

IS: 1838 (Part-I)	Specification for preformed fillers for expansion joints in concrete pavements and structures (non-extruding and resilient type).
IS: 2204	Code of practice for construction of reinforced concrete shell roof.
IS: 2210	Criteria for the design of reinforced concrete shell structures and folded plates.
IS: 2438	Specification for roller pan mixer.
IS: 2502	Code of practice for bending and fixing of bars for concrete reinforcement.
IS: 2505	General requirements for concrete vibrators, immersion type.
IS: 2506	General requirements for concrete vibrators, screed board type.
IS: 2514	Specification for concrete vibrating tables.
IS: 2645	Specification for Integral cement water proofing compounds.
IS: 2722	Specification for portable swing weigh batches for concrete. (single and double bucket type)
IS: 2750	Specification for Steel scaffolding.
IS: 2751	Code of practice for welding of mild steel plain and deformed bars for reinforced concrete construction.
IS: 3025	Methods of sampling and test waste water.
IS: 3366	Specification for Pan vibrators.
IS: 3370 (Part I to IV)	Code of practice for concrete structures for the storage of liquids.
IS: 3414	Code of practice for design and installation of joints in buildings.
IS: 3550	Methods of test for routine control for water used in industry.
IS: 3558	Code of practice for use of immersion vibrators for consolidating concrete.
IS: 4014 (Parts I & II)	Code of practice for steel tubular scaffolding.
IS: 4326	Code of practice for earthquake resistant design and construction of buildings.
IS: 4461	Code of practice for joints in surface hydro-electric power stations.
IS: 4656	Specification for form vibrators for concrete.
IS: 4925	Specification for batching and mixing plant.



IS: 4990	Specification for plywood for concrete shuttering work.
IS: 4995 (Parts I & II)	Criteria for design of reinforced concrete bins for the storage of granular and powdery materials.
IS: 5256	Code or practice for sealing joints in concrete lining on canals.
IS: 5525	Recommendations for detailing of reinforcement in reinforced concrete work.
IS: 5624	Specification for foundation bolts.
IS: 6461	Glossary of terms relating to cement concrete.
IS: 6494	Code of practice for water proofing of underground water reservoirs and swimming pools.
IS: 6509	Code of practice for installation of joints in concrete pavements.
IS: 7861	Code of practice for extreme weather concreting. (Parts I & II)
IS: 9012	Recommended practice for shot concreting.
IS: 9103	Specification for admixtures for concrete.
IS: 9417	Recommendations for welding cold worked steel bars for reinforced concrete construction.
IS: 10262	Recommended guidelines for concrete mix design.
IS: 11384	Code of practice for composite construction in structural steel and concrete.
IS: 11504	Criteria for structural design of reinforced concrete natural draught cooling towers.
IS: 12118	Specification for two-parts poly sulphide.
IS: 12200	Code of practice for provision of water stops at transverse contraction joints in masonry and concrete dams.
IS: 13311	Method of non-destructive testing of concrete.
Part-1	Ultrasonic pulse velocity.
Part-2	Rebound hammer.
SP: 23	Handbook of concrete mixes
SP: 24	Explanatory Handbook on IS: 456-1978
SP: 34	Handbook on concrete reinforcement and detailing.

Precast Concrete Works

SP: 7(PartVI/Sec.7) National Building Code- Structural design of prefabrication and



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systems building.

IS: 10297 Code of practice for design and construction of floors and roofs using precast reinforced/prestressed concrete ribbed or cored slab units.

IS: 10505 Code of practice for construction of floors and roofs using pre-cast reinforced concrete units.

Masonry and Allied Works

IS: 1905 Code of Practice for Structural Safety of Buildings-Masonry walls.

IS: 2212 Code of Practice for Brickwork.

IS: 2250 Code of Practice for Preparation and use of Masonry Mortar.

SP: 20 Explanatory hand book on masonry code.

Sheeting Works

IS:277 Galvanised steel sheets (plain or corrugated).

IS: 459 Unreinforced corrugated and semi-corrugated asbestos cement sheets.

IS: 513 Cold-rolled carbon steel sheets.

IS: 730 Specification for fixing accessories for corrugated sheet roofing.

IS: 1626 Specification for Asbestos cement building pipes and pipe fittings, gutters and gutter fittings and roofing fittings.

IS: 2527 Code of practice for fixing rain water gutters and down pipe for roof drainage.

IS: 3007 Code of practice for laying of asbestos cement sheets.

IS: 5913 Methods of test for asbestos cement products.

IS: 7178 Technical supply conditions for tapping screw.

IS: 8183 Bonded mineral wool.

IS: 8869 Washers for corrugated sheet roofing.

IS: 12093 Code of practice for laying and fixing of sloped roof covering using plain and corrugated galvanised steel sheets.

IS: 12866 Plastic translucent sheets made from thermosetting polyester resin (glass fibre reinforced).

IS: 14246 Specification for continuously pre-painted galvanised steel sheets and coils.



Fabrication and Erection of Structural Steel Work

IS: 2016	Specification for plain washers.
IS: 814	Specification for covered Electrodes for Metal Arc Welding for weld steel.
IS: 1852	Specification for Rolling and Cutting Tolerances for Hot rolled steel products.
IS: 3502	Specifications for chequered plate.
IS: 6911	Specification for stainless steel plate, sheet and strip.
IS: 3757	Specification for high strength structural bolts
IS: 6623	Specification for high strength structural nuts.
IS: 6649	High Tensile friction grip washers.
IS: 800	Code of practice for use of structural steel in general building construction.
IS: 816	Code of practice for use of Metal Arc Welding for General Construction.
IS: 4000	Code of practice for assembly of structural joints using high tensile friction grip fasteners.
IS: 9595	Code of procedure of Manual Metal Arc Welding of Mild Steel.
IS: 817	Code of practice for Training and Testing of Metal Arc Welders.
IS: 1811	Qualifying tests for Metal Arc Welders (engaged in welding structures other than pipes).
IS: 9178	Criteria for Design of steel bins for storage of Bulk Materials.
IS: 9006	Recommended Practice for Welding of Clad Steel.
IS: 7215	Tolerances for fabrication steel structures.
IS: 12843	Tolerance for erection of structural steel.
IS: 4353	Recommendations for submerged arc welding of mild steel and low alloy steels.
SP: 6 (Part 1 to 7)	ISI Hand book for structural Engineers.
IS: 1608	Method of Tensile Testing of Steel products other than sheets, strip, wire and tube.
IS: 1599	Method of Bend Tests for Steel products other than sheet, strip, wire and tube



IS : 228	Methods of chemical Analysis of pig iron, cast iron and plain carbon and low alloy steel.
IS : 2595	Code of Practice for Radio graphic testing.
IS : 1182	Recommended practice for Radiographic Examination of fusion welded butt joints in steel plates.
IS : 3664	Code of practice for Ultra sonic Testing by pulse echo method.
IS : 3613	Acceptance tests for wire flux combination for submerged Arc Welding.
IS : 3658	Code of practice for Liquid penetrant Flaw Detection.
IS : 5334	Code of practice for Magnetic Particle Flaw Detection of Welds.

Plastering and Allied Works

IS : 1635	Code of practice for field slaking of Building lime and preparation of putty.
IS : 1661	Application of cement and cement lime plaster finishes.
IS : 2333	Plaster-of-paris.
IS : 2402	Code of practice for external rendered finishes.
IS : 2547	Gypsum building plaster.
IS : 3150	Hexagonal wire netting for general purpose.

Acid and Alkali Resistant Lining

IS : 158	Ready mixed paint, brushing, bituminous, black, lead free, acid, alkali & heat resisting.
IS : 412	Specification for expanded metal steel sheets for general purpose.
IS : 4441	Code of practice for use of silicate type chemical resistant mortars.
IS : 4443	Code of practice for use of resin type chemical resistant mortars.
IS : 4456	Method of test for chemical resistant tiles. (Part I & II)
IS : 4457	Specification for ceramic unglazed vitreous acid resistant tiles.
IS : 4832	Specification for chemical resistant mortars.
	Part I Silicate type
	Part II Resin type
	Part III Sulphur type



IS : 4860	Specification for acid resistant bricks.
IS : 9510	Specification for bitumasitc, Acid resisting grade.

Water Supply, Drainage and Sanitation

IS : 458	Specification for concrete pipes.
IS : 554	Dimensions for pipe threads, where pressure tight joints are made on thread.
IS : 651	Specification for salt glazed stoneware pipes.
IS : 774	Flushing cisterns for water closets and urinals.
IS : 775	Cast iron brackets and supports for wash basins and sinks.
IS : 778	Copperalloy gate, globe and check valves for water works purposes.
IS : 781	Cast copper alloy screw down bib taps and stop valves for water services.
IS : 782	Caulking lead.
IS : 783	Code of practice for laying of concrete pipes.
IS : 1172	Basic requirements for water supply, drainage and sanitation.
IS : 1230	Cast iron rain water pipes and fittings.
IS : 1239	Mild steel tubes, tubulars and other wrought steel fittings.
IS : 1536	Centrifugally cast (Spun) iron pressure pipes for water, gas and sewage.
IS : 1537	Vertically cast iron pressure pipes for water, gas and sewage.
IS : 1538	Cast iron fittings for pressure pipe for water, gas and sewage.
IS : 1703	Ball valves (horizontal plunger type) including float for water supply purposes.
IS : 1726	Cast iron manhole covers and frames.
IS : 1729	Sand cast iron spigot and socket, soil, water and ventilating pipes, fittings and accessories.
IS : 1742	Code of practice for building drainage.
IS : 1795	Pillar taps for water supply purposes.
IS : 1879	Malleable cast iron pipe fittings.
IS : 2064	Code of practice for selection, installation and maintenance of



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	sanitary appliances.
IS : 2065	Code of practice for water supply in building.
IS : 2326	Automatic flushing cisterns for urinals.
IS : 2470 (Part-I & II)	Code of practice for installation of septic tanks.
IS : 2501	Copper tubes for general engineering purposes.
IS : 2548	Plastic seat and cover for water-closets.
IS : 2556 (Part 1 to 15)	Vitreous sanitary appliances (vitreous china).
IS : 2963	Non-ferrous waste fittings for wash basins and sinks.
IS : 3114	Code of practice for laying of cast iron pipes.
IS : 3311	Waste plug and its accessories for sinks and wash basins.
IS : 3438	Silvered glass mirrors for general purposes.
IS : 3486	Cast iron spigot and socket drain pipes.
IS : 3589	Electrically welded steel pipes for water, gas and sewage (200mm to 2000mm nominal diameter).
IS : 3989	Centrifugally cast (Spun) iron spigot and socket soil, waste and ventilating pipes, fittings and accessories.
IS : 4111 (Part I to IV)	Code of practice for ancillary structure in sewerage system.
IS : 4127	Code of practice for laying of glazed stone-ware pipes.
IS : 4764	Tolerance limits for sewage effluents discharged into inland-surface waters.
IS : 4827	Electro plated coating of nickel and chromium on copper and copper alloys.
IS : 5329	Code of practice for sanitary pipe work above ground for buildings.
IS : 5382	Rubber sealing rings for gas mains, water mains and sewers.
IS : 5822	Code of practice for laying of welded steel pipes for water supply.
IS : 5961	Cast iron grating for drainage purpose.
IS : 7740	Code of practice for road gullies.
IS : 8931	Cast copper alloy fancy bib taps and stop valves for water services.



IS : 8934	Cast copper alloy fancy pillar taps for water services.
IS : 9762	Polyethylene floats for ball valves.
IS : 10446	Glossary of terms for water supply and sanitation.
IS : 10592	Industrial emergency showers, eye and face fountains and combination units.
IS : 12592	Specification for precast concrete manhole covers and frames.
IS : 12701	Rotational moulded polyethylene water storage tanks.
SP: 35	Hand book on water supply and drainage.
-	Manual on Sewerage and sewage treatment (Published by CPH & EEO) As updated.

Doors, Windows and Allied Works

IS : 204	Tower Bolts
Part-I	Ferrous metals.
Part-II	Nonferrous metals.
IS : 208	Door Handles.
IS : 281	Mild steel sliding door bolts for use with padlocks.
IS : 362	Parliament Hinges.
IS : 420	Specification for putty, for use on metal frames.
IS : 1003 Part-I door	Specification for timber panelled and glazed shutters- (Part-I) shutters.
IS : 1038	Steel doors, windows and ventilators.
IS : 1081	Code of practice for fixing and glazing of metal (steel and aluminium) doors, windows and ventilators.
IS : 1341	Steel butt hinges.
IS : 1361	Steel windows for industrial buildings.
IS : 1823	Floor door stoppers.
IS : 1868	Anodic coatings on Aluminium and its alloys.
IS : 2202 (Part-II)	Specification for wooden flush door shutters (solid core type); particle board face panels and hard board face panels
IS:2209	Mortice locks (vertical type).



IS:2553	Safety glass
IS:2835	Flat transparent sheet glass.
IS:3548	Code of practice for glazing in buildings.
IS:3564	Door closers (Hydraulically regulated).
IS : 3614	Fire check doors; plate, metal covered and rolling type.
IS:4351	Steel door frames.
IS:5187	Flush bolts.
IS:5437	Wired and figured glass
IS:6248	Metal rolling shutters and rolling grills.
IS:6315	Floor springs (hydraulically regulated) for heavy doors.
IS:7196	Hold fasts.
IS:7452	Hot rolled steel sections for doors, windows and ventilators.
IS:10019	Mild steel stays and fasteners.
IS:10451	Steel sliding shutters (top hung type).
IS:10521	Collapsible gates.

Roof Water Proofing and Allied Works

IS:1203	Methods of testing tar and bitumen.
IS:1322	Specification for bitumen felts for water proofing and damp proofing.
IS:1346	Code of practice for water proofing of roofs with bitumen felts.
IS:1580	Specification for bituminous compound for water proofing and caulking purposes.
IS:3067	Code of practice for general design details and preparatory work for damp proofing and water proofing of buildings.
IS:3384	Specification for bitumen primer for use in water proofing and damp proofing.

Floor Finishes and Allied Works

IS:1237	Specification for cement concrete flooring tiles.
IS:1443	Code of practice for laying and finishing of cement concrete flooring tiles.
IS:2114	Code of practice for laying in-situ terrazzo floor finish.
IS:2571	Code of practice for laying in-situ cement concrete flooring.



IS:3462	Specification for unbacked flexible PVC flooring.
IS:4971	Recommendations for selection of industrial floor finishes.
IS:5318	Code of practice for laying of flexible PVC sheet and tile flooring.
IS:8042	Specification for white portland cement.
IS:13801	Specification for chequered cement concrete flooring tiles.

Painting and Allied Works

IS:162	Specification for fire resisting silicate type, brushing, for use on wood, colour as required.
IS:1477	Code of practice for painting of ferrous metals in buildings.
Part-I	Pretreatment.
Part-II	Painting.
IS:1650	Specification for colours for building and decorative finishes.
IS:2074	Specification for red oxide-zinc chrome, priming, ready mixed paint air drying.
IS:2338	Code of practice for finishing of wood and wood based materials.
Part-I	Operations and workmanship
Part-II	Schedules
IS:2395	Code of practice for painting concrete, masonry and plaster surfaces.
Part-I	Operations and workmanship.
Part-II	Schedule.
IS:2524	Code of practice for painting of nonferrous metals in buildings.
Part-I	Pretreatment.
Part-II	Painting.
IS:2932	Specification of synthetic enamel paint, exterior, under-coating and finishing.
IS:2933	Specification enamel paint, under coating and finishing.
IS:4759	Code of practice for hot dip zinc coating on structural steel and other allied products.
IS:5410	Specification for cement paint



IS:5411 (Part-I)	Specification for plastic emulsion paint-for exterior use
IS:6278	Code of practices for white washing and colour washing.
IS:10403	Glossary of terms relating to building finishes.

Piling and Foundation

IS:1080	Code of practice for design and construction of simple spread foundations.
IS:1904	Code of practice for design and construction of foundations in Soils; General Requirements.
IS:2911	Code of practice for designs and construction of Pile foundations (Relevant Parts).
IS:2950 (Part-I)	Code of practice for designs and construction of Raft foundation.
IS:2974 (Part-I TO V)	Code of practice for design and construction of machine foundations.
IS:6403	Code of practice for determination of Allowable Bearing pressure on Shallow foundation.
IS:8009	Code of practice for calculation of settlement of foundation subjected to symmetrical vertical loads.
Part-I	Shallow foundations.
Part-II	Deep foundations.
IS:12070	Code of practice for design and construction of shallow foundations on rocks.
DIN:4024	Flexible supporting structures for machines with rotating machines.
VDI:2056	Criteria for assessing mechanical vibrations of machines.
VDI:2060	Criteria for assessing rotating imbalances in machines. Stop Log and Trash Rack
IS:4622	Recommendations for fixed - wheel gates structural design.
IS:5620	Recommendations for structural design criteria for low head slide gates.
IS:11388	Recommendations for design of trash rack for intakes.
IS:11855	General requirements for rubber seals for hydraulic gates. Roads
IRC:5	Standard specifications and Code of practice for road bridges, section-I general Features of Design.



IRC:14	Recommended practice of 2cm thick bitumen and tar carpets.
IRC:16	Specification for priming of base course with bituminous primers.
IRC:19	Standard specifications and code of practice for water bound macadam.
IRC:21	Standard specifications and Code of practice for road bridges, section-III - Cement concrete (plain and reinforced).
IRC:34	Recommendations for road construction in waterlogged areas.
IRC:36	Recommended practice for the construction of earth embankments for road works.
IRC:37	Guidelines for the Design of flexible pavements.
IRC:56	Recommended practice for treatment of embankment slopes for erosion control.
IRC:73	Geometric design standards for rural (non-urban) highways.
IRC:86	Geometric Design standards for urban roads in plains.
IRC:SP:13	Guidelines for the design of small bridges & culverts.
IRC - Publication	Ministry of Surface Transport (Roads Wing), Specifications for road and bridge works.
IS:73	Specification for paving bitumen
Loadings	
IS:875 (Pt. I to V)	Code of practice for design loads other than earthquake) for buildings and structures.
IS:1893	Criteria for earthquake resistant design of structures.
IS:4091	Code of Practice for design and construction of foundation for transmission line towers & poles.
IRC:6	Standard specifications & code of practice for road bridges, Section-II Loads and stresses.
M.O.T.	Deptt. of railways Bridge Rules.
Safety	
IS:3696 (Part I & II)	Safety code for scaffolds and ladders.
IS:3764	Safety code for excavation work.
IS:4081	Safety code for blasting and related drilling operations.
IS:4130	Safety code for demolition of buildings.



IS:5121	Safety code for piling and other deep foundations.
IS:5916	Safety code for construction involving use of hot bituminous materials.
IS:7205	Safety code for erection on structural steelwork.
IS:7293	Safety code for working with construction machinery.
IS:7969	Safety code for handling and storage of building materials
IS:11769	Guidelines for safe use of products containing asbestos.
-	Indian Explosives Act. 1940 as updated.

Architectural design of buildings

SP:7	National Building Code of India
SP:41	Hand book on functional requirements of buildings (other than industrial buildings)

Miscellaneous

IS:802	Code of practice for use of structural steel in (Relevant parts) overhead transmission line towers.
IS:803	Code of practice for design, fabrication and erection of vertical mild steel cylindrically welded in storage tanks.
IS:10430	Criteria for design of lined canals and liner for selection of type of lining.
IS:11592	Code of practice for selection and design of belt conveyors.
IS:12867	PVC handrails covers.
CIRIA	Design and construction of buried thin-wall pipes. Publication

REFERENCE CODES AND STANDARDS FOR CONTROL AND INSTRUMENTATION

The design, manufacture, inspection, testing & installation of all equipment and system covered under this specification shall conform to the latest editions of codes and standards mentioned below and all other applicable VDE, IEEE, ANSI, ASME, NEC, NEMA, ISA AND Indian Standards and their equivalents.

Temperature Measurements

1. Instrument and apparatus for temperature measurement - ASME PTC 19.3 (1974).
2. Temperature measurement - Thermocouples ANSI MC 96.1 - 1982.
3. Temperature measurement by electrical Resistance thermometers - IS:2806.
4. Thermometer - element - Platinum resistance - IS:2848.

Pressure Measurements

1. a) Instruments and apparatus for pressure measurement - ASME PTC 19.2 (1964).



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- b) Electronic transmitters BS:6447.
- 2. Bourdon tube pressure and vacuum gauges - IS:3624 - 1966.
- 3. Process operated switch devices (Pr. Switch) BS-6134.

Flow Measurements

Instruments and apparatus for flow measurements - ASME PTC 19.5 (1972) Interim supplement, Part-II.

Measurement of fluid flow in closed conduits - BS-1042.

Electronic Measuring Instrument & Control Hardware/ Software

1. Automatic null balancing electrical measuring instruments - ANSI C 39.4 (Rev. 1973): IS:9319.
2. Safety requirements for electrical and electronic measuring and controlling instrument - ANSI C 39.5 - 1974.
3. Compatability of analog signals for electronic industrial process instruments - ISA - S 50.1 (1982) ANSI MC 12.1 - 1975.
4. Dynamic response testing of process control instrumentation ISA - S 26 (1968).
5. Surge Withstand Capability (SWC) tests - ANSI C 37.90 a/IEEE-472 or suitable class of IEC-255-4 equivalent to ANSI C37.90a/IEEE-472.
6. Printed circuit boards - IPC TM - 650, IEC 326 C.
7. General requirement and tests for printed wiring boards - IS 7405 (Part-I) 1973.
8. Edge socket connectors - IEC 130-11.
9. Requirements and methods of testing of wire wrap terminations DIN 41611 Part-2.
10. Dimensions of attachment plugs & receptacles - ANSI C 73 - 1973 (Supplement ANSI C 73 a - 1980).
11. Direct acting electrical indicating instrument - IS:1248 - 1968 (R).
12. Standard Digital Interface for Programmable Instrumentation - IEEE-488.2 - 1990.
13. Information Processing Systems - Local Area Networks - Part 2 : Logical Link Control - IEEE-802.2 - 1989.
14. Standard for Local Area Networks : Carrier Sense Multiple Access with Collision Detection - IEEE-802.3 - 1985.
15. Supplements A, B, C and E to Carrier Sense Multiple Access with Collision Detection - IEEE-802.3 - 1988.



16. Standard for Local Area Networks : Token - Passing Bus Access Method - IEEE-802.4 - 1985.
17. Standard for Local Area Networks : Token - Ring Access Method and Physical Layer Specification - IEEE-802.5 - 1985.
18. IEEE Guide to Software Requirements Specifications - IEEE-830 - 1984.
19. Hardware Testing of Digital Process Computers - ISA RP55.1 - 1983.
20. Electromagnetic Susceptibility of Process Control Instrumentation - SAMA PMC 33.1 - 1978.
21. Interface Between the Data Terminal Equipment and Data Circuit - Terminating Equipment Employing Serial Binary Data Interchange - EIA-232- D-1987.
22. Electromagnetic Compatibility for Industrial Process Measurement and Control Equipment, Part 3 : Radiated Electromagnetic Field Requirements - IEC 801-3-1984.

Instrument Switches and Contact

1. Contact rating - AC services NEMA ICS 2 - 1978 (with revision through May 1983), Part - 2-125, A6000.
2. Contact rating - DC services NEMA ICS 2-1978 Part-2 125, N600.

Enclosures

1. Type of Enclosures - NEMA ICS Part - 6 - 1978 (with Rev. 1 4/80) through 110.22 (Type 4 to 13).
2. Racks, panels and associated equipment - EIA : RS - 310 C- 1983 (ANSI C 83.9 - 1972).
3. Protection class for Enclosures, cabinets, control panels & desks - IS:2147 - 1962.

Apparatus, enclosures and installation practices in hazardous area

1. Classification of hazardous area - NFPA 70 - 1984, Article 500.
2. Electrical Instruments in hazardous dust location - ISA - 512.11, 1973.
3. Intrinsically safe apparatus - NFPA 493 1978.
4. Purged and pressurised enclosure for electrical equipment in hazardous location - NFPA 496-1982.
5. Enclosures for Industrial Controls and Systems - NEMA IS 1.1 - 1977.

Sampling System

1. Stainless steel material of tubing and valves for sampling system - ASTM A 296-82, Grade 7 P 316.
2. Submerged helical coil heat exchangers for sample coolers ASTM D11 92-1977.



3. Water and steam in power cycle - ASME PTC 19.11.
4. Standard methods of sampling system - ASTM D 1066-99.

Annunciators

1. Specifications and guides for the use of general purpose annunciators - ISA S 19.1, 1979.
2. Surge withstand capability tests - ANSI C 37.90a - 1989/IEEE-472 or suitable class of IEC 255-4 equivalent to ANSI C37.90a 1989/IEEE-472
3. Damp heat cycling test - IS:2106
4. Specification for Electromagnetic Susceptibility - SAMA DMC 33, 1/78

Protections

1. Relays and relay system associated with electric power apparatus. ANSI C 37.90, 1 - 1989.
2. General requirements & tests for switching devices for control and auxiliary circuits including contactor relays - IS:6875 (Part-I) - 1973.
3. Turbine water damage prevention - ASME TDP-1-1980.
4. Boiler safety interlocks - NFPA Section 85 B - 1984, 85 C - 1991.

UPS System

1. Practices and requirements for semi-conductor power rectifiers - ANSI C 34.2, 1973.
2. Relays and relays system associated with electrical power apparatus - ANSI C 3.90 - 1983.
3. Surge withstand capability test - ANSI C 37.90 1 -1989.
4. Performance testing of UPS - IEC 146.
5. Stationary cells & Batteries Lead Acid type (with tubular positive plates) specification IS-1651-1991.
6. Recommended practice for sizing large lead storage batteries for generating stations & sub-stations - IEEE-485-1985.
7. Printed Circuit Board - IPC TM 650, IEC 326C.
8. General Requirements & tests for printed wiring boards, IS:7405 (Part-I) 1973.

Control Valves

1. Control valve sizing - Compressible & Incompressible fluids - ISA S 75.01-1985.
2. Face to face dimensions of control valves - ANSI B 16.00 - 1973.
3. ISA Hand Book of Control Valves - (ISBN : B: 1047-087664-234-2).



4. Codes for pressure piping - ANSI B 31.1
5. Control Valve leak class - ISA RP 39.6

Process Connection & Piping

1. Codes for pressure piping "power piping" - ANSI B 31.1.
2. Seamless carbon steel pipe ASTM - A - 106.
3. Forged & Rolled Alloy steel pipe flanges, forged fittings and valves and parts - ASTM - A - 182.
4. Material for socket welded fittings - ASTM - A - 105.
5. Seamless ferritic alloy steel pipe - ASTM - A - 335.
6. Pipe fittings of wrought carbon steel and alloy steel - ASTM - A - 234.
7. Composition bronze of metal castings - ASTM - B - 62.
8. Seamless Copper tube, bright annealed - ASTM - B - 168.
9. Seamless copper tube - ASTM - B - 75.
10. Dimension of fittings - ANSI - B - 16.11.
11. Valves flanged and butt welding ends - ANSI - B - 16.34.

Instrument Tubing

1. Seamless carbon steel pipe - ASTM - A 106.
2. Material of socketweld fittings - ASTM - A105.
3. Dimensions of fittings - ANSI - B - 16.11.
4. Code for pressure piping, welding, hydrostatic testing - ANSI B 31.1.

Cables

1. Thermocouples extension wires/cables - ANSI MC 96.1 - 1992.
2. Requirements for copper conductor-Wiring cables for telecommunications & information processing system - VDE:0815.
3. Colour coding of single or multi-pair cables - ICEA - S - 61-402 (third edition) NEMA WCS - 1979 with revisions thorough 2/83.
4. Insulation & Sheathing compounds for cables : VDE 0207 (Part-4, 5 & 6).
5. Guide design and installation of cable systems in power generating stations (insulation, jacket materials) - IEEE Std. 422-1977.
6. Rules for Testing insulated cables and flexible cables : VVDE - 0472
7. Requirements of vertical flame propagation test - IEEE 383 - 1974 (R 1980)
8. Standard specification for tinned soft or annealed copper wire for electrical purpose



- ASTM B-33-81.
- 9. Oxygen index and temperature index test - ASTM D - 2863.
- 10. Smoke density measurement test - ASTM D - 2843.
- 11. Acid gas generation test - IEC - 754 - 1.
- 12. Swedish Chimney test - SEN - 4241475 (F3).
- 13. Teflon (FEP) insulation & sheath test - ASTM D - 2116.
- 14. Thermocouple compensating cables - Testing requirements & sampling plan IS:8784.
- 15. PVC insulated electric cables for working voltage upto and including 1100 V - IS:1554 (Part-I).

Cable Trays, Conduits

1. Guide for design and installation of cable systems in power generating station (Cable trays, support systems, conduits) - IEEE Std. 422, 1977, NEMA VE-1 1979, NFPA 70-1984.
2. -do- Test Standards. NEMA VE-1-1979.
3. Zinc coating "hot dip" on assembled products for galvanising of carbon steel cable trays - ASTM A - 386-78.

Public Address System

1. Specifications for loud speakers - IS:7741 (Part-I, II and III)
2. Code of safety requirement for electric mains operated audio amplifiers - IS:1301
3. Specification for Public Address Amplifiers - IS:10426.
4. Code of practice for outdoor installation of PA system - IS:1982.
5. Code of practice for installation for indoor amplifying and sound distribution system - IS:1881.
6. Basic environmental testing procedures for electronic and electrical items - IS:9000.
7. Characteristics and methods of measurements for sound system equipment - IS:9302
8. Code of practice of electrical wiring installations (System voltage not exceeding 650 volts) - IS:732
9. Rigid steel conduits for electric wiring - IS:9537 (Part-I and II)
10. Fittings for rigid steel conduits for electrical wiring - IS:2667
11. Degree of protection provided by enclosure for low voltage switchgear and control gear - IS:2147.



Vibration Monitoring System

1. API 670 - 1994
2. BS : 4675 Part-2



ANNEXURE-I

MFGR.'s LOGO		MANUFACTURER'S NAME AND ADDRESS		MANUFACTURING QUALITY PLAN						PROJECT :															
				SUB-SYSTEM:		ITEM :		ACCEPTANCE NORMS	REFERENCE DOCUMENT	QUANTUM OF CHECK	TYPE OF CHECK	CLASS	CHARACTERI STICS	COMPONENT & OPERATIONS	CHARACTERI STICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	AGENCY	REMARKS		
						QP NO.:	REV.NO:																	DATE:	PAGE: ... OF....
1.		2.		3.		4.		5.		6.		7.		8.		9.		10.		11.					
LEGEND: * RECORDS, IDENTIFIED WITH "TICK" (✓) SHALL BE ESSENTIALLY INCLUDED BY SUPPLIER IN QA DOCUMENTATION. ** M: MANUFACTURER/SUB-SUPPLIER C: SUPPLIER/NOMINATED INSPECTION AGENCY, N: THE OWNER P: PERFORM W: WITNESS AND V: VERIFICATION. AS APPROPRIATE, CHP: THE OWNER SHALL IDENTIFIED IN COLUMN "N"																								DOC. NO.: REV..... CAT.....	
MANUFACTURER/ SUB-SUPPLIER		MAIN-SUPPLIER		SIGNATURE		FOR THE OWNER USE		REVIEWED BY		APPROVED BY		APPRO VAL SEAL													



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ANNEXURE-II

SUPPLIER'S LOGO		SUPPLIER'S NAME AND ADDRESS		FIELD QUALITY PLAN						PROJECT : PACKAGE : CONTRACT NO. : MAIN-SUPPLIER:					
				ITEM :		QP NO.:		REV.NO.:						DATE:	
				SUB-SYSTEM :		PAGE: OF....									
S. NO	ACTIVITY AND OPERATION	Characteristics / instruments	CLASS# OF CHECK	TYPE OF CHECK	QUANTUM OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	REMARKS						
1.	2.	3.	4.	5.	6.	7.	8.	9.	10.						
LEGEND: * RECORDS, IDENTIFIED WITH "TICK" (✓) SHALL BE ESSENTIALLY INCLUDED BY SUPPLIER IN QA DOCUMENTATION. LEGEND TO BE USED: CLASS #: A = CRITICAL, B=MAJOR, C=MINOR; 'A' SHALL BE WITNESSED BY THE OWNER FQA, 'B' SHALL BE WITNESSED BY OWNER'S ERECTION / CONSTRUCTION DEPTT. AND 'C' SHALL BE WITNESSED BY ERECTION SUPPLIER (A & B CHECK SHALL BE OWNER CHP STAGE)												DOC. NO.:			
MANUFACTURER/SUB-SUPPLIER SIGNATURE		MAIN-SUPPLIER		FOR THE OWNER USE		REVIEWED BY		APPROVED BY		APPROVAL SEAL					



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ANNEXURE-III

Project Package Supplier Bidder No.		Stage :		LIST OF ITEMS REQUIRING QUALITY PLAN AND SUB-SUPPLIER APPROVAL				DOC. NO.:	
								REV. NO.:	
								DATE :	
				SUB-SYSTEM:				PAGE : OF	
S. N.	Item	QP/ Insp. Cat.	QP No.	QP Sub. Schedule	Proposed sub-supplier	Place	Sub-suppliers approval status / category	Sub-supplier Details submission schedule	Remarks

LEGENDS

1. SYSTEM SUPPLIER/SUB-SUPPLIER APPROVAL STATUS CATEGORY (SHALL BE FILLED BY the Owner)

A – For these items proposed vendor is acceptable to the Owner. To be indicated with letter "A" in the list alongwith the condition of approval, if any.

DR – For these items "Detailed required" for the Owner review. To be identified with letter "DR" in the list.

NOTED – For these items vendors are approved by Main Supplier and accepted by the Owner without specific vendor approval from the Owner. To be identified with "NOTED."

2. QP/INSPN CATEGORY :

CAT-I: For these items the Quality Plans are approved by the Owner and the final acceptance will be on physical inspection witness by the Owner.

CAT-II: For these items the Quality Plans approved by the Owner. However no physical inspection shall be done by the Owner. The final acceptance by the Owner shall be on the basis review of documents as per approved QP.

CAT-III: For these items Main Supplier approves the Quality Plans. The final acceptance by the Owner shall be on the basis certificate of conformance by the main supplier.

UNITS/WORKS: Place of manufacturing Place of Main Supplier of multi units/works.

[illegible]

ANNEXURE-V

Project : Stage :		FIELD WELDING SCHEDULE (To be raised by the Bidder)				DOC. NO.:									
Bidder :		Welding Code:				REV. NO.:									
Bidder No. :						DATE :									
System :						PAGE : OF									
Sl. No.	DRG No. for Weld Location and Identification mark	Description of parts to welded	Matl. Spec.	Dimensions	Processes of welding	Type of Weld	Electrode filler spec.	WPS. No.	Min. pre-heat	Heat treatment		NDT method/Quantum	REF		Remarks
										Temp.	Holding time		Spec No.	ACC Norm Ref.	
NOTES:															
SIGNATURE															



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ANNEXURE-VI
DOCUMENTS DISTRIBUTION SCHEDULE

S.No.	Description of Document	DESEIN				UPRVUNL			
		HO		SITE		HO		SITE	
		HC	CC	HC	CC	HC	CC	HC	CC
1.	Drawings, Data Sheets, Calculation, all equipment / Instrument Schedule, BOM etc. a) For Approval b) Resubmission c) For Information	6*	1	-	-	2	1	-	-
2.	Final Approved Documents	2	1 + 1 CD	1	1	1	1 + 2 CD	4	1 + 1 CD
3.	Drawings / Documents 'As Built'	2	1 + 1 CD	1	1	2	1 + 2 CD	4	1 + 1 CD
4.	Type Test Reports (Initial)	4*	1 + 1 CD	-	-	2	1 + 2 CD	-	-
5.	Type Test Report (Final)	2	1 + 1 CD	1	1	2	1 + 2 CD	4	1 + 1 CD
6.	Piping / Equipment Analysis (Transient) etc., Model Study Report (Draft) including Input / Output date etc.	4*	1	-	-	2	1 + 1 CD	-	-
7.	Piping / equipment Analysis (Transient) etc. Model Study Report (Final Approval) including Input / Output date	2	1 + 1 CD	-	-	2	1 + 2 CD	2	1 + 1 CD
8.	Erection Manual (Draft)	3*	1CD	-	-	1	1CD	-	-



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S.No.	Description of Document	DESEIN						UPRVUNL					
		HO		SITE		HO		HO		SITE		SITE	
		HC	CC	HC	CC	HC	CC	HC	CC	HC	CC	HC	CC
9.	Erection Manual 'Final'	1	1CD	1	-	1	-	1	1CD	2	1CD	2	1CD
10.	O&M Manual 'Draft'	3*	1CD	+	-	1	-	1	1CD	-	-	-	-
11.	O&M Manual 'Final'	1	1CD	1	-	1	-	1	1CD	2	1CD	2	2CD
12.	Commissioning Procedure 'Draft'	3*	1CD	-	-	1	-	1	1CD	-	-	-	-
13.	Commissioning Procedure 'Final'	1	1CC	1	-	1	-	1	1CD	2	1CD	2	1CD
14.	PG Test Procedure "Draft"	3*	1	-	-	1	-	1	1	-	-	-	-
15.	PG Test Procedure 'Final'	1	1 + 1 CD	1	-	2	1 + 1 CD	2	1 + 1 CD	2	1 + 1 CD	2	1 + 1 CD
16.	Progress Report	3	1CD	1	-	2	-	2	1CD	1	1CD	1	1CD
17.	PG Test Report for Approval	4*	1	-	-	2	-	2	1 + 1 CD	-	-	-	-
18.	Approved PG Test Report	1	1 + 1 CD	1	-	2	-	2	1 + 1 CD	4	1 + 1 CD	4	1 CD
19.	Project Completion Report	1	1 + 1 CD	1	-	1	-	1	1CD	1	1CD	1	1CD
20.	Vendor Details in respect of proposed vendors including Contractor's evaluation Report	1	1CD	-	-	1	-	1	1CD	-	-	-	-
21.	Monthly Vendor / QP Approval Status	1	1	-	-	2	-	2	1	1	1	1	1
22.	Manufacturing QPs, Field QPs for review / comments	6*	1	-	-	2	-	2	1CD	-	-	-	-
23.	Manufacturing QPs, Field QP, Final	1	1CD	1	-	2	-	2	1CD	2	1CD	2	1CD
24.	QA documents Package for equipment / field activities etc.	1	1CD	1	-	1	-	1	1CD	1	1CD	1	1CD



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* -

HC -

CC -

CD -

HO -

Consultant will return one (1) commented document to Vendor and CE (UPRVUNL), Lucknow

Hard Copy

Soft Copy thru e-mail

CD ROM

Head Office of Consultant / UPRVUNL

ANNEXURE-VII

PRODUCT	AREAS OF TRAINING REQUIREMENT			Operation & Maintenance Of Plant
	Product Design	Plant Visit	Visit To Manufacturer's Work	
STEAM GENERATOR	Thermal design and hydraulic circulation balance	Familiarization with various system and equipment	Manufacturing processes of pressure parts, and equipments	Control philosophy operation, notices, logic & protection schemes, O&M manual familiarization O&M issues
	Combustion and Air & gas weight calculation	Performance data collection analysis and review	Welding process	
	Pressure part calculation	O&M feed back	Testing facilities	Familiarization of special maintenance techniques.
	Pressure part and strength calculation	Operation history of various equipment and system	Product development in process	Special tool and tackles familiarization
	Tube metal temp. Calculation and selection.	Failure analysis	Future plan for technology induction	
	Performance calculation		R&D work in-progress	
	Duct design.			
	Pressure part			
	Equipment and system sizing and selection of mills, fans, airpreheater, soot blowers, dampers, valves heater, soot blowers, dampers, valves, feeders, burners start-up system, fuel firing system, draft plant			
	Flow scheme development of air & flue gas, fuel oil, auxiliary steam, main and reheat steam feed water.			



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ANNEXURE-VII

PRODUCT	AREAS OF TRAINING REQUIREMENT			Operation & Maintenance Of Plant
	Product Design	Plant Visit	Visit To Manufacturer's Work	
	Layout of overall plant, steam generator area, pressure part arrangements, platforms, equipment, piping and duct, coal pipe, flue gas ducts, bunker arrangement, valves and damper, ESP area, cable & piping tressels etc. Erection strategies, erection procedures Performance and demonstration tests.			
MANDAYS	120	20	20	20
CFD model development and validation for Steam Generator	Familiarisation of fundamentals and basis for the development of the CFD models. Solving of set of simple problems by Owner's engineers with the help of trainer. Hands on experience on the development of detailed/realistic CFD models for the steam generator and ESP. The Bidder/trainer shall develop CFD models for SG & ESPs per the Contract requirement with complete association of the Owner's engineers. Validation of the above CFD model for SG & ESP by Bidder in association with the Owner's Engineers.			
MANDAYS	120 for SG and 60 for ESP	-	-	-



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ANNEXURE-VII

PRODUCT	AREAS OF TRAINING REQUIREMENT			Visit To Manufacturer's Work Of Plant	Operation & Maintenance Of Plant
	Product Design	Plant Visit	Visit To Manufacturer's Work Of Plant		
TURBINE GENERATOR AND IT'S INTEGRAL AUXILIARIE S	Turbine cycle optimization and turbine performance in off design condition.	Familiarization of power plants of various makes of turbines for super critical units	Manufacturing processes of turbine		
	Rotor design and strength calculation	Collection of data for analysis of availability of turbines	Assembly of turbine		
	Rotor dynamic behaviour studies wrt natural frequency, critical speed, vibration etc.	Comparative studies for integral systems of turbine	Testing of turbines		
	Blade profile/root design and blade strength design, blade vibration analysis	O&M history/problems related to turbine	Product development in process		
	Casing & diaphragm design	Failure analysis	Future plan for technology induction		
	Labyrinth seal selection & design for different turbine configurations		R&D work in progress		
	Selection of turbine type (i.e. Tandem vs. cross compounding, separate HP/IP vs. combined HP/IP, material of construction etc.)				
	Design principle for Up rating/down rating of existing design/ modules for the specific project.				
	Selection of nos., type and arrangement of bearings, load calculation on bearings, bearing oil flow calculation				
	Selection, design and control principle for Turbine governing system				



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ANNEXURE-VII

PRODUCT	AREAS OF TRAINING REQUIREMENT			Operation & Maintenance Of Plant
	Product Design	Plant Visit	Visit To Manufacturer's Work	
MANDAYS	Performance calculation			
	Steam path audit			
	Layout principle of various equipment's of TG and its integral system			
	Latest technological advancements			
	45	10	10	
Boiler Feed Pumps	Techno-economic studies for Selection of BFP Configuration and its drive	Familiarization of power plants of various makes of feed pumps	Manufacturing process of various components of BFP	
	Criteria for selection of boiler Feed Pump parameters	Data collection of BFP parameters and configuration	Assembly of BFP	
	Rotor design, strength calculation and rotor dynamic behavior studies wrt critical speed, vibration etc	Collection of data for analysis of availability of BFP	Testing, capabilities of BFP at works wrt performance, NPSH, thermal shock, dry run, visual cavitation, string test, axial thrust measurement	
	Impeller design and its hydraulic behavior	O&M history/problems related to BFP	Product development in process	
	Role of critical parameters such as NPSH(R), Suction specific speed, running clearances, speed etc. in design of feed pumps	Comparative studies for various types of BFP & its features	Future plan for technology induction	
	Material selection of BFP components			
	Guiding factors for selection of BFP seals		R&D work in progress	

ANNEXURE-VII

PRODUCT	AREAS OF TRAINING REQUIREMENT			Operation & Maintenance Of Plant
	Product Design	Plant Visit	Visit To Manufacturer's Work	
MANDAYS	Computation of axial thrust under various flows			
	Performance calculation			
	Transient analysis in pump suction piping wrt NPSH margin			
	Latest technological trends in BFP design			
	20	5	10	
Condenser	Selection of condenser type and its optimization wrt temp rise across condenser, pressure drop in condenser, surface area etc.	Comparative studies of salient features	Manufacturing process of various components of condenser Assembly	
	Techno economic studies for Selection of condenser tube material and other parts depending on water quality	Collection of data for analysis of availability of Condenser	Testing capability at works	
	Condenser support selection & design	O&M history/problems related to condenser	Product development in process	
	Sizing of condenser w.r.t. super critical units		Future plan for technology induction	
	Latest technological trends in condenser arrangement and design		R&D work in progress	
MANDAYS	Condenser vacuum system design			
	10	5	5	
Feed Regenerative Equipment'	Thermal and mechanical design calculation of heaters	Comparative studies of salient features	Manufacturing process of various components of heaters	
	Basis of selecting horizontal/vertical	Analysis of data	Assembly	



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ANNEXURE-VII

PRODUCT	AREAS OF TRAINING REQUIREMENT			Operation & Maintenance Of Plant
	Product Design	Plant Visit	Visit To Manufacturer's Work	
s	heaters			
	Selection of TTD and DCAs for various heaters, and their effect on turbine heat rate	O&M history/problems related to heaters	Testing capability at works	
	Configuration of HP heaters (2x50% v/s100% capacity		Product development in process	
	Sizing criteria for De- aerator/Heaters		Future plan for technology induction	
	Selection of tube & tube sheet material of heaters		R&D work in progress	
MANDAYS	Latest technological trends in heaters design			
	15	10	10	
3-dimen- sional CFD modelling	CFD model develop ment and validation of design data for steam turbine, BFP, CEP, condenser, heaters etc.			
MANDAYS	20			
Training for Balance of Plant Equipment	120	40	40	40
The details of training modules for various BoP equipments & systems shall be decided during detailed engineering.				



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CONTROL & INSTRUMENTATION				
DDCMIS-Man Machine Interface - Hardware & Operating System	Hardware & Software organization of the system Basis of selection of H/W memory sizing Operating system features, interface with other system, openness & inter- operability Upgradability System testing features	Operational feedback		
MANDAYS	16	6		
DDCMIS-Man Machine Interface System Engineering & Application Software	Specific system customization Various system modules & interface with OS Database organization & development Development of mimics Other application like calculations, logs historical storage functionalities & use	Operation feedback		
MANDAYS	40	6		
DDCMIS - Control System Hardware	Basic design features for system & its modules System capabilities & system design techniques Communication with MMI & other system	Operation feedback Manufacturing processes special attention to handling of the modules Maintenance facilities		
MANDAYS	20	5	10	



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ANNEXURE-VII

PRODUCT	AREAS OF TRAINING REQUIREMENT			Visit To Manufacturer's Work	Operation & Maintenance Of Plant
	Product Design	Plant Visit			
DDCMIS- Control system Application Software	Database structure Organisation & inter- face between application program & database	Operational feedback		System integration & System capabilities testing	
	Application for implementation of Control functions				
	Study of standard algorithms & development of new algorithms				
	12		4		
DDCMIS - Control Loop Study	General description of closed loop controls of thermal power plant	Specific operational feedback			
	Critical analysis of few control loops e.g., TSCS Stress Control boiler start-up control etc.				
MANDAYS	4	2			
DDCMIS- Burner Management System	Hardware logic, NFPA/ VDE requirements other safety standard	Operational feedback		Manufacturing procedure& precautions for handling the system System testing facilities	
	Flame scanner location				
MANDAYS	10	3		3	
DDCMIS - EHTC, Turbine stress control system,	Basic design concept& features	Operational feedback		Manufacturing procedure & precautions for handling the system System testing facilities	
	Logics of turbine stress control system				

ANNEXURE-VII

PRODUCT	AREAS OF TRAINING REQUIREMENT			Operation & Maintenance Of Plant
	Product Design	Plant Visit	Visit To Manufacturer's Work	
Turbine protection system & ATRS	Implementation of failsafe philosophy in turbine protection system			
MANDAYS	10	3	3	
Furnace and Flame Viewing System.	Theory & principle of operation Details of software & methods of modification/ customisation	Operational feedback		
Misc. systems for SG/TG C&I				
Electric Power Supply System	Theory & design features		Manufacturing/assembly process	
Wherever "DDCMIS" is indicated, it will mean SG C&I part of DDCMIS, which is in Contractor's Scope.				
QUALITY ASSURANCE & INSPECTION QA SYSTEM & PROGRAMME	Integrated QA Management System for enhanced reliability of equipments	Operational feedback Co-relation of reliability and performance of the equipment with implementation of QA system.	Appreciation of implementation of QA Programmes in various manufacturing, assembly and testing activities.	
	QA system in design, procurement, manufacturing, installation and operation of the equipments/ systems			
	QA system for developing and establishing new processes and vendors.	Appreciation of use of	Appreciation of developmental	

ANNEXURE-VII

PRODUCT	AREAS OF TRAINING REQUIREMENT			Operation & Maintenance Of Plant
	Product Design	Plant Visit	Visit To Manufacturer's Work	
		structured Engg./QA documentation during Operational phase of plant and during RLA studies of plant	activities for new processes and vendors. System of prequalification of special processes	
MANDAYS	System of structured documentation of Engg. And test records 16	3		
PLC	Hardware organization		Manufacturing process of PLC hardware Integration & testing facilities	
	Operating system features			
	Data base organization			
	Logic/loop algorithm			
	Development of control logic & loop s/w & MMI application development			
MANDAYS	16	-	2	
Electric Power Supply System (UPS & 24 V DC system)	Theory & design features		Manufacturing/assembly process Testing methodology	
MANDAYS	10	2		
PRODUCT (ELECTRICAL) GENERATOR	AREAS OF TRAINING REQUIREMENT			
	(a) Design aspects of the following areas	- Operational feed back	(a) Manufacturing process for	



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ANNEXURE-VII

PRODUCT	AREAS OF TRAINING REQUIREMENT				Operation & Maintenance Of Plant
	Product Design	Plant Visit	Visit To Manufacturer's Work		
	- Insulation system	- Familiarisation with different sub-systems	- Core		
	- Cooling medium & arrangement		- Winding bars		
	- Winding & core support systems		- Assembly		
	b) Design aspects of other auxiliary systems		(b) Testing facilities		
	MANDAYS	30	15	15	
	Generator Excitation System including AVR.	Design features of various sub-systems	- Operational feed back	- Manufacturing process& testing facilities for various equipment of excitation system	
400 KV Switchyard Equipments	Excitor	- Familiarisation with various equipment functioning at reference plants			
	PMG				
	Transformer				
	Controllers & different limiters etc.				
	PSS & associated system studies				
			Concepts and operational aspects for the offered equipments		
Substation Automation System				Training for site personnel for operation, maintenance & troubleshooting of total system for 5 working days at UPRVUNL site	
MV AND LT Switchgear: Numerical relays & Switchgear SCADA system	Numerical relay engineering & associated training for relay software & O&M SCADA system design, engineering & associated training for SCADA & O&M				



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ANNEXURE-VII

PRODUCT	AREAS OF TRAINING REQUIREMENT			Operation & Maintenance Of Plant
	Product Design	Plant Visit	Visit To Manufacturer's Work	
MDBFP motor CW motor & BWCP motor	Design criteria for the stator core and winding, rotor core & winding, Insulation system & Cooling arrangement Study of forces & vibration Diagnostic & testing of large Electrical machines	Operational feedback	Manufacturing process & testing facilities	
MANDAYS	30	15	15	
Boiler Feed pump H.T. Motor	Design Criteria for the Stator core & wdg Rotor core & wdg Insulation system Cooling arrangement	Operational feed back	Manufacturing process & test facilities	
MANDAYS	10	5	5	
CRITICAL PIPING & POWER CYCLE PIPING	Design familiarization for critical piping of supercritical Plant Optimization study for sizing including pressure drop calculation and selection of single or double lead together with Owner's engineers Design and stress analysis of lines with Expansion Joints together with Owner's engineers	Familiarization with feedback (in super critical plant) on failure analysis and vibration analysis of piping. Study of Feed back regarding hanger setting strategies and practice	Cold Setting of spring hanger Cyclic tests carried on spring hangers. Cyclic tests carried on expansion joints	



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ANNEXURE-VII

PRODUCT	AREAS OF TRAINING REQUIREMENT			Operation & Maintenance Of Plant
	Product Design	Plant Visit	Visit To Manufacturer's Work	
	Design and stress analysis of piping systems with two phase flow involving Owner's engineers		Manufacturing process of critical piping components and appreciation of their testing facilities at shop	
	Transient analysis and optimum sizing of feed suction piping together with Owner's engineers.			
	Static and dynamic analysis of critical piping including seismic and other occasional load analysis (safety valve blowing condition). A joint activity together with Owner's engineers.			
	Study and collection of data pertaining to special welding requirements (pre and post weld heat treat ment and electrode selection criteria etc.) of materials used in high temp piping system.			
	Study and collection of data on special requirements in case of welding dissimilar metals and electrode selection criteria			
MANDAYS	45	10	10	



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UPS system	Theory & design features Manufacturing/assembly process Testing methodology	5
24 V DC system	Trouble shooting and fault analysis. Theory & design features Manufacturing/assembly process Testing methodology	5
SWAS	Trouble shooting and fault analysis Theory & design features Trouble shooting and fault analysis	5
Communication System	Theory & design features Trouble shooting and fault analysis	4
PSSS System	Theory & design features Trouble shooting and fault analysis	5
QA SYSTEM & PROGRAMME	Integrated QA Management system for enhanced reliability of equipments QA system in design, procurement, manufacturing, installation and operation of the equipments/ systems QA system for developing and establishing new processes and vendors System of structured documentation of Engg and test records Appreciation of implementation of QA Programme in various manufacturing, assembly and testing activities Appreciation of develop-mental activities for new processes and vendors System of pre-qualification of special processes	10
Controls & Instruments	Familiarization with control system and instrumentation QA System for manufacture of reliable components. Manufacturing activities for critical instruments/items Implementation of testing programme to ensure reliability	20
Simulator	a. System design structure and basis of design b. Hardware components and their configuration c. System Software and Simulation Software Tools d. Plant process modelling and DCS emulation e. Project specific application development, configuration and modifications including equipment modelling and interconnections of models, graphics development , configuring equations etc, f. Maintenance and troubleshooting of hardware and software components	24

DCPL

PADO	Theory & design features	10
	Trouble shooting and fault analysis	
CEMS	Theory & design features	5
	Trouble shooting and fault analysis	
AAQMS	Theory & design features	5
	Trouble shooting and fault analysis	
C&I Lab Instruments	Theory & design features	6
	Trouble shooting and fault analysis	
DMS	Theory & design features	5
	Trouble shooting and fault analysis	
Station LAN & MIS	Theory & design features	5
	Trouble shooting and fault analysis	
Note	One week shall constitute of five (5) man days.	



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CHAPTER 6 : ERECTION CONDITIONS OF CONTRACT**1.0 GENERAL**

- 1.1 The following provisions shall supplement the conditions already contained in the other parts of these specifications and documents and shall govern that portion of the work of this contract which is to be performed at site. The erection requirements and procedures not specified in these documents shall be in accordance with the recommendations of the equipment manufacturer, or as mutually agreed to between the Owner and the Contractor prior to commencement of erection work.
- 1.2 The Contractor upon signing of the Contract shall, in addition to a Project Co-ordinator, nominate another responsible officer as his representative at Site suitably designated for the purpose of overall responsibility and co-ordination of the Works to be performed at Site. Such a person shall function from the Site office of the Contractor during the pendency of Contract.

2.0 REGULATION OF LOCAL AUTHORITIES AND STATUTES

- 2.1 In addition to the local laws and regulations, the Contractor shall also comply with the Minimum Wages Act and the Payment of Wages Act (both of the Government of India) and the rules made there under in respect of its labour and the labour of its sub-contractors currently employed on or connected with the contract. Some labour welfare schemes & rules to be followed by Contractor are annexed to this section as Annexure I & Annexure II. However, these are minimum & should be limiting criteria.
- 2.2 All registration and statutory inspection fees, if any, in respect of his work pursuant to this Contract shall be to the account of the Contractor. However, any registration, statutory inspection fees lawfully payable under the provisions of the Indian Boiler Regulations and any other statutory laws and its amendments from time to time during erection in respect of the plant equipment ultimately to be owned by the Owner, shall be to the account of the Owner. Should any such inspection or registration need to be re-arranged due to the fault of the Contractor or his Sub-Contractor, the additional fees for such inspection and/or registration shall be borne by the Contractor.

3.0 WELDING OF PRESSURE PARTS AND HIGH PRESSURE PIPING

The welding of all pressure parts and high pressure piping shall be in accordance with the following requirements:

3.1 Qualification of Weld Procedures

Only qualified welding procedures as per ASME Section IX shall be used by contractor at site. Procedure, qualification records along with WPS shall be submitted for review. Welding procedure shall indicate all essential and non essential parameters as per ASME Section IX. Makes of welding consumables shall be subject to Owner's approval.

3.2 Welder's Qualification

- 3.2.1 Welders, who are qualified in accordance with the latest applicable requirements of the Indian Boiler Regulations, shall be permitted to perform any welding work on the pressure parts and its attachment welding. In addition



to such statutory qualification requirements, the welders shall also undergo a satisfactory pre-production qualification test to be conducted by the Contractor at site as per ASME Section IX in presence of Owner / Engineer, prior to performing work under these specifications. The services of an independent testing laboratory shall be retained by the Contractor to perform welder qualification tests for welders.

- 3.2.2 All the welders carrying out welding at site shall carry an identification badge, which shall indicate the category and the grade of welding for which they have been tested and authorized to carry out welding. All such badges shall be countersigned by the Owner.

3.3 Records

Welders' performance shall be monitored regularly and record of their performance shall be maintained by contractor in a manner acceptable to the Owner. Contractor shall maintain such records including record of procedure qualification & welder qualification and hand-over to the Owner at the end of work.

3.4 Marking

On completion of each joint, the welder shall mark his regularly assigned identification mark near the joint. The welder's identification numbers, inspection stamps or code symbol stamps and any other information shall not be directly stamped on any alloy steel piping. In alloy steel piping, all such information shall be stamped on separate marking plate which shall be tack welded on pipe near the weld.

4.0 HEAT TREATMENT

- 4.1 Pre-heating, post-heating and post-weld stress relief operations of all welds, shall be performed in accordance with the requirements of applicable code. Local post weld stress relieving heat – treatments shall be adopted only in cases where it is normally impracticable to subject the entire assembly as such for stress relieving operations. Heating may be by means of electric induction coils or electric resistance coils. Oxy-acetylene flame heating or exothermic chemical heating methods will not be permitted. Complete recording of the temperatures throughout the stress relieving cycle of the material and the weld subjected to heat treatment shall be made by means of a potentiometric recorder. Recorders other than those of potentiometric type shall not be used for such temperature recording during stress relieving operations.
- 4.2 The contractor & Owner's representative, at start and at the end of HT Cycle shall sign the time and temperature charts for heat-treatment.
- 4.3 After setting up the weld joint for heat treatment operation, the Owner's signature shall be obtained on the strips chart of the recorder prior to starting of heat treatment cycle. The right hand corner of the strip chart at the starting point of the heat treatment cycle shall contain details like the weld number, material, diameter and thickness, method of heating adopted, prescribed ranges of heat treatment temperatures, date of heat treatment, reference to item number of the Field welding Schedule (as specified at clause # 7.0 of this chapter) etc.



5.0 Weld Edge Preparation

Preparation at site of weld joint shall be in accordance with details acceptable to the Owner. Wherever possible, machining or automatic flame cutting shall be used for edge preparation. Hand flame cutting will be permitted only where edge preparation otherwise is impractical. All slag shall be removed from cuts and all the hand cuts shall be ground smooth to the satisfaction of the Owner. Flame cutting of alloy steel pipe shall be avoided. Wherever such cutting is done, a 200mm length at the cut face shall be removed by machining. Pneumatic hand tools such as edge preparation, tube cutting machine can be used.

6.0 CLEANING AND SERVICING

- 6.1 The inside of all tubes, pipes, valves and fittings shall be free from dirt and loose scales before being erected. All the pipelines shall be thoroughly blown and/or flushed. Each steam and water tubes shall be blown with compressed air and shall be subjected to 'ball test' before erection to ensure that no obstructions exist. A system for recording of all such operations shall be developed and maintained in a manner to ensure that no obstructions are left inside the tubes and no tubes are left uncleaned and untested.
- 6.2 All valves and valve actuators, and dampers and damper actuators, if any, shall be thoroughly cleaned and serviced prior to pre-commissioning tests and/or Initial Operations of the plant. A system for recording of such servicing operation shall be developed and maintained in a manner acceptable to the Owner and to ensure that no valves or dampers including their actuators are left unserviced.
- 6.3 All interior surfaces of the turbine shall be thoroughly cleaned prior to boxing-up to remove all traces of oil preservations.

7.0 FIELD WELDING SCHEDULE

The Contractor shall submit to the Owner, a certified and complete field welding schedule for all the field welding activities to be carried out in respect of the pressure parts involved in the equipment furnished and erected by him, at least 90 days prior to the scheduled start of erection work at site. Such schedule will be strictly followed by the Contractor during the process of erection. The above field-welding schedule to be issued by the Contractor shall contain the following:

- (a) Drawing No. (s)
- (b) Location of the weld
- (c) Size of the weld (outside diameter and thickness)
- (d) Type of joints
- (e) Material specifications
- (f) Size of fillet on backing ring, when the type of joint is with backing ring
- (g) Electrode / filler metal specifications
- (h) Number of welds per unit
- (i) Quantity of filler metal per weld
- (j) Indication of required Non-destructive Examination (NDE) for each weld
- (k) Pre-heat temperatures for welding
- (l) Process of welding
- (m) Post-welding heat treatment temperature ranges, duration, under as specified at clause no. 4.0 – of this chapter entitled "Heat Treatment".



- (n) Qualification details of weld procedures to be adopted as specified under as specified at clause no. 3.1 – of this chapter entitled "Qualification of Weld Procedures".

8.0 SITE RUN MISCELLANEOUS PIPING

Sketches or diagrams of the proposed routings of all piping not already indicated and routed on the shop drawings which were reviewed by the Owner, shall be submitted to the Owner for review. Owner's acceptance of such site routings shall be obtained before the piping is erected. All these site run piping shall be installed in such a manner as to present an orderly and neat installation. They shall be located as to avoid obstruction of access and passages. Valves, instruments or any other special items shall be located convenient for operation by the operating personnel. Pipe runs shall be plumb or level except where pitch for drainage is required. Pipe runs that are not parallel to the building structure, walls or column rows shall be avoided so that deflection of pipes between hangers does not exceed 6mm. No miscellaneous pipe shall be routed and installed above or adjacent to electrical equipment.

9.0 THERMAL EXPANSIONS

All piping installation shall be such that no excessive or destructive expansion forces exist either in the cold condition or under condition of maximum temperature. All bends, expansion joints and any other special fittings, necessary to provide proper expansion, shall be incorporated. During installation of expansion joints and anchors, care must be taken to make sure that full design movement is available at all times for maximum to minimum temperature and vice-versa.

10.0 PIPING SUPPORTS

- 10.1 Hangers, supports and anchors shall be installed as required to obtain a safe, reliable and complete pipe installation. All supports shall be properly levelled and anchored when installed. The anchors shall be so placed that thermal expansion will be absorbed by bends without subjecting the valves or equipment to excessive strains.
- 10.2 The hanger assemblies shall not be used for the attachment of rigging to hoist the pipe into place. Other means shall be used to securely hold the pipe in place till the pipe support is completely assembled and attached to the pipe and building structures and spring support is set to accommodate the pipe way. All temporary rigging shall be removed in such a way that the pipe support is not subjected to any sudden load. All piping, having variable spring type supports, shall be held securely in place by temporary means during the hydraulic test of pipe system. Constant support type spring hangers used during hydraulic test shall be pinned or blocked solid during the test. After complete installation and insulation of the piping and filling of the piping with its normal operating medium, the pipe support springs shall be adjusted to the cold positions. If necessary, the spring support shall be re-adjusted to the hot positions after the line has been placed for service at its normal maximum operating temperature conditions. Electric arc welding only shall be used to weld all pipe supports to structural steel members that form part of the building supporting structure. The structural beams shall not be heated more than necessary during welding of supports and such welds shall run parallel to the axis of the span. All lugs or any other attachments welded to the piping shall be of the same material as the pipe.



11.0 PRESSURE TESTING

- 11.1 On completion of erection of pressure parts, a hydraulic test in accordance with the requirements of the Indian Boiler Regulations shall be performed by the Contractor.
- 11.2 All the valves, high pressure pipes and inter-connected pipes connecting the pressure parts shall be tested along with pressure parts. All blank flanges or any removable plugs required for openings not closed by the valves, and piping provided, shall be furnished by the Contractor. The pressurization equipment including water piping from the supply, needed for the above test shall also be furnished by the Contractor. Any defects noticed during the testing are to be rectified and the unit re-tested. If any welding is done on the pressure parts after the Hydraulic test, the Hydraulic test for that portion of pressure parts shall be repeated.
- 11.3 The hydraulic test shall be considered successful only on certification to that effect by the concerned inspecting Authority as per the provisions of the Indian Boiler Regulations and the Owner.

12.0 THERMOWELLS AND FLOW NOZZLES

- 12.1 All the thermo wells and flow nozzles in the equipment furnished under the technical specifications shall be installed as a part of this work.
- 12.2 All thermo well connections incorporated in the steam service shall be plugged during the pressure testing and the blow out of steam piping systems. Upon completion of the blow out operation, all thermo wells shall be installed and seam welded. Similarly, all flow nozzles in the steam lines shall also be installed only on completion of steam blowing operations unless otherwise agreed to by the Owner, depending upon the sequence of cleaning and purging operations to be adopted by the Contractor at the field.

13.0 INSULATION, LAGGING AND CLADDING

The provision of insulation, lagging and cladding of the various equipments and portion of the equipment covered under the Contract, shall be furnished by the Contractor as specified elsewhere or agree to separately in writing. Welds required for holding insulation on pressure parts shall be carried out by IBR qualified welder.

- 13.1 In case of equipment other than steam turbine, Lugs made out of MS rods of 5mm dia conforming to IS 280 or equivalent shall be welded on the surface at intervals of 250mm pitch zigzag to support insulation. Mineral wool mats with wire netting on both sides shall be applied against the surface with lugs piercing through. The edges of mattress shall be laced together with galvanized MS 0.71mm dia (22 SWG) IS 280 or equivalent (soft) lacing wire. Galvanized binding wire of 1.63 mm dia (16 SWG) IS 280 or equivalent (soft) will be used criss-cross between lugs to hold it. The lugs will then be bent over the netting.
- 13.2 Unless otherwise specified, all equipment insulation shall be covered with aluminium cladding / jacketing. The thickness of aluminium sheet shall not be less than 0.63mm. Galvanic corrosion shall be prevented by carefully avoiding permanent contact of aluminium cladding with copper, copper alloys, tin, lead nickel or nickel alloys including monel metal. Where cladding is attached to



carbon steel or low alloy steels, the steel shall first be prime painted with zinc chromate and then painted with aluminium paint. The use of lead base paints for this purpose shall be avoided.

- 13.3 Prior to application of cladding, all surface imperfections such as ducts, cracks and voids shall be filled with insulation cement so as to form a smooth base for the final shall be machine rolled and formed. All overlaps at longitudinal joints shall face downwards. The fixing of cladding shall be by means of screws and they shall be adequate in number and be so place is such location as to produce tight joints eliminating 'bellying'. The screws, as far as possible, shall be uniformly placed and on centres not exceeding 150mm except where insulated outside diameters are smaller than 230mm in which case spacing shall be on centres not exceeding 100mm. Self tapping type screws, of 12mm size of stainless steel / aluminium alloy as per the requirements shall be used. All joints wherever possible shall be lapped a minimum of 50mm. The overlaps of longitudinal joints shall be a 10mm turn back edge. Butt joints such as those at piping tees, shall be made using a rolled seam. Suitable provisions for expansion movement shall be provided in joints. Hinged or sliding doors for convenience shall be provided in the cladding at all access openings, non-projecting connections, important codes stampings etc.

13.4 Piping, Pipe Fittings & Valves

All piping insulation and metal cladding furnished with the equipment to be erected shall be applied as specified herein.

13.4.1 Piping

The insulation on piping shall be applied using wire loops on 150mm centres. These wire loops shall be thoroughly embedded into the outer insulation surface and all cracks, voids and depressions shall be filled with insulating cement suitable for the piping temperature so as to form a smooth base for application of cladding. The wires used for piping insulation shall be of 20 SWG. The surface shall be smooth and uniform before applying the outer covering. All piping insulation ends shall be terminated at a sufficient distance from flanges to facilitate removal of bolts.

13.4.2 Flanges

Insulation on flanges shall be by means of blocks of insulating material securely bound to the flange by wire loops. Such blocks of insulation shall be long enough to overlap the adjacent pipe insulation by an amount equal to the thickness of adjacent pipe insulation. Smooth finish shall be obtained by the application of insulating cement. Alternatively, sectional pipe insulation of proper diameter may be used. Insulation on flanges shall not be done until the pipe and equipment have been in service during the initial operation and till all the flange bolts have been re-tightened.

13.4.3 Bends and Elbows

Insulation on bends and elbows shall be cut into sections sufficiently short to form a reasonable smooth external surface. After the application of insulation material in place, it shall be smoothly coated with insulating cement. Elbows may be insulated as above or alternatively by means of specially moulded insulation enclosures.



13.4.4 Cladding

Cladding shall be of aluminium sheet of thickness as per details given in detail Technical Specification or will be provided during detail engineering shall be machine rolled and formed to accurately fit insulation curvatures. Cladding shall be secured using self-tapping screws. Screws shall be adequate number and so located as to produce tight joints. The spacing of screws shall be as far as possible uniform and on centres not exceeding 150mm. For outside diameters less than 230 mm, spacing of screws shall be on centres not exceeding 100mm adequate number of screws shall be provided for fixing the cladding and be so placed in such locations, as to produce a smooth cladding finish without 'bellying'. Insulated elbows having insulated diameters less than 330mm shall be provided with preformed smooth aluminium elbow jackets. Wherever possible, all joints should be lapped a minimum of 50mm with joints facing downwards and so placed that they are obscured from normal points of vision. All the joints in the cladding shall be made with suitable provisions for expansions. All butt joints such as those at piping tees shall be made using rolled seams. In addition, to prevent galvanic corrosion, suitable action, as stipulated as specified at clause no 13.5 of this chapter, shall be taken.

13.4.5 Valves and Fittings

All valves and fittings installed in the pipelines shall also be applied with insulation and furnished with suitably shaped boxes so as to facilitate easy dismantling of the fittings. The insulation thickness for valves, valve fittings etc. shall be same as that used on the line on which they are installed. All voids shall be properly filled up with insulating material and as per the directions of the Owner.

13.5 Protection of Equipment during Insulation Applications

All equipment and structures shall be suitably protected from damage while applying insulating after completion of insulation. All equipment and structures shall be thoroughly cleaned and remove insulating materials which might have fallen on them.

14.0 Code Requirements

The erection requirements and procedures to be followed during the installation of the equipment shall be in accordance with the relevant Indian Electricity Rules & Codes, Indian Boiler Regulations, CEA Guidelines, ASME codes and accepted good practices, the Owner's Drawings and other applicable Indian recognized codes and laws and regulations of the Government of India.

15.0 Electrical Safety Regulations

15.1 In no circumstances will the Contractor interfere with fuses and electrical equipment belonging to the other Contractor or Owner.

15.2 Before the Contractor connects any electrical appliances to any plug or socket belonging to the other Contractor or Owner, he shall:

- (a) Satisfy the Owner that the appliance is in good working condition;
- (b) Inform the Owner of the maximum current rating, voltage and phases of the appliances;



- (c) Obtain permission of the Owner detailing the socket to which the appliances may be connected.

The Owner will not grant permission to connect until he is satisfied that

- (a) The appliance is in good condition and is fitted with a suitable plug.
- (b) The appliance is fitted with a suitable cable having two earth conductors, one of which shall be an earthed metal sheath surrounding the cores.

15.3 No electric cable in use by the other Contractor / Owner will be disturbed without permission. No weight of any description will be imposed on any such cable and ladder or similar equipment will rest against or be attached to it.

15.4 No repair work shall be carried out on any live equipment. The equipment must be declared safe by the Owner and a permit to work issued before any work is carried out.

15.5 The Contractor shall employ the necessary number of qualified, full time electricians to maintain his temporary electrical installation.

16.0 Removal of Material

No material bought to the site shall be removed from the site by the contractor and/or his sub-contractors without the prior written approval of the OWNER.

17.0 INSPECTION, TESTING AND INSPECTION CERTIFICATES

The provisions of the clause entitled Inspection, Testing and Inspection Certificates given in Chapter 05: GTR, Volume-II, shall also be applicable to the erection portion of the Works. The Owner shall have the right to re-inspect any equipment through previously inspected and approved by him at the Contractor's works, before and after the same are erected at Site. If by the above inspection, the Owner rejects any equipment, the Contractor shall make good for such rejections either by replacement or modification / repairs as may be necessary to the satisfaction of the Owner. Such replacements will also include the replacements or re-execution of such of those works of other Contractors and/or agencies, which might have got damaged or affected by the replacements or re-work done to the Contractor's work.

18.0 ACCESS TO SITE AND WORKS ON SITE

18.1 Suitable access to site and permission to work at the Site shall be accorded to the Contractor by the OWNER in reasonable time.

18.2 In the execution of the Works, no person other than the Contractor or his duly appointed representative, Sub-Contractor and workmen, shall be allowed to do work on the Site, except by the special permission, in writing by the OWNER or his representative.

19.0 CONTRACTOR'S SITE OFFICE ESTABLISHMENT

The Contractor shall establish an Office at the Site and keep posted an authorized representative for the purpose of the Contract. Any written order or



instruction of the Owner or his duly authorized representative shall be communicated to the said authorized resident representative of the Contractor and the same shall be deemed to have been communicated to the Contractor at his legal address.

20.0 CO-OPERATION WITH OTHER CONTRACTORS

20.1 The Contractor shall co-operate with all other Contractors or Workmen of the Owner, who may be performing other works on behalf of the Owner and the workmen who may be employed by the Owner and doing work in the vicinity of the works under the Contract. The Contractor shall also arrange to perform his work as to minimise, to the maximum extent possible, interference with the work of other Contracts and their workmen. Any injury or damage that may be sustained by the employees of the other Contractors and the OWNER, due to the Contractor's work shall promptly be made good at his own expense. The OWNER shall determine the resolution of any difference or conflict that may arise between the Contractor and other Contractors or between the Contractor and the workmen of the OWNER in regard to their work. If the work of the Contractor is delayed because of the any acts of omission of another Contractor, the Contractor shall have no claim against the OWNER on that account other than an extension of time for completing his works. OWNER shall have full access to visit the contractor's site at any time for inspection and surveillance checks.

20.2 The OWNER shall be notified promptly by the Contractor of any defects in the other Contractor's works that could affect the Contractor's Works. The OWNER shall determine the corrective measures if any, required to rectify this situation after inspection of the works and such decisions by the OWNER shall be binding on the Contractor.

21.0 DISCIPLINE OF WORKMEN

The Contractor shall adhere to the disciplinary procedure set by the UPRVUNL in respect of his employees and workmen at Site. The UPRVUNL shall be at liberty to object to the presence of any representative or employee of the Contractor at the Site, if in the opinion of the UPRVUNL such employee has mis-conducted himself or is incompetent, negligent or otherwise undesirable then the Contractor shall remove such a person objected to and provide in his place a competent replacement.

22.0 CONTRACTOR'S FIELD OPERATION

22.1 The Contractor shall keep the OWNER informed in advance regarding his field activity plans and schedules for carrying out each part of the works. Any review of such plan or schedule or method of work by the OWNER shall not relieve the Contractor of any of his responsibilities towards the field activities. Such reviews shall also not be considered as an assumption of any risk or liability by the OWNER or any of his representatives and no claim of the Contractor will be entertained because of the failure or inefficiency of any such plan or schedule or method of work reviewed. The Contractor shall be solely responsible for the safety, adequacy and efficiency of plant and equipment and his erection methods.

22.2 The Contractor shall have the complete responsibility for the conditions of the Work-Site including the safety of all persons employed by him or his Sub-Contractor and all the properties under his custody during the performance of



the work. This requirement shall apply continuously till the completion of the Contract and shall not be limited to normal working hours. The construction review by the OWNER is not intended to include review of Contractor's safety measures in, on or near the Work-Site, and their adequacy or otherwise.

23.0 PHOTOGRAPHS AND PROGRESS REPORT

23.1 The Contractor shall furnish three (3) prints each to the OWNER of progress photographs of the work done at Site. Photographs shall be taken as and when indicated by the OWNER or his representative. Photographs shall be adequate in size and number to indicate various stages of erection. Each photograph shall contain the date, the name of the Contractor and the title of the photograph.

23.2 The above photographs shall accompany the monthly progress report detailing out the progress achieved on all erection activities as compared to the schedules. The report shall also indicate the reasons for the variance between the scheduled and actual progress and the action proposed for corrective measures, wherever necessary.

23.3 The Contractor shall submit the progress of work in video cassettes (2 copies) quarterly highlighting the progress and constraints at site.

24.0 MAN-POWER REPORT

24.1 The Contractor shall submit to the UPRVUNL, on the first day of every month, a man hour schedule for the month, detailing the man hours scheduled for the month, skill- wise and area-wise.

24.2 The Contractor shall also submit to the UPRVUNL on the first day of every month, a man power report of the previous month detailing the number of persons scheduled to have been employed and actually employed, skill- wise and the areas of employment of such labour.

25.0 PROTECTION OF WORK

The Contractor shall have total responsibility for protecting his works till it is finally taken over by the UPRVUNL. No claim will be entertained by the UPRVUNL or the representative of the UPRVUNL for any damage or loss to the Contractor's works and the Contractor shall be responsible for complete restoration of the damaged works to original conditions to comply with the specification and drawings. Should any such damage to the Contractor's Works occur because of other party not being under his supervision or control, the Contractor shall make his claim directly with the party concerned. If disagreement or conflict or dispute develops between the Contractor and the other party or parties concerned regarding the responsibility for damage to the Contractor's Works the same shall be resolved as per the provisions of the as specified at clause no 20.00.00- of this chapter entitled "Co-operation with other Contractors." The Contractor shall not cause any delay in the repair of such damaged Works because of any delay in the resolution of such disputes. The Contractor shall proceed to repair the Work immediately and no cause thereof will be assigned pending resolution of such disputes.

26.0 EMPLOYMENT OF LABOUR



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- 26.1 In addition to all local laws and regulations pertaining to the employment of labour to be complied with by the Contractor pursuant to GCC, the Contractor will be expected to employ on the work only his regular skilled employees with experience of the particular work. No female labour shall be employed after darkness. No person below the age of eighteen years shall be employed.
- 26.2 All travelling expenses including provisions of all necessary transport to and from Site, lodging allowances and other payments to the Contractor's employees shall be the sole responsibility of the Contractor.
- 26.3 The hours of work on the Site shall be decided by the UPRVUNL and the Contractor shall adhere to it. Working hours will normally be eight (8) hours per day - Monday through Saturday.
- 26.4 Contractor's employees shall wear identification badges while on work at Site.
- 26.5 In case the OWNER becomes liable to pay any wages or dues to the labour or any Government agency under any of the provisions of the Minimum Wages Act, Workmen Compensation Act, Contract Labour Regulation Abolition Act or any other law due to act of omission of the Contractor, the OWNER may make such payments and shall recover the same from the Contractor's Bills.

27.0 FACILITIES TO BE PROVIDED BY THE UPRVUNL

27.1 Electricity

Complete construction power requirement (including power for bidder's labour camp & staff colony) will be available on chargeable basis based on prevailing commercial rates of DISCOM.

27.2 Water

Contractor shall make all arrangements himself for the supply of construction water as well as potable water for labour and other personnel at the worksite/colony.

27.3 Communication

The OWNER will extend the telephone facilities, if available at Site, for purposes of Contract. The Contractor shall be charged at actual for such facilities.

27.4 Railway Siding

Railway siding shall be provided by OWNER for coal transportation to site. However the same may not be available to the bidder for material/supplies transport etc. Bidder has to plan on its own for movement of ODC consignment to plant site.

- 27.5 Handing over of Site for construction

Further, irrespective of readiness of railway siding, owner reserves the option of coal supply in stockyard before the synchronization of unit for which bidder has to ensure readiness of coal supply system up to mill bunker.

28.0 FACILITIES TO BE PROVIDED BY THE CONTRACTOR

28.1 Contractor's site office Establishment



The Contractor shall establish a site office at the site and keep posted an authorized representative for the purpose of the contract, pursuant to GCC.

28.2 Tools, tackles and scaffoldings

The Contractor shall provide all the construction equipments, tools, tackles and scaffoldings required for pre-assembly, installation, testing, commissioning and conducting Guarantee tests of the equipments covered under the Contract. He shall submit a list of all such materials to the UPRVUNL before the commencement of pre-assembly at Site. These tools and tackles shall not be removed from the Site without the written permission of the UPRVUNL. The Contractor shall arrange Dozer, Hydra, Cranes, Trailer, etc. for the purpose of fabrication, erection and commissioning.

28.3 Testing Equipment and Facilities

The contractor shall provide the necessary testing, equipment and facilities.

28.4 Site laboratory for civil works

Contractor shall provide and maintain a site laboratory for the testing of construction material under the direction and general supervision of UPRVUNL.

28.5 First-aid

28.5.1 The Contractor shall provide necessary first-aid facilities for all his employees, representatives and workmen working at the Site. Enough number of Contractor's personnel shall be trained in administering first-aid.

28.5.2 The UPRVUNL will provide the Contractor, in case of any emergency, the services of an ambulance for transportation to the nearest hospital.

28.6 Cleanliness

28.6.1 The Contractor shall be responsible for keeping the entire area allotted to him clean and free from rubbish, debris etc. during the period of Contract. The Contractor shall employ enough number of special personnel to thoroughly clean his work-area at least once in a day. All such rubbish and scrap material shall be stacked or disposed in a place to be identified by the UPRVUNL. Materials and stores shall be so arranged to permit easy cleaning of the area. In areas where equipment might drip oil and cause damage to the floor surface, a suitable protective cover of a flame resistant, oil proof sheet shall be provided to protect the floor from such damage.

28.6.2 Similarly the labour colony, the offices and the residential areas of the Contractor's employees and workmen shall be kept clean and neat to the entire satisfaction of the UPRVUNL. Proper sanitary arrangements shall be provided by the Contractor, in the work-areas, office and residential areas of the Contractor

29.0 LINES AND GRADES

29.1 All the Works shall be performed to the lines, grades and elevations indicated on the drawings. The Contractor shall be responsible to locate and layout the Works..



- 29.2 Basic horizontal and vertical control points will be established and marked by the Owner at Site at suitable points. These points shall be used as datum for the works under the Contract. The Contractor shall inform the Owner well in advance of the times and places at which he wishes to do work in the area allotted to him so that suitable datum points may be established and checked by the Owner to enable the Contractor to proceed with his works. Any work done without being properly located may be removed and/or dismantled by the Owner at Contractor's expense.

30.0 FIRE PROTECTION

- 30.1 The work procedures that are to be used during the erection shall be those which minimise fire hazards to the extent practicable. Combustible materials, combustible waste and rubbish shall be collected and removed from the Site at least once each day. Fuels, oils and volatile or flammable materials shall be stored away from the construction and equipment and materials storage areas in safe containers. Untreated canvas, paper, plastic or other flammable flexible materials shall not at all be used at Site for any other purpose unless otherwise specified. If any such materials are received with the equipment at the Site, the same shall be removed and replaced with acceptable material before moving into the construction or storage area.
- 30.2 Similarly corrugated paper fabricated cartons etc. will not be permitted in the construction area either for storage or for handling of materials. All such materials used shall be of water proof and flame resistant type. All the other materials such as working drawings, plans etc. which are combustible but are essential for the works to be executed shall be protected against combustion resulting from welding sparks, cutting flames and other similar fire sources.
- 30.3 All the Contractor's supervisory personnel and sufficient number of workers shall be trained for fire-fighting and shall be assigned specific fire protection duties. Enough of such trained personnel must be available at the Site during the entire period of the Contract.
- 30.4 The Contractor shall provide enough fire protection equipment of the types and number for the warehouses, office, temporary structures, labour colony area etc. Access to such fire protection equipment, shall be easy and kept open at all time.

31.0 SECURITY

The Contractor shall have total responsibility for all equipment and materials in his custody stores, loose, semi-assembled and/or erected by him at Site. The Contractor shall make suitable security arrangements including employment of security personnel to ensure the protection of all materials, equipment and works from theft, fire, pilferage and any other damages and loss. All materials of the Contractor shall enter and leave the UPRVUNL Site only with the written permission of the UPRVUNL in the prescribed manner.

32.0 CONTRACTOR'S AREA LIMITS

The Owner will mark-out the boundary limits of access roads, parking spaces, storage and construction areas for the Contractor and the Contractor shall not trespass the areas not so marked out for him. The Contractor shall be responsible to ensure that none of his personnel move out of the areas marked out for his operations. In case of such a need for the Contractor's personnel to



work out of the areas marked out for him the same shall be done only with the written permission of the Owner.

33.0 CONTRACTOR'S CO-OPERATION WITH THE OWNER

In case where the performance of the erection work by the Contractor affects the operation of the system facilities of the UPRVUNL, such erection work of the Contractor shall be scheduled to be performed only in the manner stipulated by the UPRVUNL and the same shall be acceptable at all times to the Contractor. The UPRVUNL may impose such restrictions on the facilities provided to the Contractor such as electricity, etc. as he may think fit in the interest of the UPRVUNL and the Contractor shall strictly adhere to such restrictions and co-operate with the UPRVUNL. It will be the responsibility of the Contractor to provide all necessary temporary instrumentation and other measuring devices required during start-up and operation of the equipment systems which are erected by him. The Contractor shall also be responsible for flushing and initial filling of all the oil and lubricants required for the equipment furnished and installed by him, so as to make such equipment ready for operation. The Contractor shall be responsible for supplying such flushing oil and other lubricants unless otherwise specified elsewhere in documents and specifications.

34.0 PRE-COMMISSIONING AND COMMISSIONING ACTIVITIES

34.1 GENERAL

- 34.1.1 The Contractor upon completion of installation of equipments and system shall conduct pre-commissioning and commissioning activities, to make the equipment/systems ready for safe, reliable and efficient operation on sustained basis. All pre-commissioning/commissioning activities considered essential for such readiness of the equipment/systems including those mutually agreed and included in the Contractor's quality assurance programme as well as those indicated in clauses elsewhere in the technical specifications shall be performed by the Contractor.
- 34.1.2 The pre-commissioning and commissioning activities including Guarantee tests, checks and trial operations of the equipment / systems furnished and installed by the Contractor shall be the responsibility of the Contractor as detailed in relevant clauses in Technical Specification. The Contractor shall provide, in addition, test instruments, calibrating devices etc. and labour required for successful performance of these operations. If it is anticipated that the above test may prolong for a long time, the Contractor's workmen required for the above test shall always be present at site during such operations.
- 34.1.3 The following activities shall be carried out by the Contractor, eighteen (18) month prior to schedule date of commissioning of the equipments/systems installed by him.
- a) The Contractor shall furnish the organization chart of his operation and commissioning engineers for the acceptance of Owner. Adequate number of operation and commissioning engineers shall be deployed by the Contractor to effectively meet the requirement of round the clock operation in shifts also, till the plant is taken over by the Owner.



- b) The Contractor shall submit the bio-data containing the details of experience of his operation and commissioning engineers for the acceptance of Owner.
 - c) The Contractor shall furnish the deployment schedule of his operation and commissioning engineers for the acceptance of the Owner.
 - d) Apart from above, Contractor shall ensure deployment of sufficient skilled/semi-skilled/unskilled manpower during pre-commissioning and commissioning activities.
- 34.1.4 It shall be the responsibility of the Contractor to provide all necessary temporary instrumentation and other measuring devices required during start-up and initial operation of the equipment / systems which are installed by him.
- 34.1.5 The Contractor shall also be responsible for flushing and initial filling of all oils and lubricants required for the equipment furnished and installed by him so as to make such equipment ready for operation. The Contractor shall be responsible for supplying such flushing oil and other lubricants unless otherwise specified elsewhere in these specifications and documents.

34.2 COMMISSIONING DOCUMENTATION

- 34.2.1 The Contractor shall submit the commissioning documentation, comprising of Standard checklists, pre-commissioning procedures, testing schedules, commissioning schedules and commissioning networks for various equipment / systems covered under the contract, for the approval of Owner.
- 34.2.2 Standard checklist, as the name suggests, shall be a fairly general documents, containing the list of all checks required to be carried out for similar and repetitive type of equipment to ensure consistent and thorough checking. An indicative list of such equipment is enclosed as Annexure 1.
- 34.2.3 The testing schedule is a document, designed for safe and systematic commissioning of individual equipment/sub-system (for example Boiler Feed Pump, condensate pump, compressor etc.) commissioning schedule is a document envisaged for commissioning of a system (for example feed system, Condensate system, Compressed Air System, Fire water system, Unit commissioning etc.). The testing / commissioning schedule shall have a standard format in order to maintain consistency of presentation, content and reporting. A brief write up on the contents of the Testing Schedule / Commissioning Schedule is enclosed as Annexure-II.
- 34.2.4 The Contractor shall submit the list of commissioning documentation to be submitted by him, alongwith their submission schedule for various equipment / systems covered under the contract, within six (6) months from the date of award of contract, for the acceptance of Owner.
- 34.2.5 The Contractor shall submit the commissioning documentation, for various equipment covered under the contract, for the approval of Owner at least 18 months before the scheduled date of commissioning of the equipment / systems.

34.3 COMMISSIONING ACTIVITIES



- 34.3.1 Upon completion of pre-commissioning activities/ tests, the contractor shall initiate commissioning of facilities. During commissioning the Contractor shall carry out system checking and reliability trails on various parts of the facilities.
- 34.3.2 Contractor shall carry out the checks / tests at site to prove to the Owner that each equipment of the supply complies with requirements stipulated and is installed in accordance with requirements specified.
- 34.3.3 Before the plant is put into initial operation the Contractor shall be required to conduct test to demonstrate to the Owner that each item of the plant is capable of correctly performing the functions for which it was specified and its performance, parameters etc. are as per the specified / approved values. These tests may be conducted concurrently with those required under commissioning sequence.
- 34.3.4 The Contractor shall also demonstrate the performance of all C&I equipment, the tests on main equipment of prior to that as the case may be.
- 34.3.5 Other tests shall be conducted, if required by the Owner, to establish that the plant equipment is in accordance with requirements of the specifications.
- 34.3.6 The Contractor shall conduct all the commissioning tests and undertake commissioning activities pertaining to all other auxiliaries and equipments including all electrical and C&I equipment / systems not specifically brought out above but are within the scope of work and facilities being supplied and installed by the Contractor and follow the guidelines indicated above or elsewhere in these technical specifications.

34.4 Initial Operation

Upon completion of system checking / Tests as above and as a part of commissioning of facilities, complete plant / facilities shall be put on initial operation as stipulated in Chapter -5 "General Technical Requirements".

35.0 MATERIALS HANDLING AND STORAGE

- 35.1 All the equipments furnished under the Contract and arriving at Site shall be promptly received, unloaded and transported and stored in the storage spaces by the Contractor.
- 35.2 Contractor shall be responsible for examining all the shipment and notify the UPRVUNL immediately of any damage, shortage, discrepancy etc. for the purpose of UPRVUNL's information only. The Contractor shall submit to the UPRVUNL every week a report detailing all the receipts during the week. However, the Contractor shall be solely responsible for any shortages or damage in transit, handling and / or in storage and erection of the equipment at Site. Any demurrage, wharfage and other such charges claimed by the transporters, railways etc. shall be to the account of the Contractor.
- 35.3 The Contractor shall maintain an accurate and exhaustive record detailing out the list of all equipment received by him for the purpose of erection and keep such record open for the inspection of the UPRVUNL.
- 35.4 All equipment shall be handled very carefully to prevent any damage or loss. No bare wire ropes, slings, etc. shall be used for unloading and/or handling of the equipment without the specific written permission of the UPRVUNL. The



equipment stored shall be properly protected to prevent damage either to the equipment or to the floor where they are stored. The equipment from the store shall be moved to the actual location at the appropriate time so as to avoid damage of such equipment at Site.

- 35.5 All electrical panels, controls gear, motors and such other devices shall be properly dried by heating before they are installed and energised. Motor bearings, slip rings, commutators and other exposed parts shall be protected against moisture ingress and corrosion during storage and periodically inspected. Heavy rotating parts in assembled conditions shall be periodically rotated to prevent corrosion due to prolonged storage.
- 35.6 All the electrical equipment such as motors, generators, etc. shall be tested for insulation resistance at least once in three months from the date of receipt till the date of commissioning and a record of such measured insulation values maintained by the Contractor. Such records shall be open for inspection by the UPRVUNL.
- 35.7 The Contractor shall ensure that all the packing materials and protection devices used for the various equipments during transit and storage are removed before the equipment are installed.
- 35.8 The consumables and other supplies likely to deteriorate due to storage must be thoroughly protected and stored in a suitable manner to prevent damage or deterioration in quality by storage.
- 35.9 All the materials stored in the open or dusty location must be covered with suitable weatherproof and flame-proof covering material wherever applicable.
- 35.10 If the materials belonging to the Contractor are stored in areas other than those earmarked for him, the UPRVUNL will have the right to get it moved to the area earmarked for the Contractor at the Contractor's cost.
- 35.11 The Contractor shall be responsible for making suitable indoor storage facilities to store all equipment which require indoor storage. Normally, all the electrical equipments such as motors, control gear, generators, exciters and consumables like electrodes, lubricants etc. shall be stored in the closed storage space. The UPRVUNL, in addition, may direct the Contractor to move certain other materials, which in his opinion will require indoor storage, to indoor storage areas which the Contractor shall strictly comply with.

36.0 CONSTRUCTION MANAGEMENT

- 36.1 The field activities of the Contractors working at Site, will be coordinated by the Owner and the Owner decision shall be final in resolving any disputes or conflicts between the Contractor and other Contractors and tradesmen of the Owner regarding scheduling and co-ordination of work. Such decision by the Owner shall not be a cause for extra compensation or extension of time for the Contractor.
- 36.2 The Owner shall hold weekly meetings of all the Contractors working at Site, at a time and place to be designated by the Owner. The Contractor shall attend such meetings and take notes of discussions during the meeting and the decisions of the Owner and shall strictly adhere to those decisions in performing his Works. In addition to the above weekly meeting, the Owner may call for other meeting either with individual Contractors or with selected



number of Contractors and in such a case the Contractor if called, will also attend such meetings.

36.3 Time is the essence of the Contract and the Contractor shall be responsible for performance of his works in accordance with the specified construction schedule. If at any time, the Contractor is falling behind the schedule, he shall take necessary action to make good for such delays by increasing his work force or by working overtime or otherwise accelerate the progress of the work to comply with the schedule and shall communicate such actions in writing to the Owner, satisfying that his action will compensate for the delay. The Contractor shall not be allowed any extra compensation for such action.

36.4 The Owner shall however not be responsible for provision of additional labour and/or materials or supply or any other services to the Contractor except for the coordination work between various Contractors as set out earlier.

37.0 FIELD OFFICE RECORDS

The Contractor shall maintain at his Site Office up-to-date copies of all drawings, specifications and other Contract Documents and any other supplementary data complete with all the latest revisions thereto. The Contractor shall also maintain in addition the continuous record of all changes to the above Contract Documents, drawings, specifications, supplementary data, etc. effected at the field and on completion of his total assignment under the Contract shall incorporate all such changes on the drawings and other Engineering data to indicate as installed conditions of the equipment furnished and erected under the Contract. Such drawings and Engineering data shall be submitted to the Owner in required number of copies.

38.0 CONTRACTOR'S MATERIALS BROUGHT ON TO SITE

38.1 The Contractor shall bring to Site all equipment, components, parts, materials, including construction equipment, tools and tackles for the purpose of the Works under intimation to the UPRVUNL. All such goods shall, from the time of their being brought vest in the UPRVUNL, but may be used for the purpose of the Works only and shall not on any account be removed or taken away by the Contractor without the written permission of the UPRVUNL. The Contractor shall nevertheless be solely liable and responsible for any loss or destruction thereof and damage thereto.

38.2 The UPRVUNL shall have a lien on such goods for any sum or sums which may at any time be due or owing to him by the Contractor, under, in respect of or by reasons of the Contract. After giving a fifteen (15) days notice in writing of his intention to do so, the UPRVUNL shall be at liberty to sell and dispose off any such goods, in such manner as he shall think fit including public auction or private treaty and to apply the proceeds in or towards the satisfaction of such sum or sums due as aforesaid.

38.3 After the completion of the Works, the Contractor shall remove from the Site under the direction of the UPRVUNL the materials such as construction equipment, erection tools and tackles, scaffolding etc. with the written permission of the UPRVUNL. If the Contractor fails to remove such materials, within fifteen (15) days of issue of a notice by the UPRVUNL to do so then the UPRVUNL shall have the liberty to dispose off such materials as detailed under as specified at clause no 38.2 of this chapter and credit the proceeds thereto to the account of the Contractor.



39.0 PROTECTION OF PROPERTY AND CONTRACTOR'S LIABILITY

39.1 The Contractor shall be responsible for any damage resulting from his operations. He shall also be responsible for protection of all persons including members of public and employees of the UPRVUNL and the employees of other Contractors and Sub- Contractors and all public and private property including structures, building, other plants and equipments and utilities either above or below the ground.

39.2 The Contractor will ensure provision of necessary safety equipment such as barriers, sign-boards, warning lights and alarms, etc. to provide adequate protection to persons and property. The Contractor shall be responsible to give reasonable notice to the UPRVUNL and the UPRVUNLs of public or private property and utilities when such property and utilities are likely to get damaged or injured during the performance of his Works and shall make all necessary arrangements with such UPRVUNLs, related to removal and/or replacement or protection of such property and utilities.

40.0 PAINTING

For painting refer Chapter7-Painting in Vol-II.

Painting for piping shall also conform to the painting specification of the respective chapter.

Painting for Electrical equipments/systems shall conform to the painting specification given in Electrical portion of technical specifications.

41.0 INSURANCE

41.1 In addition to the conditions covered under the Clause entitled "Insurance" in Section-IV - General Conditions of Contract (GCC), the following provisions will also apply to the portion of works to be done beyond the Contractor's own or his Sub-Contractor's manufacturing Works.

41.2 Workmen's Compensation Insurance

This insurance shall protect the Contractor against all claims applicable under the Workmen's Compensation Act, 1948 (Government of India). This policy shall also cover the Contractor against claims for injury, disability disease or death of his or his Sub- Contractor's employees, which for any reason are not covered under the Workmen's Compensation Act, 1948. The liabilities shall not be less than the following:

Workmen's Compensation	- As per Statutory Provisions
Employee's Liability	- As per Statutory Provisions

41.3 Comprehensive Automobile Insurance

This insurance shall be in such a form to protect the Contractor against all claims for injuries, disability, disease and death to members of public including the UPRVUNL's men and damage to the property of other arising from the use of motor vehicles during on or off the Site operations, irrespective of the



Ownership of such vehicles. The liability covered shall be as herein indicated or as per the statutory requirement, whichever is higher:

Fatal Injury	:	Rs.100,000 each person
	:	Rs.200,000 each occurrence
Property Damage	:	Rs.100,000 each occurrence

41.4 Comprehensive General Liability Insurance

41.4.1 The insurance shall protect the Contractor against all claims arising from injuries, disabilities, disease or death of members of public or damage to property of others, due to any act or omission on the part of the Contractor, his agents, his employees, his representatives and Sub-Contractors or from riots, strikes and civil commotion. This insurance shall also cover all the liabilities of the Contractor arising out of the Clause entitled "Defence of Suits" in Section General Conditions of Contract (GCC).

41.4.2 The hazards to be covered will pertain to all the Works and areas where the Contractor, his Sub-Contractors, his agents and his employees have to perform work pursuant to the Contract.

41.4.3 The above are only illustrative list of insurance covers normally required and it will be the responsibility of the Contractor to maintain all necessary insurance coverage to the extent both in time and amount to take care of all his liabilities either direct or indirect, in pursuance of the Contract.

42.0 UNFAVOURABLE WORKING CONDITIONS

The Contractor shall confine all his field operations to those works which can be performed without subjecting the equipment and materials to adverse effects during inclement weather conditions, like monsoon, storms, etc. and during other unfavourable construction conditions. No field activities shall be performed by the Contractor under conditions which might adversely affect the quality and efficiency thereof, unless special precautions or measures are taken by the Contractor in a proper and satisfactory manner in the performance of such Works and with the concurrence of the UPRVUNL. Such unfavourable construction conditions will in no way relieve the Contractor of his responsibility to perform the Works as per the schedule

43.0 PROTECTION OF MONUMENTS AND REFERENCE POINTS

The Contractor shall ensure that any finds such as relic antiquity, coins, fossils, etc. which he may come across during the course of performance of his Works either during excavation or elsewhere, are properly protected and handed over to the Owner. Similarly the Contractor shall ensure that the benchmarks, reference points, etc. which are marked either with the help of Owner or by the Owner shall not be disturbed in any way during the performance of his Works. If, any work is to be performed which disturb such reference, the same shall be done only after these are transferred to other suitable locations under the direction of the Owner. The Contractor shall provide all necessary materials and assistance for such relocation of reference points etc.

44.0 WORK & SAFETY REGULATIONS

44.1 General



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- i) The contractor shall comply with all the requirements of "The Building and Other Construction Workers (Regulation of Employment & Conditions of Service) Act," 1996 and its Central Rule 1998 / State Rules, CEA Regulations on Safety Requirements (2011) and any other statutory requirements as applicable.
- ii) The Contractor shall follow UPRVUNL Safety Rules as issued from time to time with respect to safety in construction & erection.
- iii) The contractor shall have the approved Safety, Health and Environment (SHE) Policy in respect of Safety and health of Building Workers and it shall be circulated widely and displayed at conspicuous place in Hindi and local language understood by the majority of the workers. A copy of the safety policy should be submitted to Engineer in charge.
- iv) The contractor shall submit the safety plan comprising of methods to implement the Safety Policy/ Rules, Risk assessment and ensuring Safety at work areas, Safety audits, inspections and its compliance, Supervision and responsibility to ensure Safety at various levels, Safety training to employees, review of Safety and accident analysis, ensure Health and Safety Procedures to prevent accidents to Engineer I/C for approval. The typical format of Safety plan as annexed at Annexure - III. The Bidder shall also comply to the CEA Regulation on Safety Requirements, 2011.
- v) The Contractors shall ensure proper safety of all the workmen, materials, plant and equipment belonging to him or to the UPRVUNL or to others, working at the Site.
- vi) All equipments used in construction and erection by the contractor shall meet BIS / International Standards and where such standards do not exist, the Contractor shall ensure these to be absolutely safe. All equipments shall be strictly operated and maintained by the contractor in accordance with manufacturer's operation manual. The contractor should also follow Guidelines / Rules of the UPRVUNL in this regard.
- vii) The Contractors shall provide suitable latest Personal Protective Equipments of prescribed standard to all their employees and workmen according to the need. The Engineer I/c shall have the right to examine these safety equipments to determine their suitability, reliability, acceptability and adaptability. The contractor should also ensure these before their use at worksite.
- viii) The Contractor shall provide safe working conditions to all workmen and employees at his workplace including safe means of access, railings, stairs, and ladders, scaffolding, work platforms, toe boards etc. The scaffoldings shall be erected under the control and supervision of an experienced and competent person. For erection of scaffolds, access, work platforms etc. shall be good and the contractor shall use standard quality of material.
- ix) The Contractor shall follow and comply with all the Safety Rules,



standards, code of practices of UPRVUNL and relevant provisions of applicable laws pertaining to the safety of workmen, employees, plant and equipment as may be prescribed from time to time without any protest or contest or reservation. In case of any unconformity between statutory requirement and the Safety Rules of the UPRVUNL referred above, the latter shall be binding on the Contractor unless the statutory provisions are more stringent. As and when required he can refer / obtain copy of UPRVUNL safety documents as stated above.

- x) The contractor shall have his own arrangements with nearby hospitals for shifting and treatment of sick and injured.

The medical examination of the workers employed in hazardous areas shall be conducted as per Rule 223 Of The Building and Other Construction Worker (Regulation of Employment and Condition of Service) Central Rule 1998 their health records shall be maintained accordingly and to be submitted to Engineer I/c when asked for. If any worker found suffering from occupational health hazard, the worker should be shifted to suitable place of working and properly treated under intimation to Engineer I/c. The medical fitness certificate to be submitted to Engineer (I/c).

- xi) First Aid boxes equipped with requisite articles as specified in the Rule 231 of The Building and Other Construction Worker (Regulation of Employment and Condition of Service) Central Rule 1998 shall be provided at construction sites for the use of workers. Training has to be provided on first aid to workmen & office bearers working at site.

44.1.1 Emergency Action Plan

The contractor shall prepare an emergency action plan approved by his competent authority to handle any emergency occurred during construction work. Regular mock drills shall be organized to practice this emergency plan. The Emergency Action Plan should be widely circulated to all the employees and suitable infrastructure shall be provided to handle the emergencies.

44.1.2 Scaffolding

The contractor shall take all precautions to prevent any accidental collapse of scaffolding or fall of persons from scaffolding. The contractor should ensure that scaffolding are designed by a competent person and its erection and repairs should be done under the expert supervision. The scaffolding shall meet the required strength and other requirements for the purpose for which the scaffold is erected. The material used for scaffold should conform to the BIS / International standards.

44.1.3 Opening

The contractor shall ensure that there is no opening in any working platform/any floor of the building, which may cause fall of workers or material. Whenever an opening on a platform/any floor of the building is unavoidable, the opening should be suitably fenced and necessary measures for protection against falling objects or building workers from such platform are taken by providing suitable safety nets, safety belts or other similar means.



44.1.4 Explosives

The contractor shall take all precautions while handling, using, storing or transporting of all explosives. Before usage of any explosive necessary warning / danger signals be erected at conspicuous places to warn the workers and general public. The contractor should strictly ensure that all measures and precautions required to be complied for use, handling, storing or transportation of explosives under the rules framed under the Explosives Act, 1884.

44.2 Fencing of Machinery

The contractor shall provide suitable fencing or guard to all dangerous and moving parts of machinery.

The contractor shall not allow any of the employees to clean, lubricate, repair, adjust or examine during machinery in motion, which may cause injury to the person.

44.3 Carrying of Excessive Weight by a Worker

The worker shall not be allowed to lift by hand or carry over his head back or shoulder more than the maximum limit set by the prescribed rules for the construction Workers.

44.4 Dangerous and Harmful Gases / Equipment

The contractor shall ensure that the workers are not exposed to any harmful gases during any construction activity including excavation, tunnelling, confined spaces etc.

The contractor should not allow any worker to go into the confined space unless it is certified by Engineer (I/c) to be safe and fit for the entry to such work place. Proper record and work permits should be followed to carry out such works.

44.5 Overhead Protection

The contractor shall ensure that any area exposed to risk of falling materials, articles or objects is roped off or cordoned off or otherwise suitably guarded from inadvertent entry of any person.

Wherever there is a possibility of falling of any material, equipment or construction workers while working at heights, a suitable and adequate safety net should be provided. The safety net should be in accordance with BIS Standards.

44.6 Working at Heights

All working platforms, ways and other places of construction work shall be free from accumulations of debris or any other material causing obstructions and tripping.

Wherever workers are exposed to the hazard of falling into water, the contractor shall provide adequate equipment for saving the employees from drowning and rescuing from such hazards. The contractor shall provide boat or



launch equipped with sufficient number of life buoys, life jackets etc. manned with trained personnel at the site of such work.

Every opening at elevation from ground level through which a building worker, vehicle, material equipment etc. may fall at a construction work shall be covered and/or guarded suitably by the contractor to prevent such falls.

Wherever the workers are exposed to the hazards of falling from height, the contractor shall provide full harness safety belts fitted with fall arresting systems to all the employees working at higher elevations and life line of 8 mm diameter wire rope with turn buckles for anchoring the safety belts while working or moving at higher elevations. Safety nets shall also be provided for saving them from fall from heights and such equipment should be in accordance with BIS standards.

Wherever there is a possibility of falling of any material, equipment or construction workers while working at heights, a suitable and adequate safety net should be provided. The safety net should be in accordance with BIS Standards.

The contractor shall provide standard prefabricated ladders on the columns where the workers are required to use them as an access for higher elevations till permanent staircase is provided. The workers shall be provided with safety belts fitted with suitable fall arresting system (Fall arrestors) for climbing/getting down through ladders to prevent fall from height.

44.7 Handling of Hazardous Chemicals

The Contractor will notify well in advance to the Engineer I/c of his intention to bring to the Site any container filled with liquid or gaseous fuel or explosive or petroleum substance or such chemicals which may involve hazards. UPRVUNL shall have the right to prescribe the conditions, under which such container is to be stored, handled and used during the performance of the works and the Contract shall strictly adhere to and comply with such instructions. The Engineer I/c shall have the right at his sole discretion to inspect any such container or such construction plant / equipment for which material in the container is required to be used and if in his opinion, its use is not safe, he may forbid its use. No claim due to such prohibition shall be entertained by UPRVUNL and UPRVUNL shall not entertain any claim of the Contractor towards additional safety provisions / conditions to be provided for / constructed.

Further, any such decision of the Engineer I/c shall not, in any way, absolve the Contractor of his responsibilities and in case, use of such a container or entry thereof into the Site area is forbidden by UPRVUNL, the Contractor shall use alternative methods with the approval of the UPRVUNL without any cost implication to the UPRVUNL or extension of work schedule.

Where it is necessary to provide and / or store petroleum products or petroleum mixtures and explosives, the Contractor shall be responsible for carrying-out such provision and / or storage in accordance with the rules and regulations laid down in Petroleum Act 1934, Explosives Act 1948, and Petroleum and Carbide of Calcium Manual published by the Chief Inspector of Explosives of India. All such storage shall have prior approval of the Engineer I/c. In case any approvals are necessary from the Chief Inspector (Explosives) or any statutory authorities, the Contractor shall be responsible for obtaining the same.



The Contractor shall be fully responsible for the safe storage of his and his Sub-contractor's radio-active sources in accordance with BARC/DAE (Bhabha Atomic Research Centre/ Department of Atomic Energy, Govt. of India) Rules and other applicable provisions. All precautionary measures stipulated by BARC/DAE in connection with use, the contractor would take storage and handling of such material.

The contractor shall provide suitable personal protective equipments to the workers who are handling the hazardous and corrosive substances including alkalis and acids.

As a precautionary measure the contractor should keep the bottles filled with distilled water in cupboard/Boxes near work place for emergency eye wash by worker exposed to such hazardous chemicals.

44.8 Eye Protection

The contractor shall provide suitable personal protective equipment to his workmen depending upon the nature of hazards and ensure their usage by the workers engaged in operations like welding, cutting, chipping, grinding or similar operations which may cause injuries to his eyes.

44.9 Excavation

The contractor shall take all necessary measures during excavation to prevent the hazards of falling or sliding material or article from any bank or side of such excavation which is more than one and a half meter above his footing by providing adequate piling, shoring, bracing etc. against such bank or sides.

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.

44.10 Electrical Hazards

The contractor should ensure that all electrical installations at the construction work comply with the requirements of latest electricity acts / rules.

The contractor shall take all adequate measures to prevent any worker from coming into physical contact with any electrical equipment or apparatus, machines or live electrical circuits which may cause electrical hazards during the construction work. The contractor shall provide the sufficient ELCBs / RCCBs for all the portable equipments, electrical switchboards, distribution panels etc. to prevent electrical shocks.

The contractor should ensure use of single / double insulated hand tools or low voltage i.e., 110 volts hand tools.

The contractor should also ensure that all temporary electrical installations at the construction works are provided with earth leakage circuit breakers.

44.11 Vehicular Traffic



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The contractor should employ vehicle drivers who hold a valid driving license under the Motor Vehicles Act, 1988.

44.12 Lifting Appliances, Tools & Tackles, Lifting Gear And Pressure Plant & Equipment etc.

The contractor shall ensure all the lifting appliances, tools & tackles including cranes etc., lifting gear including fixed or movable and any plant or gear, hoists, Pressure Plant and equipment etc. are in good condition and shall be examined by competent person and only certified shall be used at sites. Periodical Examination and the tests for all lifting / hoisting equipment & tackles shall be carried out. A register of such examinations and tests shall be properly maintained by the Contractor and will be promptly produced as and when desired by the Engineer I/c or by the person authorized by him.

44.13 Excessive Noise, Vibration

The contractor shall take adequate measures to protect the workers against the harmful effect of excessive noise or vibration. The noise should not exceed the limits prescribed under the concerned rules, Noise Pollution (Regulation and Control) Rules, 2000.

44.14 Electrical Installations

The Contractor shall not interfere or disturb electric fuses, wiring and other electrical equipment belonging to the UPRVUNL or other contractors under any circumstances, whatsoever, unless expressly permitted in writing by the Engineer I/c to handle such fuses, wiring or electrical equipment.

Before the Contractor connects any electrical appliances to any plug or socket belonging to the other contractor or the UPRVUNL, he shall

- i.) Satisfy the Engineer I/C that the appliance is in good working condition;
- ii.) Inform the Engineer I/C of the maximum current rating, voltage and phases of the appliances;
- iii.) Obtain permission of the Engineer I/C detailing the sockets to which the appliances may be connected.

The Engineer I/C will not grant permission to connect until he is satisfied that:

- a. The appliance is in good condition and is fitted with suitable plug; having earth connection with the body.
- b. Wherever armoured / metallic sheathed multi core cable is used, the same armoured / sheathed should be connected to earth.
- iv.) No repair work shall be carried out on any live equipment. The Engineer I/c must declare the equipment safe and a permit to work shall be issued by the UPRVUNL / contractor as the case may be to carry out any repair / maintenance work. While working on electric lines / equipments whether live or dead, suitable type and sufficient quantity of tools will have to be provided by the contractor to electricians / workmen / Officers.



- v.) The contractor shall employ necessary number of qualified, full time Electricians/ Electrical Supervisors to maintain his temporary electrical installation.

The installations are provided with suitable ELCBs and RCCBs wherever required.

44.15 Safety Organisation

- 44.15.1 The contractor employing more than 250 workmen whether temporary, casual, probationary, regular or permanent shall employ at least one full time safety officer exclusively to supervise safety aspects of the equipments and workmen, who will coordinate with the UPRVUNL Safety Officer. Further requirement of safety officers, if any, shall be guided by Rule 209 of The Building and Other Construction Worker (Regulation of Employment and Conditions of Service) Central Rule 1998. In case the work is being carried out through subcontractor, the employees / workmen of the sub contractor shall also be considered as the contractor's employees/workmen for the above purpose.

In case of contractor deploying less than 250 workmen he should designate one of his Engg /supervisor or the contractor himself (if he is directly supervising the work) as safety officer in addition to his existing responsibilities. The Engg/ supervisor should get at least 2days safety training from any reputed organization or from UPRVUNL before resuming the work. If already trained in past the declaration along with trg. certificate to be furnished to UPRVUNL safety officer.

- 44.15.2 The name and address of such Safety Officer of the Contractor will be promptly informed in writing to the EIC with a copy to the Project Safety Officer before he starts work or immediately after any change of the incumbent is made during currency of the Contract.

44.16 Reporting of Accident and Investigation

In case any accident occurs during the construction / erection or other associated activities undertaken by the Contractor thereby causing any near miss, minor or major or fatal injury to his employees due to any reason, whatsoever, it shall be the responsibility of the Contractor to promptly inform the same to the Engineer I/C, UPRVUNL Safety Officer with a copy to UPRVUNL Head of Project in the prescribed form and also to all the authorities envisaged under the applicable laws.

44.17 Right to stop Work

- 44.17.1 The Engineer I/C shall have the right at his sole discretion to stop the work, if in his opinion the work is being carried out in such a way that it may cause accidents and endanger the safety of the persons and / or property, and / or equipments. In such cases, the contractor shall be informed in writing about the nature of hazards and possible injury / accident and he shall comply to remove shortcomings promptly. The Contractor after stopping the specific work can, if felt necessary appeal against the order of stoppage of work to the Project Manager within 3 days of such stoppage of work and decision of the Project Manager in this respect shall be conclusive and binding on the Contractor.



- 4.17.2 The Contractor shall not be entitled for any damages / compensation for stoppage of work, {Sub-Clause XVIII (I)} due to safety reasons and the period of such stoppage of work shall not be taken as an extension of time for Completion of the Facilities and will not be the ground for waiver of levy of liquidated damages.

44.18 Fire Protection

The contractor shall provide sufficient fire extinguishers at place /s of work. The fire extinguishers shall be properly maintained as per relevant BIS Standards. The employees shall be trained to operate the fire extinguishers / equipment.

44.19 Penalties

- a) If the Contractor fails in providing safe working environment as per the Safety Rules of UPRVUNL or continues the work even after being instructed to stop the work by the Engineer I/C as provided the Contractor shall be penalized at the rate of Rs. 25,000/- per day or part thereof till the instructions are complied with and so certified by the Engineer I/C. However, in case of accident, the provisions contained below shall also apply in addition to the penalties mentioned in this sub-clause.
- b) If the Contractor does not take all safety precautions and / or fails to comply with the Safety Rules as prescribed by the UPRVUNL or under the applicable law for the safety of the plant and equipment and for the safety of personnel and the contractor does not prevent hazardous conditions which cause injury to his own employees or employees of other contractors, or UPRVUNL's employees or any other person who are at the Site or adjacent thereto, the Contractor shall be responsible for payment of penalty as per the following schedule:-

i. Fatal injury or accident causing death:

Penalty @10% of contract value or Rs. 5,00,000/- per person, whichever is less.

ii. Major injuries or accident causing 25% or more permanent disablement to workmen or employees:

Penalty @2.5% of contract value or Rs. 1,00,000/- per person whichever is less

Permanent disablement shall have the same meaning as indicated in 'The Workmen's Compensation Act' 1923.

The penalty mentioned above shall be in addition to the compensation payable to the workmen/employees under the relevant provisions of the 'The Workmen's Compensation Act 1923' and rules framed there under or any other applicable laws as applicable from time to time.

- c) If any contractor worker found working without using the safety equipment like safety helmet, safety shoes, safety belts, etc. or without anchoring the safety belts while working at height the Engineer I/C / Safety Officer of UPRVUNL shall have the right to penalize the contractor for Rs. 200/-



per person per day and such worker shall be sent out of the workplace immediately and shall not be allowed to work on that day. Engineer I/C / Safety Officer of UPRVUNL will also issue a notice in this regard to the contractor.

- d) If two or more fatal accidents occur at same UPRVUNL site under the control of contractor during the period of contract and he has
- i. not complied with keeping adequate PPEs in stock or
 - ii. defaulted in providing PPEs to his workmen
 - iii. not followed statutory requirements / UPRVUNL safety rules
 - iv. been issued warning notice/s by UPRVUNL head of the project on non observance of safety norms
 - v. Not provided safety training to all his workmen, the contractor can be debarred from getting tender documents in UPRVUNL for two years from the date of last accident.
- e) The safety performance will also be one of the overriding criteria for evaluation of overall performance of the contractors by UPRVUNL. The contractor shall submit the accident data including fatal / non-fatal accidents for the last 3 years where he has undertaken the construction activities Projects-wise along with the tender documents. This will also be considered for evolution of tender documents. If the information given by the contractor found incorrect, his contract will be liable to be terminated.

44.20 Award

If the Contractor's performance on safety front is found satisfactory i.e. without any fatal/reportable accident in the year of consideration he may be considered for suitable award "ACCIDENT FREE SAFETY MERITORIOUS AWARD" as per scheme of the UPRVUNL.

45.0 FOREIGN PERSONNEL

- 45.1 The Contractor shall submit to the UPRVUNL data on all personnel he proposes to bring into India from abroad for the performance of the Works under the Contract, at least sixty (60) days prior to their departure to India. Such data will include for each person the name, his present address, his assignment and responsibility in connection with the works, and a short resume of his qualification, experience etc. in relation to the work to be performed by him.
- 45.2 Any person unsuitable and unacceptable to the UPRVUNL shall not be brought to India. Any person brought to India, if found unsuitable or unacceptable by the UPRVUNL, the Contractor shall within a reasonable time make alternate arrangements for providing a suitable replacement and repatriation of such unsuitable personnel.
- 45.3 No person brought to India for the purposes of the works shall be repatriated without the consent of the UPRVUNL in writing, based on a written request from the Contractor for such repatriation giving reasons for such an action to the UPRVUNL. The UPRVUNL may give permission for such repatriation provided he is satisfied that the progress of work will not suffer due to such repatriation.



- 45.4 The cost of passports, visas and all other travel expenses to and from India, incurred by the Contractor shall be to his account. The UPRVUNL will not provide any residential accommodation and/or furniture for any of the Contractor's personnel including foreign personnel and Contractor shall make his own arrangements for such facilities in the area allotted at Site, to him by the UPRVUNL for that purpose.
- 45.5 The Contractor and his expatriate personnel shall respect all Indian Acts, Laws, rules and regulations and shall not in any way interfere with Indian political and religious affairs and shall conform to any other rules and regulations which the Government of India and the UPRVUNL may establish from time to time, on them. The Contractor's expatriate personnel shall work and live in close co-operation and coordination with their co-workers and the community and shall not engage themselves in any other employment neither part-time nor full-time nor shall they take part in any local politics.
- 45.6 The UPRVUNL shall assist the Contractor, to the extent possible, in obtaining necessary permits to travel to India and back, by issue of necessary certificates and other information needed by the Government agencies

46.0 FOUNDATION DRESSING & GROUTING FOR EQUIPMENTS/EQUIPMENTS BASES

- 46.1 The surfaces of foundations shall be dressed to bring the top surface of the foundations to the required level, prior to placement of equipment / equipment basis on the foundations.
- 46.2 All the equipment / equipment bases, shall be grouted and finished as per these specifications unless otherwise recommended by the equipment manufacturer.
- 46.3 The concrete foundation surfaces shall be properly prepared by chipping, grinding as required to bring the top of such foundation to the required level, to provide the necessary roughness for bondage and to assure enough bearing strength.

46.4 Grout

- 46.4.1 The grout shall be high strength grout having a minimum characteristic compressive strength of 60 N/mm² at 28 days from being cast. The grout shall be chloride free, cement based, free flowing, non-metallic grout.
- 46.4.2 The grout shall have good flow ability even at very low water / grout powder ratio.
- 46.4.3 The grout shall have characteristics of controlled expansion to be able to occupy its original volume to fill the voids and to compensate for shrinkage. Grout shall be of pre-mix variety so that only water needs to be added before use.
- 46.4.4 The mixing of the Grout shall conform to the recommendations of the manufacturer of the Grout.



46.5 Placing of Grout

- 46.5.1 After the base has been prepared, its alignment and level has been checked and approved and before actually placing the grout, a low dam shall be set around the base at a distance that will permit pouring and manipulation of the grout. The height of such dam shall be at least 25 mm above the bottom of the base. Suitable size and number of chains shall be introduced under the base before placing the grout, so that such chains can be moved back & forth to push the grout into every part of the space under the base.
- 46.5.2 The grout shall be poured either through grout holes if provided or shall be poured at one side or at two adjacent sides to make the grout move in a solid mass under the base and out in the opposite side. Pouring shall be continued until the entire space below the base is thoroughly filled and the grout stands at least 25mm higher all around than the bottom of the base. Enough care should be taken to avoid any air or water pockets beneath the bases.
- 46.5.3 In addition to the above, recommendations of Grout manufacturer shall also be followed.

46.6 Finishing of the Edges of the Grout

- 46.6.1 The poured grout should be allowed to stand undisturbed until it is well set. Immediately thereafter, the dam shall be removed and grout which extends beyond the edges of the structural or equipment base plates shall be cut off, flushed and removed. The edges of the grout shall then be pointed and finished with 1:2 cement mortar pressed firmly to bond with the body of the grout and smoothed with a tool to present a smooth vertical surface. The work shall be done in a clean and scientific manner and the adjacent floor spaces, exposed edges of the foundations, and structural steel and equipment base plates shall be thoroughly cleaned of any spillage of the grout.

46.7 Checking of Equipment after Grouting

- 46.7.1 After the grout is set and cured, the Contractor shall check and verify the alignment of equipments, alignment of shafts of rotating machinery, the slopes of all bearing pedestals, centering of rotors with respect to their sealing bores, couplings, etc. as applicable and the like items to ensure that no displacement had taken place during grouting. The values recorded prior to grouting shall be used during such post grouting check-up and verifications. Such pre and post grout records of alignment details shall be maintained by the Contractor in a manner acceptable to the Owner.

47.0 SHAFT ALIGNMENTS

All the shafts of rotating equipment shall be properly aligned to those of the matching equipments to as perfect an accuracy as practicable. The equipment shall be free from excessive vibration so as to avoid overheating of bearings or other conditions which may tend to shorten the life of the equipment. The vibration level of rotating equipments measured at bearing housing shall conform to Zone A of ISO 10816. All bearings, shafts and other rotating parts shall be thoroughly cleaned and suitably lubricated before starting.

48.0 DOWELLING

All the motors and other equipment shall be suitably dowelled after alignment of shafts with tapered machined dowels as per the direction of the Owner.

49.0 CHECK OUT OF CONTROL SYSTEMS

After completion of wiring, cabling furnished under separate specification and laid and terminated by the UPRVUNL, the Contractor shall check out the operation of all control systems for the equipment furnished and installed under these specifications and documents.

50.0 COMMISSIONING SPARES

50.1 It will be the responsibility of the Contractor to provide all commissioning spares including consumable spares required for initial operation till the completion of facilities. The Contractor shall furnish a list of all commissioning spares within 60 days from the date of Notification of Award and such list shall be reviewed by the Owner and mutually agreed to. However, such review and agreement will not absolve the Contractor of his responsibilities to supply all commissioning spares so that initial operation do not suffer for want of commissioning spares. All commissioning spares shall be deemed to be included in the scope of the Contract at no extra cost to the Owner.

50.2 These spare will be received and stored by the Contractor at least three (3) months prior to the schedule date of commencement of initial operation of the respective equipment and utilized as and when required. The unutilized spares and replaced parts, if any, at the end of successful completion of guarantee tests shall be the property of the Contractor and he will be allowed to take these parts back at his own cost with the permission of Owner.

51.0 CABLING

51.1 All Cables shall be supported by conduits or cable tray run in air or in cable channels. These shall be installed and exposed runs parallel or perpendicular to dominant surfaces with right angle turn made of symmetrical bends or fittings. When cables are run on cable trays, they shall be clamped at minimum intervals of 2000mm or otherwise as directed by the Owner.

51.2 Each cable, whether power or control, shall be provided with a metallic or plastic tag of an approved type, bearing a cable reference number indicated in the cable and conduit list (prepared by the Contractor), at every 5 meter run or part thereof and at both ends of the cable adjacent to the terminations. Cable routing is to be done in such a way that cables are accessible for any maintenance and for easy identification.

51.3 Sharp bending and kinking of cables shall be avoided. The minimum radii for PVC insulated cables 1100 V grade shall be 15D (where D is the overall diameter of the cable). Installation of other cables like high voltage, coaxial, screened, compensating, mineral insulated shall be in accordance with the cable manufacturer's recommendations. Wherever cables cross roads and water, oil, sewage or gas lines, special care should be taken for the protection of the cables in designing the cable channels.

51.4 In each cable run some extra length shall be kept at a suitable point to enable one or two straight through joints to be made, should be cable develop fault at a later date.



- 51.5 Control cable terminations shall be made in accordance with wiring diagrams, using identifying codes subject to the Owner's approval. Multicore control cable jackets shall be removed as required to train and terminate the conductors. The cable jacket shall be left on the cable, as far as possible, to the point of the first conductor branch. The insulated conductors from which the jacket is removed shall be neatly twined in bundles and terminated. The bundles shall be firmly but not tightly tied utilizing plastic or nylon ties or specifically treated fungus protected cord made for this purpose. Control cable conductor insulation shall be securely and evenly cut.
- 51.6 The connectors for control cables shall be covered with a transparent insulating sleeve so as to prevent accidental contact with ground or adjacent terminals and shall preferably terminate in Elmex terminals and washers. The insulating sleeve shall be fire resistant and shall be long enough to over pass the conductor insulation. All control cables shall be fanned out and connection made to terminal blocks and test equipment for proper operation before cables are corded together.

52.0 EQUIPMENTS DELIVERY AND ERECTION

52.1 General Requirements

- a) This part covers Contractor's responsibilities for packing, shipping, warehousing and the installation of all equipment and materials furnished and installed under this specification.
- b) The Contractor shall submit for Owner's approval draft manual for Equipment Delivery and Erection (EDE Manual) covering detailed instructions, write-up, technical data, drawings, check-lists, documentation formats for all activities after equipment manufacture upto installation of equipment. This manual shall cover general instructions for all equipment and specific instructions for individual equipment wherever required and shall include at least the following:
 1. Instructions for packing, shipping, receiving handling, warehousing and storage.
 2. Instructions for location and installation of equipment furnished by this specification.
 3. Installation drawings for field mounted equipment, panels, cubicles and other equipment covered under this specification.
 4. Instruction relating installation of piping/tubing, support and routing drawings of impulse pipes / signal tubes and tube/cable trays.
 5. Check lists and quality assurance hold point.
 6. Format for all related documentation.
- c) The EDE Manual shall conform to the requirements of this specification, all applicable codes and standards, recommendations of equipment manufacturers and accepted good engineering practices and shall be subject to Owner approval during detailed engineering.
- d) The Contractor shall ensure that all work under this part shall be performed as per the requirements of this specification. Owner approved EDE Manual and drawing / documents approved by the Owner during detailed engineering.

52.2 Crating



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- b) All equipment and materials shall be suitably coated, wrapped, or covered and boxed or crated for moist humid tropical shipment and to prevent damage or deterioration during handling and storage at the site.
- c) Equipment shall be packed with suitable desiccants, sealed in water proof vapour-proof wrapping and packed in lumber of plywood enclosures, suitably braced, tied and skidded. Lumber enclosures shall be solid, not slatted.
- d) Descants shall be either silica gel or calcium sulphate, sufficiently ground to provide the required surface area and activated prior to placing in the packaging. Calcium sulphate desiccants shall be of a chemical nature to absorb moisture. In any case, the desiccant shall not be of a type that will absorb enough moisture to go into solution. Desiccants shall be packed in porous containers, strong enough to withstand handling encountered during normal shipment. Enough desiccant shall be used for the volumes enclosed in wrapping.
- e) Review by the Owner of the Contractor's proposed packaging methods shall not relieve the Contractor of responsibility for damage or deterioration to the equipment and materials specified.
- f) All accessory items shall be shipped with the equipment. Boxes and crates containing accessory items shall be marked so that they are identified with the main equipment. The contents of each box and crates shall be indicated by markings on the exterior.
- g) All boxes, crates, cases bundles, loose pieces, etc. shall be marked consecutively from No.1 upward throughout all shipments from a given port to completion of the order without repeating the same number.
- h) An itemized list of contents shall be enclosed inside each case and one other copy securely fastened to the outside of the case in a tin or light weight sheet metal envelope or pocket. The lists shall be plainly marked and placed in accessible locations to facilitate receipt and inspection. The packing list shall indicate whether shipment is partial or complete and shall incorporate the following information on each container, etc. according to its individual shipping number:
 - 1. Export case markings
 - 2. Case number
 - 3. Gross weight and net weight in Kilograms
 - 4. Dimensions in centimeters
 - 5. Complete description of material
- i) Packaging or shipping units shall be designed within the limitations of unloading facilities and the equipment which will be used for transport. Complications involved with ocean shipment and the limitations of ports, railways and roads shall be considered. It shall be the Contractor's responsibility to investigate these limitations and to provide suitable packaging to permit safe handling during transit and at the job site.
- j) Electrical equipment, control and instrumentation shall be protected against moisture and water damage. All external gasket surfaces and flange faces, couplings, motor pump shafts, bearing and like items shall be



thoroughly cleaned and coated with rust preventive compound as specified above and protected with suitable wood, metal or other substantial type covering to ensure their full protection.

- k) Equipment having antifriction or sleeve bearings shall be protected by weather tight enclosures.
- l) Coated surfaces shall be protected against impact, abrasion, discolouration and other damage. Surfaces which are damaged shall be repaired.
- m) All exposed threaded parts shall be greased and protected with metallic or other substantial type protectors. All female threaded openings shall be closed with forged steel plugs. All pipings, tubing, and conduit equipment and other equipment openings shall be sealed with metallic or other rough usage covers and tapped to seal the interior of the equipment piping, tubing, or conduit.
- n) Provisions shall be made to ensure that water does not enter any equipment during shipment or in storage at the plant site.
- o) Returnable containers and special shipping devices shall be returned by the manufacturer's field representative at the Contractor's expense.
- p) While packaging the material, care shall be taken for the limitation from the point of view of availability of railway wagon sizes in India.

52.3 Factory Assembly

- a) Instrument enclosures shall be supplied and erected completely in the factory with instrument, air supply and blow down piping with necessary valves, fittings, etc. and also all electrical wiring between the instruments and the enclosure terminal blocks. Control panel and cubicles shall also be fully wired in the factory. Control panel mounted equipments are to be dismantled from the panels before shipment and individually packed for shipment. Electronic control modules of the plug-in type are to be removed from equipment racks after factory checkout are individually packed for shipment. Other equipment shall be fully assembled at the factory, except for necessary shipping splits in panels.
- b) All separately packaged accessories items and part shall be shipped with the equipment. Containers for separately packaged items shall be marked so that they are identified with the main equipment. An itemized packing slip, indicating what is in that carton only, shall be attached to the outside and inside of each container used for packing.
- c) A master packing slip covering all accessories items for a given piece of equipment which are shipped in separate containers, shall be attached to one container.

52.4 Equipment Installation

a) General Requirements

1. The Contractor shall furnish all construction materials, tools and equipment and shall perform all work required for complete installation



of all control and instrument equipment furnished under this specification.

2. Contractor shall prepare detailed installation drawings for each equipment furnished under this specification for Owner's approval. Installation of all equipment/systems furnished by this specification shall be as per Owner's approval.
3. Erection procedures not specified herein shall be in accordance with the recommendations of the equipment manufacturers. The procedures shall be acceptable to the Owner.
4. The Contractor shall coordinate his work with other suppliers where their instruments and devices are to be installed under specifications.

b) Installation Materials

All materials required for installation, testing and commissioning of the equipment shall be furnished by the Contractor.

c) Regulator Requirements

All installation procedures shall confirm with the accepted good engineering practice and with all applicable government laws, regulations and codes.

d) Cleaning

All equipment shall be cleaned of all sand, dirt and other foreign materials immediately after removal from storage and before the equipment is brought inside the power plant building or to other installation sites. All piping and tubes shall be air blown.

e) Equipment Assembly

Equipment installed under these specifications shall be assembled if shipped unassembled. The equipment shall be dismantled and reassembled as required to perform the installation and commissioning work described in these specifications.

f) Equipment Setting

Field mounted instruments and accessories shall be bracket or sub panel mounted on the nearest suitable firm steel work or masonry. The brackets, stands, supports and other miscellaneous hardware required for mounting instruments and accessories such as receiver gauge, air set, valve manifold, purge-meter etc. shall be furnished and installed. No field mounted instruments shall be installed such that it depends for support or rigidity on the impulse piping or on electrical connection to it.

Indicating type field mounted instruments shall be installed in such a way that centre of indicating dial shall be about 1600-1800 mm from operating floor level. Non-indicating type field instruments shall be installed such that operating handle of manifold block/isolating cock comes within 1600mm from operating floor level.

All free standing instrumentation cabinets and panels shall be located within the construction tolerances of +/- 3mm of the location dimensions indicated on the Owner's plant arrangement drawings.

g) Free Standing Equipment



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Free-standing Cabinets shall be attached to the floor, concrete equipment bases or supporting steel as indicated on the manufacturer's drawings and the Owner's Plant Arrangement Drawings. The cabinets shall be shimmed for proper alignment before bolting them to the floor. Adjacent enclosures shall be shimmed to maintain mutually level appearance before they are attached to floor. Vibration dampening mounts shall be installed between supporting structures and panels when specified.

h) Non-free Standing Equipment

1. Non-free standing local enclosures and cabinets shall be mounted in accessible locations on columns, walls, or stands in locations as indicated on the Owner's Plant Arrangement Drawings. Bracket and stands shall be fabricated as required to install the local enclosures and cabinets in a workman like manner.
2. Rough edges and welds on all fabricated supports shall be ground smooth. The supports shall be finished with two coats of primer and two coats of paint as specified in this part.

i) Equipment Location

1. All individual items of equipment not located in cabinets or on panels and racks are located approximately according to the floor elevation and the nearest building column designated by the Owner.
2. Solenoid valves not located in enclosures or mounted on valves shall be mounted in easily accessible protected locations near the components with which they are associated.
3. All brackets, stands, supports and other miscellaneous hardware required for mounting devices shall be furnished and installed.
4. Thermometers shall be installed in the process lines and ducts as required and adjusted for ease in reading.
5. Permanent temperature wells on the main steam, hot reheat and cold reheat piping shall not be installed until steam blowing has been completed. Temporary temperature wells shall be installed in the main and reheat steam piping during steam blow and discarded after completion.
6. Any required adapting hardware such as pipe bushings, nipples, drilled caps and the like shall be provided for complete installation of control devices into process connections.
7. For location of C&I related equipment/devices, the requirement specified elsewhere in the technical specification may be referred.

j) Installation of Field Mounted Instruments and devices

The Contractor shall submit installation drawings for all field mounted equipment furnished under this specification for Owner's approval. These drawings shall meet the requirements of this specification, installation drawings, applicable codes and standards and recommendations of manufacturers of instruments / devices. All installation work under this



specification shall be strictly as per installation drawings approved by the Owner during detailed engineering stage.

In addition to above relevant Portion as specified elsewhere in technical specification may be referred.

k) Piping Connections

1. All equipment having piping connections shall be leveled, aligned and wedged in place but shall not be grouted or bolted prior to the initial fitting and alignment of connecting piping. All equipment shall, however, be grouted or bolted to its foundation prior to final bolting or welding of the connection piping.
2. All flanged joints shall be checked and retightened after approximately 10 days of operation at normal operating temperature.

l) Equipment Checkout

1. All equipment shall be cleaned after installation. Equipment subject to pressure differentials shall be checked for leakage.
2. After erection, all equipment having moving parts, having electrical apparatus, or subject to pressure differentials shall be trial-operated.

m) Defects

1. All defects in erection shall be corrected to the satisfaction of the Owner and the Project Manager. The dismantling and reassembly of Contractor furnished equipment to remove defective parts, replace parts, or make adjustments shall be included as a part of the work under these specifications.
2. The removal of control and instrument equipment in order to allow bench calibration, if required, and the re-installation of the said equipment after calibration shall also be included as a part of the work under these specifications.

n) Equipment Protection

1. All equipment to be erected under these specifications shall be protected from damage of any kind from the time of contract award until commissioning of each unit.
2. The equipment shall be protected during storage as described herein.
3. Equipment shall be protected from weld spatter during construction.
4. Suitable guards shall be provided for protection of personnel on all exposed rotating or moving machine parts. All such guards with necessary spares and accessories shall be designed for easy removal and maintenance.
5. Equipment has glass components such as gauges, or equipment having other easily breakable components, shall be protected during the



construction period with plywood enclosures or other suitable means. Broken, stolen, or lost components shall be replaced by the Contractor.

6. Machine finished surfaces, polished surfaces, or other bare metal surfaces which are not to be painted, such as machinery shafts and couplings shall be provided temporary protection during storage and constructional periods by a coating of a suitable non-drying, oily type, rust preventive compound.

53.0 WELDING - SPECIAL REQUIREMENTS

If the manufacturer has special requirements relating to the welding procedures for welds at the terminals of the equipments to be performed under separate specifications, the requirements shall be submitted to the Project Manager in advance of commencement of erection work.

54.0 DEVIATIONS DISPOSITIONING

Any deviation to the contract and UPRVUNL approved documents shall be properly recorded in the format prescribed by UPRVUNL. All the deviations shall be brought to the knowledge of UPRVUNL's representative for suitable dispositioning.

55.0 NON-DESTRUCTIVE TESTING (NDT)

The contractor shall record results of NDTs carried out at site in the format acceptable to UPRVUNL. All the radiographs & its report duly signed & correlated to the job shall be handed over to the UPRVUNL. Sensitivity of all the test equipment shall be compatible to the job & acceptance norms agreed.

56.0 TESTING EQUIPMENT & FACILITIES

Contractor shall provide the testing equipment and facilities necessary to carry out tests & inspections.



ANNEXURE-I

**STANDARD CHECKLIST
COMMISSIONING/TESTING ESSENTIAL PRE-REQUISITE****1. MECHANICAL****A) VALVES**

- 1) MANUALLY OPERATED VALVE
- 2) ELECTRICALLY OPERATED VALVE
- 3) PNEUMATICALLY ACTUATED VALVE
- 4) HYDRAULICALLY ACTUATED VALVE
- 5) SAFETY VALVE
- 6) ELECTROMATIC RELIEF VALVE
- 7) STEAM TRAP
- 8) BUTTERFLY VALVE (ELECTRICALLY OPERATED)
- 9) BUTTERFLY VALVE (MANUALLY OPERATED)
- 10) BUTTERFLY VALVE (FOUR WAY-ELECTRICAL)
- 11) NON-RETURN VALVE (INCLUDING HYDRAULIC/PNEUMATIC FCNRVS)
- 12) THREEWAY CONTROL VALVE
- 13) RELIEF VALVE
- 14) DIFFERENTIAL PRESSURE REGULATING VALVE
- 15) FLOAT OPERATED VALVES

B) TANKS AND PRESSURE VESSELS

- 1) TANKS (METAL) UP TO 20M²
- 2) TANKS (LARGE STORAGE)
- 3) PRESSURE VESSEL (BELOW 17 BARS)
- 4) AIR RECEIVER
- 5) PRESSURE VESSEL-ACCESS DOOR
- 6) TURBINE MAIN OIL TANK

C) PUMPS

- 1) PUMP LOW PRESSURE CENTRIFUGAL (MOTOR DRIVEN)
- 2) PUMP UP TO 350HP (260KW)
- 3) PUMP SUMP INSTALLATION
- 4) GEAR PUMP/SCREW PUMP

D) PIPE WORK SYSTEM

- 1) STEAM SERVICES
- 2) WATER SERVICES
- 3) OIL/FIRE RESISTANT FLUID SYSTEM
- 4) AIR SERVICES (COMPRESSOR)
- 5) HIGH PRESSURE SERVICES
- 6) CONSTANT LOAD SUPPORT
- 7) SPRING SUPPORTS
- 8) HANGERS AND OTHER SUPPORTS

E) STRAINER AND FILTER

- 1) STRAINER/FILTER BASKET TYPE
- 2) STRAINER ROTARY (LOW PRESSURE)
- 3) FILTER & STRAINERS CENTRIFUGAL SEPARATORS
- 4) FILTER & STRAINER Y-TYPE



- 5) FILTER&STRAINER(PLATETYPE)
- 6) PURIFIER
- 7) FILTER-COMPRESSED AIRLINE

F) HEATEXCHANGER

- 1) HEATEXCHANGER(GENERAL)
- 2) HEATEXCHANGER-OIL/WATER
- 3) ROTARYAIR HEATER

G) FANSANDCOMPRESSORS

- 1) FANS-NON-PRESSURELUBRICATED
- 2) FANS-AXIALFLOWPRESSURELUBRICATED
- 3) COMPRESSORS-GENERAL
- 4) DAMPERS&GATES

H) CRANESANDELEVATORS

- 1) AUXILIARYOVERHEADCRANE
- 2) TRAVELSUPPORTSTRUCTURE FORCRANE
- 3) LONGTRAVEL&CROSSTRAVERSEMOTIONOFCRANE
- 4) MAINAUX.HOISTMOTION(CRANE)
- 5) ELECTRICHOIST

I) POWERTRANMISSION

- (1.) POWERTRANMISSIONGEARBOX (2.) BEARING
- (2.) BEARING
- (3.) FLUIDCOUPLINGS

2. ELECTRICAL

- 1) D.C.MOTOR
- 2) HVSQUIRRELCAGEINDUCTIONMOTOR
- 3) 415VSQUIRRELCAGEINDUCTIONMOTOR
- 4) MOTOROPERATEDACTUATORS
- 5) LT SWITCHGEARS/MCC
 - i) STANDARDCHECLISTSFORALLTYPESOFRELAYSUSED IN SWITCHGEARS PROTECTIONSYSTEM
 - ii) PTCARRIAGEANDCUBICLES
 - iii) CABLE/BUS DUCT/BUSBARS
 - iv) CONTRACTORMODULE
 - v) SWITCHFUSEMODULE
 - vi) MASTERPANEL OFLUBEOILPANEL
 - vii) FEEDERPANELOFLUBEOILPANEL
 - viii) SPACEHEATERANDCABLEMODULE
 - ix) CONTROLTRANSFORMERMODULE
 - x) HTCIRCUITBREAKER
 - xi) 415VCIRCUITBREAKER
- 6) POWERCABLE
- 7) CONTROLCABLE
- 8) AUXILIARYCABLE
- 9) D.C.CABLE
- 10) EXPLOSIONPROOFELECTRICAL EQUIPMENT
- 11) JUNCTIONBOX
- 12) CONTROLTRANSFORMERMODULE
- 13) BRUSHGEARASSEMBLY



- 14) AUX.CONTROLANDRELAYPANELDESK
- 15) INDICATINGINSTRUMENT
- 16) RECORDINGINSTRUMENT
- 17) INTEGRATINGINSTRUMENT

3. CONTROL & INSTRUMENTATION

- A) CONDUCTIVITY ANALYSING EQUIPMENT INCLUDING TEST PROCEDURES
- B) PHANALYSERINCLUDINGTESTPROCEDURE
- C) SILICAANALYSER
- D) LEVELSWITCH(FLOATACTUATED)
- E) LEVELSWITCH(ELECTRODETYPE)
- F) LEVELSWITCH(DISPLACERACTUATED)
- G) TRANSMITTER(FLOATOPERATEDPNEUMATICOUTPUT)INCLUDING TESTINGPROCEDURE
- H) LEVELINDICATOR(FLOAT/PULLEYTYPE)
- I) LOCALTEMPERATUREINDICATORSINCLUDINGTESTPROCEDURE
- J) RESISTANCE THERMOMETER ELEMENT INCLUDING TEST PROCEDURE
- K) THERMOCOUPLEELEMENTANDCONNECTINGCABLE
- L) THERMOCOUPLEANDRESISTANCETHERMOMETERCONVERTOR/ TRANSMITTERINCLUDINGTESTPROCEDURES.
- M) TEMPERATURE SWITCH/THERMOSTAT INCLUDING TESTPROCEDURES
- N) COLDJUNCTIONBOXES
- O) ZENERBARRIER
- P) O₂ ANALYSER
- Q) O₂INHYDROGENINCLUDINGTESTPROCEDURES
- R) PRESSUREANDVACUUMGAUGE
- S) PRESSUREANDVACUUMSWITCHINCLUDINGTESTPROCEDURE
- T) DIFFERENTIAL PRESSURETRANSMITTERINCLUDINGTESTPROCEDURE
- U) DIFFERENTIALPRESSURESWITCHINCLUDINGTESTPROCEDURE.
- V) FLOWINDICATOR(VARIABLEAREA)
- W) ORIFICEPLATE
- X) TURBINEFLOWTRANSMITTER
- i) FLOWSWITCH
- ii) WEIR
- iii) NOZZLE
- iv) FLOW INDICATOR (PNEUMATIC INPUT) INCLUDING TEST PROCEDURE
- v) FLOWINTEGRATOR(PNEUMATICINPUT) INCLUDING TESTPROCEDURE
- vi) FLOWINDICATOR(FLOATOPERATED)INCLUDING TESTPROCEDURE
- vii) VENTURI(FLUID)
- viii) FLOWSWITCH(MAGNETICTYPE)
- ix) AVERAGINGINLET
- x) LIMITSWITCHES
- Y) TURBINESUPERVISORYMEASURINGSYSTEM
- Z) POSITIONMEASUREMENTANDINDICATIONINCLUDING TESTPROCEDURES
- AA) TACHOMETER
- BB) VIBRATIONMEASUREMENT
- CC) DIGITALINDICATOR
- DD) MOVINGCOILINDICATORINCLUDINGTESTPROCEDURE
- EE) RECORDERINCLUDINGTESTPROCEDURE
- FF) FLAMESCANNER



GG)	ELECTRICALAUTOMANUALCONTROLSTATION
HH)	PUSHBUTTONMODULE
II)	ALARMANNUNCIATOREQUIPMENTINCLUDINGTESTPRO
JJ)	TESTPROCEDURE FORELECTRONICMODULESOFDDCMIS
KK)	THERMOCONTROLVALVE
LL)	TESTPROCEDUREFORADJUSTMENTOFMODULATING CONTROLLER-PIDTERMS
MM)	TESTPROCEDUREINDICATING CONTROLLER-ELECTRICALINPUT ANDPNEUMATICOUTPUT

Note: The items which are not part of this specification may be considered as not applicable.



ANNEXURE-II

**BRIEF WRITE UP ON THE CONTENTS OF TESTING
SCHEDULE / COMMISSIONING SCHEDULE**

Testing Schedules should be designed to ensure that the plant area, equipment or apparatus are tested and commissioned and will operate as per the UPRVUNL's specifications and good engineering practices.

Testing Schedule/Commissioning Schedule is required to be of a standard format in order to maintain consistency of presentation, content and reporting.

Testing Schedule/Commissioning Schedules should contain the following sections to make the document self-contained:

1. Plant Details/Design data
2. Testing Objective/Proposals
3. State of the Plant
 - a) Erection Status with respect to Mech Elect and C&I
 - b) Availability of the services required
 - c) Safety requirements as per Manufacturer's
4. Test method including completion/acceptance criteria
5. Results
6. Appendix
 - a) Testing Programme
 - b) Mech/Elect/C&I-Plant item completing list
 - c) List of Drawing/documents required for carrying out the testing.



ANNEXURE - III

SAFETY PLAN

1. Safety Policy of the Contractor to be enclosed
2. When was the Safety Policy last reviewed
3. Details of implementation procedure / methods to implement Safety Policy / Safety Rules
4. Name, Qualification, experience of Safety Officer
5. Review of Accidents Analysis Method, Methods to ensure Safety and Health
6. Unit executive responsible to ensure Safety at various levels in work area
7. List of employees trained in safety employed before execution of the job. Give the detail of training
8. Safety Training Targets, Schedules, methods adopting to provide safety training to all employees
9. Detail of checklist for different jobs/work and responsible persons to ensure compliance (copy of checklist to be enclosed)
10. Regular Safety Inspection Methods and Periodicity and list of members to be enclosed
11. Risk Assessment, Safety Audit by Professional Agencies, Periodicity
12. Implementation of Recommendations of Audit/Inspections. Procedures for implementation and follow up
13. Provision for treatment of injured persons at work site
14. Review of overall safety by top Management and Periodicity
15. System for Implementation of Statutory legislations
16. Issue of PPEs to employees, Periodicity / stock on hand etc

Signature
Head of the Organisation
with date & stamp



CHAPTER 10 : STORAGE OF EQUIPMENT / GOODS AT SITE**1.0 SCOPE**

- 1.1 This specification details the general guidelines for storage of mechanical and electrical equipment at site from the date equipment are taken over by the CONTRACTOR until the same are erected and handed over to the OWNER.
- 1.2 The equipment covered under this specification shall be stored in the type of storage as recommended by the MANUFACTURER/OWNER/CONSULTANT.

2.0 CONSTRUCTION OF STORES

- 2.1 Normally, the OWNER makes available the space for the CONTRACTOR to construct the necessary stores as specified.
- 2.2 To the extent feasible, materials should be stored near the point of erection. The storage areas should have adequate unloading and handling facilities with adequate passage space for movement of material handling equipment such as cranes, fork lift trucks, etc. The storage of materials shall be properly planned to minimise wasteful handling during retrieval of items required for erection.
- 2.3 The outdoor storage areas as well as semi-closed stores shall be provided with adequate drainage facilities to prevent water logging. The CONTRACTOR shall check the satisfactoriness of these facilities prior to monsoon.
- 2.4 The stores sheds shall be built in conformity with fire safety requirements. The stores shall be provided with adequate lights and fire extinguishers. 'No smoking' signs shall be placed at strategic locations. Safety precautions shall be strictly enforced.
- 2.5 In case of storage of certain equipment / materials, it may be necessary to maintain specified temperature ranges. In such cases, it is the responsibility of the CONTRACTOR to provide adequate heating / air conditioning facilities on round the clock basis. The CONTRACTOR shall check that space heaters, heating bulbs and air conditioners are kept energised continuously as applicable. In the event there is a prolonged failure of electric power, rendering such air-conditioners/space heaters inoperative, the CONTRACTOR shall make alternative arrangements to ensure that items under storage do not suffer any damage / deterioration on this account.
- 2.6 Adequate lighting facility shall be provided by the CONTRACTOR in storage areas and storage sheds and security personnel positioned to ensure enforcement of security measures to prevent theft and loss of materials entrusted to him by the OWNER. The CONTRACTOR shall carry out regular inventory of materials received, issued and erected and notify the OWNER of any loss when noticed.
- 2.7 The CONTRACTOR shall provide adequate number of competent stores personnel including store-keepers, clerical staff, inspection engineers, watchmen and security staff to efficiently store and maintain the equipment / material entrusted to him.
- 2.8 Where necessary, the CONTRACTOR shall provide necessary space heating and other protective care to equipment in case it will take a long time to haul them

to the stores. Any equipment left in the open under such conditions shall be, if required, covered with tarpaulin.

3.0 MAINTENANCE DURING STORAGE

- 3.1 Where unloading from the carriers and transport to warehouses is excluded from the CONTRACTOR'S scope .The CONTRACTOR shall take over the materials from the OWNER'S storage area / sheds.
- 3.2 Where materials is unloaded by the OWNER before the CONTRACTOR arrives at site or even when the CONTRACTOR is already at site, the OWNER can hand over the material to the CONTRACTOR and thereupon it will be the responsibility of the CONTRACTOR to store and maintain these material in a proper and approved manner.
- 3.3 While taking over the materials, the CONTRACTOR shall carry out inventory and inspection of the same and submit a report of his observations to the OWNER. After taking over of the equipment / materials, the CONTRACTOR is solely responsible for the same until handing over to the OWNER the erected plant and surplus materials, if any. The CONTRACTOR is responsible for maintenance of the equipment / materials in storage, during erection and until commissioning including protection of the same against theft, elements of nature and corrosion damages. In case commissioning of the equipment is delayed, the CONTRACTOR shall be responsible for maintenance of the erected plant and equipment as directed by OWNER / CONSULTANT.
- 3.4 The CONTRACTOR shall repack the equipment after inspection and store the same in an orderly manner, preserving their identification slips, tags and instruction booklets, etc., required during erection. The storage of materials shall be equipment-wise. Loose parts shall be stored in sheds on racks, preserving the identification marks and tags in good condition. The group codes shall be displayed on the racks.
- 3.5 The CONTRACTOR shall carry out frequent inspection of materials stored and also extend necessary facilities to the OWNER / CONSULTANT to carry out such inspection, when considered necessary. The CONTRACTOR shall implement the suggestions of the OWNER/CONSULTANT in this connection.
- 3.6 At no time shall any materials be stored directly on ground. All materials shall be stored minimum 200 mm above the ground by providing good wooden sleepers.
- 3.7 Welded and cast units shall be stored in such manner that there is no danger of distortion.
- 3.8 All special measures to prevent corrosion shall be taken by the CONTRACTOR.
- 3.8.1 Materials which carry protective coating shall not be wrapped in paper, cloth, etc., as these are liable to absorb and retain moisture. The CONTRACTOR shall inspect the materials and in case of signs of wear or damages to protective coating, that portion shall be cleaned with carbon tetra chloride or any other approved solution and coated with an approved protective paint. Complete record of all such observations and protective measures taken shall be maintained.
- 3.9 While handling the equipment, no dragging on the ground is permitted. The CONTRACTOR shall submit his scheme for handling major pieces of equipment



for approval by the OWNER / CONSULTANT prior to actual handling of the same. In cases where a scheme is recommended by the OWNER / MANUFACTURER, it shall be strictly adhered to.

- 3.10 The CONTRACTOR shall periodically inspect materials with specific reference to
- 3.10.1 Ingress of moisture and corrosion damages.
- 3.10.2 Damage to protective coating.
- 3.10.3 Open ends in pipes, vessels and equipment. In case any open ends are noticed, the CONTRACTOR shall get them capped.
- 3.10.4 Insulation of electrical equipment. Regular insulation checks are essential and these values shall be properly logged.
- 3.10.5 Any damages to equipment / materials.
- a) In case of any damages, these shall be promptly notified to the OWNER. In all cases, the repairs / rectification shall be carried out strictly as directed by the OWNER / CONSULTANT.
- b) If such repairs / rectification is necessitated due to causes attributable to the CONTRACTOR, such repairs / rectification shall be carried out at no extra cost to the OWNER. In other cases, compensation for such repair / rectification works will be as mutually agreed to.
- c) In case such damages are attributable to the CONTRACTOR and if, in the opinion of the OWNER/ CONSULTANT, the CONTRACTOR is not competent to carry out necessary repairs / rectification, the OWNER shall get this done by any other agency and recover the expenditure incurred by him from the CONTRACTOR.

4.0 MODES OF STORAGE

Given below are the general guidelines for storage of various equipments under the broad storage classifications. Wherever the specific recommendations of the MANUFACTURER/OWNER/CONSULTANT are at variance with what is indicated below, the former shall prevail.

4.1 Special Storage – Air Conditioned

The following materials are normally stored in air conditioned storage.

4.1.1 Welding Electrodes

These deteriorate under adverse conditions of storage and are preferably stored in air conditioned storage. As an alternative, if approved, these can also be stored in hot boxes / ovens.

It is essential to regularly inspect the conditions of electrodes and ensure that temperature is maintained within specified range at all times.

- 4.1.2 **Ball, needle and roller bearings:** These shall be stored in their original packing.



- 4.1.3 Photographic materials and films:** These shall be stored in their original moisture vapor proof packages.
- 4.1.4 Rubber Goods:** These shall be protected against sunlight and artificial light as well as high humidity conditions.
- 4.1.5 Hydraulic / Electronic equipment / instruments and components -** These shall be stored in sealed packages.

4.2 Closed storage

The following materials are normally stored in closed storage.

~~4.2.1 Cement bags.~~

- 4.2.2 All small parts / components liable to be misplaced / lost. These shall include the following:

- a) Small structural cleats, bolts, nuts, washers, etc. High tensile bolts and nuts shall be stored in separate sealed boxes with proper identification to avoid mix up with other items
- b) Pipe hangers, spring hangers, etc. The identification numbers on spring hangers shall be carefully preserved during storage
- c) Stainless steel and copper tubes, pipe fittings, etc.
- d) Electrical clamps, cable boxes, cable glands, ferrules, fuses, control cables, copper cables and grounding strips, push button switches, etc.
- e) Pilot valves, pull rods, keys, control valves. These shall be greased, wrapped in paraffin paper and stored in packing boxes
- ~~f) Turbine governing system components~~

- 4.2.7 Drive units of regenerative air heaters, fans, mills, etc., motors, pumps, blowers, ejectors and compressors, including those supplied disassembled.
- 4.2.8 Oil and hydrogen coolers.
- 4.2.9 Seal oil and gas control system equipment.
- 4.2.10 All indoor switch gear equipments.
- 4.2.11 Bus ducts, exciters, excitation system equipment, voltage regulators, circuit breakers, potential and current transformers, lightning arrestors, bushings, storage batteries and cells.



- 4.2.12 All instrument parts such as measuring instruments, controllers and regulators, interlock system, control drive units, gauges, instrument valves, thermocouples and leads.
- 4.2.13 Thermal and insulation materials. Mineral wool, glass wool, castable refractories, fire bricks, asbestos, etc.
- 4.2.14 ~~DM plant chemicals and resins.~~
- 4.2.15 Synthetic paints. Normally in separate stores.

4.3 Semi-Closed Storage

The following materials are normally stored in semi-closed storage.

- 4.3.1 ~~Condenser tubes stored in boxes.~~
- 4.3.2 Dust collector elements in boxes.
- 4.3.3 Coal mill liners, shell, coal feeders and gates, separator assembly.
- 4.3.4 Boiler dampers, manhole doors, mountings, casing frames, buck stays, Air pre-heater frames tubes, baskets. Burner panels and burners, Electrostatic precipitator shell, discharge and collecting plates.
- 4.3.5 Fan impellers, large assembled pumps, compressors, crushers, pulleys and idlers, wagon tippler drive assemblies and bearings, outdoor motors, etc..
- 4.3.6 Large C. I. Valves, butterfly valves, stop and control valves, expansion joints.
- 4.3.7 Outdoor switch gears and panels, small transformers, cable tray parts, etc.
- 4.3.8 ~~Crane rope drums, hoists, trolleys. Wire ropes in drums covered with tarpaulin.~~
- 4.3.9 Bearing stands
- 4.3.10 Conveyor belts

4.4 Open Storage

The following materials are normally stored in open storage.

- 4.4.1 Fabricated and un-fabricated structural steel members, Chimney steel, stairways and hand rails. Gallery steel Crane bridges and steel members, Reinforcement steel.
- 4.4.2 Coarse aggregates and sand.
- 4.4.3 Un-fabricated pipes and fabricated pipe assemblies, Concrete and hume pipes. Large diameter conduits / pipes in boxes, Ash disposal pipes.
- 4.4.4 ~~Boiler, drum, tubes, tube panels and headers.~~
- 4.4.5 Mill drums, bunker plates, etc.
- 4.4.6 ~~Condenser shell parts, water boxes, etc.~~



5.4 Rotating Equipment such as Pumps and Compressors

- 5.4.1 These are normally stored in assembled condition in closed / semi-closed storage. When stored in semi-closed storage, they shall be covered with tarpaulin and bed plates shall rest fully on sleepers.



- 5.4.2 The CONTRACTOR is responsible for proper lubrication of these equipment as directed.
- 5.4.3 The gear boxes and oil sumps shall be kept filled with recommended lubricating gear oil. The couplings and bearings shall be covered with approved grease and nozzle flanges screwed with caps or suitably plugged.
- 5.4.4 Pumps, if delivered in dis-assembled condition, shall be stored with the parts properly greased and wrapped in paraffin paper. Smaller parts are to be stored on racks whereas larger parts on sleepers in closed storage. Occasional flushing with hot lubricating oil may have to be carried out, if so directed; in the cases of equipment such as boiler feed pump.
- 5.4.5 The shafts of rotating equipment shall be turned by 90° every week to avoid rotor journals from rusting and to ensure that shaft is free to rotate.
- 5.4.6 The CONTRACTOR shall maintain record of lubrication with details of lubricants used as well as protective measures carried out.

5.5 Piping and Valves

- 5.5.1 All pipes shall be stored on sleeper beds with open ends securely capped. The beveled ends shall be protected with a coating of approved grease. If so directed, inside surfaces of piping shall be coated with approved protective solution.
- 5.5.2 Pipes shall be neatly arranged and stacked for easy identification and retrieval.
- 5.5.3 Pipes shall be blown with air prior to installation and it shall be ensured that there is no obstruction.
- 5.5.4 Valves shall be stored with the discs screwed down on the seat so that packing surfaces are not exposed to dust. All machined surfaces shall be covered with grease. Preservation of identification tags is essential to avoid installation in a wrong service.

5.6 Switch gear & Control Panels

- 5.6.1 Depending on whether these are of indoor or outdoor design, these shall be stored in closed / semi-closed storage.
- 5.6.2 The spaced heaters, where provided, shall be kept connected with power supply irrespective of mode of storage where space heaters are not provided, use of adequate number of heating bulbs is recommended.
- 5.6.3 Insulation resistance shall be measured at regular intervals and megger values properly logged.



transformer oil or as recommended by the MANUFACTURE / OWNER / CONSULTANT.

- 5.7.2 Prior to charging any transformer, it is essential to check the satisfactoriness of insulation values and di-electric strength of oil.

5.8 Cells, Accumulators, Batteries

These shall be stored in a dry and well ventilated place and protected from extreme cold. Internal parts of large cells are loose and the cells should be handled with care to avoid displacement of internals. Saw dust shall never be used for packing batteries as it is hygroscopic.

5.9 Cables

Cable drums if stored indoors shall be in dry, ventilated stores. Cables are normally supplied with ends sealed. When a length is cut, the end should be resealed. The drums shall be stored with adequate spacing between them for better air circulation.

5.10 Motors

Besides general procedures such as regular inspection and recording of insulation resistances, in the case of LT motors, if so recommended, low voltage current flow through the windings may be maintained during storage.

5.11 Instruments

- 5.11.1 These are stored on racks in closed storage and in air conditioned storage if so recommended. These shall be stored in their packages in dry condition and shall be handled with extreme care.
- 5.11.2 Instrument flanges and nozzles, if directed, shall be coated with technical Vaseline.
- 5.11.3 In the case of fragile instruments, the storage shall be in a separate zone away from where heavy materials are stored to minimise danger of damage.

5.12 STEEL

5.12.1 Reinforcement steel:

Reinforcement steel shall not be kept in direct contact with the ground but stacked on top of an arrangement of timber sleepers or the like. If stored for long periods, these may be coated with cement wash before stacking to prevent loose scales and rust. Fabricated reinforcement shall be carefully stored to prevent damage, distortion, corrosion and deterioration.

5.12.2 Structural steel:

Structural steel could safely be stored in open storage but with sufficient space in between for handling and crane movement. All steel shall be stored 200 mm above ground on suitable packing to avoid damage. It should be stored according to sizes and sections preferably in the order required for erection. The area for open storage should be properly graded to avoid water logging in the storage area. Steel shall not be stored in the vicinity of areas where excavation or grading will be done. Scratched or abraded steel shall be given a



coat of primer for protection after unloading and handling prior to erection. All milled and machined surfaces shall be properly protected from rust / corrosion by suitable coating.

5.14 Synthetic Paints

These have limited life and as a safeguard against possible deterioration, the drums shall be inverted at regular intervals as specified to minimise risk of hard settling of pigments.

6.0 DOCUMENTATION

The CONTRACTOR'S store-keeping function will include maintaining various records as required by the OWNER / CONSULTANT. These records shall include but not be limited to:

- 6.1 Supplier wise record of equipment / material received stored and issued for erection as well as stock position.
- 6.2 Record of inspection and repairs carried out, protective measures and lubrication of equipment in storage as well as erected until the same are taken over by the OWNER.





**1X660 MW PANKI EXTN
TECHNICAL SPECIFICATION
FOR
MILL REJECT SYSTEM (PNEUMATIC TYPE)

SPECIFIC TECHNICAL REQUIREMENTS-
MECHANICAL**

SPECIFICATION No: PE-TS-426-160-A001

**PACKAGE: MILL REJECT SYSTEM
(PNEUMATIC TYPE)**

SECTION-I

SUB-SECTION-IA

REV. 00

DATE: JUNE 2019

**SUB-SECTION – IA
CUSTOMER SPECIFICATION
LOW PRESSURE PIPING**

PART OF SPECIFICATION PE-TS-426-160-A001

Chapter 27: LP PIPING, VALVES & SPECIALITIES**27.0 LP PIPING, VALVES & SPECIALITIES****27.1 Equipment sizing Criteria**

- 27.1.1 All the piping systems and equipment supplied under this package shall be designed to operate without replacement and with normal maintenance for a plant service life of 30 years, and shall withstand the operating parameter fluctuations and cycling which can be normally expected during this period.
- 27.1.2 For all LP piping system covered under this specification, sizing and system design shall be to the requirements of relevant codes and standard indicated elsewhere. In addition to this, requirements of any statutory code as applicable shall also be taken into consideration.
- 27.1.3 Inside diameters of piping shall be calculated for the flow requirements of various systems. The velocities for calculating the inside diameters shall be limited to the following.

a) Water Application**Water Velocity in m/sec**

	Pipe Size	Below 50 mm	50-150 mm	200 mm & above
a)	Pump suction	-----	1.2 - 1.5	1.2 - 1.8
b)	Pump discharge and recirculation	1.2-1.8	1.8 - 2.4	2.1 - 2.5
c)	Header	----	1.5 - 2.4	2.1 - 2.4

The pipes in CW, ACW & DMCW system shall be designed to maintain a maximum velocity of 2 m/s inside the pipelines at pump discharge.

Pipe line under gravity flow shall be restricted to a flow velocity of 1 m/sec generally. Channels under gravity flow shall be sized for a maximum flow velocity of 0.6 m/sec.

WILLIAM & HAZEN formula shall be used for calculating the friction loss in piping systems with the following "C" value.

i)	Carbon steel pipe	100
ii)	CI Pipe/Ductile Iron	100
iii)	Rubber lined steel pipe	120
iv)	Stainless steel pipe	100

For calculating the required pump head for pump selection, at least 10% margin shall be taken over the pipe friction losses and static head shall be calculated from the minimum water level of the tank/sump/reservoir from which the pumps draw water.

b) Compressed Air Application

Compressed air – 15.0 m/sec. (under Average Pressure & Temp. conditions)

- 27.1.4 The pipes shall be sized for the worst (i.e. maximum flow, temp. and pressure values) operating conditions.
- 27.1.5 Based on the inside dia. so established, thickness calculation shall be made as per ANSI B 31.1 OD and thickness of pipes shall than be selected as per ANSI B 36.10/IS-1239 Heavy grade/IS-3589/ASTM-A-53/API-5L/ANSI B 36.19 as the case may be.
- 27.1.6 Corrosion allowance of 1.6 mm will be added to the calculated thickness being considered.
- 27.1.7 Bend thinning allowance/manufacturing allowance etc. shall be as per the requirement of the design code provision.
- 27.1.8 High points in piping system shall be provided with vents alongwith valves as per the system requirement. Low points shall be provided with drains alongwith drain valves as per the system requirement. Drain lines shall be adequately sized so as to clear condensate in the lines. Material for drain and vent lines shall be compatible with that of the parent pipe material.
- 27.1.9 Material of construction for pipes carrying various fluids shall be as specified elsewhere.
- 27.1.10 Compressed air pipe work shall be adequately drained to prevent internal moisture accumulation and moisture traps shall be provided at strategic locations in the piping systems.
- 27.1.11 Depending upon the size and system pressure, joints in compressed air pipe work shall be screwed or flanged. The flange shall be welded with the parent pipe at shop and shall be hot dip galvanized before dispatch to site. Alternatively, the flanges on GI pipes may be screwed-on flanges also.
- 27.1.12 Threaded joints shall be provided with Teflon sealant tapes.
- 27.1.13 Following types of valves shall be used for the system/service indicated.

System	Type of Valves					
	Butterfly	Gate	Globe	Check	Ball	Plug
Water	X	X	X	X	X	
Air		X	X	X	X	
Drains & Vents			X	X	X	
Fuel oil		X	X	X	X	X

In water service, valves above 200 NB size may be butterfly valves.

27.1.14 Recirculation pipes alongwith valves, breakdown orifices etc. shall be provided for important pumping systems as indicated in respective process and instrumentation diagrams (P&IDs). The recirculation pipe shall be sized for minimum 30% design flow of single pump operation or the recommended flow of the pump manufacturer whichever is higher.

27.1.15 All Piping 450 NB & Above shall be designated as Large dia Piping.

27.2.00 TECHNICAL SPECIFICATION

27.1.00 GENERAL

Specific technical requirements of low-pressure piping, fittings, supports, valves, specialties and tanks etc. have been covered under this Sub-section. It includes details pertaining to design and material of construction for piping, fittings, valves, equipment, etc. cleaning/surface preparation application of primer and painting on over ground piping. It also includes detailed technical requirement of laying underground/buried piping including water proofing/anti corrosive protection. It also covers design, engineering, manufacturing, fabrication, technical details of piping, valves, specialties, piping hangers/supports, tanks etc.

27.2.00 Pipes and fittings

27.2.1 All low pressure piping systems shall be capable of withstanding the maximum pressure in the corresponding lines at the relevant temperatures. However, the minimum thickness shall be adhered to. The bidder shall furnish the pipe sizing / thickness calculation as per the criteria mentioned above under LP piping equipment sizing criteria of this Technical Specification.

27.2.2 Piping and fittings coming under the purview of IBR shall be designed satisfying the requirements of IBR as a minimum.

27.2.3 Supporting arrangement of piping systems shall be properly designed for systems where hydraulic shocks and pressure surges may arise in the system during operation. Bidder should provide necessary protective arrangement like anchor blocks/anchor bolt etc. for the safeguard of the piping systems under above mentioned conditions. The requirement will be, however, worked out by the contractor and he will submit the detailed drawings for thrust/anchor block to the Employer. External, and internal, attachments to piping shall be designed so as not to cause flattening of pipes and excessive localized bending stresses.

27.2.4 Bends, loops, off sets, expansion or flexible joints shall be used as required in order to prevent overstressing the piping system and to provide adequate flexibility. Flexibility analysis (using software packages such as Caesar-II etc.) shall be carried out for sufficiently long piping (straight run more than 300M).

27.2.5 The hot lines shall be supported with flexible connections to permit axial and lateral movements. Flexibility analysis shall be carried out for pipelines which have considerable straight run as indicated above and necessary loops/expansion joint etc. shall be provided as may be necessary depending on layout.

- 27.2.6 Piping and fittings shall be manufactured by an approved manufacturer of repute. They should be truly cylindrical of clear internal diameter, of uniform thickness, smooth and strong, free from dents, cracks and holes and other defects.
- 27.2.7 For rubber lined ERW pipes, beads shall be removed.
- 27.2.8 Inspection holes shall be provided at suitable locations for pipes 800 NB and above as required for periodic observations and inspection purposes.
- 27.2.9 At all intersection joints, it is Contractor's responsibility to design and provide suitable reinforcements as per the applicable codes and standards.
- 27.2.10 For large size pipes/duct, at high point and bends/change of direction of flow, air release valves shall be provided as dictated by the system requirement and operation philosophy & tripping conditions of pumping system. Sizing criteria for air release valves shall be generally on the basis of valve size to pipe diameter ratio of 1:8. Requirement shall be decided as per relevant code.

Transient analysis / surge analysis wherever specified and required shall be conducted in order to determine the location, number and size of the Air-Release valve on certain long distance/high volume piping systems such as CW/ ACW/ Raw Water etc.

27.3.00 Material

- 27.3.1 Alternate materials offered by Bidder against those specified shall either be equal to or superior to those specified, the responsibility for establishing equality or superiority of the alternate materials offered rests entirely with the Bidder and any standard code required for establishing the same shall be in English language.
- 27.3.2 No extra credit would be given to offers containing materials superior to those specified. Likewise no extra credit would be given to offers containing pipe thickness more than specified.
- 27.3.3 All materials shall be new and procured directly from the manufacturers. Materials procured from traders or stockiest are not acceptable.
- 27.3.4 All materials shall be certified by proper material test certificates. All material test certificates shall carry proper heat number or other acceptable reference to enable identification of the certificate that certifies the material.
- 27.3.5 Material of construction for pipes carrying various fluids shall be as follows:

1	Intake Water, Raw water, Ash water, Circulating Water (CW), Aux. Cooling water (ACW), clarified Water, CW blow down, *Effluent disposal, service water, AHP Seal Water, Air Pre-Heater Wash water, Passivated DM Water and clarifier sludge.	IS-2062 Gr. B/ASTM-A-36/ASTM A-53 type 'E' Gr. B/IS-3589 Gr. 410/IS-1239 Heavy. Buried CW pipes shall be encased in 500 mm thk RCC. At road crossings live loads should be considered and this encasing thickness shall vary accordingly. 150 NB & above pipes shall be spiral welded.
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2	Dematerialized water, (condenser Make up water, Boiler fill and Deaerator Fill water) & DMCW overhead tank make-up water	Stainless steel to ASTM A-312, Gr. 304 welded for sizes above 50mm NB Stainless steel to ASTM A312, Gr. 304 sch. 40 Seamless for sizes 50 mm and below
3.	*Drinking (potable) water	ASTM A-53 type E Gr. B galvanized /IS 1239 heavy galvanized/IS 3589 Gr 410 Galvanized to IS-4736 or equivalent.
4.	Instrument air & plant air.	ASTM A-53 type E Gr. B galvanized /IS 1239 heavy galvanized/IS 3589 Gr 410 Galvanized to IS-4736 or equivalent.
5.	Fuel Oil piping	API5L

NOTE: Bidder to note that for Effluent disposal system and potable water system for colony (* marked) Ductile Iron (DI) pipes conforming to IS 8329 and for fittings IS 9523 can be offered as an alternate to the mild steel/ galvanized mild steel pipes as specified above for standalone or outside plant boundary stretches. Various design aspects of DI piping has been discussed later in Annexure-I.

- 27.3.6 In water lines, pipes upto 150 mm NB shall conform to ANSI B36.10/ASTM-A-53, Type-E Gr. B/IS:1239 Gr. Heavy and minimum selected thickness shall not be less than IS: 1239 Grade heavy except for demineralised water, drinking water and condensate spill lines.
- 27.3.7 Pipes of above 150 mm NB shall be to AWWA-C200/ANSI B 36.10/ASTM A-53/IS 3589 Gr. 410. Pipe to be fabricated by the bidder shall be rolled and butt welded from plates conforming to ASTM A-53 type 'E' Gr. B/IS 2062 Gr. B/ASTM-A-36. However, larger pipes, i.e. 1000 mm NB and above shall be made from plates conforming to ASTM A 36/IS 2062 Gr. B and shall meet the requirements of AWWA-M-11(for deflection & buckling criteria considering water filled pipe as well as vacuum condition that may prevail during transient/ surge conditions, truck-load, rail-load and weight density for compacted soil or any other load as the case may be).
- 27.3.8 In demineralised water service, the pipes upto 50 NB shall be of stainless steel ASTM A 312, Gr. 304 sch. 40 Seamless. The size for these pipes shall be to ANSI B 36.19. These shall be socket welded. The material for pipe from 65 mm NB upto and including 400 NB shall be to ASTM A 312, Gr. 304 (welded). In no case the thickness of fittings shall be less than parent pipe thickness.
- Bidder/Contractor shall note that pipes offered as per a particular code shall conform to that code in all respects i.e. Dimension, tolerances, manufacturing methods, material, heat treatment, testing requirements, etc. unless otherwise mentioned elsewhere in the specification.
- 27.3.9 Instrument air, Plant (service) air lines and Drinking water lines shall be to ASTM A 53 type E grade B/ANSI B 36. 10/IS 3589, Gr. 410/IS: 1239 Heavy (in case thickness calculated is more than gr. Heavy, ANSI B 36.10 Schedule numbers shall be followed) and galvanized to IS 4736 or any equivalent

internationally reputed standard. The material of the pipes shall be to ASTM A 53 type 'E' Gr. B/IS: 3589, Gr. 410/IS: 1239 Gr. Heavy. The fittings shall be of either same as parent material or malleable iron to IS-1879 (galvanized).

- 27.3.10 Spiral welded pipes as per API-5L/IS-3589 are also acceptable for pipe of size above 150 NB. However minimum thickness of the pipes shall be as elaborated in above clauses.
- 27.3.11 Condensate lines shall be to ASTM A 106 Gr. B and dimension to ANSI B 36.10 schedule "standard" as minimum to be maintained.
- 27.3.12 If carbon steel plates of thickness more than 12 mm are used for manufacture of pipes, fittings and other appurtenances, then the same shall be control-cooled or normalized as the case may be following the guidelines of the governing code.
- 27.3.13 Buried CW Pipes/ headers shall be minimum 12 mm thick, encased in 500 mm thk RCC. However this thickness shall be reviewed for live loads at road crossings according to AWWA M11 and increased adequately, if required.

27.4.0 Piping Wall Thickness

- 27.4.1 The calculation of wall thickness required for pipelines subject to internal and/or external pressure shall be based on the formulae and recommendations as given in the applicable codes. Adequate allowances shall be made towards thinning due to bending, weakening at branch connections, threading, commercial tolerances on pipe wall thickness, corrosion and erosion, etc., and the same shall be subject to approval by Purchaser. In any case a minimum corrosion allowance of 1.6 mm shall be considered while selecting the thickness.
- 27.4.2 In case of carbon steel materials, the nominal wall thickness of pipeline shall not be less than the minimum acceptable values given below:

NB mm (inch)	15 (1/2)	30 (3/4)	25 (1)	32 (1¼)	40 (1.5)	50 (2)	65 (2.5)	80 (3)	100 (4)	125 (5)
Min. thickness, mm	3.2	3.2	3.6	3.6	3.6	3.6	3.6	4.0	4.5	5.4
NB mm (inch)	150 (6)	200 (8)	250 (10)	300 (12)	350 (14)	400 (16)	450 (18)	500 (20)	600 (24)	
Min. thickness, mm	5.4	6.35	6.35	6.35	7.1	7.1	7.1	8.0	8.0	

- > NB 600 mm to NB 900 mm - 8.0 mm
- > NB 900 mm to NB 1200 mm - 10.0 mm
- > NB 1200 mm to 1400 mm - 12.0 mm
- > NB 1400 mm to 1600 mm - 14.0 mm
- > NB 1600 mm to NB 2200 mm - 16.0 mm
- > NB 2200 mm - 18.0 mm

NOTE: For buried CW pipe with 500 mm thick RCC encasing (as detailed in cl. no. 27.3.5), the minimum acceptable thickness shall be as indicated below.

> NB 600 mm to NB 900 mm	-	8.0 mm
> NB 900 mm to NB 1200 mm	-	10.0 mm
> NB 1200 mm	-	12.0 mm

27.5.00 Piping Layout

- 27.5.1 Piping shall be grouped together where practicable and routed to present a neat appearance.
- 27.5.2 Piping routing shall be such as to provide sufficient clearance for removal and maintenance of equipment, easy access to valves, instruments and other accessories. The piping shall not encroach on the withdrawal space of various equipments.
- 27.5.3 Over head piping shall have a normal minimum vertical clearance of 2.5 meters above walkways and working areas and 8 m above roadways/railways. When several pipelines are laid parallel, flanged joints must be staggered. Welded and flanged joints should as far as possible be located at one third span from supports. If the support is situated right under the welded joints this joint must be reinforced with a strap. Flanged and welded joints must be avoided in the middle of the span. Valves should be located in such a manner so as to ensure their convenient operation from the floor or the nearest platform.
- 27.5.4 Pipelines of NB 50 size and below are regarded as field run piping. It is Bidder's responsibility to plan suitable layouts for these system insitu. Bidder shall prepare drawings indicating the layout of field run pipe work. These drawings shall be approved by Project Manager to the installation of the field run pipe work. Based on these approved layouts the Bidder shall prepare the BOQ of field run-pipe and submit to Employer for approval.
- 27.5.5 All piping shall be routed so as to avoid interference with other pipes and their hangers and supports, electrical cable trays, ventilation ducting, structural members, equipment etc.
- 27.5.6 Adequate clearance shall be ensured with respect to the above to accommodate insulation and pipe movements, if any.
- 27.5.7 Piping shall generally be routed above ground but where specifically indicated / approved by the project Manager the pipes may be arranged in trenches or buried. Pipes at working temperature above the ambient shall however not be buried.
- 27.5.8 Sufficient up stream and down stream lengths shall be provided for flow measuring devices, control valves and other specialties.
- 27.5.9 All local instruments shall be located on pipelines as to render them observable from the nearest available platforms.
- 27.5.10 Openings provided in the wall for pipelines must be closed with bricks and mortar with 10-12 mm clearance between brick work and pipe after taking care of insulation and thermal movement, if any. The clear space must be filled with felt or asbestos or approved filling compound.

27.6.00 Slope/Drains and Vents

- 27.6.1 Suitable slope shall be provided for all pipelines towards drain points. It is Bidder responsibility to identify the requirements of drains and vents, and supply the necessary pipe work, valves, fittings, hangers and supports etc. As per the system requirement low points in the pipelines shall be provided with suitable draining arrangement and high points shall be provided with vent connections where air or gas pockets may occur. Vent shall not be less than 15 mm size. Drains shall be provided at low points and at pockets in piping such that complete drainage of all systems is possible. Drain shall not be less than 15 mm for line size up to 150 mm, not less than 20 mm up to 300 mm and not less than 25 mm for 350 mm to 600 mm pipes and not less than 50 mm for 600 mm and above pipes.
- 27.6.2 Air piping shall be sloped so that any part of the system can be drained through the shut-off drain valve or drain plugs.

27.7.0 Pipe Joints

In general all water lines 65 mm NB and above, are to be joined generally by butt welding except the locations where valves/fittings are to be installed with flanged connections and 50 mm and below by socket welding unless mentioned otherwise specifically. All air lines shall be of screwed connection and rubber lined pipes of flanged connections.

27.7.1 Screwed Joints

- (a) Threading of pipes shall be carried out after bending, heat treatment etc. If not possible, threading may be done prior to these operations but proper care should be taken to protect them from damage. Threads shall be to ANSI B 2.1 (taper) NPT/IS:554 unless specified otherwise.
- (b) Galvanized pipe shall generally be joined by screwing into sockets. The exposed threaded portion on the outside of the pipes shall be given a zinc silicate coating. Galvanized pipes shall not be joined by welding. Screwed ends of GI pipes shall be thoroughly cleaned and painted with a mixture of red and white lead before jointing. For galvanized pipe sizes above 150 mm NB, screw & socket jointing as per ASTM-A-865 shall be employed for both pipe-to-pipe and pipe-to-fitting jointing. For pipe to fitting connection since no direct threading can be done on the fittings (supplied as per ASTM-A-234 Gr. WPB and ANSI B-16.9) necessary straight pipe lengths acting as match pieces shall be welded to the fitting at both ends and subsequently the free ends of the straight lengths shall be threaded as per ASTM A-865 for jointing with main pipe. Once welding of fittings with match pieces and threading of free ends of match pieces are over, the entire fabricated piece shall be galvanized, or in case match pipes and fittings are already galvanized before the above mentioned fabrication then suitable application of Zinc-Silicate paste adequately at the welded surface (both in side & out side) after welding with zinc rich electrode, alongwith the nascent threaded metal portion at both free ends given the same application of Zinc Silicate paste. Alternatively flanged jointing may be employed for pipe sizes 100 NB and above. However, the bidder shall ensure the galvanized pipe joints do not fail during hydro test.