

**Telangana State Power Generation Corporation Ltd.  
1x800 MW Kothagudem TPS**

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- g) Funnels, tundishes for drips & drains including all miscellaneous drain piping and drain piping from tundish outlet up to drain points. All drain and vent lines shall be conveniently terminated either in flash tanks or permanent drain trenches of the Power Station.

All steam and saturated water open drains shall be drained through a water seal in drain funnels/tundish with a water connection in funnels/tundish for maintaining water seal level in them.

All oily effluent drains should be separately routed and connected to separate pit.

- h) For the isolation and check valves located on the main steam (MS), hot reheat (HR), cold reheat (CR), L.P. bypass and extraction lines, suitable line drains shall be provided just upstream and downstream of each of these valves. No drain is needed at the downstream of L.P. bypass isolation valve. Each of these drains shall be independently led to the condenser with branching off to atmosphere.

Line drains from MS, HR, CR, L.P. bypass & high pressure (above 40 Kg/Sq.Cm.) extraction lines shall be provided with double isolation valves in series for each branch - each located at the two extreme ties of the line drain route. The valve near the condenser should be motorised one. The balance line drains shall be provided with only one isolation valve for each branch.

- i) Bolts, nuts, washers, temporary and permanent gaskets, fasteners as required for interconnecting piping, valves & fittings as well as for terminal points.
- j) Complete insulation material for piping, valves, specialties & auxiliary equipment specified in this specification and as called for in the specification for thermal insulation.
- k) Painting of all piping, valves & specialties at site.

4.01.02 Bidder shall furnish his own layout and technical details of piping, valves, specialties and accessories along with his offer.

Following general requirements shall however be provided :

- a) Instrument Connections

The following instrument tappings shall be provided :

- i) Pressure Tappings

The Contractor shall furnish stubs and root valves for all gauge, transmitter and pressure test connections as required. The number of root valve for each connection shall be two (2) for system design pressure equal to or greater than 40 KG/Sq.cm.g.

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- ii) Temperature Tappings
- The Contractor shall supply all stubs and mount the thermowells.
- iii) Flow Measurement Tappings
- The Contractor shall provide stubs and root valves similar to the above for all differential pressure taps at flow nozzle and orifice plate installations.
- b) Pipe stubs and blanking plates required for chemical cleaning and hydro testing.
- c) Flanges, spool pieces, gaskets, ring joints, jointing materials, aluminium and stainless steel forged marking plate and temporary piping for steam blowing.
- d) Drain/drip pockets on steam piping as per stipulation of ASME, TDP Vol.-I and general requirement.
- e) Expansion marker for high temperature steam lines.
- f) Fine threaded Radiography holes with stubs and suitable matching plugs, which shall be finally seal welded for piping, more than 25 mm nominal thickness.
- For conducting performance test of Turbo-Generator and Boiler, the required pressure, temperature, flow measurement points shall be provided.
- g) Provision for creep measurement on the piping operating in creep region viz. main steam and hot reheat.
- 4.01.03 Electrodes and filler wires required for stainless steel and alloy steel welding during shop fabrication at works and erection/installation at site.
- 4.01.04 All temporary pipes and accessories, supporting arrangement for cleaning, flushing and steam blowing of the main steam, cold reheat and hot reheat piping including HP/LP by pass piping and auxiliary steam piping.
- 4.02.00 **Scope of Services**
- 4.02.01 The Contractor shall design the piping system and perform necessary stress analysis of all piping and dynamic analysis as necessary.
- 4.02.02 For stress analysis purpose, individual piping systems shall be considered. All anchors are to be designed, supplied and erected by the Contractor.
- 4.02.03 Stress analysis and hanger selection for all piping including piping attachment for hangers/supports, all auxiliary supporting structures are included in the scope of the Contractor.

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- 4.02.04 The Contractor shall submit the design calculations for pipe sizing, thickness with specified diameters of pipes and stress analysis data to Owner/Engineer for review/reference/records. Pressure drop calculation for main steam, cold reheat and hot reheat piping to be submitted by the Contractor to show the adequacy of pipe sizes.
- 4.02.05 Preparation of detailed fabrication drawings (isometric) of shop fabricated piping which are of size 50 mm NB and above should be based on the "Released for Construction" drawings.
- "As built" drawings of the power cycle piping layout shall also be prepared by the Contractor based on any layout modifications made at site over "Released For Construction Drawings".
- 4.02.06 The Contractor shall design and detail all piping supports including restraints, guides, stops, snubbers, dampers etc. based on the final stress analysis and hanger load data. The Contractor's design of all supports shall be submitted to the Engineer for review.
- 4.02.07 The Contractor shall furnish separate sketches for each support, restraint, anchor, snubber, dampers etc. These sketches shall include the location with reference to column co-ordinates, identification number, bill of material, design loads, operating load, spring stiffness, amount of spring pre-compression, etc. and method of attachment to the pipe and steel structure.
- 4.02.08 In order to ensure that all piping, supporting elements, anchors and restraints have been installed and adjusted in accordance with the drawings and other written instructions of the Contractor, the hangers associated with the main steam, hot reheat, cold reheat, HP & LP by-pass, feed water, auxiliary steam piping etc. shall be inspected as follows :
- a) After hydro test, with the piping in the cold position, with all travel stops removed, with the pipe completely insulated and in all respects ready for start-up.
  - b) Piping in the hot position, with the unit operating at maximum load.
  - c) Piping in the hot position after 6 months of operation.
  - d) Piping in the cold position during first complete shutdown after at least 6 months of operation.
- The contractor shall depute his personnel for this purpose to site if the plant is officially handed over to the owner before such inspection after 6 months of operation.
- 4.02.09 At the time of each inspection, the Contractor shall determine the necessity for revision, adjustment or replacement of pipe supporting elements, restraints and anchors. Any changes proposed shall be incorporated by the Contractor after Owner/Engineer's concurrence.
- 4.02.10 All shop tests satisfying the requirements of Indian Boiler Regulations (IBR), ANSI standards, the standards enumerated herein and/or as specified.

- 4.02.11 Furnishing drawings, data, design calculations, stress analysis results.
- 4.02.12 Furnishing certified copies of test results for all tests and examinations specified in the specification and for the mandatory tests and analysis required by the ASTM material specification, for the materials used for piping and the pressure parts of the valves.
- 4.02.13 Obtaining approval from Chief Inspector of Boilers as per Indian Boiler Act, including the following :
- a) For all pipelines coming under the purview of Indian Boiler Regulations (IBR) necessary approval of the design and layout drawings shall be obtained from the Chief Inspector of Boilers, and furnished to the Purchaser/Engineer. Necessary certificates of design, manufacture and tests in specified Form of IBR, for each fabricated pipe with proper identification shall be submitted.
  - b) For fittings & specialties, viz. valves, flanges, traps & other specialties, etc. of all pipelines coming under the purview of IBR, Certificate of design, manufacture and tests in specified Form of IBR with appropriate identification shall be furnished to the Owner/ Engineer.
  - c) Erection & testing of the pipe lines coming under the purview of IBR shall meet all the requirements of IBR and certificate of manufacture & tests in specified Form of IBR, for each of the erected pipe lines shall be submitted to the Purchaser/ Engineer prior to the application of insulation and/or flushing the line before commissioning
- 4.02.14 Steam blowing or chemical cleaning of piping systems, as specified elsewhere in the specification, after complete erection is to be carried out, which also includes supply, erection and dismantling of temporary piping, valves and fittings.
- 4.03.00 Omission of specific reference to any item or material or work which is necessary for completion of the piping systems, shall not relieve the bidder of the responsibility of furnishing all material and services for a complete installation satisfying the operational and other requirements stated in the specifications.
- 4.04.00 Drawing indicating the layout of pipe work shall be prepared in line with the flow diagrams and shall be provided as part of the Contract. These drawings shall indicate the position of all supports, guides, restraints and anchors; all drain and vent connections and the position of all pipes. All piping systems shall be arranged to allow adequate falls in the direction of flow, except where otherwise approved by the Engineer. At the points of drainage, drain pockets of ample size and approved construction shall be fitted as per details indicated in the enclosed drawings.

## 5.00.00 SPECIFIC DESIGN CRITERIA

Sl. No.	Item	Criteria
1.00	<b>Design, fabrication &amp; Erection</b>	
1.01	Design, fabrication, testing & erection of Power Cycle Piping, valves & specialties for critical piping system under purview of IBR, as specified.	To satisfy IBR, ANSI/ ASME B31.1 latest code.
1.02	Design, fabrication, testing & erection of Power cycle piping, valves & specialties for non-critical piping system, which are not purview of IBR, as specified.	To satisfy ANSI/ASME B31.1 latest code.
1.03	Design of safety valve installation.	To conform with the Non-mandatory rules for the design of safety valve installation of ANSI/ASME B31.1.  Open discharge installation preferred.
2.00	<b>Piping Flexibility Analysis</b>	
2.01	Piping to be analysed	All piping having sizes equal to or above 50 mm NB & design temperature 100 Deg.C and more.
2.02	Code to be followed	ANSI/ASME B31.1 latest & also satisfying IBR latest.
2.03	Loading conditions to be considered  <b>Note:</b> Contractor shall justify with reasoning in case any one of the specified loads is not considered in analysis.	a) Internal pressure  b) Thermal loads due : i) Piping thermal expansion ii) Anchor displacement due to thermal movements of piping anchors.
		c) Piping weight consisting of weight of piping, valves, bends, fittings, insulation etc. as well as weight of support components like clamps, shoes, suspension rods, trapeze etc. & weight of contained fluid.
		d) Test or cleaning fluid load.
		e) Equivalent static loads due to discharge of safety valve (SV), Electromatic relief valve (ERV), simultaneous discharge of SV & ERV where applicable.
		f) Dynamic load due to steam hammer (if applicable).
		g) Seismic loads due : i) Equivalent static load due to seismic inertia effect. ii) Equivalent static load due to seismic anchor displacement.

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Sl. No.	Item	Criteria
		h) Wind load where applicable.
2.04	<p>Loading Combinations</p> <p><b>Note:</b> Contractor shall clearly indicate the basis of his judicious selection or loading combination for support, restraints and anchor design.</p>	<p>Design load for supports, restraints, anchors &amp; supporting structures shall be obtained by proper selection of one or combination of two or more of the loads as per item 2.03 above based on the possibility of independent or simultaneous occurrence.</p> <p>Component of thermal expansion reaction range expected to appear at cold condition, as per Equation 9 &amp; 10 of ANSI/ ASME B31.1 shall be considered in loading combinations.</p> <p>An overload factor of 1.30 shall be considered over the computed loads except occasional loads before combining them.</p>
2.05	Combination of Stresses	The computed stress under different loading conditions shall be combined as per Equation 11, 12 & 13 of ANSI/ASME B31.1 & the stress shall be within allowable limits.
2.06	Allowable Stress Values	For piping materials other than ASME/ ASTM materials, values shall be derived as per the criteria defined in Appendix-P of ASME Boiler & Pressure Vessel Code, Section-VIII, Division 1 while computing pipe wall thickness, and flexibility analysis shall be conducted as per ANSI/ASME B31.1. However higher pipe wall thickness derived between IBR regulation & ANSI/ASME B31.1 code shall be considered.
2.07	Factor to be considered in flexibility analysis	<p>a) Contractor shall consider value of stress range reduction factor "f" for cyclic conditions due to temperature reversals equal to ONE.</p> <p>b) Stress intensification factors at all transitions, fittings &amp; all branches as per ANSI/ASME B31.1.</p> <p>c) Variation in supporting effort by variable spring due to pipe movements.</p>
2.08	Piping layout	Flexibility analysis of Piping is to be conducted as per the offered piping layout. In case any modification of piping layout is felt essential to maintain stresses & terminal reactions within allowable ranges, same are to be carried out by the Contractor after discussion with Owner.
3.00	Design Pressure & Temperature	As per IBR. Wherever not clearly stipulated in IBR, criteria stipulated in ASME/ ANSI 31.1 for selecting design pressure & temperature shall be followed.

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Sl. No.	Item	Criteria
4.00	Material of construction of piping, valves & specialties	ASME/ASTM materials
5.00	<b>Hangers, supports etc.</b>	
5.01	Type	<p>a) Variable spring :</p> <p>i) Where the variation in supporting effort between hot and cold condition does not exceed 20% of the load.</p> <p>ii) The resulting effect of load take-up/release by a group of hangers in a span does not overstress the piping span or cause overloading at equipment terminals.</p> <p>iii) Thermal deflection between hot &amp; cold conditions does not exceed 40 mm.</p>
		b) Constant load - For thermal deflection between hot and cold conditions exceeding 40 mm. and or, for load variation beyond 20%
		c) Spring hangers should not be loaded more than 80% of the spring travel range.
		d) Rigid hangers & restraints - To be judiciously selected, without exceeding the stipulated limits of terminal forces & moments & stress level. Struts shall be considered where compressive load is expected.
		e) Snubbers, dampers etc. - To take seismic/dynamic loads, thrust due to safety valve discharge. Effort shall be made to limit its use by judicious placement of rigid hangers.
		f) Bottom support spring hangers to be avoided as far as possible.
5.02	Design, materials, fabrication testing and erection of hangers, supports, anchors, guides etc.	a) As per ANSI/ASME B31.1 latest code.
		b) Hanger suspension rods, tie-rods/struts should have proper arrangement & adequate length, so that thermal movements in direction which are free are not constrained and should not make an angle more than 4 degrees with vertical due to horizontal pipe movements.

**Note :** In case turbine steam stop valve is not anchored, steam hammer analysis of the main steam & HP/LP By-pass pipe line on stop valve closing shall be carried out.

6.00.00      **DESIGN AND CONSTRUCTION**

6.01.00      **General Considerations**

6.01.01      Pipe sizing and piping system design shall conform to the requirements of power piping code ANSI B31.1. Statutory requirements as laid down in Indian Boiler Regulations (latest edition) will also be taken care in pipe system designs. Pipe wall thickness as calculated by ANSI Code formula will also be checked for IBR requirements for piping systems falling under IBR purview.

6.01.02      Inside diameters of piping shall first be calculated for the flow requirement of various systems. The velocity limits for calculating the inside diameters are listed below :

- |    |                                                                    |                                          |
|----|--------------------------------------------------------------------|------------------------------------------|
| a) | Main Steam hot and cold reheat pipes                               | 75 m/sec.                                |
| b) | Auxiliary steam (Aux. steam to take care of various design flows). | 40 m/sec.                                |
| c) | Feed Water                                                         |                                          |
|    | i) Suction                                                         | 2.0 m/sec.                               |
|    | ii) Discharge                                                      | 6.0 m/sec.                               |
| d) | HP bypass                                                          |                                          |
|    | i) Upstream                                                        | 75 m/sec.                                |
|    | ii) Downstream                                                     | 150 m/sec.                               |
| e) | LP bypass                                                          |                                          |
|    | i) Upstream                                                        | 75 m/sec.                                |
|    | ii) Downstream                                                     | 150 m/sec.                               |
| f) | Extraction steam                                                   |                                          |
|    | i) Superheated steam                                               | 60 m/sec.                                |
|    | ii) Saturated steam                                                | 30 m/sec.                                |
| g) | Condensate                                                         |                                          |
|    | i) Discharge                                                       | 5.0 m/sec.                               |
|    | ii) Suction                                                        | 1.5 m/sec.                               |
| h) | Heater Drains:                                                     | 1.5 m/sec                                |
| i) | Heater Vents:                                                      | 25 m/sec                                 |
| j) | Other piping                                                       | As per good proven engineering practice. |

**Note:** This standard sets the maximum limits of the flow velocity.

Lower velocities may be selected if found necessary.

Inside diameters thus calculated shall be checked for allowable pressure drop for various systems. Pressure drop in main steam line shall not be more than 90% of the pressure differential between superheater outlet header and HP turbine inlet valves at BMCR. Similarly, combined pressure drop in cold and hot reheat piping will not exceed 90% of the available pressure differential between HP turbine exhaust and LP turbine inlet valves minus the reheater drop. The available pressure differential in the complete reheat line from HPT exhaust to IPT inlet shall not be more than 10% of the pressure at HPT exhaust. Wherever possible 5D/6D radius bends will be used to minimise the pressure drop in the main steam, cold & hot reheat piping systems.

Pipes shall be sized for the worst (i.e. maximum flow, temperature and pressure values) operating condition. In case of BFP suction pipe sizing "transient analysis" shall be carried out for optimum sizing of the system in order to establish the pipe inside diameter for minimum pressure drop in system to match with the pump NPSH requirements under worst operating conditions. The Boiler Feed Discharge pipe-work shall be designed for the maximum final feed water temperature down-stream of H.P. heaters and the maximum closed valve pressure of the boiler feed pump upto and including downstream valve at FRS in the following two cases, whichever gives a higher pressure.

- a) Temperature of water from deaerator
- b) Deaerator storage tank working at its maximum possible pressure with saturated water.

Feed regulating station (FRS) located at upstream of HP heaters and no isolating valve provided at economizer inlet, the design pressure of boiler feed discharge piping at downstream of FRS shall be worked out corresponding to design pressure of the boiler. This shall be for HP heaters provided with spring loaded relief valve(s) or having provision of media operated three way valves at inlet/ outlet of HP heater(s) as per approval of IBR so as to prevent BFP shut off pressure being communicated to downstream piping system and HP heaters.

In addition to this the rest of the design basis shall be same as for other water services described above.

- 6.01.03 Thickness calculation shall be made on the basis of procedure and formula given in ANSI/ASME B 31.1. Stress values of piping material for calculation shall be selected from tables given in ANSI B31.1. Thickness thus calculated shall then be checked based on the procedure and formula given in IBR and based on higher of the two calculations (after adding manufacturing tolerance), the next heavier commercial wall thickness shall then be selected from thickness schedules (e.g. sch.40, sch 80, etc) in ASME B36.10 for OD controlled pipes and from manufactures' schedules for ID controlled pipes.

However, in cases where the calculated thickness for OD controlled pipe falls beyond the thickness corresponding to the listed schedule nos. as given in

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ANSI B36.10 for the pipe size, both ID and OD controlled pipes to manufactures' schedules are acceptable.

OD controlled pipes shall be to the dimensional standards ANSI B36.10 for carbon & alloy steels pipes and ANSI B36.19 for stainless steel pipes.

To account for losses due to corrosion, erosion etc. during the plant service life, an allowance of 1.6 mm/0.75 mm shall be considered in the minimum wall thickness calculation of pipes as per ASME B31.1/IBR respectively.

The design pressure and temperature, down-stream of any pressure reducing valve upto and including the first block valve shall be the same as that at up-stream of pressure reducing valve. The piping at down stream of de-superheater shall be designed for spray failure condition. The length of piping system considered for spray failure condition shall not be less than the length required for proper spray mixing as recommended by de-superheater supplier.

However, in no case, the selected pipe thickness shall be less than Sch.80 for alloy steel & carbon steel pipes of sizes 50 Nb & below. The selected thickness for SS pipes shall not be less than Sch.40S of ANSI B36.19.

Further, for the piping systems likely to be subjected to two phase flow, i.e. down stream of control valves on heater drain lines etc. and for the length of piping which is required for the proper mixing of spray water at downstream of de-superheater, the selected thickness shall not be less than :

(a.) Sch.40 for pipe sizes above 50 NB, but below 300 NB and

(b.) Sch. STD for pipe sizes 300 NB and above.

- 6.01.04 No pipe work shall be run in trenches carrying electrical cables.
- 6.01.05 Pipes shall not be less than 20 mm bore unless authorised by the Engineer.
- 6.01.06 Site fabricated pipes shall be installed only where they do not exceed 50 mm. bore and where their use has been approved in writing and shown on a scale drawing.
- 6.01.07 All piping shall be identified by means of colour strips and by adequate lettering, conveniently spaced and located. Identification colours and lettering shall be as approved.
- 6.01.08 Air release and drain branches shall be provided wherever necessary depending upon the layout and arranged so that the drains and air release valves are located for easy operation.
- 6.01.09 All valved drains in vacuum services shall be provided with screwed cap.
- 6.02.00 **Stress and Flexibility Analysis**
- 6.02.01 Overall procedure of stress & flexibility analysis shall be as per latest revision of ANSI B31.1/IBR and according to material used.

- 6.02.02 Complete and comprehensive stress and flexibility analysis of the piping shall be done by computer using an approved standard program.
- 6.02.03 All piping of design temperature exceeding 100°C and nominal size equal to or above 50 mm except otherwise mentioned in Specific Design Criteria shall be stress analysed considering the effects stipulated therein.
- 6.02.04 The method of analysis due to seismic effects on static equivalent basis shall be submitted to Owner for approval prior to start of the analysis.
- 6.02.05 Stresses in pipes and fittings due to the above effects shall be limited to level prescribed by IBR wherever applicable. Other stress criteria not prescribed by IBR shall be guided by ANSI B31.1. Suitable stress intensification factors shall be assumed. Allowable stresses shall be computed by methods prescribed by IBR wherever applicable. However, such allowable stresses shall not be more than those prescribed by the relevant codes/standards.
- 6.02.06 The results of stress analysis shall be submitted for approval by Engineer before start of Fabrication or Erection clearly confirming the following :
- a) The terminal forces and moments are within permissible limit.
  - b) Forces and moments on supports, anchors and restraints attached to building/supporting structures are within permissible limit.
  - c) Stresses on piping are within acceptable limit stipulated in the applicable codes.
  - d) Pipe movements are acceptable for the spacing in between adjacent pipes and between pipes and adjacent structures/ equipment etc.
  - e) Stress checking for occasional loading.
  - f) All other stress/flexibility checking as stipulated in IBR/ American codes whichever is stringent.
- Above stress analysis results shall be used for checking the piping design.
- 6.02.07 The finalised flexibility analysis in the form of a report indicating procedure of analysis, pipe sizing based on specified diameter, spring hanger summary, design load charts for Anchors. Restraints and hanger supporting structures delineating different loading conditions, stress charts, loading on terminal anchors, along with isometric drawings of piping for flexibility analysis shall be submitted to Purchaser for review.
- 6.02.08 All high temperature lines shall be provided with expansion markers with scales at certain hanger locations, as decided by the Engineer. The Contractor shall guarantee and prove during trial run, after a few cycles of operation that the range of thermal movements in three directions from cold to hot condition at the expansion marker locations are within  $\pm 20\%$  of the calculated values.

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If the error exceeds the above limit, necessary adjustments and rectifications shall be carried out by him at no extra cost, till the above requirement is fulfilled.

**6.03.00 Material Specification**

6.03.01 Material for pipes and fittings shall be as stipulated in Annexure-I enclosed. Bidder may note that ASTM materials have been considered for Main Steam, Hot reheat, Cold reheat, HP & LP bypass pipings and all the tendering information in the specification for such pipes have been given based on this material of piping. In case bidder wants to offer alternative piping material, same may be accepted by the Purchaser depending on the merits of alternative material. In that case pipe stress analysis, hanger selection etc. for such pipings are to be carried out by the Contractor accordingly.

6.03.02 Pipe attachments for supports, anchors and restraints, which are coming in direct contact with pipes and are inside the insulation of high temperature pipes shall have similar materials as the piping concerned. All other materials of supports, anchors and restraints shall be of tested quality and as per manufacturer's standards.

6.03.03 For rubber lined pipe, lining should be applied in three (3) layers, giving a total thickness not less than 4.5 mm.

**6.04.00 Fabrication**

Except where otherwise specified all piping shall have butt-welded connections with a minimum of flanged joints necessary for maintenance. All high pressure steam valves and accessories shall have welded connections. Where flanges are adjacent to welded fittings, weld neck flanges shall be used.

Branches shall, in general, be formed by welding. Standard fittings may be used in positions and for sizes where approval have been given in detail drawings. Pipe bends and tees shall be truly cylindrical and of uniform section. All welded branches shall be reinforced where needed as per the applicable codes/ regulations.

Unless otherwise specified, for all welded lines with pressure above 7 kg./sq. cmg. and/or temperature above 200 Deg.C branch connections for branch sizes up to 25% of welded mains shall be made with special forged steel welded fittings.

6.04.01 The piping systems shall be constructed in accordance with the requirements of ANSI B31.1. The requirements of IBR 1950 (with latest amendments) shall be complied with for the piping systems, which are under the purview of IBR.

6.04.02 Piping shall be fabricated in the shop in the largest transportable sections to minimise the number of field weld joints. The choice of field weld joints locations shall be based on the traverse of the pipe through walls, floors, sleeves or other restrictive areas. Support attachments for major piping shall be done at shop.

6.04.03 All workmanship shall be carried out using methods and procedures of best

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recognised pipe fabrication practice and must be done in a good and workman like manner in accordance with latest revisions. ANSI standards, ASME Codes, PFI standards and IBR as applicable.

6.04.04 All high-pressure steam valves and accessories shall have welded connections.

6.04.05 Mitred bends and elbows will not be accepted unless otherwise specified. Only forged tees, 90° elbows and 45° elbows are acceptable. In case the Bidder wants to deviate from this requirement on the ground of non-availability of such forged items, the bidder may submit alternative offer for Owner's consideration with sufficient documents to justify the same. In such a case the concerned fittings shall be manufactured with necessary reinforcing pads, bend thinning allowance etc. to satisfy code requirements.

6.04.06 All pipes bends shall be made true to angle with no negative tolerance and shall have a smooth surface free of flat spots, crease and corrugations.

A cross section through any bend portion of the pipe shall be true in diameter. All pipe bends shall have a radius of not less than 3 times the nominal pipe size unless otherwise mentioned. Pipe bends shall be made from straight pipe pieces of sufficiently higher thickness so that after thinning, the minimum thickness of bends shall not be less than the minimum thickness required for the straight pipe. Thinning allowance shall be considered as per ANSI B 31.1. The ends of pipe and welded fittings shall be bevelled according to details shown in the relevant piping codes.

6.04.07 Pipes of size 65 mm NB and above shall be shop fabricated and of size 50 mm NB and below shall be field run.

6.04.08 All welding shall be made in such a manner that complete fusion and penetration are obtained without any excessive amount of filler metal beyond root area. The reinforcement shall be applied in such a manner that it shall have a smooth contour merging gradually with the surface of adjacent pipe and welded fittings. Backing rings shall not be used on any pipe welds, unless otherwise approved by the Engineer.

Pipe and attachments shall be properly aligned prior to welding. If tack welds are used the tacks shall be either fused into the first layer of weld or else chipped out.

All welding for steam and feed pipe work shall be electrical welding using the shielded arc process and electrodes in accordance with the relevant code. For pipes up to and including 100 mm. bore, provided the pipe does not exceed 12.7 mm. in thickness, gas welded butt joints will be accepted without backing rings.

Welded joints in pipe work shall be pre-heated to a temperature as required by the agreed standard or code or to the approval of the Engineer. The temperature shall be maintained during the welding operation and a record of metal temperature shall be obtained by means of a recording thermometer throughout the welding operation.

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All welds shall be built-up by the application of multiple layers or passes. The thickness of metal applied for each layer or pass shall not exceed 3 mm. Each layer shall be cleaned and lightly peened before the next layer is applied.

Before being assigned to welding work, each operator shall have passed a qualification test as prescribed in the applicable Code/ Regulations. Each approved welder shall have an identification number which shall be indicated on all welds.

6.04.09 Welded joints shall be stress relieved as per ANSI B31.1./IBR. Stress relieving temperature shall be measured by thermocouple pyrometers or other suitable equipment. Readings of temperature against time shall be recorded.

6.05.00 **Welding**

6.05.01 General

Full scale joints preparation sketches (to be included with the welding procedure) shall show all dimensions including tolerances for bevel angle, land size and off-set and root gap. Adequate copies of detailed welding procedure for approval of IBR shall be furnished.

6.05.02 Cutting and Bevelling

- a) Carbon steel piping : End preparation for butt welding shall be done by machining/flame cutting.
- b) Chrom-Moly steel : End preparation for butt welding shall be done by machining.
- c) Socket welding : Socket weld end preparation shall be done by saw or machine cutting.

6.05.03 Welding Electrodes and Rods

All special welding electrodes and filler wires to be supplied and used for the work under this specification shall be of reputed make, approved/tested quality with valid test certificate and shall have proven performance record for similar application. Approval of the Owner as well as IBR should be sought in selection of the electrodes for specific uses.

The certificate of electrode shall incorporate all the chemical and physical test data and tests witnessed by a representative of the Inspecting Authority recognised under IBR.

6.06.00 **Hangers, Supports, Anchors and Restraints**

6.06.01 Hangers and supports shall be capable of carrying the sum of all concurrently acting loads.

6.06.02 All the hangers/supports shall be of reputed make, approved/tested quality

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and shall have proven performance record for similar application. They shall be designed to provide the required supporting efforts and allow pipeline movement with thermal changes without causing overstress. The design shall also prevent complete release of the piping load in the event of spring failure or misalignment and all parts of supporting equipment shall be fabricated and assembled so that they will not be disengaged due to movement of the supported piping. Necessary guides, anchors, braces and structural steel to be attached to building/boiler structure as well as any braces and/or dampeners required to eliminate piping vibration and seismic loading shall be provided.

- 6.06.03 In general piping shall be supported in such a manner to maintain drainage slopes, prevent interference with structure and piping and keep flexible supports in proper adjustment so that they will move within their design operating ranges. Normally pipe supports and anchors shall be selected at those points in the building where provision has been made for the loads imposed. The cutting of floor/roof beams or the reinforcement in slabs will not be permitted. Piping attached to a plant item shall be supported in such a way that the weight of the piping is not taken by the plant item.

Support spacing shall be as per good engineering practice. However, in no case it shall be less than support spacing stipulated in ANSI B31.1.

- 6.06.04 The design of the pipe supports and hangers and their locations shall be guided by the following general principles:

- a) Criteria of loading shall be as per "Specific Design Criteria" enclosed.
- b) Design loads for anchors, restraints, hanger supporting structures shall be as per the criteria stipulated in "Specific Design Criteria".
- c) Supports shall be adequate for extra loading due to hydrostatic tests and when piping system is full of water during chemical cleaning.
- d) Supports for relief valve stacks shall be adequate for both the pipe weight and the thrust developed when the valve is open.
- e) There should not be any interference of the hangers with other piping, pipe supports, cable trays structure, equipment etc.
- f) Besides vibration elimination, hangers shall ensure that the amplitude of oscillations in the pipe work owing to shock and vibration due to variation of fluid flow from zero to full capacity remains within approved limits.

- 6.06.05 Attempts shall be made to use variable spring and rigid hangers as much as possible. Rigid hangers shall preferably be used where vertical movement of the pipe is negligible.

Variable spring supports/hangers may be used provided the following conditions are met.

- a) The variation in supporting effort between hot and cold condition does

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not exceed 20% of the load, which is higher of the operating condition, and cold setting load.

- b) The resulting effect of load take-up/release by a group of hangers in a span does not overstress the piping span or cause overloading at equipment terminals.
- c) Thermal deflection between hot and cold conditions does not exceed 40 mm.

Otherwise, constant load type support/hangers must be used. On the other hand rigid hangers can be used where possible without exceeding the stipulated limits of terminal forces and moments and the stress subject to the Purchaser/Consultant's approval.

An exception may be made in the instance where the piping movement occurs at a hanger supporting a portion of a piping riser on which rigid support is also located. In this case, variable spring hangers may be used for any amount of expansion up to the full recommended working range of the spring, provided the change in the supporting effect of the variable spring is added to the design load of the rigid support assembly. However, the acceptance of such a system will be at Purchaser's/Consultant's discretion.

- 6.06.06 All design and fabrication including loading and allowable stresses shall be in accordance with ANSI B31.1. Note shall be taken of the requirements against earthquake at site. Hangers and supports for systems shall be completely engineered and prefabricated for all piping 50 mm. and above. Sufficient random materials shall be furnished for field support of all lines of smaller diameter.
- 6.06.07 For pipes of design temperature 100°C. and more, bottom supports shall be avoided as far as possible and hanger type supports shall only be used. However, where bottom support cannot be avoided, the same shall be provided with suitable shoes along with balls/rollers/rockers to minimise frictional resistance against thermal movements. The material of shoe as well as the ball/rockers/rollers shall be suitable for the design temperature of the supported pipe and shall be of sufficient hardness so as to permit a reasonably long life keeping its roundness and maintaining a low friction factor. Where a constant load type support is required, the bottom support shall also be of constant load type.
- 6.06.08 Where stress analysis calculations are performed, the location of anchors, guides and restraints shall be based on the results of the final stress analysis. Such anchors, guides and restraints shall be designed for the maximum forces and moments encountered. Spring hangers shall be selected to allow the movements determined by the stress analysis.
- 6.06.09 The Contractor shall design and provide all supplementary steel required to properly secure and support all pipe supports, guided restraints, anchors, shock absorbers, etc. furnished. Purchaser shall provide only the main steel work or, embedded plates in the concrete.
- 6.06.10 Accurate weight balance calculations shall be made to determine the required

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- supporting force at each hanger location and the pipe weight load at each equipment connection.
- 6.06.11 Provision shall be made for support of piping, which may be disconnected during maintenance work.
- 6.06.12 Supports shall be designed to prevent transfer of excessive loads from support to support or to equipment as the line expands or contracts. Support components shall be attached in places where they will not damage other construction either during or after installation. Cantilever type support shall not be taken from brick wall. Brackets may be used where piping is adjacent to vertical surfaces, suitable for support use, these shall be supported from columns/RCC structures.
- 6.06.13 All large pipes and all long pipes shall have at least two supports each arranged so that any length of pipe or valve may be removed without any additional supports being required.
- 6.06.14 Support steel shall be of structural quality. Perforated strap, wire or chain shall not be used. Support components shall be connected to support steel by welding, by bolting or by beam clamps. Boltholes shall be drilled, not burned. Support components may be bolted to concrete using approved concrete anchors.
- 6.06.15 Double nuts or lock-nuts shall be used on hanger rods and bolts in all cases.
- 6.06.16 Variable springs shall be furnished with travel stops. The travel stops shall be factory installed at the "cold" position.
- 6.06.17 Spring hangers should not be loaded more than 80% of the spring travel range.
- 6.06.18 Both constant load and variable spring support/hanger shall be provided with outside indicators for deflection and load. Provision for the site adjustment of load at least  $\pm 10\%$  shall be incorporated. Also spring locking arrangement and turnbuckles of load/position adjustment shall be provided for all hangers.
- 6.06.19 Constant load type spring support/hangers shall be so selected as to permit, for the specific load, an over-travel of at least 25 mm or 20% (whichever is greater) of the specified range of vertical travel. The initial setting of the hangers/supports shall be such that half of the "over-travel" is allowed in either direction. Constant support hangers shall have a support variation of no more than 6% throughout the total travel range.
- 6.06.20 Rigid support shall be designed with adequate margins of safety so that variations in load distribution on them are of little consequence. All rigid hangers shall be provided with means for vertical adjustment after erection.
- 6.06.21 Where the piping system is subject to shock loads, such as thrust imposed by the actuation of safety valves (SV), hanger design shall include provision for shock absorbing devices of approved design.
- Vertical restraints near safety valves shall be preferred for taking SV discharge thrust, provided equipment terminal reactions remains within

allowable limit.

Attempts shall be made to avoid use of shock absorbers, dampers etc. as far as possible to take care of occasional loading like seismic effect etc. by proper engineering of the piping design and effective use of restraints. However, shock absorbers, VISCO- dampers, wherever felt necessary are to be supplied and erected by the bidder.

- 6.06.22 Layout of piping shall be properly designed to avoid excessive vibration by effective use of restraints. However, wherever felt necessary, shock absorbers, VISCO-dampers shall be supplied and erected by the bidder.
- 6.06.23 Hanger rods (except Rigid hangers where both tension and compression may occur) shall be subjected to tensile loading only. At hanger locations where lateral movement is anticipated, suitable linkage and rocking washers shall be provided to permit swing.
- 6.06.24 For all hangers, the length of suspension shall be so selected that the hanger rod may never make an angle of more than 4° with vertical due to horizontal pipe movements. If this cannot be avoided by erecting the hanger vertically for cold condition, it shall be suitably off set so that the above requirement is fulfilled in cold as well as hot conditions. Hangers shall be designed so that they cannot become disengaged by movements of the supported pipe.
- 6.06.25 Supports, guides and anchors shall be so designed that excess heat will not be transmitted to the building steel.
- 6.06.26 Tie rods/struts shall preferably be used for restraints to achieve low friction restraining.
- The Tie-rods/struts shall have proper arrangement and adequate length, so that, thermal movements in other directions, which are intended to be free are not constrained and there is no appreciable shift in centreline of pipe or the elevation of the supporting point on pipe due to sway. The design shall have provisions for adjusting the length to take up any slack and securely locking in position permanently once adjustment is done.
- 6.06.27 All relevant hangers shall be designed to take the dynamic movements for dynamic loading in addition to the thermal movements.

6.07.00 **Valves and Accessories**

6.07.01 **General Requirements**

- a) All valves shall be of approved make and type and shall have cast/ forged steel bodies with covers and glands of approved construction. The valves shall be provided with electric motors/solenoids and actuators as required.
- b) Valves and specialties to be supplied shall be used for various steam and water services of the power cycle system and shall be located indoor/ outdoor and on horizontal/vertical runs of the pipe lines. However, locating the valves on vertical runs should be avoided as far

as possible.

- c) All valves shall, unless otherwise approved, have ends prepared for butt-welding and the internal diameter shall be the same as the internal diameter of the pipes to be joined. Where valves are accepted with flanges, they shall comply with the requirements of the approved Code of Practice for the respective pressure and temperature conditions of the piping system.
- d) All valves shall receive tests at Manufacturer's or Contractor's works in accordance with the specific requirements of the approved Codes of Practice so that the same is acceptable to IBR where applicable. Valves shall be rising stem or otherwise as approved by the Purchaser.
- e) Gate valves have been specified with the intention of achieving isolation and tight shut-off. In full open condition, these valves should offer minimum of resistance to fluid flow.
- f) Globe valves have been specified with the intention of achieving good control of fluid passing. The plug and seat will have therefore suitable profiles for obtaining such controlling action.
- g) Check valves have been specified in order to prevent reverse flow through them.
- h) Steam traps with strainers will be used in the drain lines from various steam pipes such that only condensed steam can be drained.
- i) All valves shall function smoothly without sticking, rubbing or vibration on opening or closing.
- j) Material, design, manufacture, testing etc. for all valves and specialties along with the accessories shall conform to the latest editions of codes as specified or approved equivalent and acceptable to IBR.
- k) By-pass valves shall be provided for high pressure and larger size valves as per standards followed and as felt necessary for smooth and easy operation, even though not specifically mentioned in the specification.
- l) Motor operated valves shall be designed as specified hereinafter.
- m) Valves subjected to vacuum shall have sufficient long deep-seated packing. Valves in general shall preferably be of such design as to permit repacking while in service by providing back seating arrangement duly tested during manufacture.
- n) All flanged valves and specialties shall be provided with two (2) counter flanges, bolts, nuts, washers, gaskets etc.
- o) Valves and specialties along with counter flanges coming under the

purview of IBR shall meet all the requirements of IBR duly approved by the Purchaser.

- p) For pneumatically actuated valve, if any, the Bidder shall provide necessary instrument air connection near the valve. All accessories including solenoid valves etc. as necessary for the actuation of this valve shall be supplied.
- q) For all sizes below 50 mm, socket welded end valves may be used.
- r) All valves shall have outside screwed spindles and screwed thread of spindle shall not pass through or into the stuffing box. Where valves are exposed to the weather, protective covers shall be provided for the spindles, which shall be subject to approval.
- s) Valves requiring sealing water shall be adequately deep and shall be equipped with lantern ring to admit pressurised water for gland-sealing. Gland sealing water shall be tapped from one tapping point on the condensate extraction pumps discharge header and shall be reduced in pressure as per the requirement.
- t) The stops which limit the travel of any valve in the "Open" or "Shut" position shall be arranged exterior to the valve body.
- u) All regulating valves shall be designed to prevent erosion of the valve plugs and seats when the valves are operated partially opened. The valves shall have contoured plug.
- v) Approved access arrangements shall be provided for all valves and particular attention shall be given to those valves fitted with gearing, which require lubrication of the valve itself.
- w) Valves which cannot be operated from the floor or walkways shall be provided with suitable extension rods and linkages. If such a valve is provided with integral bypass then similar arrangement shall be done for the bypass valve also. The extension shall be such that the hand wheel is at a height of approximately one metre above the level of the floor or platform from which the valve is to be operated. Where required they shall be provided with head-stocks and pedestals of rigid construction and where gears or level wheels are used these shall be of cast steel or suitable quality cast iron with machine cut teeth. Where extension spindles are fitted, all thrust when opening or closing the valves shall be taken directly on the valve body. The extension linkage shall be so designed to take care of the thermal movements of the valve body with the pipe on which the valve is installed. The connection of the extension spindle to the valve stem shall be through a flexible coupling.

The extension spindle shall be of the same materials as that of the valve stem. The floor stands shall have column, not less than Group-B of ASTM-126. Necessary nuts and bolts for mounting the floor stands on foundation shall have to be provided. Adequate means of easy lubrication shall have to be provided for valves and operating

extension components.

- x) Stems shall preferably be arranged vertically with gland at the top, however, in no circumstances must the stem be inclined downward from horizontal or gland be at the bottom. Globe valves shall be installed with the pressure under the disc. Valves shall not be fitted in inverted position.
- y) Where necessary, for accessibility, grease nipples shall be fitted at the end of extension piping and where possible these shall be grouped together and mounted on a common panel situated at a convenient position. A separate nipple shall be provided to lubricate each point. The Contractor shall supply the first fill of oil or grease for these parts. The Contractor shall supply a suitable manually operated grease gun for the standard type of nipple provided.
- z) The spindles for all valves for use outside the building shall have weatherproof protection covers of approved construction.
- aa) All valves shall be fitted with indicators so that it may be readily seen whether the valves are open or shut. In the case of those valves fitted with extended spindles, indicators shall be fitted both to the extended spindles and to the valve spindles.
- bb) Plastic or bakelite valve hand wheels will not be accepted.
- cc) All valves shall be closed by rotating the hand wheel in a clockwise direction when looking at the faces of the hand wheel. The face of each hand wheel shall be clearly marked with the words 'Open' and 'Shut' with arrows adjacent to indicate the direction of rotation to which each refers.
- dd) Each valve hand wheel shall be fitted with a circular nameplate of a approved material indicating the valve tag number, duty or service intended and the function of the valve. The nameplates shall incorporate the colour code corresponding to the service of the piping.
- ee) Wherever practicable, heavy valves of total weight including actuator, drive motor, integral by-pass etc., equal to or greater than 500 kg. shall be provided with suitable lugs to permit direct suspension by hanger rods or direct resting on bottom support, as applicable.
- ff) Special attention shall be given to the operating mechanism for large size valves in order that quick and easy operation is obtained and maintenance is kept to a minimum.
- gg) Eyebolts shall be provided where necessary to facilitate handling heavy valves or parts of valves.
- hh) The Bidder shall supply with his bid and in addition during the course of the Contract, comprehensive drawings showing the design of valves, test pressure and working pressure/temperatures. They should include a parts list referring to the various materials used in the valve

construction.

- ii) For high temperature application above 600°F (315°C), all gate valves shall preferably be of wedge type construction.
- jj) All sampling and root valves shall be of integral body bonnet type.

#### 6.07.02 Design Requirements

- a) Design working pressure and temperature as well as pressure rating of all valves and specialties has been listed in Annexure-II of this Section. Valves and Specialties are to be supplied conforming to specified pressure rating.
- b) Steel body gate valves shall preferably be in accordance with American Petroleum Institute, U.S.A., Standard No.API-600 or other approved international standards.

Carbon steel gate valves in size 50 mm and below shall be in accordance with API-602 or any other approved international standards.

- c) Globe valves shall generally conform to BS-1873 or approved international standards, subject to other requirement specified in the specification.
- d) Check valves shall conform to BS-1868 or approved international standards and shall be of swing check type.

The body seat for swing check valves shall be inclined at such an angle as to minimise chatter.

To enable the internal parts to be examined or renewed without removing the valves from the pipeline, the flanged cover should be used. The body shall be stamped with an arrow to indicate the correct flow direction.

- e) Safety Valve

The safety relief valves shall be direct spring loaded type and shall be provided with casing levers. The valves shall be of rugged construction suitable for long periods of uninterrupted service. The safety relief valves shall conform to the requirements of ASME Boiler and pressure vessel code, Section-VIII and IBR as applicable and shall be installed as per recommended rules for the design of safety valve installations in ANSI B31.1.

- f) Motor Operated Valves

- i) Motor operated valves shall be fitted with both hand and motor operating gears and where a by-pass valve is provided this also shall be provided with both hand and motor operated gear and interlocks to ensure that the by-pass valve is opened

- before the main valve. Each valve shall be complete with a device for automatically stopping the motor when the valve gate has reached the "full open" or "full close" position (with a minimum increase in the torque). The motor shall be placed in such a position relative to the valve that there is no possibility of leakage of liquid, steam or corrosive gas from valve joints on the motor or control equipment.
- ii) The hand operating and motor operating mechanism shall be so interlocked that the hand operating mechanism is disconnected before the motor is started. Valves shall be provided with seating control and except where specifically approved by the engineer for small valves, a slipping clutch or other torque-limiting device shall be incorporated in the motor drive. The opening or closing the valve shall be controlled by means of push buttons labelled respectively "open" and "stop". The control shall be so arranged that the motor can be stopped with the valve in any position by means of "stop" push button and after having been stopped, can be re-started in either direction by the "open" or "close" push buttons hand operating mechanism shall be placed in an accessible position from the floor.
- iii) Necessary output signal (4-20 mA) shall be given for provision of positioning indicator in U.C.B.
- g) For reheater isolation, for hydraulic testing as well as wet lay up reheater isolating devices shall be provided on cold reheat and hot reheat lines, at boiler outlet. Isolating device shall consist of a robust cast steel body with carbon steel (ASTM A216 GR WCB) material for cold reheat application and alloy steel (ASTM A 217 GR WC 9) for hot reheat application suitable for pressure and temperature condition which they will be subjected. These shall be of welded type construction and shall form part of the pipeline during normal operation without any leakage. Before hydrostatic test top cover and bonnets are removed and a separate test closure assembly with sealing rings are inserted to close the flow patch. The test closure assembly shall be of disc type construction with appropriate seal and a preloading lever to form a complete tight assembly for effective closure during hydraulic testing. Drains shall be provided on both side of the device to detect leakage.
- h) Drain Valves, Steam traps and Strainers
- i) Drain Valves
- All drain valves shall be of approved type and shall have cast or forged steel bodies with covers and glands of approved construction. Spindles shall be of stainless steel and the materials of internal parts shall be suitable for operation at the maximum working pressure and temperature of the piping to which they are connected. Valves should be full-way type, unless otherwise specified and in full open position the bore of

the valve should not be obstructed by any part of the gate. The internal diameter of all valves at the bore and at the ends adjacent to the pipe work shall be similar to the internal diameter of the connecting pipe work. Valves shall be designed for continuous operation in partially open condition without erosion of the valve seats or faces. Where valve seats are shrouded the design of the shroud shall be such as to prevent foreign matter lodging in the valve seat.

All drain traps shall be of approved make, size and type and shall be complete with air cock and casing mechanism. All internal parts shall be constructed from approved material and shall be renewable. Trap bodies and covers shall be of cast or forged steel and shall be suitable for operation at the maximum working pressure and temperature of the steam piping to which they are connected.

ii) Steam Traps and Strainers

- The steam traps shall be inverted bucket or thermodynamic type complete with integral or separate strainers.
- The internal components of traps shall be of AISI-316 stainless steel construction. Material of construction of the body shall be selected by the Bidder based on the service conditions stipulated.
- All Y-type strainers, wherever provided with steam traps or otherwise, shall have AISI-316 stainless steel screen of not more than 20 mesh size. Screen open area shall be at least three (3) times the pipe internal cross-sectional area. The strainer shall have a screwed blow-off connection with a removable plug. Material of construction of the body shall be selected by the bidder based on the duty conditions specified.
- All traps and strainers shall have socket weld ends as per ANSI B16.11 for size NB 50 mm and smaller and butt weld ends as per B 16.25 for size NB 65 mm and above.
- Steam drain traps shall be provided with strainers, inlet and discharge valves and by-passes and test cocks as schematically indicated in the enclosed drawing. Materials and other details of these valves shall meet the specified requirement.

i) Pump Suction Strainer

The strainer at condensate Transfer pump should be removable type conical strainer assembly. The spool pipe shall have flanged ends suitable for direct mounting on condensate Transfer pump suction

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

j) Non-return Valves

i) All non-return valves shall be of approved type and make and the pressure drop shall be subject to approval. Non-return valves for steam services and on pump discharge sides shall be provided with approved dash pots, where required, and with prior approval.

ii) The body seat for swing check valves shall be inclined at such an angle as to minimise chatter.

iii) To enable the internal parts to be examined or removed without removing the valves from the pipeline, the flanged cover should be used. The bodies shall be stamped with an arrow to indicate the correct flow direction.

iv) Provision shall be made to drain both sides of a horizontal non-return valve where such a valve adjoins an isolating valve for non-return valves mounted on vertical pipe integral by-pass shall be used to facilitate draining as stated earlier.

k) De-super heaters

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

7.00.00 **INSPECTION, TESTING AND INSTALLATION**

7.01.00 **Testing of Piping at Works**

7.01.01 Material Test and Analysis

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

7.01.02 Hydrostatic Test

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

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

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

7.01.03 Wall Thickness Tests

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

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

7.02.00 **Capacity Tests for Pipe Supports**

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

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

7.03.00 **Testing of Valves & Specialties at Works**

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

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

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

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

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

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

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

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

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

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

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

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

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

**7.07.00 Tests at Site**

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

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

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

**7.08.00 Pre-Commissioning Testing**

**7.08.01 Alignment Test**

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

**7.08.02 Heat Treatment**

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

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

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

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

**7.08.03 Radiography Test**

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

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

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

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

Ultrasonic test per weld joint.

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

7.08.04      **Hydrotest**

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

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

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

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

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

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

7.09.00      **Installation**

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

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

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

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

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

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

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

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

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

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

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

- 7.09.05 Drainpipe work shall be designed as per ANSI B31.1.
- High pressure drains (above 40 kg/sq.cm) shall have two valves in series and that near the condenser or flash box shall be motor operated arranged to open and close to ensure minimum wear on one valve.
- High-pressure drains shall have a screw-down non-return valve at the point of discharge near the manifold of the Flash tank to prevent backflow of flashed steam.
- Low-pressure drains shall have steam traps of an approved design complete with strainers, isolating valves and by-pass valves.
- Low-pressure drains shall have an isolating valve at the point of take-off from the pipe or vessel to be drained or as near as possible for convenient operation.
- Pipe wall thickness shall be as per international standard approved by Owner/Engineer during detailed engineering.
- Drain pockets of an approved size and construction shall be provided for all steam lines.
- Arrangement of valves in the drain line shall be as shown in the Bidder's P & I Diagram.
- 7.09.06 All electrical actuators and pneumatic/hydraulic actuator shall be erected, aligned, adjusted and finally set to the satisfaction of the Owner. This includes adjustment and setting of torque and limit switches.
- 8.00.00 **DRAWINGS, DATA, INFORMATION & MANUALS**
- 8.01.00 **Drawings, data, Information to be furnished by the Bidder along with the Bid**
- 8.01.01 A complete list of all piping systems and corresponding materials included in the scope of work.
- 8.01.02 A complete list of all valves with their quantities and ratings.
- 8.01.03 Manufacturer's catalogue indicating design and construction of spring hangers, valves, specialties offered.
- 8.01.04 Manufacturer's catalogue indicating complete range of available size and rating of pipes and fittings.
- 8.02.00 **After Award of Contract**
- 8.02.01 Layout drawings as well as Isometric drawings (for line sizes NB 50 mm and larger) showing the routing of various piping and location of hangers, restraints, anchors, valves etc.

- 8.02.02 Detail fabrication drawings of all shop fabricated piping system indicating design parameters and complete bill of material (Relevant Standards and grades to be indicated) and information/ data pertaining to the hydrostatic and non-destructive test requirements.
- 8.02.03 Detail dimensioned drawing of each valve, specialties, indicating tag no., pressure rating, manufacturing standard, bill of material and hydrostatic test pressures. The drawing shall include the end preparation details and shall indicate the position of the hand wheel/operator. Technical particulars of motor operators wherever applicable shall also be indicated.
- 8.02.04 Detail dimensioned drawing of each type of hangers and supports including guides, anchors, snubbers etc. with bill of materials (relevant standards and grades to be indicated).
- 8.02.05 General arrangement drawing for each hanger/support/anchor etc. indicating identification number, auxiliary supporting structural details, other details and information as required in the specification and typical details of Hangers & supports drawing enclosed with the specification.
- 8.02.06 Wiring diagram for all limit switches of motor operated valves.
- 8.02.07 Detail drawing with design calculation for the special Y-fittings on pipes, if any.
- 8.02.08 The loading data required for design of structures.
- 8.02.09 Miscellaneous Data/Documents
- a) Complete schedule of pipe lines in a format as approved by the Engineer indicating at least the line number, line description, pipe class (as per specification designation) design pressure and temperature, hydrostatic test pressure, insulation thickness, valve specification code, pipe material indicating standard and grade, number of BW/SW/Flanged joints and whether IBR certification needed.
  - b) Complete schedule of valves in format as approved by the Engineer indicating at least tag no, location, size, pressure class, design parameters, operation, make, quantity, special requirement if any etc.
  - c) Bill of material of hangers and supports in a format approved by the Engineer indicating at least the hanger/support number, type, operating load, cold setting load, Hydrostatic test load, movement of attachment point in X, Y and Z direction, line no. on which the hanger/support is located, insulation thickness of the pipe line, hanger rod length, angular deflection of hanger rod from vertical under hot and cold conditions etc.
  - d) Approval certificates from IBR in relevant forms regarding design, fabrication and testing of piping and valves for the piping system which are under the purview of IBR.
  - e) Design calculation for pipe wall thickness finally adopted.

- f) Reinforcement calculations as per ANSI B 31.1 for all set on type branch connections.
- g) A document containing the flexibility analysis procedure and results showing the forces and moments at various support points, anchors, equipment terminals etc. as elaborated before in this specification.
- h) Procedure of shop and site tests, test reports and test certificates for all tests conducted at shop.
- i) Quality assurance schedule, including report containing all pertinent details of the heat-treating cycle for all pipes, fittings, valves, specialties etc.
- j) Detailed erection procedure for piping, valves, specialties and auxiliary equipment including complete details of welding of joints to be done at site. All necessary instructions/recommendation shall be given for satisfactory erection of piping, valves specialties and auxiliary equipment.
- k) Erection, operation and maintenance manuals.

**ANNEXURE-I**

**MATERIALS OF CONSTRUCTION FOR PIPING & FITTINGS**

Materials used in piping, fittings & specialties shall be as stipulated in the IBR and various codes as specified. However, the following basic guidelines shall in any case be followed for pipe materials :

<b>Service</b>	<b>Material, Equivalent/Superior to</b>
i) Temp. Up to 410 Deg.C	Carbon Steel, ASTM A-106, Gr. B or C Seamless. ASTM A-105/ A-234 WPB/WPC
ii) Temp. Above 410 Deg.C to 510 Deg.C	Alloy Steel, ASTM A-335, P11 ASTM A-182 F11; A-234 WP11
iii) Temp. Above 510 Deg.C to 540 Deg.C	Alloy Steel, ASTM A-335, P22/P91 ASTM A-182 F22/F91; A-234 WP22/91
iv) Temp. Above 540 Deg.C to 600 Deg.C	Alloy Steel, ASTM A-335, P91 ASTM A-182 F91; A-234 WP91
v) Corrosive	Stainless Steel.

## ANNEXURE-II

## MATERIALS OF CONSTRUCTION FOR VALVES

Materials for Valves shall be equivalent/superior to the following, for non-corrosive services:

Working Class	Valves Size	Material	
		Body Bonnet Cover	Stem Hinge Pin
i) Temp. Up to 410°C	65 mm & above	ASTM A-216, Gr. WCBWCC	13% Cr. Steel (ASTM A-182, Gr. F6a)- min. hardness 200 HB
	50 mm & below	ASTM A-105	
ii) Temp. Above 410°C to 510°C	65 mm & above	ASTM A-217, Gr. WC6	ASTM A-182, Gr. F6a - min. hardness 200 HB
	50 mm & below	ASTM A-182, Gr. F11	
iii) Temp. Above 510°C to 540°C	65 mm & above	ASTM A-217, Gr. WC9	ASTM A-182, Gr. F6a - min. hardness 200 HB
	50 mm & below	ASTM A-182, Gr. F22	
iv) Temp. above 540°C to 600°C	65 mm & above	ASTM A-217, Gr. WC/C12	ASTM A-182, Gr. F6a - min. hardness 200 HB
	50 mm & below	ASTM A-182, Gr. F91	

**Note** : Non-return valves in corrosion service shall be swing check type, suitably lined.

**TECHNICAL SPECIFICATION FOR  
LOW PRESSURE PIPING, VALVES AND SPECIALITIES**

## **CONTENT**

<b>CLAUSE NO.</b>	<b>DESCRIPTION</b>
1.00.00	GENERAL INFORMATION
2.00.00	CODES AND STANDARDS
3.00.00	SCOPE OF WORK
4.00.00	GENERAL DESIGN AND CONSTRUCTION
5.00.00	DRAWINGS, DATA, INFORMATION & MANUALS
6.00.00	BROAD GUIDELINES FOR ERECTION AND INSTALLATION OF L.P. PIPING

### **ATTACHMENTS**

ANNEXURE-I	SPECIFICATION OF PIPES FOR DIFFERENT SERVICES
ANNEXURE-II	SERVICE OF VARIOUS CATEGORIES OF VALVES
ANNEXURE-III	SPECIFICATION OF VALVES

**LOW PRESSURE PIPING, VALVES AND SPECIALTIES****1.00.00 GENERAL INFORMATION**

This section covers all the low-pressure piping up to 400mm NB size, associated valves and specialties that include but is not limited to the following systems.

- 1.01.00 Service Air System - shall consist of distributions service air to different buildings.
- 1.02.00 Instrument Air System - shall comprise of distribution of instrument quality air to pneumatically operated instruments/ valves/dampers.
- 1.03.00 Demineralised Water Supply system including hot well make-up water piping from condensate storage tank.
- 1.04.00 Demineralised Water closed cycle cooling system.
- 1.05.00 Service water system.
- 1.06.00 Potable water system.
- 1.07.00 Any other low pressure piping as found necessary during detail engineering shall also be included.

**2.00.00 CODES AND STANDARDS**

2.01.00 In addition to the requirements spelt out in Volume IIA, the design, manufacture, inspection and testing of the piping, fittings, valves and specialties covered under this specification shall conform, in general, to the standards and codes (latest edition) mentioned below:

- 2.01.01 IS-1239 : Mild steel tubes, tubular and other wrought steel fittings  
[Part-I & II]
- 2.01.02 IS-3589 : Electrically welded steel pipes for water, gas and sewage (150 to 2000 mm nominal diameter)
- 2.01.03 IS-554 : Dimensions for pipe threads where pressure tight joints are required on the threads.
- 2.01.04 IS-1363 : Hexagonal head bolts, screws and nuts (size range M5 M36)  
[Part-I & II]

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2.01.05	IS-1364	:	Precision and Semi-precision hexagon bolts, screws, nuts and lock nuts (diameter range 6 to 39 mm)
2.01.06	IS-3138	:	Hexagon bolts & nuts (M42 to M150)
2.01.07	IS-5312	:	Swing check type reflux (non-return) valves.
2.01.08	IS-2379	:	Colour code for the identification of pipelines.
2.01.09	IS-2016	:	Plain washers
2.01.10	IS-2712	:	Compressed asbestos fibre jointing
2.01.11	ANSI B-16.5	:	Steel pipe flanges and flanged fittings
2.01.12	ANSI B-16.9	:	Wrought steel Butt welding flanged
2.01.13	ANSI B-16.11 : ANSI B-36.10 :		Forged steel fittings, Socket-welding and Threaded. Steel pipes thickness
2.01.14	API-600	:	Steel gate valves
2.01.15	BS-2633	:	Class I Arc welding of ferrite steel pipe work for carrying fluids.
2.01.16	BS-534	:	Specification for steel pipes and specials for water and sewage.
2.01.17	BS-5351	:	Specification for Ball valves.
2.01.18	AWWA-C-504	:	Specification for Butterfly valves.
2.01.19	AWWA-C-208	:	Dimension for fabricated steel water pipe fittings.
2.02.00	Other international codes and standards may also be offered by bidder. However, same may be subject to acceptance by the Purchaser.		

**3.00.00 SCOPE OF WORK**

- 3.01.00 The equipment and materials to be supplied shall include but not be limited to the following:
- a) Supply of all low pressure piping including bends, elbows, tees, branches, laterals, crosses, reducing union, couplings, caps, saddles, shoes, flanges, blank flanges, Y-pieces etc. as required for the piping system under the scope of this section.
  - b) Matching pipes, matching pieces like reducers/enlargers etc., counter flanges with bolts, nuts, washers, temporary and permanent gaskets, threaded union etc.
  - c) Supply and machining work of flanges, pipe spools and matching pipes to connect flow measuring orifices/nozzles with the main pipe work.