceptance Test Y – Test applicable

* Transfer time and Over shoot /under shoot during load & system transfer shall be recorded.

Note: 1) This is an indicative list of tests/checks. The manufacturer is to furnish a detailed quality plan indicating the Practices and Procedure adopted along with relevant supporting documents.

CONTROL VALVE ACTUATORS AND ACCESSORIES

ITEMS \ TESTS	MAKE,MODEL, TAG (R)	DIMENSION(R)	SURFACE FINISH(R)	HEAT TREATMENT(R)	MATERIAL TEST CERTIFICATES(R)	IBR CERTIFICATES(R)	HYDRAULIC TEST(R)	UT/RADIOGRAPHY FOR >900 LB RATING(R)	MPI/DP(R)	PRESSURE RESISTANCE(R)	SEAT LEAKAGE(R)	TIMING OPEN/CLOSE(R)	LINEARITY/HYSTERISIS(R)	FUNCTIONAL TEST, REVIEW FOR MAKE AND TC OF ACCESSORIES(R)
CONTROL VALVE AND ACTUATOR														
OVERALL	Y	Y	Y			Y	Y				Y	Y	Y	Y
BODY		Y	Y	Y	Y			Y	Y	Y				
BONNET		Y	Y	Y	Y									
TRIM		Y			Y			Y *						
PNEUMATIC ACTUATOR	Y	Y								Y				
ELECTRO PNEUMATIC POSITIONER	Y													Y

R- ROUTINE TEST A - ACCEPTANCE TEST Y - TEST APPLICABLE

Y* - **UT ON SPINDLE DIA >= 40 MM.**

NOTE : **1)** This is an indicative list of tests/checks. The manufacture is to furnish a detailed quality plan indicating his practice & procedure along with relevant supporting documents during QP finalization for all item.

ELECTRICAL ACTUATOR WITH INTEGRAL STARTER

TEST/ATTRIBUTES CHARACTERISTICS / ITEM/ COPONENT/ SUB SYSTEM ASSEMBLY/ TESTING	RPM (R)	No Load Current (R)	IR & HV Test(R)	Mounting Dimension(R)	All routine Test as per Standard & Specification(R)	Correct Phase Sequence(R)	Operation & Setting of limit Switch/Torque Switch(R)	Stall Torque/Current (A)	Hand Wheel operation/ Auto de clutch function (A)	Function of Aux. like Potentiometer, space heater, position	EPT output (R)	Grease leakage (R)	Local/ Remote (Open-Stop-Close) Operation(R) Safety check (Single phasing, Phase correction, Tripping etc.) (A)
ELECTRICAL ACTUATOR WITH INTEGRAL STARTER(IS_9334)													
Motor	Y	Y	Y	Y	Y								
Final Testing	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y

Note: 1) This is an indicative list of tests/checks. The manufacturer is to furnish a detailed quality plan indicating the practices and procedure adopted along with relevant supporting documents.

(R) - Routine Test (A) - Acceptance Test Y - Test applicable

CONTROL DESK, LVS PANEL, PLC PANEL, SMOKE DETECTOR, FIRE ALARM & CONTROL SYSTEM

ITEMS \ TESTS	Visual (R)	GA, BOM ,Lay Out of components (R)	Dimensions (R)	Paint Shade/Thickness/Adhesion (R)	Alignment of Section (R)	Component Rating/ Make / Type (R)	Wiring (R)	IR & HV (R)	Review of TC for instruments/ Devices/ Recorders, Indicators/ mosaic Items/ Transducers (R)	Accessibility of TBS/ Devices (R)	Illumination (R)	Functional Check for Control Element ,	Mimic (R)	Test as per IEC 1131 (R) *	Test as per Std (R) & (A)	Functional test of complete system(a)
1. Control Desk	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y			
2. LVS Panel	Y	Y	Y	Y	Y	Y	Y	Y	Y						Y	Y
3. Annunciation, Control, PLC Panel	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y			Y	Y	Y
4.Smoke Detectors (UL-268,EN-54 PT-7), Heat Detectors(UL-521/EN 54 PT-5) Annunciation/ Control Panel (UL -864, EN-54, PT-2)															Y	Y

Note: 1) This is an indicative list of test/ checks. The manufacturer is to furnish a detailed quality plan indicating the Practice and Procedure along with relevant supporting documents.

- *Applicable for PLC
- Y - Test Applicable , (R) - Routine Test (A) - Acceptance Test

STEAM WATER AND ANALYSIS SYSTEM

ITEMS \ TESTS	Visual (R)	GA, BOM, Layout of construction feature(R)	Dimension (R)	Paint Shade/thickness (R)	Alignment of Section (R)	Component Ratings/Make/Type (R)	Wiring (R)	Make,Model,Type,Rating (R)	IR&HV (R)	Review of TC for instrument/devices/Valves/ fittings (R)	Accessibility of TBs/Devices (R)	Illumination (R)	Tubing (R)	Leak/Hydro test (A)	Calibration test of analyser (R)	Vacuumisation test of assembly (R)	Chilled water tank dimensions and insulation (R)
SWAS Panels/Racks *	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y		
Chiller unit *	Y	Y	Y			Y	Y	Y	Y	Y				Y		Y	Y

Note: R-Routine Test A- Acceptance Test Y – Test applicable

Note: 1) This is an indicative list of tests/checks. The manufacturer is to furnish a detailed quality plan indicating the Practices and
Procedure adopted along with relevant supporting documents.
* Applicable for BOP/STATION C&I

PUBLIC ADDRESS SYSTEM – IP Based							
Attributes Characteristics / **Item Components Sub System Assembly**	Make, Model, Type, Rating, (R)	Dimension / constructional requirement(R)	Functional / operational check(R)	Switching capability and sequence(R)	No. of inputs/outputs, display(R)	SPL level and Sweep test response(R)	Operational check regarding communication with different zones (R)
LAN Switch/Network Switch	Y		Y	Y	Y		
Call Stations	Y		Y				
Amplifier (Standalone)	Y		Y				
Power Supply	Y		Y				
Loud Speaker	Y	Y	Y			Y	
EPBAX	Y		Y				
Master Control Unit	Y		Y				
Media Converter	Y		Y				
Software	Y		Y				
Enclosure (Outdoor application)	Y	Y	Y				
Acoustic Hood	Y	Y	Y				
Server, Work Station, Storage Device	Y		Y				
Integrated Testing							Y

Note : 1) This is an indicative list of test/checks. The manufacturer is to furnish a detailed quality plan indicating the Practice and procedure along with relevant supporting documents.

R –Routine Test Y -Test Applicable

CLOSED CIRCUIT TELEVISION SYSTEM (CCTV) – IP Based									
Attributes Characteristics / **Item Components Sub System Assembly**	Make, Model, Type, Rating, TC(R)	Dimension/constructional requirement(R)	Functional/operational check(R)	Switching capability and sequence(R)	No. of inputs/outputs, display(R)	Provision for connectivity with the LVS(R)	Pan range/speed, tilt/tilt speed(R)	Operational check from key board/control panel(R)	Commands from LAN Switch/Network Switch(R)
LAN Switch/Network Switch	Y		Y	Y	Y	Y			
Key boards	Y		Y						
Cameras	Y	Y	Y						
Lens	Y	Y	Y						
Camera Housing	Y	Y	Y						
Pan & Tilt unit	Y	Y	Y				Y		
Media Converter	Y		Y						
Monitor	Y	Y	Y						
Software	Y		Y						
Server, Work Station, Storage Device	Y		Y						
Complete System	Y	Y	Y	Y	Y	Y	Y	Y	Y

Note : 1) This is an indicative list of test/checks. The manufacturer is to furnish a detailed quality plan indicating the Practice and procedure alongwith relevant supporting documents.
R –Routine Test Y -Test Applicable

DDCMIS

1.00.00 REQUIREMENTS OF AUTHORISATION-TO-SHIP-TEST (ATST) FOR DDCMIS

1.01.00 (a) Authorization-to-ship-test (ATST) or Factory Acceptance Test (FAT) (both terms have been used interchangeably) shall include all required tests to fully demonstrate to Employer's satisfaction that each equipment/sub-system/system as well as software modules furnished as per this specification as well as DDCMIS as a whole, fully meets the functional, parametric and other requirements of this specification and Employer's approved drawings/documents under all operating regimes. The procedure defined here is applicable for one DDCMIS system. Number of DDCMIS systems and their sub-systems shall be as defined in Part-A of technical specifications.

(b) Contractor to note that ATST / FAT procedure given below in subsequent clauses are only indicative in order to help the Contractor in understanding the requirements and help him in submitting a detailed procedure based on these guidelines meeting all the specification requirements.

(c) The results of the following activities shall be made available to the Employer's representative before start of ATST / FAT.

(i) Compliance check for Major Design Feature (including Customization if any), as per Part-C, GTR or agreements regarding this.

(ii) Implementation check of various applications including those based on NTPC input, as per Part-C, GTR or agreements regarding this.

(d) Generally, the ATST / FAT shall be carried out with the equipment earmarked for the particular project and unit. However, for the following item, the testing can be carried out with similar / equivalent dummy equipment fulfilling the following condition, subject to Employer's approval.

SN	ITEM	CONDITION
1	LVS	Testing of LVS functionalities can be done by using monitors connected to the LVS Workstations. Dispatch of LVS can be allowed like a cat-III item, but only after successful testing of functionalities as indicated above.

2	LVS WS / OWS	LVS WS / OWS for the first unit to be tested on the target machines. In case the testing carries over to next unit, dummy equipment may be used. Dispatch of LVS WS / OWS of subsequent units can be allowed like a cat-III item, but only after successful testing of first unit as indicated above.
3	MASTER CLOCK	Can be directly dispatched if alternate test set-up for time synchronization can be arranged.
4	NETWORK COMPONENT	To be done with target machines only for first unit. In case the testing carries over to next unit, dummy equipment may be used. Dispatch of network components of subsequent units / station can be allowed like a cat-III item, but only after successful testing of functionalities as indicated above.
5	VARIOUS BUS SYSTEM CABLES	For FAT, the target Main system bus shall be used. In case the testing carries over to next unit, dummy equipment may be used.

1.01.01 The Authorization-To-Ship-Test (ATST) shall include all reasonable exercises which the combination of equipment and software can be expected to perform. These tests shall be divided into, as a minimum, but not limited to the following categories:

(a)	Hardware tests	
(b)	Functional tests	
(c)	Parametric test	

All reference documents like all approved drawings / documents, NTPC specifications, DDCMIS system manuals, etc. shall be available at the start of ATST. The Quality Assurance related tests shall be as per approved QP (Quality Plan) for DDCMIS. The ATST tests are briefly described in subsequent clauses.

1.01.02 Hardware tests

These tests shall include but not be limited to the following tests. These tests will be conducted on full population on sample basis as finalized during ATST procedure finalization and NTPC engineer's decision during ATST.

(a.) Verification of healthiness of all types of modules e.g., I/O modules, controller modules, processors, peripherals, etc. on a sample basis.

(b.) System configuration:

(1.) Verification of system configuration with reference to approved configuration diagrams including verification of controller configuration, group / sub-group segregation; grouping of controllers, I/O redundancy, verification of multiple measurement scheme, HMIPIS configuration, etc.

(2.) Verification of major features of complete DDCMIS like on line removal of I/O and controller modules, etc. in line with specification requirements.

(3.) Verification of spare capacity for example spare channels, spare wired-in space in cabinets/ cubicles, terminal blocks, peripherals, etc. as per approved documents.

(c.) Simulation of inputs / Outputs

System shall have feature to simulate/ forcing I/Os on OWS / LVS OWS. Additionally hardware simulation of I/Os shall be available for specific applications like fail safe system.

(d.) Accuracy test:

System accuracy for each type of analog input shall be demonstrated on sample basis, if this test is not carried out in MDFT.

(e.) Demonstration of the manual and auto switchover from master to standby system bus, controllers, I/Os, processors etc.

(f.) Loop reaction time shall be demonstrated for loops / logics / functions applicable as per specification and ATST procedure.

(g) SOE function shall be tested as follows, where the same is applicable (refer Part-A of specifications). For SER function, verification of resolution of SOE inputs, time synchronization with master clock, data base modification, SOE report, printout, other features etc. For this purpose a test-simulator to generate sequences of 1 ms resolution for 50 points (or as agreed during finalization of ATST procedure) distributed in different panels shall be made available during testing.

(h) Power supply:

Testing of power supply system to DDCMIS, tolerance of DDCMIS w.r.t. voltage & frequency limits as specified, performance of DDCMIS with power supply break as specified .(One sample of each type)

(i) Diagnostics Tests :

On – line diagnostic tests on HMIPIS, individual peripherals, Control System, programmer stations, etc.

1.01.03 Functional Tests

The following tests shall be carried out on Contractor's DDCMIS.

(a.) Functional tests of CLCS:

(1.) Verification of proper signal acquisition, conditioning and distribution, 2 transmitters / 3 transmitter selection.

(2.) Verification of proper realization of controller functions like bump less transfer from auto to manual and vice versa, functional checking of bias circuit (wherever provided), etc.

(3.) Verification of response of control system by simulating changes in the system inputs in line with the approved ATST procedure.

(4.) Verification of signal exchange between FGs and from other systems (if applicable)

(b.) Functional tests of OLCS:

(1.) Verification of proper signal acquisition, conditioning and distribution, 1v2, 2v3 implementation.

(2.) Verification of proper realization of logic functions, sequence control functions, running of complete start up program sequence in all modes of operation, shut down program, etc.

(3.) Verification of logic computation in controller by simulating inputs.

(4.) Verification of signal exchange between FGs and from other systems (if applicable)

(c.) Functional tests for HMIPIS

(1.) Verification of all types of displays, logs including their formats, bar graphs, X-Y plots etc. availability of all operator functions.

(2.) Verification of event generation and handling capabilities of HMIPIS processors by simulating various types of events/data and observing associated event sequence display and alarms.

(3.) Calculations:

All calculations shall be tested on sample basis to demonstrate that these are in accordance with the specification and Employer's inputs as applicable. The Contractor shall prepare ~~all~~ tests cases for calculations for proper verification for the features required for each type of computations.

(4.) Checking historical storage and retrieval functions including long term storage.

(5.) Testing of initialization and loading of configuration data, etc.

(6.) Verification of all programmer's stations functions for HMIPIS and Control System, as well as for documentation facility as specified.

(7.) Testing of each peripheral viz., monitors, printers, optical disks, hard disk drive, etc.

(8.) Testing of time synchronization function of system time of DDCMIS (Control System, HMIPIS & Systems on LAN). In case it is not possible to bring the master clock procured under this package, then signal generator with stable source, capable of generating all required type of synchronizing signal to be arranged by Contractor.

(9.) Testing of the Station LAN shall be carried out with unit DDCMIS (with panels), standalone DDCMIS (with panels or software simulation) and at least one (1) other DDCMIS system (with panels or software simulation), as well as two client PC's, one third party PLC and Numerical relay system (if applicable). Bidder shall arrange a PC with OPC server (excluded from his scope of supply) which shall be used by the Bidder to simulate signal exchange between Bidder's Station LAN and third party PLC during the testing of Station LAN, at Bidder's works.

(10.) Unified HMIPIS:

Testing of Unified HMIPIS functionality as per respective approved documents.

(d.) Security Audit (as applicable)

(1.) For checking compliance to the security policies & procedures in Station LAN/HMI of all DDCMIS, security audit by a certified auditor (as per CERT- IN panel) is to be arranged by the Contractor during ATST. This shall include vulnerability assessment of the workstations/ servers and penetration testing of the Station LAN through the firewall from a node

outside the network. Suitable actions based on the findings of the security audit shall be carried out by the Contractor.

1.01.04 Parametric tests

Following tests shall be carried out to test Contractor's DDCMIS w.r.t. specification requirements.

(a.) For control system (CLCS+OLCS):

(1.) CPU loading

(2.) Cycle time/controller reaction time.

(3.) Memory spare capacity

(b.) For MMIPIS

(1.) CPU loading

(2.) Spare duty cycle

(3.) Spare memory capacity

(c.) Spare duty cycle for system bus

(d.) Various display & command response time

(e.) System accuracy (if not carried out in MDFT)

(f.) Display update time on OWS LVS

Parametric tests of Unified HMIPIS for complete Unit DDCMIS shall also be carried out, if specified in Part-A of specifications.

1.02.00 Integrated Test Set-Up

For integrated testing of the total DDCMIS system, the Contractor shall employ a test set-up, which will be capable of generating I/O signals in a requisite manner. It is preferable to adopt soft signal simulating device to avoid / minimize the cumbersome process of physical connection of I/Os through potentiometers, switches, Lamps / LEDs etc. The exact configuration / set-up shall be as finalized during detailed engineering.

1.02.01 The Contractor is to submit Authorization-To-Ship-Test (ATST) procedure and requirements of above and other applicable clauses of this specification. Since, the exact definition & extent / parameters of ATST can be finalized only when the engineering of DDCMIS has been finalized to a great extent, it is required that the detailed draft ATST procedure be submitted by the Contractor at a later date as intimated by the Employer during engineering stage for Employer's comment and finalization. Contractor shall incorporate all modifications, additions/ deletions to the ATST procedure as indicated by the Employer. The ATST shall be conducted as per Employer approved procedure for ATST. The

Employer reserves the right to ask the Contractor to conduct any other test not covered in ATST procedure also during the ATST which may be required to fully satisfy the Employer regarding full compliance with specification requirements. Contractor shall conduct all such tests also within the quoted lump sum price for this contract.

1.02.02 The results of all ATS Tests shall be properly documented by the Contractor and submitted to Employer along with all annexures.

1.02.03 Following the tests, if in the opinion of the Employer, the system has not been adequately manufactured, programmed, tested or debugged the Contractor shall make good all deficiencies, and re-run the test to fully satisfy the Employer regarding full compliance with specification requirements and requisite quality standards.

1.02.04 The system shall not be shipped without approval of Employer in writing.

1.02.05 Upon successful completion of Authorization-To-Ship Test, the Employer will provide the Contractor with a written authorization for shipment of the system equipment to the project site.

1.02.06 All final documentation as per requirement of this specification shall be available at the time of Authorization-To-Ship-Test and this shall be dispatched along with the equipment in required number of copies.

1.02.07 Contractor shall note that no payments towards dispatch of equipment and subsequent activities shall be due and payable to the Contractor till the Contractor is able to successfully demonstrate to Employer's satisfaction that the DDCMIS and parts thereof fully meet the Authorization-To-Ship Test requirements.

1.02.08 The ATST or FAT of DDCMIS shall be conducted at the employer approved works of the DDCMIS supplier or DDCMIS Supplier's Associate. Further DDCMIS shall be supplied from the same works.

2.00.00 The ATST requirements as indicated above shall form an integral part of QAP (Quality Assurance Plan) of DDCMIS system(s) envisaged for the package/project. Over and above the tests and requirement indicated above, the QP for DDCMIS system shall be submitted to employer for approval. The QAP envisaged for the offered DDCMIS system for employer shall also include testing of following attributes of the offered system by Employer.

2.01.00 The tests indicated in the following QA tables are indicative list of tests/checks. The manufacturer is to furnish a detailed quality plan indicating the Practices and Procedure adopted along with relevant supporting documents, if desired by employer.

DISTRIBUTED DIGITAL CONTROL MONITORING & INFORMATION SYSTEM (DDCMIS)										
TESTS / **ITEMS**	Pre Power on Check (#) (R)	Post Power on Check (%) (R)	Internal cabling / Wiring checking(R)	Door Alignment, waviness, and Locking (R)	Louvers, Fans, wire mesh, Lifting arrangement (R)	HV / IR on wired panels (R)	Paint Shade, Thickness and Illumination (R)	Hardware/Make as per BOM (R)	Dimensions, GA, layout (R)	Environmental Stress Screening test (R).
DDCMIS										
DDCMIS CUBICLES	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
OWS and Peripherals								Y		
R-Routine Test		A- Acceptance Test					Y – Test applicable			

Note: 1) These test are minimum requirement and necessary covered in Manufacturing Quality Plan and manufacturer is also need to include their practices and Procedure in MQP along with relevant supporting documents.

Pre power on check: - Wire dressing, looseness, Availability of Fuses and MCB, Modules are inserted properly, Earthing connection, Input Voltage checking, Availability of resistance matt near panels, Availability of Electro Static Discharge measure for electronics components.

% Post Power On Check: - Current & power consumption of DDCMIS Cabinets, I/O check as per signal flow.

TG RELATED SPECIFIC INSTRUMENTATION AND CONTROL								
TEST/ATRIBUTES CHARACTERISTICS / ITEM	Linearity(R)	Frequency Response(R)	Calibration with simulated output.(R)	Spectrum(Harmonic Analysis (A)	Predictive Analysis Functions (A)	Storage & Comparative analysis of vibration(A)	Generation/analysis of plots (A)	Simulation test & generation of operator guidance (A)
TURBO SUPERVISORY/ VIBRATION MONITORING SYSTEM								
Proximeter	Y	Y						
Accelerometer	Y	Y						
LVDT	Y							
Monitor	Y		Y*					
Overall System				Y	Y	Y	Y	Y

R-Routine Test A- Acceptance Test Y – Test applicable

Note: 1) – This is an indicative list of tests/checks. The manufacturer is to furnish a detailed quality plan indicating the Practices and Procedure adopted along with relevant supplying documents.

* applicable for monitor electronics

SG RELATED SPECIFIC INSTRUMENTATION AND CONTROL

TEST/ATRIBUTES CHARACTERISTICS / ITEM/ COPONENT/ SUB SYSTEM ASSEMBLY/ TESTING	Make, Model, Type, Rating(R)	Visual Check(R)	Dimensional Check(R)	Drop Test (Sample)(A)	Physical & Chemical properties(A)	HV/ IR Test (R)	GA/BOM/Paint Shade Thickness,	Hydraulic Test(R)	IBR form III-C Certification(R)	RT/UT on welds(R)	Functional Checks(R)	Integrated test with Simulation (R)
ELECTRONIC SEPERATOR LEVEL INDICATOR												
Electrodes	Y	Y	Y	Y	Y	Y		Y				
Pressure vessels	Y	Y	Y		Y			Y	Y	Y		
Valves/Key Interlock	Y	Y	Y				Y	Y			Y	
Final inspection of complete System (Panel ,Cabinet ,Display Unit)	Y	Y	Y			Y	Y				Y	Y

R-Routine Test A- Acceptance Test Y – Test applicable

Note: 1) – This is an indicative list of tests/checks. The manufacturer is to furnish a detailed quality plan indicating the Practices and Procedure adopted along with relevant supplying documents.

1.0.0 INTRODUCTION

1.1.0 This part of the technical specification shall be read in conjunction with other parts of the technical specifications, general technical requirements & erection conditions of the contract. Wherever IS code or standards have been referred they shall be the latest revisions.

1.2.0 The rate for respective items of work or price shall include the cost for all works, activities, equipment, instrument, personnel, material etc. whatsoever associated to comply with sampling, testing and quality assurance requirement including construction tolerances and acceptance criteria and as specified in subsequent clauses of this part of the technical specifications. The QA and QC activities in all respects as specified in the technical specifications/ drawings / data sheets / quality plans / contract documents shall be carried out at no extra cost to the NTPC.

1.3.0 The contractor shall prepare detailed construction and erection methodology scheme which shall be compatible to the requirements of the desired progress of work execution, quality measures, prior approvals if any and the same shall be got approved by the Engineer-in-charge. If required, work methodology may be revised/ reviewed at every stage of execution of work at site, to suit the site conditions by the contractor at no extra cost to the NTPC.

2.0.0 QUALITY ASSURANCE PROGRAMME

2.1.0 The contractor shall adopt suitable Quality Assurance Programme (QAP) to ensure that the equipments and services under the scope of contract whether manufactured or performed within contractor's works or at his sub-contractor's premises or at the NTPC's site or at any other place of work are in accordance with the specifications. Such QAP shall be outlined by the contractor and shall be finally accepted by the NTPC or their authorized representative after discussions before the start of work.

3.0.0 QA AND QC MANPOWER

3.1.0 The contractor shall nominate one overall QA coordinator for the contract detailing the name, designation, contact details and address at the time of post bid discussions. All correspondence related to Quality Assurance shall be addressed by the contractor's QA coordinator to NTPC. NTPC shall address all correspondence related to Quality issues to the contractor's QA coordinator. The contractor's QA coordinator shall be responsible for co-ordination of Quality activities between various divisions of the contractor and their sub-vendors on one hand & with NTPC on the other hand.

3.2.0 The contractor shall appoint a dedicated, experienced and competent QA&QC in-charge at site, preferably directly reporting to the Project Manager, supported as necessary by experienced personnel, to ensure the effective implementation of the approved QAP. Based on the finalized L-2 network and the approved Field Quality plan, the contractor shall finalize and submit a deployment schedule of QA&QC personnel along with their details to NTPC for approval/ acceptance and further shall ensure their availability well before the start of the concern activity.

3.3.0 The QA&QC in-charge shall have the organizational freedom and authority to implement the requirements of these quality assurance arrangements, free from commercial and programme restraints. The QA&QC setup of the contractor shall consist of qualified and

experienced Civil, Electrical, Mechanical Engineers and Laboratory assistants with their supporting staff both at their works and site.

3.4.0 The deployment of man power for QA & QC set up shall be affected on the basis of agreed manpower deployment schedule, which shall be prepared by the contractor based on the L-2 network and the same shall be submitted to the engineer-in-charge for acceptance.

4.0.0 SAMPLING AND TESTING OF CONSTRUCTION MATERIALS

4.1.0 The method of sampling for testing of construction materials and work / job samples shall be as per the relevant IS / standards / codes and in line with the requirements of the technical specifications / quality plans. All samples shall be jointly drawn, signed and sealed wherever required, by the contractor and the Engineer-in-Charge or his authorized representative.

4.2.0 The contractor shall carry out testing in accordance with the relevant IS / standards / codes and in line with the requirements of the technical specifications / quality plans. Where no specific testing procedure is mentioned, the tests shall be carried out as per the best prevalent engineering practices and to the directions of the Engineer-in-charge. All testing shall be done in the presence of the Engineer-in-Charge or his authorized representative.

4.3.0 Before execution of any civil work the contractor shall conduct full-scale suitability tests on various construction and building material such as fine and coarse aggregates, cement, reinforcement, construction chemicals, supplementary cementitious materials and construction water to ascertain their suitability for use and the concrete mix designs conducted from reputed institutes such as NCB-Ballabhgarh, CSMRS-Delhi, IIT's, etc. as agreed by the engineer-in-charge. The test samples for such full scale testing shall be jointly sampled and sealed by the engineer and contractor, thereafter these shall be sent to the concerned laboratory through the covering letter signed by field quality assurance (FQA) representative of the Engineer-in-Charge.

4.4.0 The contractor shall timely initiate the action with regard to the evaluation of aggregates and other building material including concrete mix design, so as to ensure completion of these tests before start of civil works at site, thereby not affecting any project work. The test reports and recommendations for suitability of the materials including concrete mix design shall be promptly submitted by the contractor to the Engineer-in-Charge.

5.0.0 LABORATORY AND FIELD TESTING

5.1.0 The field laboratory for QA and QC activities shall be constructed and set-up by the contractor. The Laboratory building shall be constructed and installed with the adequate facilities to meet the requirement of envisaged test setup. Temperature and humidity controls shall be available wherever necessary during testing of samples. The quality plan shall identify the testing equipments/ instrument, which the contractor shall deploy and equip the field quality laboratory for meeting the field quality plan requirements. The contractor shall furnish a comprehensive list of testing equipments/ instrument required to meet the planned/scheduled tests for the execution of works for NTPC acceptance/ approval. The contractor shall mobilize the requisite laboratory equipment and QA&QC manpower at least 15 days prior to the planned test activity as per the schedule of tests.

5.2.0 All equipments and instruments in the field shall be calibrated before the commencement of tests and then at regular intervals, as per the manufacturer's recommendation and as directed by the NTPC. The calibration certificates shall specify the fitness of the equipments and instruments within the limit of tolerance for use. Contractor shall arrange for calibration of equipments and instruments by an NABL / NPL accredited agency and the calibration report shall be submitted to NTPC.

5.3.0 The tests which cannot be carried out in the field laboratory shall be done at NTPC acceptable testing laboratories. The test samples for such test shall be jointly selected and sealed by the engineer and thereafter these shall be sent to the concerned laboratory through the covering letter signed by NTPC Engineer-in-Charge. The test report along with the recommendations shall be obtained from the laboratories without delay and submitted to NTPC.

5.4.0 Based on the schedule of work agreed with the engineer-in-charge and the approved FQP, the contractor shall prepare a schedule of tests and submit them to the engineer-in-charge and organize to carry out the tests as scheduled / agreed.

6.0.0 PURCHASE AND SERVICE

6.1.0 The list of manufacturers/ sub-vendors for all the BOIs envisaged in contract including shall be included in the bid proposal by the contractor which shall be discussed / reviewed by the NTPC during post bid discussions and the list of proposed manufacturers / sub-vendors for each of the BOIs shall be agreed/ approved. If any item is left out or gets included during detailed engineering, the contractor shall propose the manufacturer's / sub-vendor's details for review / approval of NTPC, prior to initiating the procurement of such materials.

6.2.0 Where the manufacturers are placed in details required ("DR") category, the details of the manufacturers / sub-vendors placed in the "DR" category shall be submitted to the NTPC for approval in the prescribed NTPC format within the period agreed at the time of post bid discussions. The contractor's proposal shall include vendor's site facilities, expertise, facilities established at the respective works, the process capability, process stabilization, QC systems followed, experience list, etc. along with his own technical evaluation for identified sub-Contractors proposed. The formats for furnishing above details shall be given to the Contractor at post bid discussion stage. Monthly progress reports on sub-contractor detail submission / approval shall be furnished. Such manufacturers / sub-vendors approval shall not relieve the contractor from any obligation, duty or responsibility under the contract.

6.3.0 To facilitate advance planning of material testing/ approval of bought out items, well before the start of activity as per L-2 network, representative samples shall be procured by the contractor from approved sub-vendors and submitted to the Engineer-in-Charge for his approval before bulk procurement at least two months prior to start of works. In case of manufacturers test certificate (MTC) is submitted for acceptance, it shall be clearly traceable and correlated with the consignment received at site. MTC of all bought out items shall essentially contain all the test parameters / characteristics specified in the technical specifications / standards / codes. In case the manufacturer's test certificate does not mention these details, sample from each lot shall be tested for these properties at the third party lab acceptable to NTPC. Approval of material / sample by the Engineer-in-Charge shall not relieve the contractor of his responsibility, for their conformance to the specification, as well as the requisite performance and quality of material.

6.5.0 Structural Structural steel (plates and rolled sections i.e. channels, beams & angles) and

Reinforcement steel supply if in the scope of the contractor shall be procured from Primary Steel Producers (Refer NOTE below). Currently, Primary Steel Producers acceptable are SAIL, JSW Steel Ltd, Jindal Steel & Power, Tata steel Ltd. (for Reinforcement steel/TMT bars), RINL (for long products/Rolled sections and Reinforcement steel/TMT bars), Essar Steel India Ltd. (for Flat products/ Steel Plates), Electrosteel steel Ltd. (for Reinforcement steel/TMT bars) and Monnet Ispat and Energy Ltd. (for long products/Rolled sections and Reinforcement steel/TMT bars). Subsequently, if any new Primary Steel Producer/s are proposed during execution of contract, the same may be considered for acceptance subject to meeting the following qualifying requirements:

i) The proposed supplier should be a Primary Steel Producer, having a minimum production capacity of one million tons per annum (MTPA).

ii) The proposed supplier should be a regular manufacturer of Steel Plates and / or Rolled Sections and / or Reinforcement Steel for the last two years as on date of submission of proposal.

iii) The proposed supplier should also be a registered licensee with Bureau of Indian Standards for BIS:1786/2062 at the time of submission of proposal.

NOTE: The “Primary Steel Producer” shall mean Steel Producer of any capacity, irrespective of process route, starting their operations from iron making using iron ore, virgin or processed, with necessary refining facilities and rolling/processing facilities, at a single location or else in multiple locations provided that the entire gamut of iron & steel production, from iron making to finished steel production, is owned by the same company or its subsidiary company(ies). Provided that the iron making capacity is sufficiently matching the steel making capacity. Further, downstream units should use material from the upstream units of the same company or its subsidiaries.

In case of non-availability of certain steel section/s i.e. Angle smaller than 100x100x10 mm, MS flats, rounds, square bars and chequered plate from primary steel producers, an option is given to the Main contractor to source these sections directly from SAIL Conversion/Wet Leasing agent subject to the conditions given at point no. A) below:

A) Approval conditions for procurement of structural steel sections through SAIL Conversion/Wet Leasing agent:

1. Main Contractor to ensure continuity of BIS license of the manufacturer for the sections being manufactured for NTPC supply.

2. Billets shall be procured from NTPC approved Main Steel Producers. Proper records for traceability from raw material to final product shall be maintained.

3. 100% chemical analysis of the raw material (Billets) shall be carried out as per IS: 2830. Testing of one sample per 40 MT for each type of section or part thereof shall be carried out as per IS: 2062 on finished product.

4. Each lot of delivery of finished product shall be accompanied with co-relatable Manufacturer’s Test Certificate (MTC). MTC of finished sections shall be correlated with original MTC for Billets received from Main Steel Producer and Manufacturer Test Report of chemical analysis of Billets mentioned at point no.3. MTC of finished sections shall include the reference of MTC for Billets from Main Steel Producer.

5. NTPC will have access to carry out the surveillance checks for in-process stage.

6. In case of any defects are seen in the material, Main Contractor will replace the material without any cost implication to NTPC.

In case of non-availability of certain size/s of steel tubes conforming to IS:1161 and Hollow (square and rectangular) steel sections conforming to IS: 4923 from primary steel producers, the same may be sourced from BIS approved sources having valid BIS license subject to the conditions given at point no. B) below:

B) Approval conditions for procurement of Steel tubes conforming to IS: 1161 and Hollow (square and rectangular) steel sections conforming to IS: 4923 from BIS approved sources:

1. Main Contractor to ensure continuity of BIS license of the manufacturer for the sections being manufactured for NTPC supply.
2. Raw materials shall be procured from NTPC approved Main Steel Producers.
3. 100% chemical analysis of the raw material (steel) shall be carried out as per IS: 228. Testing of samples of steel tubes and hollow sections from each lot shall be carried out as per IS: 1161 & IS: 4923 respectively on finished product.
4. Each lot of delivery of finished product shall be accompanied with co-relatable Manufacturer's Test Certificate (MTC).
5. NTPC will have access to carry out the surveillance checks for in-process stage.
6. In case of any defects are seen in the material, Main Contractor will replace the material without any cost implication to NTPC.

The specific methodology to be followed for procurement of Structural Steel and Reinforcement Bars through conversion route/BIS approved sources route shall be subject to approval by NTPC in advance

7.0.0 MANUFACTURING QUALITY PLAN AND FIELD QUALITY PLAN

7.1.0 All materials / components and equipment covered under the scope of work, shall be procured by the contractor for the purpose of the contract, after obtaining the written approval of the NTPC, which are to be manufactured at shop/ factory of the vendor/sub vendor shall be covered under a comprehensive quality assurance programme. The contractor's purchase specifications and inquiries shall call for Manufacturing Quality Plans (MQP) to be submitted by the sub-contractor/ sub-supplier/ sub-vendor. The MQP called for from the sub-contractor shall detail out for all the components and equipment, various tests / inspection, to be carried out as per the requirements of this specification and standards mentioned therein, quality practices and procedures followed by contractor's / sub-contractor's / sub-supplier's quality control organization, the relevant reference documents and standards, acceptance norms, inspection documents raised etc., during all stages of materials procurement, manufacture, assembly and final testing/ performance testing. Such quality plans of the vendors / sub-vendors shall be submitted to the NTPC for approval for MQP and such approved quality plans shall form a part of the purchase order / contract between the contractor and sub-contractor. The quality plans shall be submitted for review and approval of NTPC.

7.2.0 The contractor shall furnish copies of the reference documents/ plant standards / acceptance norms/ tests and inspection procedure etc., as referred in quality plans. These quality plans and reference documents/standards etc. will be subject to NTPC approval without which manufacturer shall not proceed. These approved documents shall form a part of the contract. In these approved quality plans, NTPC shall identify customer hold points (CHP), i.e. test/ checks which shall be carried out in presence of the NTPC Engineer-in-Charge or his authorized representative and beyond which the work shall not proceed without consent of NTPC in writing. All deviations to this specification, approved quality plans and applicable standards must be documented and referred to NTPC along with technical justification for approval and dispositioning.

7.3.0 Within three weeks of the release of the purchase orders /contracts for such bought out items /components, a copy of the same without price details but together with the detailed purchase specifications, quality plans and delivery conditions shall be furnished to the NTPC for reference / record by the contractor along with a report of the purchase orders placed so far for the contract.

7.4.0 Well before the start of the work, the contractor shall prepare and submit the Field Quality Plans (FQP) and obtain approval of NTPC, which shall detail out for all the

works, equipments, services, quality practices and procedures etc in line with the requirement of the technical specifications to be followed by the contractor at site. This FQP shall cover for all the items / activities covered in the contract / schedule of items required, right from material procurement to completion of the work at site.

8.0.0 DISPOSITIONING OF NON CONFORMITIES

8.1.0 The non-conformity for the site works on being detected / noted shall be reported by the contractor in the standard format of NTPC under the system of dispositioning of non conformity report (NCR) to the Engineer-in-Charge. The dispositioning of the NCR relating to equipment, assemblies, materials condition or process during construction / erection shall describe the proposed correction and also include the preventive / corrective action plan for future.

9.0.0 QUALITY AUDIT

9.1.0 NTPC reserves the right to carry out quality audit and quality surveillance of the quality management and control activities, systems and procedures of the contractor or their sub-contractor. The contractor shall provide all necessary assistance to enable the NTPC carry out such audit and surveillance. The contractor shall also take necessary measures, raise NCRs wherever required based on the audit findings / observations.

10.0.0 QA DOCUMENTATION PACKAGE

10.1.0 The contractor shall be required to submit the QA documentation in two hard copies and two CD ROMs, as identified in respective quality plan with tick (√) mark. Typical contents of QA documentation pertaining to field activities as per approved MQP, FQP and other agreed manuals / procedures, prior to commissioning of individual system shall generally contain the Quality Plan, Material mill test reports, Non-destructive examination results / reports, Heat Treatment Certificate/Record, Non-conformance Reports, CHP, Certificate of Conformance (COC) and MDCC.

11.0.0 GENERAL QA REQUIREMENTS

11.1.0 The contractor shall ensure that the works, BOIs and services under the scope of contract whether manufactured or performed within contractor's works or at his sub-contractor's premises or at the NTPC's site or at any other place of work are in accordance with the NTPC technical specification, applicable standards / codes, approved drawings / data sheets / quality plans and BOQ. All the works, BOIs and services shall be carried out as per the best prevalent engineering practices and to the directions of the Engineer-in-Charge.