

- 5.1.5 Consumables selected by fabricator shall be procured from reputed consumable manufacturer with the requisite approvals and shall have written consent of authorised inspector before use.
- 5.1.6 Weld deposition cladding procedure shall be qualified separately in presence of authorised inspector to yield a weld deposit that exhibits undiluted weld metal composition at a depth of 2/3rd of the cladding thickness from top of the finished overlay surface. Previously qualified & approved procedures, not older than 5 years & meeting the requirements shall be acceptable.
- 5.2 When integrally bonded clad plate is used, the lining shall be cut back at all the seams and the nozzle to shell/head joints to permit complete welding of the base metal. Weld metal shall be ground flush with the backing material surface prior to clad restoration and fully covered with the applicable weld metal overlay. The weld metal overlay shall be at least as thick as the lining but no greater than twice its thickness or 3mm above clad surface whichever is less, but consistent with the requirement given in 5.1.7 & 5.6.
- 5.3 The weld joint in the base plate shall be radiographed as specified in the Engg. Data sheet for detection of cracks/flaws, before clad side welding is carried out. Just before clad restoration welding, the prepared surface shall be inspected by 100% dye penetrant testing.
- 5.4 The weld overlay procedure shall be qualified as per ASME Code Section IX. However, the chemical analysis requirement shall be as per clause 5.6 hereunder.
- 5.5 The weld metal overlay shall be relatively smooth with no notches and undercuts that would act as stress intensifiers. Flaws on the surface of the base metal that would interfere with bonding of the overlay shall be removed by grinding.
- 5.6 A minimum of two samples of the weld metal overlay shall be taken from each overlaid shell section and each head to confirm required chemical analysis. Each manual weld overlay, such as those on nozzles and flanges, shall also be sampled. Analysis at a depth of 2/3rd of the cladding thickness from top of the finished overlay thickness shall conform to the chemistry requirements applicable for the corrosion resistant alloy specified for cladding on the engineering drawing.
- 5.7 Hardness of martensitic stainless steel (410S) and ferritic stainless steel (405) clad welds and heat affected zones shall have maximum hardness of 252 BHN when welded with 410S welding consumables. The welding procedure shall be suitably qualified with preheat, post heat and/or post weld heat treatment to meet this hardness requirement.
- 5.8 Bend test of clad weld procedure qualification shall be performed. In case of ferritic stainless steel (410S / 405) the failure of bend test shall be ignored.
- 5.9 When flush finish is required for the clad restoration side, back grinding of the base material to a depth of 2 mm can be permitted provided this reduction of thickness is compensated by the external reinforcement of the base metal weld.
- 5.10 Iron Content in Monel overlay deposit shall be limited to 2.5 % maximum.

## 6.0 INSPECTION

- 6.1 Shell, dished end and toricones formed from a clad plate shall be ultrasonically examined for lack of bond as detailed below:
- 6.1.1 100% of surface of Knuckle area and Straight face of dished ends and toricones.
- 6.1.2 Other than 6.1.1, a minimum of 10% of clad surface, not less than one square foot in each 10 square foot or fraction thereof shall be examined for lack of bond after forming.

- 6.1.3 Dished ends / toricone made from clad plate shall be ultrasonically examined after final heat treatment for lack of bond. Inspection and repair procedure shall be as per 6.1.5 below.
- 6.1.4 100% Ultrasonic examination shall be carried out of areas where attachments are to be welded directly to the cladding. The above areas shall include 50mm width of adjacent areas on both sides of attachment.
- 6.1.5 Unbonded areas that cannot be encompassed by a 1 inch diameter circle shall be repaired by weld deposit overlay in accordance with 5.1.2 of this specification. When repairs in excess of 3 percent of the total examined area are required, the vessel shall be 100 percent ultrasonically examined. Repaired areas and weld deposit overlay at weld seams shall be 100% liquid penetrant examined. Ultrasonic examination shall be in accordance with ASME A578 with acceptance standard Level C and meeting the supplementary requirement S7.
- 6.2 All weld deposit overlays, whether by manual or automatic procedures, shall be 100% liquid penetrant examined after each layer of deposit including final layer. Weld deposit overlay on machined surfaces shall be 100% liquid penetrant examined after final heat treatment. Weld deposit overlay shall be spot liquid penetrant examined (a minimum of 10% of the surface, including no less than 1 square foot in each 10 square feet or fraction thereof) after final heat treatment and shop hydrostatic testing.
- 6.3 Cracks, Fissures and circular defects greater than 1/16 inch (1.6mm) diameter in weld deposit overlay shall be completely removed and repaired. Repaired areas shall be subjected to 100% liquid penetrant examination.
- 6.4 Liquid dye penetrant examination shall be in accordance with methods described in ASTM E 165.
- 6.5 Unless otherwise specified Intergranular corrosion test (IGC) shall be carried out as per ASTM A 262. Practice-E for all 300 series material and specimen shall be inspected under a magnification of 200X. The bent specimen shall be free of any cracks or grain dropping. The microstructure shall be submitted to the Authorized Inspector for approval. This test shall be applicable for the following cases:
- Welding consumable qualification testing and welding procedure qualification testing.
  - Hot forming procedure qualification and heat treatment by using production test coupons testing.

## 7.0 HEAT TREATMENT

- 7.1 Cladded vessels or parts of vessels shall be post weld heat-treated as per the requirements of mentioned in the respective engineering data sheets.
- 7.2 When carbon steel vessels clad with unstabilized austenitic stainless steel other than low carbon grade e.g. SS 304 and SS 316 are to be post weld heat treated, they shall be heat-treated at  $510 \pm 20^\circ\text{C}$  for a period of 10 hours per inch of thickness or 10 hours whichever is longer.
- 7.3 Heat treatment of ferritic stainless steel welds and heat affected zone shall be carried out in case of hardness exceeds the allowable limit as defined in clause 5.7 above.
- 7.4 The following precautions should be observed during heat treatment of clad vessels:
- The clad material should not be exposed to a direct flame if gas or oil is used as a fuel.
  - Stainless steel clad vessels require a neutral or oxidising atmosphere during heating.

- iii) Maximum sulphur content in the fuel should not exceed 0.5%.
- iv) Marking paint and protective oil should be removed completely from the clad side before heating.

## 8.0 SURFACE CLEANING

- 8.1 Stainless steel clad surfaces must be cleaned of oxides, scale, welding flux etc. by using stainless steel wire brushes. Paints shall be removed by using suitable solvent (free from chlorides & fluorides). Oil and grease shall be removed using hot clean water and with a suitable detergent.
- 8.2 After the completion of fabrication and testing, all stainless steel clad surfaces shall be pickled and passivated in accordance with ASTM A-380. The pickling and passivation procedure shall be submitted to EIL for review.
- 8.3 The stainless steel surfaces shall be free of iron pick up. This shall be checked by Ferroxyl test in accordance with ASTM A-380.
- 8.4 Procedure for surface cleaning of Monel clad (SB 127) is as follows:
  - a) In case Surface Oxidation due to welding and iron pick up on the surface is noticed, the following pickling procedure may be adopted for cleaning the internal surfaces of the Monel cladding.
  - b) Swab with a solution made of  
Water : 1 gal.  
Nitric acid (42 D Be): 1 gal  
Common Salt : □ lb.  
Temp.: 70-100 (ambient) □F  
Time : 5 Sec.
  - c) Rinse clean repeatedly with hot water (180 oF)
  - d) Second swab with a solution with  
Water : 1 gal.  
Nitric acid (42 D Be): 1 gal  
Temp.: 70-100 (ambient) □F  
Time : 5 Sec.
  - e) Neutralisation by swabbing 1-2% Soda ash solution followed by hot water rinse.
  - f) Cleaning with saw dust or dry cloth cleaning.

The procedure shall be prequalified before being employed on the vessel.

- 8.5 Pickling/Passivation procedure of SS410S clad surface shall be as follows:

- A) Pre-cleanings of the surface contaminated with oily/greasy substances.
  - 1) Solvent cleaning by uncontaminated organic solvents such as aliphatic petroleums, followed by detergent solution cleaning.
  - 2) Alternately high pressure DM water jetting containing detergent at water pressures upto 70 mpa (10,000 psi) can be used.

## B) Pickling/Passivation Procedure

- 1) The entire surfaces of the parent metal and weldment shall be swabbed with HNO<sub>3</sub>. 10-15 percentage by volume containing Na<sub>2</sub>Cr<sub>2</sub>O<sub>7</sub> H<sub>2</sub>O (care shall be taken to avoid accidental discharge of the effluent containing Na<sub>2</sub>Cr<sub>2</sub>O<sub>7</sub> H<sub>2</sub>O into drains. It should be collected and disposed of properly in accordance with the prevailing environmental regulations) of 2-6% by weight at 21-38°C for 30-60 minutes. However, the actual time period shall be decided by a pickling procedure qualification test. This shall be followed by a DM water rinse with the rinse water pH controlled in the range of 6.5 - 7.5
- 2) Immediately after acid cleaning and water rinsing, the surface shall be swabbed with a caustic solution containing KOH, 10% by weight percent and KMNO<sub>4</sub> 4% at a temperature of 70-80°C for 5-15 minutes followed by second DM water rinsing and drying by hot air circulations at a temperature of 121-149°C for 24 hours.

### 3) Inspection after cleaning

Visual inspection shall be conducted to assess freedom from paint, oil, grease welding flux, slag, heat treating and heat forming scale, dirt, trash, metal and abrasive particles and clamps and other gross contamination under adequate light levels of 2690 IX (250 footcandles) supplemented by boroscope, mirror or other aids as necessary to properly examine inaccessible or difficult to see surfaces.

### 4) Ferroxyl Test Procedure

Ferroxyl test for free iron is highly sensitive test and should be used only when even traces of free iron or iron oxide might be objectionable. The test can be used on stainless steel to detect iron contamination, including iron-tool marks, residual iron salts from pickling solutions, iron dust, iron deposits in welds, embedded iron or iron oxide etc., The test solution is prepared by first adding nitric acid to distilled water and then adding potassium ferricyanide, in the following proportions.

Distilled water	94 Weight %	1000 Cu.cm.
Nitric Acid (60-70%)	3 Weight %	20 Cu.Cm.
Potassium Ferricyanide	3 Weight %	30 gms.

Apply solution with an aluminium, plastic, glass, or rubber atomizer having no iron or steel parts, or a swab (atomizer spray is preferred).

The appearance of a blue stain (within 15 sec. of application) is evidence of surface iron contamination (Several minutes may be required for detection of oxide steel) the solution should be removed from the surface as quickly as possible after testing using DM water or, if necessary white vinegar or a solution of 5 to 20 weight % acetic acid and scrubbing with a fiber brush. Flash the surface with DM water several times after use of vinegar or acetic acid.

Note : Potassium ferricyanide is not a dangerous poison as are the simple cyanides, however care should be taken not to heat treat or bring it in contact with concentrated acids. Solution should be handled with gloved hands only. Always use freshly prepared solution only.

## 9.0 WELD REPAIR

To the extent possible, the repair of clad stainless steel should be avoided. If unavoidable, the number of repairs at the same spot should not exceed two. The repair procedure should be




specifically qualified with IGC testing under the supervision of EIL inspection. The acceptance criteria for IGC testing shall be the same as specified for original clad overlay welding for 300 series stainless steel materials.

## 10.0 HYDRO-TESTING

For hydrostatic test, clean fresh water shall be used unless use of a different medium is approved by the purchaser. In case of austenitic stainless steel lined vessels, chloride content in water shall be less than 25 ppm. Vessel shall be dried thoroughly using hot air, immediately after draining, to prevent the possibility of evaporation and concentration of chlorides and fluorides.

बायलर क्वालिटी कार्बन स्टील प्लेटों का  
मानक विनिर्देश

STANDARD SPECIFICATION FOR  
BOILER QUALITY CARBON  
STEEL PLATES

9	08.02.2022	REVISED AND REISSUED AS STD. SPEC.		KA		NK		SM
8	19.01.2017	REVISED & REISSUED AS STD. SPEC.	RNK	SK/KJH	RKT		RN	
7	30.06.2010	REVISED & REISSUED AS STD. SPEC.	KA	RKT	AKM/DM		N.DUARI	
6	10.09.09	REVISED & REISSUED AS STD. SPEC.	VB	RKG	AKM		N.DUARI	
5	16.04.04	REVISED & REISSUED AS STD. SPEC.	DNN	AKM	SSA		SKG	
Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman	Approved by	

**Abbreviations:**

ASME	American Society of Mechanical Engineers
EN	European Norm
HIC	Hydrogen Induced Cracking
IBR	Indian Boiler Regulations
SSC	Sulphide Stress Cracking

**STANDARDS COMMITTEE**

**SMED-I (Static Equipment) ( Group code 12,13,15,26)**

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## 1.0 SCOPE

- 1.1 This specification covers requirements for carbon steel plates intended primarily for pressure vessels/heat exchangers. The steel plates shall meet the requirements of ASME Boiler and Pressure Vessel Code Section II (latest). This is intended to supplement the minimum applicable requirements of the material specification indicated in the material requisition.
- 1.2 Following codes, standards etc shall be followed in their latest edition and addenda, errata, amendments unless specified otherwise:
- 1.2.1 ASME Sec VIII Div 1
- 1.2.2 ASME Sec II part A
- 1.2.3 EN 10163: Delivery Requirements for Surface Conditions.
- 1.2.4 EN 10204: metallic products – Types of Inspection Documents.

## 2.0 GENERAL

- 2.1 Plates supplied to this specification shall conform to specification SA-20 of ASME sec II part A with additional requirements mentioned herein.
- 2.2 The tolerance on thickness of steel plates shall be positive only.
- 2.3 Final Rolling shall be lengthwise.
- 2.4 The plates shall be free from injurious defects and shall have workmanlike finish. Reconditioning/repair of plates by welding shall not be permitted. Surface conditions shall meet requirements of EN 10163 Class A Subclass 3.

## 3.0 SUPPLEMENTARY TECHNICAL REQUIREMENTS

- 3.1 All plates shall be supplied in normalised condition except when the applicable material specifications require supply of plates in quenched and tempered condition.
- 3.2 a. One product analysis of each heat shall be carried out and reported. Chemical analysis shall be as per applicable specification.
- b. The carbon content for plates shall not exceed 0.23%.

Additionally, one of the following requirements for carbon equivalent based on heat analysis, shall be also satisfied:

$$C_{eq} = C + \frac{Mn}{6} \leq 0.42 \quad \dots \quad (\text{Eqn. - 1})$$

$$C_{eq} = C + \frac{Mn}{6} + \frac{Cr+Mo+V}{5} + \frac{Cu+Ni}{15} \leq 0.43 \quad \dots \quad (\text{Eqn. - 2})$$

Equation-1 shall be used when applicable material specification specifies C and Mn only.

Equation-2 shall be used when applicable material specifies the above elements or restricted chemical requirements are specified or supplementary requirements S19 and S21 of SA-20 are specified in material requisition.

For HIC services, these requirements shall be as listed separately.

### 3.3 Ultrasonic Examination of Plates

- a. Plates having thickness 16 mm to 50 mm (both inclusive) shall be examined ultrasonically as per SA-435.
- b. For thicknesses above 50mm ultrasonic examination shall be carried out as per SA-578 and shall have acceptance standard of level-B.
- c. For quenched and tempered steel plates, ultrasonic examination shall be done after the heat treatment of plates.

### 3.4 Simulated Heat Treatment of Test Coupons

The following heat treatment shall be conducted on the test coupons representative of heat treated plates before the specified mechanical testing like tensile, bend, impact tests, etc. to meet minimum ASME Sec. II Part - A requirements and these details shall also be recorded on the test certificates.

- a. All plates supplied in Normalised condition and intended for hot rolling / hot forming:

#### Heat Treatment Cycle

One normalising\* + One stress relieving as per UCS-56 of ASME Sec. VIII Div.1 complying with UCS-85 of ASME Section VIII Div. 1.

Note: Any other special requirement shall be specified in MR.

- b. All plates supplied in Quenched & Tempered condition and intended for hot rolling/ hot forming:

#### Heat Treatment Cycle

One normalising\* + quenched & tempering + One stress relieving as per UCS-56 ASME Section VIII Div.1 complying with UCS-85 of ASME Section VIII Div.1.

Note : Tempering temperature shall be at least 20° C above highest stress relieving temperature.

\* Normalising cycle shall be as per Material Test Certificate (MTC).

- c. All plates supplied in Quenched & Tempered condition and intended for cold forming:

#### Heat Treatment Cycle

One stress relieving as per UCS-56 ASME Section VIII Div.1 complying with UCS-85 of ASME Section VIII Div.1.

- 3.5 Impact test requirements shall be ascertained as per ASME Sec VIII Div.1 or Div.2 as applicable. When required, Impact testing shall be performed as per supplementary requirement of S5 of specification SA-20 and acceptance criteria for energy absorption shall be as per table A2.15 of SA-20.

- 3.6 If specified in the material requisition, plates shall meet the requirements of Indian Boiler Regulations (IBR).

### 3.7 Additional Requirements for High Thickness Plates

Plates above 50mm thickness shall meet following additional requirements:

- a. Vacuum Degassing treatment as per the supplementary requirement S1 of specification SA-20. If vacuum degassing is not reported in the test certificates, then through thickness tests as per SA 770 shall be conducted and minimum reduction in area of 35% shall be ensured.
- b. Charpy V-notch impact test as per the supplementary requirement S5 of specification SA-20.

Material meant to be used for design temperature warmer than 0°C, impact test shall be carried out at 0°C or MDMT whichever is lower and acceptance criteria for energy absorption shall be as per Table A2.15 of SA-20. In case the acceptance criteria is not available in SA-20, then applicable design code shall be referred unless otherwise specified in material requisition.

- c. Simulated heat treatment of test coupons for all plates as per Clause 3.4 mentioned above.

### 4.0 CERTIFIED DOCUMENTS

The supplier shall furnish certificates/documents (number of copies as specified in requisition) inclusive of all the following tests required as per specification duly certified by the Inspecting Authority before shipment of plates. The actual values obtained shall be recorded in the test certificates/documents. Material certificates shall conform to EN 10204 Type 3.1/3.2 as specified.

- a. Chemical Analysis
- b. Mechanical Tests
- c. Data of heat treatment i.e. initial temperature, heating rate, soaking temperature, cooling rate, etc.
- d. Simulated Heat Treatment of Mechanical Test coupons (S3 of SA-20) at indicated Heat Treatment Cycle (if specified in the requisition or whenever applicable)
- e. Ultrasonic Examination (S8 or S12 of SA-20)
- f. Charpy V-notch impact tests (S5 of SA-20 if specified in the requisition or whenever applicable)
- g. Certification as per IBR (if specified in the requisition)
- h. SSC and/or HIC tests (if specified in material requisition)
- i. Additional tests (if specified in requisition).

### 5.0 PAINTING AND COATING

No painting/coating of any kind is permitted on the steel plates, except stencil marking. However steel plates shall be carefully protected and packed against any damage during transit and shall be of sea worthy condition.

## 6.0 INSPECTION AUTHORITY

Material test certificates, duly certified by Mill's Quality Assurance Department are acceptable i.e. 3.1 certification as per EN 10204. However, if third party inspection is required specifically for plates in material requisition, all test certificates and documents shall be duly certified by the third party. i.e. 3.2 certification as per EN 10204.

भंडारण टैंक एवं वैसल के लिये वेल्डिंग  
योग्य स्ट्रक्चरल क्वालिटी स्टील प्लेटों का  
मानक विनिर्देश

**STANDARD SPECIFICATION FOR  
WELDABLE STRUCTURAL QUALITY  
STEEL PLATES FOR STORAGE  
TANKS AND VESSELS**

7	27.03.2023	REVISED AND REISSUED AS STD. SPEC.	NSK	TK	NK	SM
6	22.09.2017	REVISED AND REISSUED AS STD. SPEC.	SK	KJH	RKT	RN
5	30.06.2010	REVISED AND REISSUED AS STD. SPEC.	KA	RKT	AKM/DM	N.DUARI
4	15.09.09	REVISED & REISSUED AS STD. SPEC.	VB	RKG	AKM,	N.DUARI
3	08.04.04	REVISED & REISSUED AS STD. SPEC.	DNN	AKM	SSA	SKG
Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	

**Abbreviations:**

EN : European Norm  
IS : Indian Standard

**Static Equipment Standards Committee**

**Convenor :** Mr. Nalin Kumar

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Mr. Tarun Kumar (Emp. No. A328)  
Mr. Tarun Khurana (Coordinator)  
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Mr. Ayush Mathur (Project)  
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Mr. Avdhesh Agarwal (SCM-Inspection)

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## 1.0 SCOPE

- 1.1 This specification covers additional and supplementary requirements for weldable structural quality Steel Plates to IS: 2062 (latest), intended primarily for storage tanks and vessels.
- 1.2 Following Codes, standards etc. shall be followed in their latest edition and addenda, errata, amendments unless specified otherwise:
- 1.3 IS:2062, IS:1852, IS:10842 (All Parts)
- 1.4 EN 10163 (All Parts): Delivery for Surface Condition.
- 1.5 EN 10204: Metallic products – Types of Inspection Documents.

## 2.0 GENERAL

- 2.1 The maximum under tolerance permissible on the thickness of plate shall be 0.25 mm. Tolerances on other dimensions of plates shall be as per IS: 1852.
- 2.2 Direction of final rolling shall be lengthwise.
- 2.3 Reconditioning/Repair of plates by welding shall not be permitted. Surface finish shall be ground/flush smooth and shall be free from any surface imperfection.

## 3.0 SUPPLEMENTARY TECHNICAL REQUIREMENTS

- 3.1 Heat analysis and product analysis shall be carried out for each heat and chemical composition shall meet the limits as specified in IS: 2062.
- 3.2 Y-groove weld crackability test as per IS: 10842 shall be carried out for plates conforming to Gr. E250 C having thickness 12mm and above.
- 3.3 Charpy impact test shall be carried out on the plates having thickness greater than 12 mm conforming to Grade E250 BR, E250 B0 & E250 C. Test temperature and acceptance criteria for energy absorption shall be as mentioned in Table-2 of the specification IS: 2062.  
For Thickness less than 12 mm (for materials E250 Gr.B0 & E250 Gr.C), if required, the minimum impact energy values of reduced sizes shall be as per Fig. 2 of the specification IS: 2062.

## 4.0 CERTIFIED DOCUMENTS

The supplier shall furnish certificates/documents (number of copies as specified in requisition) inclusive of all the following tests required as per specification, duly certified by the Inspecting Authority before shipment of plates. The actual values obtained during tests shall be recorded in the test certificates/documents. Material certificates shall conform to EN 10204 Type 3.1/3.2 as required.

- a. Chemical Analysis
- b. Mechanical Tests
- c. Data of heat treatment
- d. Charpy V-notch impact tests
- e. Y- groove crackability test

## 5.0 PAINTING AND COATING

No painting/coating of any kind is permitted on the steel plates except stencil marking. However steel plates shall be carefully protected and packed against any damage during transit and shall be of sea worthy conditions.

## 6.0 INSPECTION AUTHORITY

Material test certificates, duly certified by Mill's Quality Assurance Department are acceptable i.e. 3.1 certification as per EN 10204. However, if third party inspection is required specially for plates in requisition, all test certificates and documents shall be duly certified by the third party. i.e. 3.2 certification as per EN 10204.

क्लेड प्लेटों के लिए  
मानक विनिर्देश

STANDARD SPECIFICATION  
FOR CLAD PLATES

6	23.11.23	REVISED AND REISSUED AS STD. SPEC.	PSV	TK	KA/NK	MN
5	26.06.18	REVISED AND REISSUED AS STD. SPEC.	SK	TK	KJH	RKT
4	30.07.10	REVISED AND REISSUED AS STD. SPEC.	KA	RKT	AKM/DM	N.DUARI
3	30.09.09	REVISED AND ISSUED AS STD. SPEC.	KA	RKG	AKM	N. DUARI
2.	29.03.04	REAFFIRMED & REISSUED AS STD. SPEC.	DNN	AKM	SSA	SKG
Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
Approved by						

**Abbreviations:**

ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing & Materials
BHN	Brinell Hardness Number
EN	European Standards
IBR	Indian Boiler Regulations
IGC	Inter Granular Corrosion

**Static Equipment Standards Committee**

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## 1.0 SCOPE

This specification covers clad plates of a carbon steel or low alloy steel base integrally and continuously bonded on one side with a layer of chromium steel, chromium nickel steel, nickel chromium alloys and Monel. The base as well as the alloy cladding metal shall meet the requirements of ASME Boiler and Pressure Vessel Code Section II and EIL specifications 6-12-0011, 6-12-0017 and 6-12-0018. This is intended to supplement the minimum applicable requirements of material specification indicated in the material requisition.

## 2.0 GENERAL

- 2.1 Plates supplied to this specification shall conform to the latest issue of applicable specification SA-263, SA-264, SA-265, SA-20 and SA-578 with additional requirements mentioned herein.
- 2.2 The tolerance on thickness of base metal as well as cladding metal shall be positive only.
- 2.3 Final rolling shall be lengthwise.
- 2.4 Outside surface of the base metal shall meet requirements of EN 10163 class- A, sub class 3.
- 2.5 Unless otherwise specified in the requisition, the surface of alloy cladding shall have No.1 finish for hot rolled and 2B finish for cold rolled, as per SA-480.
- 2.6 Acid pickling shall be done for chromium nickel stainless steel cladding as per ASTM A-380. Manufacturer's standard practice for pickling shall be followed for chromium steel cladding.
- 2.7 Repair of cladding surface by welding shall not exceed 3% of surface area of individual plate.
- 2.8 The integral & continuous cladding shall be produced by roll bonding or explosion bonding process with bond integrity Class 1.

## 3.0 SUPPLEMENTARY TECHNICAL REQUIREMENTS

- 3.1 Chemical composition of the clad metal shall meet the requirement of the applicable material specification. But in case of straight chrome (13% Cr) cladding material, carbon content shall be less than 0.06%.
- 3.2 Unless otherwise specified in the requisition, heat treatment of the clad steel plate shall be as per the applicable clad plate material specification. All stabilized grades of austenitic Stainless Steel (SS 321, SS 347etc.) clad plate shall be in stabilization heat treated condition in addition to solution annealing.
- 3.3 Alloy cladding representative of each heat shall be subjected to inter-granular corrosion test as per ASTM A-262, Practice E for all 300 series material. IGC test shall be carried out after cladding process.
- 3.4 During the mill tension test of all clad steel plates, the cladding shall be removed and the tensile properties shall meet the requirements of the base material. Test specimen shall be taken transverse to rolling direction.
- 3.5 For all clad steel plates, shear test shall be conducted. Strength of bond shall be at least 20,000 psi in shear.
- 3.6 All clad steel plates shall be ultrasonically examined in accordance with SA-578 with acceptance standard level-C and shall meet the supplementary requirements S1. Integrity of clad plate shall be ensured Quality level: class-1 as per SA 263 or SA 264 or SA 265.

3.7 The ultrasonic examination shall be conducted after the specified final heat treatment of the clad steel plates.

#### 4.0 CERTIFIED DOCUMENTS

The supplier shall furnish the following certificates/documents inclusive of all tests required as per specification, duly certified by the Inspecting Authority before shipment of plates. The actual values obtained shall be recorded in the test certificates/documents. Purchaser's technical requirements shall be clearly shown in the test certificates. Material certificate shall conform to EN10204 Type 3.1/3.2 as specified.

4.1 Chemical Analysis for both cladding metal and base metal.

4.2 Mechanical test for base metal and shear strength for clad plate.

4.3 Data of heat treatment of clad plate i.e. initial temperature, heating rate, soaking temperature/time, cooling rate etc. For simulation heat treatment of base plate test coupon, chart of heat treatment is to be attached to Mill's Certificate.

4.4 Ultrasonic examination.

4.5 Inter-granular corrosion test.

4.6 Finish for a cladding & base metal.

4.7 Method of cladding.

4.8 Certification as per IBR (if specified in material requisition)

4.9 Date of manufacture.

4.10 Pickling procedure.

#### 5.0 PAINTING AND COATING

Plates are not to be painted/coated but shall be covered with plastic foils or paper or by other means for careful protection and shall be packed against any damage during transit and sea weather conditions.

#### 6.0 INSPECTION AUTHORITY

Material test certificates, duly certified by Mill's Quality Assurance Department are acceptable i.e. 3.1 certification as per EN 10204. However, if third party inspection is specified in material requisition, all test certificates and documents shall be duly certified by the third party i.e. 3.2 certifications as per EN 10204.

1% क्रोमियम-½% मॉलिब्डेनम और  
1¼% क्रोमियम-½% मॉलिब्डेनम  
स्टील प्लेटों का मानक विनिर्देश

STANDARD SPECIFICATION  
FOR  
1% Cr-½%Mo AND 1¼% Cr-½%Mo  
STEEL PLATES

6	02.04.2024	REVISED AND REISSUED AS STD. SPEC	SC	TKh	KA/NK	MN
5	28.08.2018	REVISED AND REISSUED AS STD. SPEC	SK	TK	KJH	RKT
4	30.06.2010	REVISED AND REISSUED AS STD. SPEC.	KA	RKT	AKM/DM	N.DUARI
3	15.09.09	REVISED & REISSUED AS STD. SPEC.	VB	RKG	AKM	N.DUARI
2	15.04.04	REVISED AND REISSUED AS STD. SPEC.	DNN	AKM	SSA	SKG
Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convener	Standards Bureau Chairman
Approved by						

**Abbreviations:**

ACC	Accelerated Cooling Cycle
ASME	American Society of Mechanical Engineers
BHN	Brinell Hardness Number
EN	European Norms
IBR	Indian Boiler Regulations
N	Normalized
T	Tempered

**Static Equipment Standards Committee**

Convenor: Mr. Nalin Kumar  
Co-Convenor: Mr. K. Anjaneyulu

**Members:**

Mr. Tarun Kumar (Emp. No. A328)  
Mr. Tarun Khurana (Coordinator)  
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Mr. P Barik  
Mr. Saikat Chakraborty  
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Mr. Aasheesh Handa (Projects)  
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Mr. Avdhesh Agrawal (SCM-Inspection)

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## 1.0 SCOPE

- 1.1 This specification covers 1% Cr-½%Mo and 1¼% Cr-½%Mo steel plates intended primarily for Pressure Vessels/heat exchangers. The steel plates shall meet the requirements of ASME Boiler and Pressure Vessels Code Section II. This specification is intended to supplement the minimum applicable requirements of the material specification.
- 1.2 Following codes, standards etc. shall be followed in their latest edition and addenda, errata, amendments unless specified otherwise:
  - 1.2.1 ASME Sec II, Part A
  - 1.2.2 EN 10163: Delivery Requirements for Surface Conditions.
  - 1.2.3 EN 10204: Metallic products – Types of Inspection Documents
  - 1.2.4 API RP 934-C
  - 1.2.5 API RP 934-E

## 2.0 GENERAL

- 2.1 Plates supplied to this specification shall conform to specification SA-20 with additional requirements mentioned herein.
- 2.2 The tolerance on thickness of steel plates shall be positive only.
- 2.3 Final Rolling shall be lengthwise.
- 2.4 The plates shall be free from injurious defects and shall have workmanlike finish. Reconditioning/repair of plates by welding shall not be permitted. Surface conditions shall meet requirements of EN 10163 Class A sub-Class-3.

## 3.0 SUPPLEMENTARY TECHNICAL REQUIREMENTS

- 3.1 Plates shall be supplied in Normalized and Tempered condition unless otherwise specified. Alternatively accelerated cooling from an austenitizing temperature by liquid quenching followed by tempering is also acceptable (N + ACC. + T)
- 3.2 One product analysis for each plate shall be carried out. Chemical composition shall be as per applicable material specification with additional requirement of phosphorus equal to 0.01% maximum and phosphorus plus tin equal to 0.016% maximum.

### 3.3 Ultrasonic Examination of Plates

Plates shall be ultrasonically examined after specified heat treatment as per following:

- a. Plates having thickness 16 mm to 50 mm (both inclusive) shall be examined ultrasonically as per SA-435.
  - b. For thicknesses above 50mm ultrasonic examination shall be carried out as per SA-578 and shall have acceptance standard of level-B.
- 3.4 Charpy V-notch impact test shall be carried out for each plate at (-) 18°C with average value of three specimens as 33 joules with minimum value of each specimen as 22 joules.

### 3.5 Simulated Heat Treatment on Test Coupons

All test specimen's representative of heat treated plates shall be subjected to simulated heat treatments before the specified mechanical tests like tensile, impact etc. and these details shall be recorded on the test certificates. Simulated heat treatments shall include all heat treatments involved during fabrication of the equipment (including intermediate stress-relief etc.) and final PWHT plus two additional PWHT cycles (One for repair at shop and another for future). Impact tests and hardness tests shall be carried out in both minimum and maximum heat treatment condition while other mechanical tests (tensile etc.) shall be conducted at maximum heat treatment condition.

Note: Tempering temperature shall be minimum 20°C higher than the final PWHT temperature.

### 3.6 Additional Requirements for High Thickness Plates

Plates of thickness 50mm and above shall meet the following additional requirements:

- a) Vacuum treatment as per supplementary requirement S1 of specification SA-20.
- b) Through thickness tensile test shall be carried out as per specification SA-770 for each plate and reduction of area shall be determined as per SA-370. Minimum reduction in area shall not be less than 35%.

3.7 If specified in the Material Requisition, each plate shall meet the requirements of Indian Boiler Regulation (IBR).

3.8 Hardness of plates shall be complied as per EIL Std. spec. 6-15-0091.

### 4.0 CERTIFIED DOCUMENTS

The supplier shall furnish certificates/documents (number of copies as specified in the requisition) inclusive of all the following tests required as per specification duly certified by the Inspecting Authority before shipment of plates. The actual values obtained shall be recorded in the test certificates/documents. Material certificates shall conform to EN 10204 Type 3.1/3.2 as required.

- a. Chemical Analysis
- b. Mechanical Tests
- c. Data of heat treatment i.e. initial temperature, heating rate, soaking temperature and cooling rate etc.
- d. Simulated Heat Treatment of Mechanical Test Coupons (S3 of SA-20/SA 20M) at indicated Heat Treatment cycle only.
- e. Ultrasonic Examination (S8 or S12 of SA-20/ SA-20M)
- f. Charpy V-notch impact test (S5 of SA 20/ SA-20M)
- g. Through thickness tensile test as per SA-770
- h. Certification as per IBR (If specified in the requisition)

### 5.0 PAINTING AND COATING



No painting of any kind is permitted on the steel plates. However, steel plates shall be carefully protected and packed against any damage during transit and shall be of sea-worthy condition.

## 6.0 INSPECTION AUTHORITY

Material test certificates, duly certified by Mill's Quality Assurance Department are acceptable i.e. 3.1 certification as per EN 10204. However, if third party inspection is specified in material requisition, all test certificates and documents shall be duly certified by the third party i.e. 3.2 certifications as per EN 10204.

# स्टेनलैस स्टील प्लेटों का मानक विनिर्देश

## STANDARD SPECIFICATION FOR STAINLESS STEEL PLATES

9	29.05.2023	REVISED AND REISSUED AS STD. SPEC.	 NSK	TK	NK	 SM
8	22.09.2017	REVISED AND REISSUED AS STD. SPEC.	RNK	SK/KJH	RKT	RN
7	30.06.2010	REVISED AND REISSUED AS STD. SPEC.	KA	RKT	AKM/DM	N.DUARI
6	25.09.09	REVISED AND REISSUED AS STD. SPEC.	VB	RKG	AKM	N.DUARI
5	16.04.04	REVISED AND REISSUED AS STD. SPEC.	DNN	AKM	SSA	SKG
Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convener	Standards Bureau Chairman
						Approved by

**Abbreviations:**

ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing & Materials
EN	European Standard
BHN	Brinell Hardness Number
SS	Stainless Steel

**Static Equipment Standards Committee**

**Convenor :** Mr. Nalin Kumar

**Members :**

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5.0	PAINTING AND COATING.....	5
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## 1.0 SCOPE

- 1.1 This specification covers requirements for chromium, chromium-nickel and chromium-manganese-nickel stainless and heat resisting steel plates intended primarily for pressure vessels/heat exchangers. The steel plates shall meet the requirements of ASME Boiler and Pressure Vessel Code Section II (latest). This is intended to supplement the minimum applicable requirements of the material specification indicated in the material requisition.
- 1.2 Following codes, standards etc. shall be followed in their latest edition and addenda, errata, amendments unless specified otherwise:
- 1.2.1 ASME Sec II Part A.
- 1.2.2 EN10163 (All parts): Delivery Requirements for Surface Conditions.
- 1.2.3 EN 10204: Metallic products- Types of Inspection Documents.

## 2.0 GENERAL

- 2.1 Plates supplied to this specification shall conform to specification SA-480 with additional requirements mentioned herein.
- 2.2 Adequate tolerance shall be considered on Plate length and width for shear and plasma cutting. The tolerance on thickness of plates shall be positive only.
- 2.3 Final Rolling shall be lengthwise.
- 2.4 Plates shall have no. 1 finish on both sides with reference to SA-480. Cold Rolled plates, if permitted by Requisition, shall have no. 2B finish. Repair/reconditioning of plates shall not be permitted.

## 3.0 SUPPLEMENTARY TECHNICAL REQUIREMENTS

- 3.1 All plates shall be supplied in hot-rolled, fully annealed and pickled condition. All stabilized grades of Stainless Steel (SS 321, SS 347etc.) shall be given stabilization heat treatment in addition to solution annealing. The soaking temperatures for stabilization heat treatment shall be  $915^{\circ}\text{C} \pm 10^{\circ}\text{C}$  and soaking period shall be minimum of 4 hours (2 hours for thickness  $\leq 3.5\text{mm}$ ).
- 3.2 Unless specified otherwise in material requisition, plate representative of each heat shall be subjected to intergranular corrosion tests as per ASTM A-262 Practice E for all the 300 series materials. The bend test specimen shall be examined at a magnification of 200 x; and bent specimen shall be free of any cracks or grain dropping.
- 3.3 For straight chrome (13% Cr) material, maximum carbon content shall not exceed 0.06%. Hardness of UNS no. S41000, S41008 and S40500 shall be less than 241 BHN unless otherwise specified in the ASME BPV Section II, material specification.
- 3.4 a. Plate having thickness 16 mm to 50 mm (both inclusive) shall be examined ultrasonically as per SA-435.
- b. For thickness above 50mm ultrasonic examination shall be carried out as per SA-578 and shall have acceptance standard of level-B.
- 3.5 All mandatory tests as per material specification shall be carried out. However tension test specimen shall be from finished material and shall be selected in transverse direction.

#### **4.0 CERTIFIED DOCUMENTS**

The supplier shall furnish certificates/documents (number of copies as specified in requisition) inclusive of all the following tests required as per specification duly certified by the Inspecting Authority before shipment of plates. The actual values obtained shall be recorded in the test certificates/documents. Material certificates shall conform to EN 10204 Type 3.1/3.2 as required.

- a. Chemical Analysis
- b. Mechanical Tests
- c. Data of heat treatment i.e. initial temperature, heating rate, soaking temperature, cooling rate, etc.
- d. Ultrasonic Examination
- e. Intergranular corrosion test for 300 series
- f. Intergranular corrosion test for series other than 300 (whenever specified in the requisition)
- g. Type of finish for plate surfaces

#### **5.0 PAINTING AND COATING**

Plates are not to be painted/coated but shall be covered with plastic foils or paper or by other means for careful protection and shall be packed against any damage during transit and sea-weather conditions.

#### **6.0 INSPECTION AUTHORITY**

Material test certificates, duly certified by Mill's Quality Assurance Department are acceptable i.e. 3.1 certification as per EN 10204. However, as specified, if third party inspection is required specifically for plates, all test certificates and documents shall be duly certified by the third party. i.e. 3.2 certification as per EN 10204.

# कॉलम में पैकिंग भराई के लिए मानक विनिर्देश

## STANDARD SPECIFICATION FOR FILLING THE PACKING INSIDE THE COLUMN

6	10-03-23	REVISED AND REISSUED AS STANDARD SPECIFICATION	<i>Jeewan</i> JA	<i>AK</i>	<i>Nalin</i> NK	<i>SM</i> SM
5	25-09-17	REAFFIRMED AND REISSUED AS STANDARD SPECIFICATION	SK / IK	KJHN	RKT	RN
4	06-09-10	REVISED AND ISSUED AS STANDARD SPECIFICATION	HD	SKM	AKG	ND
3	24-09-09	REAFFIRMED AND REISSUED AS STANDARD SPECIFICATION	SB	SKM/HCN	AKG	ND
Rev. No	Date	Purpose	Prepared by	Checked by	Approved by Standards Committee Convenor      Standards Bureau Chairman	



**Abbreviations:**

CMR	:	Cascade Mini-Ring
EIC	:	Engineer In Charge
IMTP	:	Intalox Metal Tower Packing

**SMED-I (Mass Transfer Mechanical & Systems) Standards Committee**

**Convenor:** Mr. Nalin Kumar

**Members:** Mr. Arun Kumar  
Mr. Inder Kumar  
Mr. P Barik  
Mr. Pankaj Gandhi  
Mr. Jeevan Agrawal – (Coordinator)  
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## 1.0 GENERAL

The purpose of this specification is to provide guidelines for filling tower packing in the column in a satisfactory manner. The tower packing in a column are either 'stacked' or 'dumped' depending on the Size and Material of Construction of tower packing and the requirements specified in the applicable drawing. Metal Packing such as IMTP (in all sizes), Hypak Rings, Pall Rings, Raschig Rings, CMR, Nutter Rings, Berl Saddles and other type of random packing upto and including 75 mm sizes, shall be normally 'dumped' in the column. When specified in the drawing, Metal tower packing above 75 mm sizes are 'stacked' in the column. Ceramic or Carbon tower packing shall be 'Stacked'. Wherever stacking is not feasible, same shall be "Dumped Wet" only in consultation with EIC.

## 2.0 DUMPED TOWER PACKING

2.1 Ensure that the support plate for the tower packing is properly installed prior to dumping the tower packing in the column.

2.2 Ensure that hand-holes (if provided) have been closed before filling the packing in the column.

2.3 Tower packing can be dumped in column in wet or dry condition. It is normally adequate to fill the packing inside the column in "Dry" condition. However, if specified to fill the packing inside the column in wet condition, ensure that at least 1.0 meter of water level is maintained above the surface of the packed bed at all times and preferably, the water level should be upto bottom of the loading manhole.

2.4 The first lot of tower packing should be carefully and slowly dumped on support plate and leveled by hand while standing on the support plate. The support plate is to be covered to a depth of 200-300 mm by this method. This assures that tower packing will not get damaged by dropping directly onto the support plate. Ensure that the assembly of support plate is satisfactory and no tower packing are falling from the support plate.

2.5 Build a trap bucket-chute construction as per Sketch 2.1 for dumping the packing in the column. While dumping the packing in the columns having diameter larger than 1400 mm, chute and sock must be moved periodically to various areas of the column as shown in Sketch 2.2 & 2.2.1 to prevent the tower packing from piling up in a particular area. The sock should be repositioned after 0.5 m<sup>3</sup> of tower packing is dumped at a position. The distance between the lower end of the sock and top of tower packing should be at least 600 mm but not more than 2000 mm for metal & plastic tower packing.

However, while dumping the packing in the columns having diameter upto 1400 mm, it is not necessary to move the chute and sock periodically to various positions in the horizontal area of the column. But ensure that the sock is located along the vertical centerline of the column as shown in Sketch 2.2 & 2.2.2. If distance between loading manway and support plate is 3.0 meter or less, tower packing can be dumped without sock.

While filling the tower packings, if distance between top of packing and bottom of loading manhole reaches 2.4 meter or less, then metal tower packing may be dumped after removing the sock from chute.

### NOTE:

For large diameter columns, it may require more than one chute with different lengths to reach across the column.

2.6 As tower packing height reaches the final elevation, tower packing shall be leveled carefully. Level off the top of packed bed by lightly tramping on the wooden plank of size 1.2 meter x 0.4 meter (Ensure that wooden plank is removed from column immediately after

the use). In case a bed limiter exists, the top of tower packing shall be in level with the bottom of bed limiter. Add tower packing until this is accomplished.

It shall be ensured that tower packing are touching bed limiter and there shall not be any void between the tower packing and bed limiter.

- 2.7 Ensure that the bed limiter for tower packing is properly installed above top of the packing and packings are not coming out from the bed limiter. In case, packings are coming out from the bed limiter, then bed limiter needs to be modified in order to hold the packing appropriately.

### 3.0 STACKED TOWER PACKING

- 3.1 For Ceramic, Carbon Tower packing and Metal Tower Packing requiring stacking, same shall be stacked vertically as shown in Sketch 3.1 with each layer of rings staggered to each other. As an alternate, Ceramic and Carbon Tower Packing, if feasible, can also be "Dumped Wet" as per procedure given in Para 2.3 above, after obtaining concurrence from EIC.

### 4.0 GENERAL NOTES

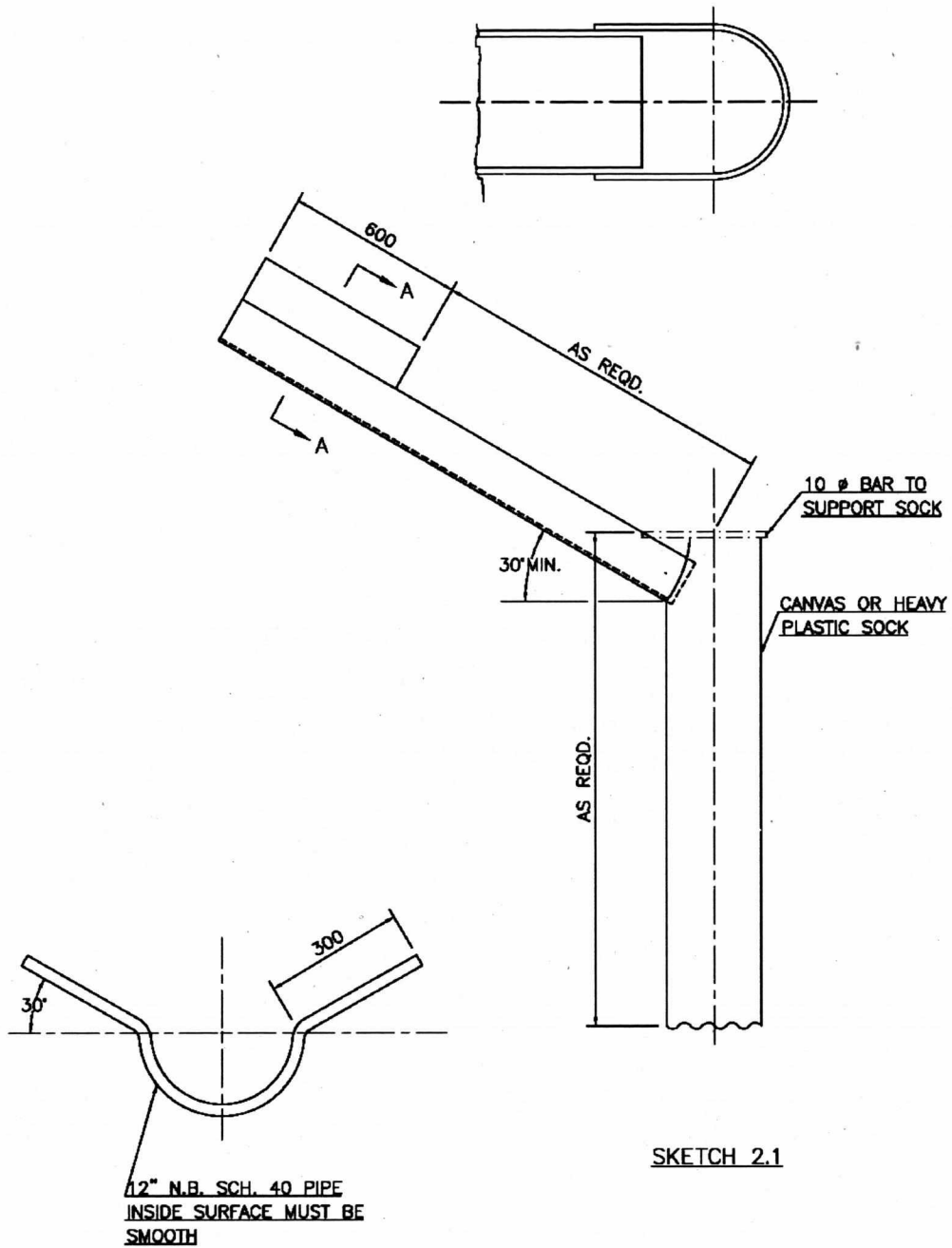
- 4.1 It shall be ensured that the top of the tower packing is reasonably horizontal (level) as the bed is being packed, so that the bed inclination is not more than 30° from horizontal at any given point of time. This normally requires, positioning the sock/chute within no more than 1.5 meter from previous positions.

- 4.2 Make sure that foreign materials such as grease and lubricants are removed from the tower packing prior to their installation in the column. Also ensure that boards, boxes, ladders etc. are not buried and left in the column. Such objects will cause excessive pressure drop and maldistribution of gas and liquid resulting in malfunctioning of the column.

- 4.3 As far as possible, walking on or excessive handling of tower packing should be avoided. It is best to place sections of the bed limiter (when used) into the column and stand on these sections while the bed limiter is assembled. If it becomes necessary to step directly on packed bed, it must be done only on a wooden plank of minimum size 0.8 meter x 0.4 meter to ensure that there is no damage to tower packing. Do not jump over the bed. Wooden plank, polythene, jute/woven socks etc. should not be left in the packed bed.

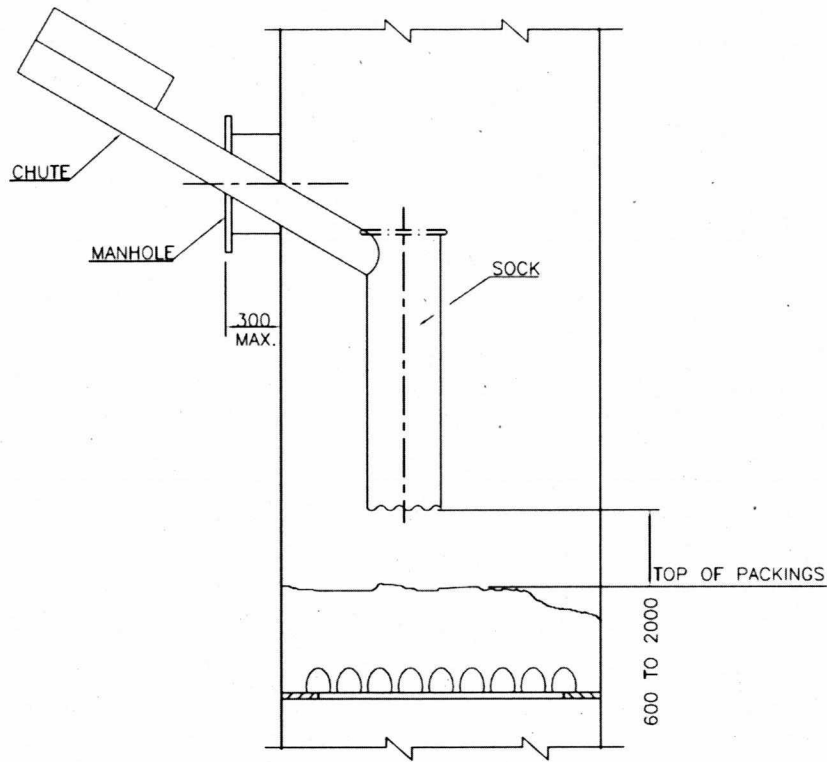
#### 4.4 Caution

If tower packing are dropped from an excessive distance and/or are directly walked on, the amount of tower packing required to fill the bed will increase. This may result in poor performance of the column and shortage of tower packing. Maintain record of quantity of tower packing dumped in individual beds of column.

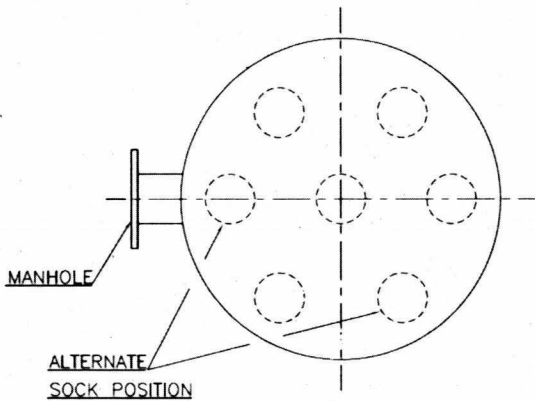


SKETCH 2.1

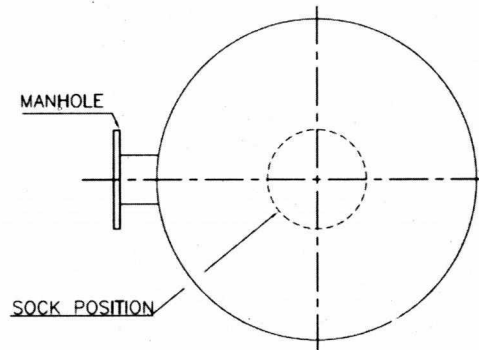
SECTION-AA



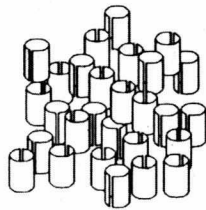
SKETCH 2.2



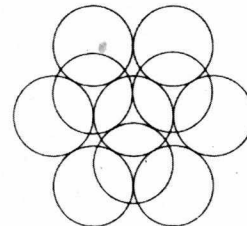
PLAN VIEW FOR COLUMNS ABOVE 1400 DIA.  
(SKETCH 2.2.1)



PLAN VIEW FOR COLUMNS UPTO 1400 DIA.  
(SKETCH 2.2.2)



SKETCH 3.1



PLAN VIEW OF SKETCH 3.1

स्टैटिक ईक्विपमेंट (प्रेशर वैसल्स हीट  
एक्सचेन्जर्स) के  
आवश्यक कठोरता के लिए  
मानक विनिर्देश

STANDARD SPECIFICATION  
FOR  
HARDNESS REQUIREMENT  
OF  
STATIC EQUIPMENT

5	24.03.25	REVISED & REISSUED AS STD. SPEC.	BVK	TKh	KA/NK	MN
4	27.12.19	REAFFIRMED & REISSUED AS STD. SPEC.	PKP	NSK	KJH	RKT
3	05.11.14	REVISED & REISSUED AS STD. SPEC.	TK	KA	RKT	SC
2	29.06.09	REAFFIRMED & REISSUED AS STD. SPEC.	VB	RKG	AKM	N.DUARI
1	26.03.04	REAFFIRMED AND REISSUED AS STANDARD SPECIFICATION	NSK	PK	SSA	SKG
0	15.03.96	ISSUED AS STANDARD SPECIFICATION	RV	SSA	RKA	AS
Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
Approved by						

**Abbreviations:**

ASTM	:	American Society for Testing & Materials
BHN	:	Brinell Hardness Number
HAZ	:	Heat Affected Zone
PWHT	:	Post Weld Heat Treatment

**Static Equipment Standards Committee**

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## 1.0 SCOPE

This specification covers general requirement of hardness of base metal, weld and heat-affected-zone (HAZ) and is applicable to all C-½ Mo, Cr-Mo steels and other materials whenever asked for in drawings/ specifications/standards. All testing shall be done after PWHT.

## 2.0 HARDNESS REQUIREMENTS

Hardness in base metals, weld and heat affected zone as per ASTM E10 shall not exceed the following:

For P1 materials	- 200 BHN
For P3 & P4 materials	- 225 BHN
For P5 & P6 materials	- 235 BHN

## 3.0 WELDING QUALIFICATION TEST

3.1. For each welding procedure qualification nine tests shall be made, three in base metal, three in weld metal and three in HAZ. Hardness requirements shall be as per cl. 2.0 above.

3.2. In addition to the requirement of 3.1 above, Vickers Micro hardness test shall be made on a full cross-section at 25 mm intervals beginning at 3 mm from the top surface with 5 kg load or with a load approved by the authorized inspector. Tests shall be made at each level for each of the following locations as per ASTM E 92:

Three tests shall be made in the weld metals, two tests in HAZ and one test in the base metal in accordance with Fig.1 and the hardness shall not exceed the following in base metal, weld metal and HAZ.

For P1 materials	- 210 VHN
For P3 & P4 materials	- 237 VHN
For P5 & P6 materials	- 247 VHN

## 4.0 PRODUCTION TEST

4.1 All pressure containing weld metals are to be checked for hardness of weld and HAZ after PWHT but before hydro-test. The hardness shall not exceed the value stipulated.

4.2 Each longitudinal seam shall be checked both internally and externally near the center and at one end.

4.3 Each circumferential weld shall be checked at four locations approximately 90° apart, both internally and externally.

4.4 Each nozzle weldments shall be checked at two locations, 180° apart, both internally and externally.

4.5 Above hardness readings shall be taken at minimum 3-4 locations inside as well as outside covering the entire seam, to the satisfaction of inspector.

## 5.0 APPROVAL

In case the hardness as obtained on production test is more than the limit specified in 2.0 above, the vendor shall submit the corrective procedure to lower the hardness in writing to EIL and/or authorized inspection agency for review/approval.

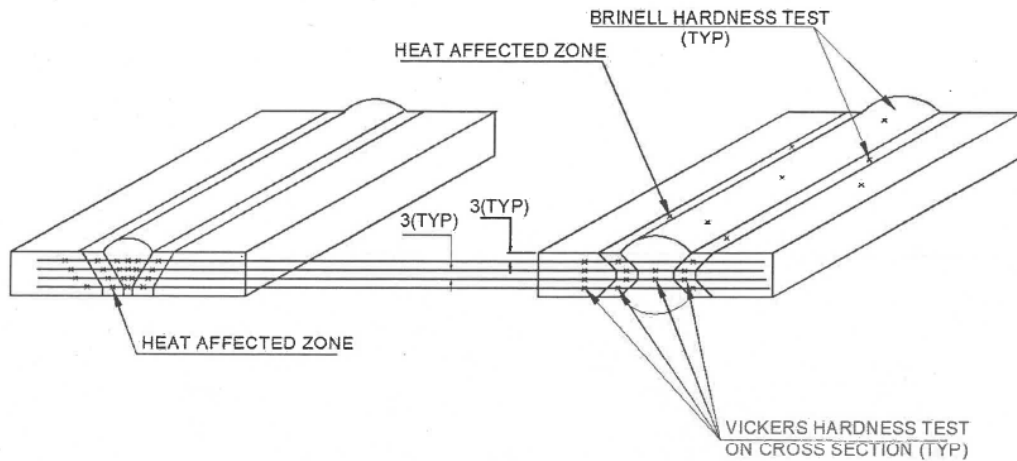

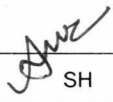



FIG.1- HARDNESS REQUIREMENT ON TEST COUPONS

वाष्प अनुमार्गन हेतु  
मानक विनिर्देश

STANDARD SPECIFICATION FOR  
STEAM TRACING

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**Abbreviations:**

A/G	-	Above Ground
B/L	-	Battery Limit
BOP	-	Bottom of Pipe
GAD	-	General Arrangement Drawing
IBR	-	Indian Boiler Regulations
NB	-	Nominal Bore
P&ID	-	Piping and Instrumentation Diagram
PSIG	-	Pounds Per Square Inch
PVC	-	Poly Vinyl Chloride
SH	-	Steam High Pressure
SL	-	Steam Low Pressure
SM	-	Steam Medium Pressure
SWG	-	Standard Wire Gauge

**Piping Standards Committee**

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## 1.0 PURPOSE

The purpose of steam tracing is to prevent the fall in process fluid temperature and maintain the same throughout the length of the line. Constant temperature maintenance helps in the free flow of fluid and its pumpability. Generally the Piping requiring steam tracing are indicated in P&IDs and line schedule, while size and number of tracers shall be provided according to this specification.

## 2.0 SCOPE

This specification outlines the requirements to be met in the design and installation of steam tracers for piping.

- Type of Steam (i.e. SL, SM or SH etc.) for tracing shall be as specified in the line schedule. The steam temperature shall be saturation temperature of the steam at a given pressure.
- Requirement for condensate return (i.e. open system or closed system & pressure in case of closed system) shall be obtained from process package.
- Size of Bought-out supply and return manifolds with inbuilt piston valves shall be 1.5" unless otherwise specified. The condensate return manifold shall be with pipe line connector having inbuilt trap and glandless piston type drain valve for upstream isolation and trap bypass. The trap shall be thermostatic type.
- Site fabricated supply & return manifold header shall be 3" NB unless otherwise specified.
- Size of tracer shall be ½" NB unless specified otherwise in the process package.
- Size of supply sub-header from Steam header & return sub-header to Condensate header shall be 1½" NB.
- Size of tracer supply & return lead lines shall be ½" pre-insulated tubing with adapters at both ends unless specified otherwise in the Job Engineering Design Basis (Piping).

Exceptions or variations covered in the process package shall take precedence over requirements covered herein.

## 3.0 REFERENCES

Standard Specification for Hot Insulation of Vessels, Piping and Equipment 6-79-0026; Latest editions of the specifications(s) referred shall be followed.

## 4.0 METHODOLOGY

### 4.1 Source of Steam Supply

Steam supply for tracing can be obtained from steam headers, independent steam supply sub-header or exhaust / bleed steam from other continuous steam users. In any case the steam tracers should always get steam even if process unit is out of operation. As far as practicable, steam supply manifold shall be laid such that lines requiring steam tracing are at minimum distance from the manifold.

### 4.2 Material

As per 'Piping Material Specification'.

### 4.3 Regulations

The IBR limit is shown in Annexure-1, Page 3 of 5 and Annexure-2, Page 3 of 6.

#### 4.4 Procedure for Preparation of Steam Tracing Installation Drawings & Use of Steam Tracing Standards:

Steam tracing installation drawings shall be prepared in accordance with the standards as per following procedure.

- 4.4.1 The numbering of steam supply and condensate return manifolds shall be as per Annexure -1, Page 3 of 5.
- 4.4.2 Steam supply sub-headers, steam supply manifolds, condensate sub-headers and condensate recovery manifolds shall be located on piping GADs of Units and Offsites.
- 4.4.3 Details of steam supply and condensate return manifolds shall be prepared. These details will indicate among other details, the size and number of various supply and return leads to and from the designated steam traced lines, as given in chart-I of Annexure-1, Page 3 of 5 and chart-I of Annexure-2, Page 3 of 6.

#### 4.5 List of Specifications to be used for Steam Tracing

##### 4.5.1 For Site Fabricated Manifolds

- |    |   |                        |
|----|---|------------------------|
| a) | Steam supply manifolds  | Annexure-1 Page 1 of 5 |
| b) | Condensate recovery manifolds   | Annexure-1 Page 2 of 5 |
| c) | Typical diagram   | Annexure-1 Page 3 of 5 |
| d) | Details of tracer arrangement   | Annexure-3 Page 1 of 3 |
| e) | Position of tracers w.r.t. pipes and tracer arrangement around valves & flanges | Annexure-3 Page 2 of 3 |
| f) | Typical tracing arrangement in Offsites - plan                                  | Annexure-1 Page 4 of 5 |
| g) | Typical tracing arrangement in Offsites - elevation                             | Annexure-1 Page 5 of 5 |
| h) | Typical tracing arrangement in Units.   | Annexure-3 Page 3 of 3 |

##### 4.5.2 For Bought-out Manifolds

- |    |   |                        |
|----|---|------------------------|
| a) | Steam supply manifolds  | Annexure-2 Page 1 of 6 |
| b) | Condensate recovery manifolds   | Annexure-2 Page 2 of 6 |
| c) | Typical diagram   | Annexure-2 Page 3 of 6 |
| d) | Typical diagram   | Annexure-2 Page 4 of 6 |
| e) | Details of tracer arrangement   | Annexure-3 Page 1 of 3 |
| f) | Position of tracers w.r.t. pipes and tracer arrangement around valves & flanges | Annexure-3 Page 2 of 3 |
| g) | Typical tracing arrangement in Offsites - plan                                  | Annexure-2 Page 5 of 6 |
| h) | Typical tracing arrangement in Offsites - elevation                             | Annexure-2 Page 6 of 6 |
| i) | Typical tracing arrangement in Units.   | Annexure-3 Page 3 of 3 |

- 4.5.3 For Steam tracing insulation 6-79-0026

#### 4.6 Design & Installation:

Design and installation of steam tracing system for piping shall be as detailed. Site fabricated bends shall be used in place of forged elbows except near steam supply and condensate return manifolds. However, in case of pre-insulated tubing, only site fabricated bends with approved bending tool shall be used. Bought-out manifolds with inbuilt glandless piston valves shall be used unless otherwise specified.

#### 4.6.1 Steam Supply Sub Headers

4.6.1.1 The layout of steam supply sub-header and supply manifold shall be arranged to minimize length of supply lead lines.

4.6.1.2 Isolation valve in the sub-headers shall be of Globe type.

4.6.1.3 Y-Type Strainer of 40 mesh size as per applicable piping class shall be provided in the steam supply sub header. Strainer shall be located between Isolation Valve and supply manifold.

4.6.1.4 Where single tracer is used directly from steam main, strainer in supply sub header shall not be provided.

#### 4.6.2 Steam Supply Manifold

Location of manifolds shall be planned to minimize the length of the supply leads served by it. Manifold shall be provided when three or more tracers are required. Length of supply lead shall not exceed 15 mtrs. Supply manifold shall generally be located on pipe rack or technological structure.

#### 4.6.3 Supply & Return Leads

The routing shall be by field for minimum length of run avoiding interferences. Clearances and maintenance joints shall be provided for operation & maintenance.

#### 4.6.4 Tracers

##### 4.6.4.1 Sizing:

Unless otherwise specified in the process package the size and number of tracers shall be as listed below:

Traced line size	No. of ½" NB tracers
4" NB & smaller	1
6" NB to 16" NB	2
18" NB & larger	3

4.6.4.2 Useful length of tracers: Following shall be used for maintaining length of ½"tracer in open and closed systems (excluding supply and return lead lines).

Operating pressure (PSIG)	20	50	100	150	200	250	300&above
Tracing Length (meters)	23.0	38.0	46.0	53.0	61.0	69.0	76.0

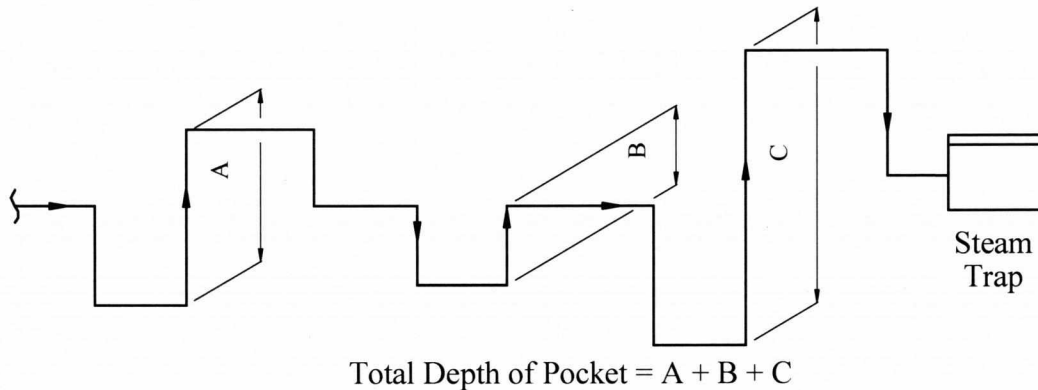
##### 4.6.4.3 Installation

a) The tracers shall be held in position by three turns of 16 SWG soft annealed galvanized iron wire spaced every one meter.

b) Whenever there is a single line to be traced, steam supply and return manifolds need not be used. In such cases, the steam supply line maybe tapped from the nearby steam header/sub header and routed along the line to be traced. At the end of the tracer run, these tracers can be drained by separate steam trapping assembly, in case Condensate return manifold is not available.

- c) The position of tracers around traced pipe shall be as per Annexure-3, Page 1&2 of 3.
- d) The tracers shall start at the highest point in a system in general. As far as possible tracers shall be routed with a continuous slope towards trap. Total pocket depth\* shall not exceed 850mm for 1.0 kg/cm<sup>2</sup> of differential pressure available (i.e. difference of pressure between upstream and down stream of the steam trap)

\* Tracer pocket depth is the distance the tracer rises in the direction of flow from a low point to high point. The total depth of pockets is the sum of all the pockets on the tracer and must not exceed the above given figure. The pocket should be considered from the point where the tracer starts its run along the traced pipe, up to the steam trap.



- e) Branch tracers to paired equipment and instruments to be provided with isolation valves and each branch to have its own trap. (See Annexure -3, Page 3 of 3)
- f) Tracer shall not be provided with low point drains.
- g) The tracers shall be laid so as not to interfere with the normal working, operation and maintenance of plant machinery.
- h) Wherever the traced piping is having flanged connections and traced piping needs to be disconnected for frequent maintenance, flushing etc., break flanges at suitable locations shall be provided on tracers. All flange connections provided on tracers shall be located outside the insulation.
- i) The installation shall be done to take care that the valves and steam traps on supply and return manifolds are easily approachable. Maximum 12 nos. of supply leads/return lines (including spares) are permitted per supply manifold/condensate return manifold.
- j) The steam supply lead lines should be routed together, as far as possible. In case of several tracers routed together, the spacing between individual tracers may be reduced to allow box type insulation. However the spacing will be adequate in all cases to permit good welding and individual clamping by U clamps, or other approved type of fastener.
- k) The tracers shall be anchored at the middle point of the tracer run and adequate free space shall be provided for the expansion of tracers at the free ends as shown in Annexure -3, Page 1 of 3.

#### 4.6.5 Steam Traps

- 4.6.5.1 Each tracer or each branch of a tracer that is split, (i.e. a tracer on suction line of a parallel pump installation) shall be separately trapped at the outlet end.
- 4.6.5.2 Steam tracing installation shall be installed so as to facilitate rapid and easy removal and replacement of traps, rather than permit emergency hand operation of the tracers, should trap become inoperable.
- 4.6.5.3 The trap discharge line shall have a block valve only if tied into a system into which more than one trap discharge.
- 4.6.5.4 For an open condensate system, locate traps so that condensate gets drained to S.S. avoiding hazard to personnel.
- 4.6.5.5 Thermostatic traps shall be used for systems wherein tracer steam design pressure is less than 21 Kg/cm<sup>2</sup>g. Traps shall be provided with inbuilt strainers.
- 4.6.5.6 The steam traps shall be hooked up as per Annexure -1, Page 2, 3, 4 & 5 of 5 and Annexure-2, Page 2, 3, 5 and 6 of 6. In case of Offsite piping, Annexure -1, Page 4 & 5 of 5 and Annexure-2, Page 5 & 6 of 6, give the typical arrangement for steam trap assemblies.

#### 4.6.6 Condensate Return System

##### 4.6.6.1 For Units:

Refer Process Design Basis(PDB). In case of recovery follow P&IDs / PDB and in case of non-recovery, route condensate to Storm Sewer outside B/L.

##### 4.6.6.2 For Offsites:

Discharge to ditches or other suitable location so as to cause no personnel hazard or excessive maintenance problem. In case no ditch is nearby, discharge as per note 6 on Annexure-1, Page 1 of 5.

#### 4.7 Supporting of Steam Tracing Systems

All the components of steam tracing system shall be adequately supported. One of the methods of supporting the supply and return manifolds has been indicated in Annexure-1, Page 5 of 5. The supply lead lines and condensate return lines should be routed together, as far as possible, with same BOP, so that they can be supported from common structural steel. In case of Pre-insulated tubing, the same shall be routed and supported as per recommendations of Supplier. To avoid undue deflection and vibration, the spacing of supports in horizontal or vertical runs should not exceed 2 meters. The tracer lines may be secured to structural members with U clamps.

#### 4.8 Testing

All tracers shall preferably be tested along with the steam piping to which they are connected. In cases where tracers are not tested with the feed steam piping, separate hydrostatic test shall be performed with test pressure of twice the design pressure. Hydrostatic test pressure shall be same for tracers falling within / outside IBR scope.

#### 4.9 Insulation

Insulation thickness, material and method of application shall be as specified in insulation standard / specification or Process Design Basis.

Composite box type insulation may be provided on the steam supply lead lines, in case they are routed together. Similarly, this may be provided for the return lines to manifolds after the run of tracers.

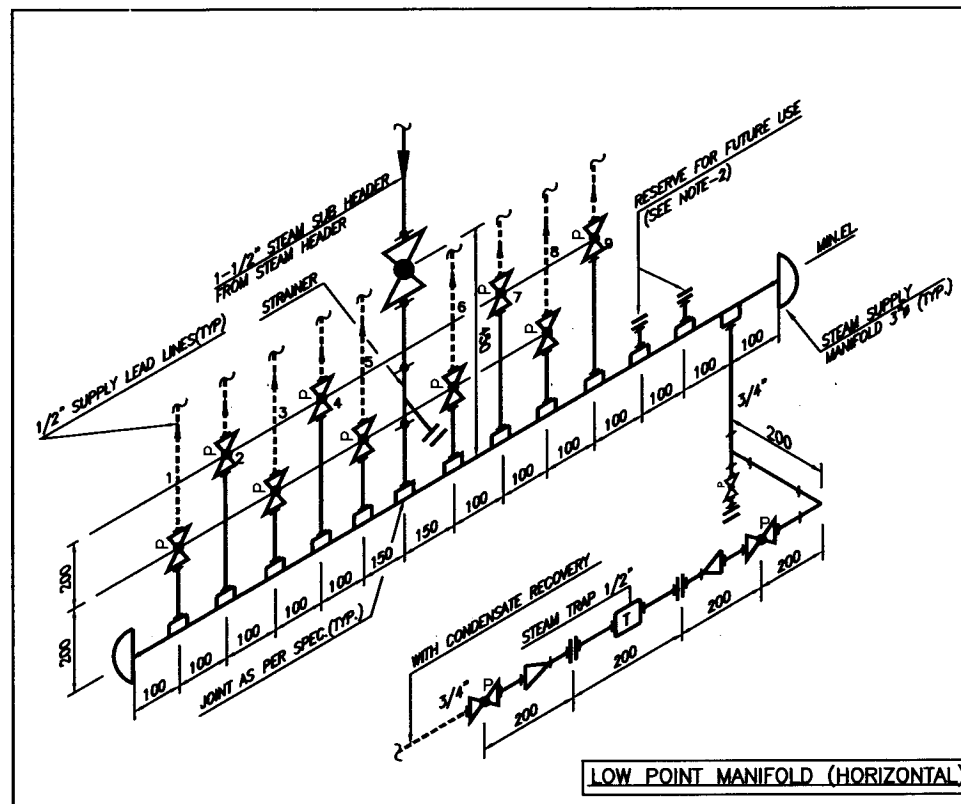
#### 4.10 Tracer Bonding With Heat Transfer Cement

In case of critical applications wherein medium pressure or high pressure steam is used for tracing, steam tracers shall be bonded using heat transfer cement.

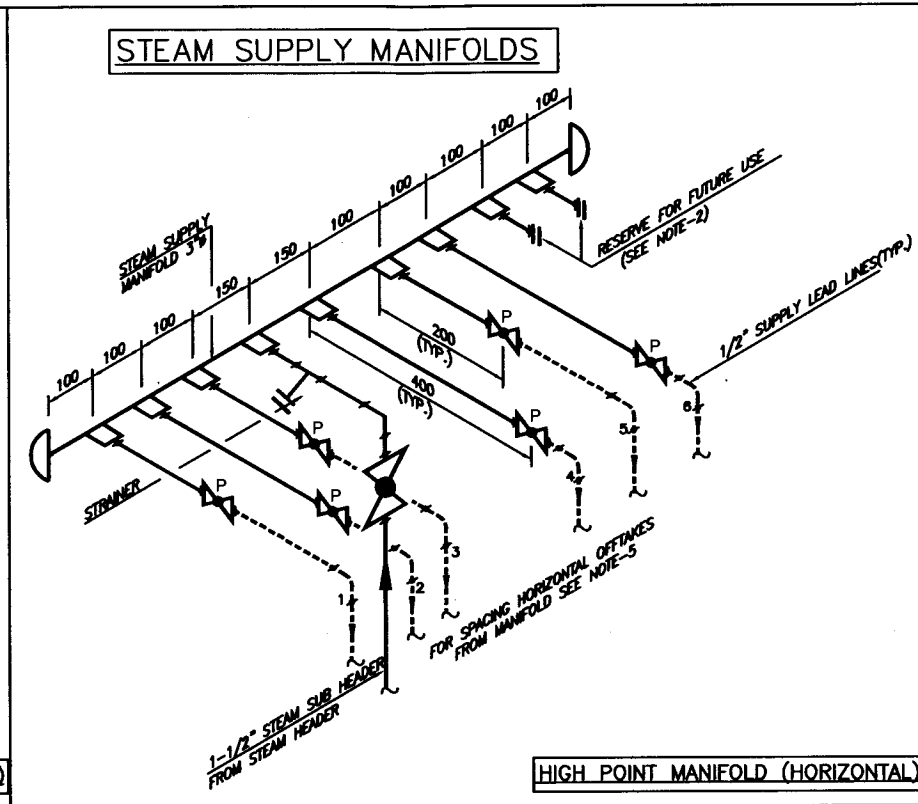
Expansion loop shall be provided on long bonded tracer lines at 9 meter intervals and at 90° turn. This is accomplished by extending the tracer line through the heat transfer cement and insulation, making loop and returning back to traced line.

#### 5.0 ATTACHMENTS

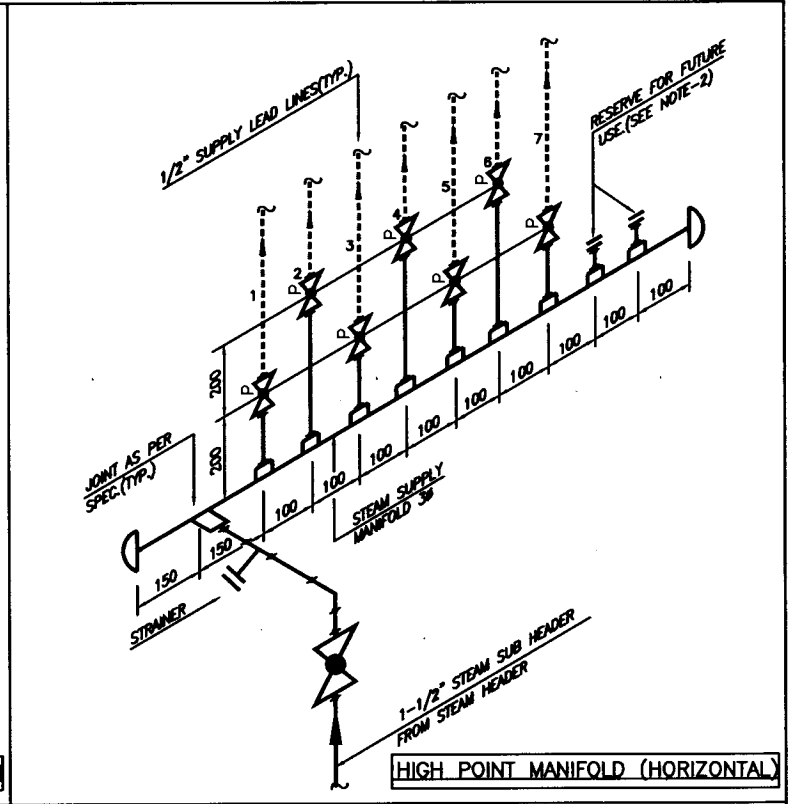
- |            |  |
|------------|--|
| Annexure-1 | Steam Tracing - Site Fabricated Manifolds (Typical Diagrams), 6-44-0007-A1 |
| Annexure-2 | Steam Tracing - Bought out Manifolds (Typical Diagrams), 6-44-0007-A2      |
| Annexure-3 | Steam Tracing – General Details (Typical Diagrams), 6-44-0007-A3           |



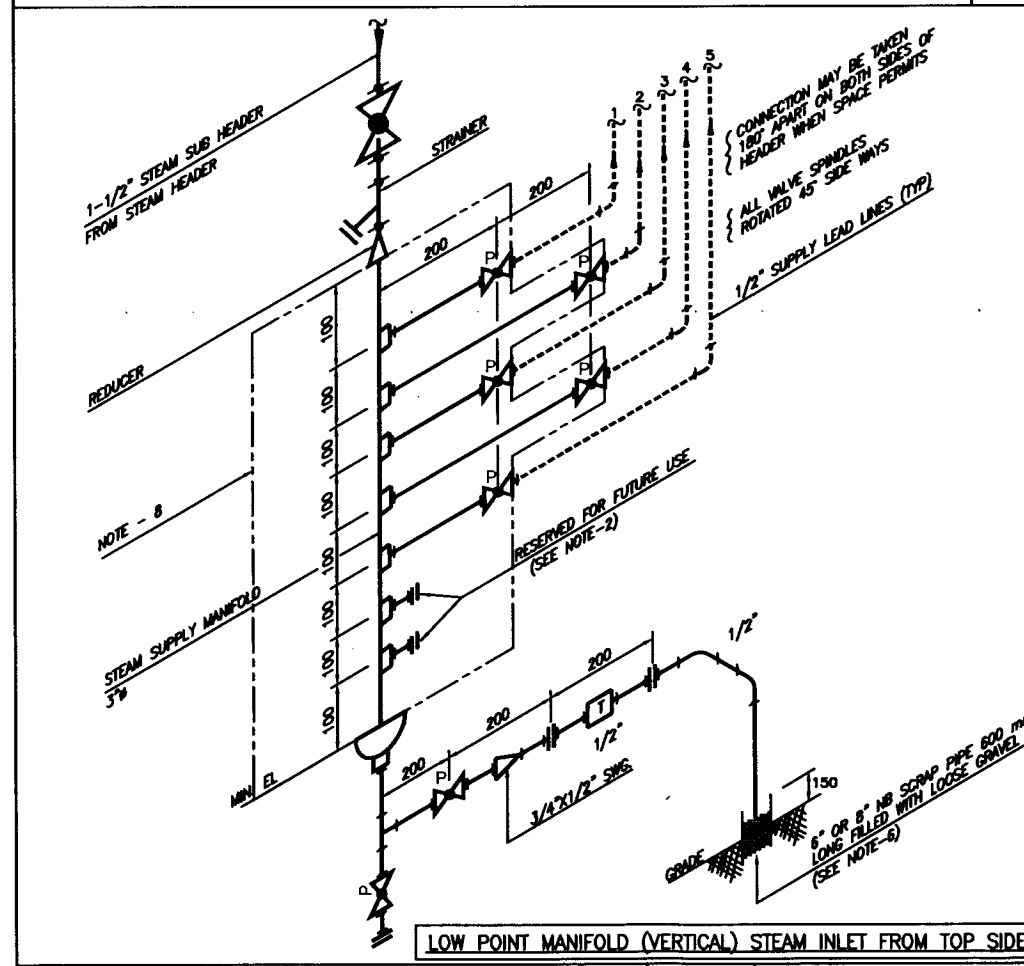
LOW POINT MANIFOLD (HORIZONTAL)



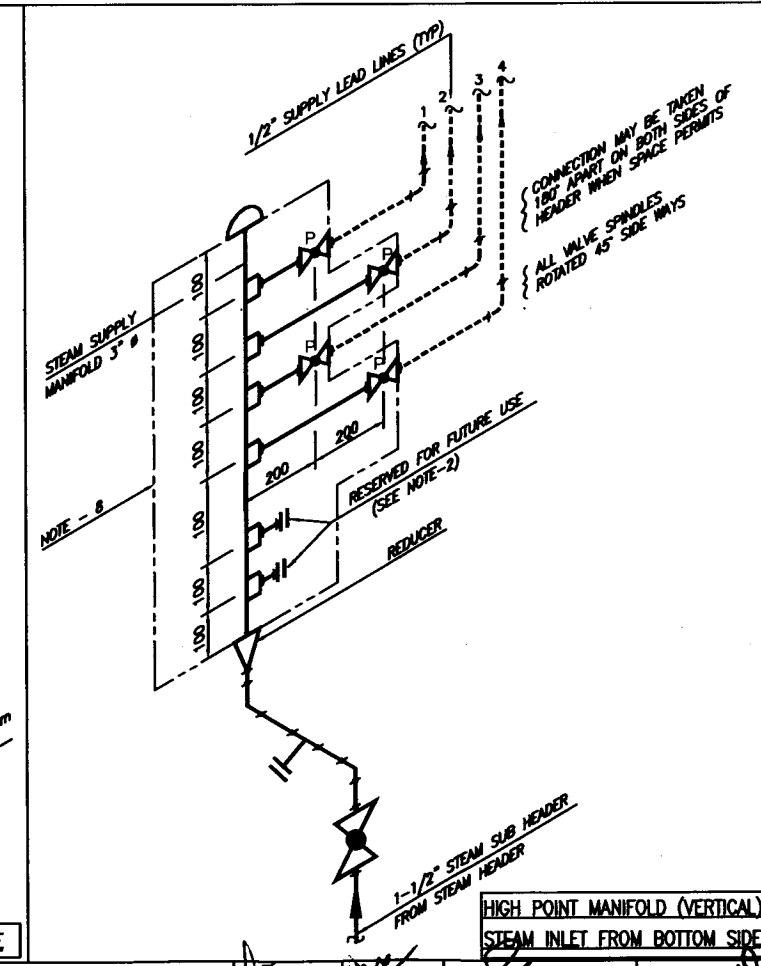
HIGH POINT MANIFOLD (HORIZONTAL)



HIGH POINT MANIFOLD (HORIZONTAL)



LOW POINT MANIFOLD (VERTICAL) STEAM INLET FROM TOP SIDE



HIGH POINT MANIFOLD (VERTICAL) STEAM INLET FROM BOTTOM SIDE

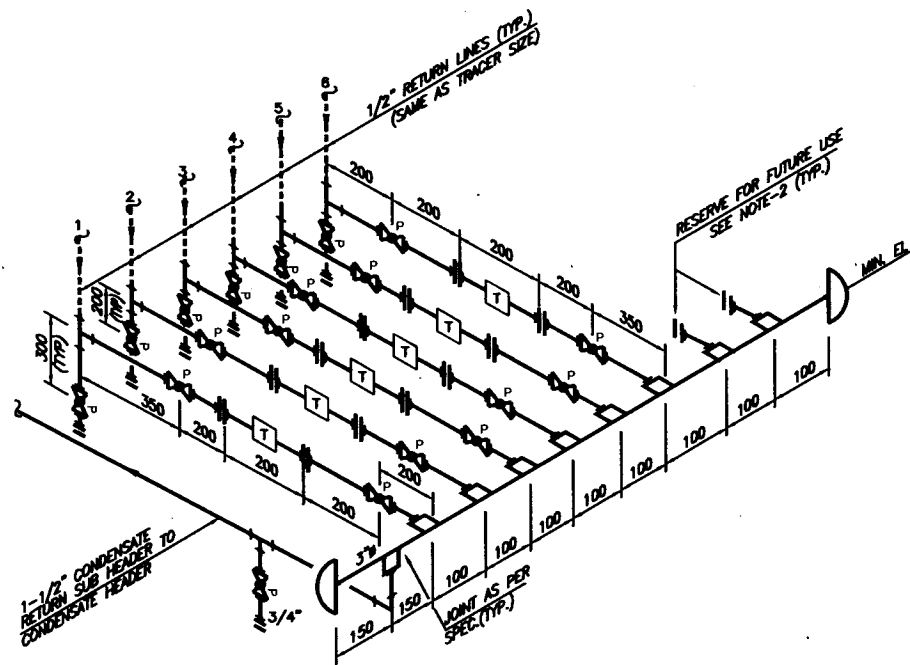
- NOTES :
1. ALL DIMENSIONS ARE IN mm UNLESS OTHERWISE NOTED.
  2. RESERVE APPROX. 20% OF TOTAL NUMBER OF TRACERS FOR FUTURE USE. (MINIMUM 2 NOS. OR AS DEFINED IN DESIGN BASIS)
  3. SIZE OF STEAM SUPPLY LEAD LINES SHALL BE 1/2" & SUPPLY SUB HEADERS SHALL BE 1-1/2".
  4. STEAM SUPPLY MANIFOLDS ARE TO BE NUMBERED. FOR DETAILS REFER PAGE 3 OF 5 OF THIS ANNEXURE.
  5. FOR HORIZONTAL OFFTAKES, SUFFICIENT OPERATING SPACE SHALL BE GIVEN FOR OPERATION OF VALVES
  6. SCRAP PIPE TO BE PROVIDED FOR OFFSITES FOR LOCATIONS WITH NO DITCHES NEARBY & AREAS WHICH ARE NOT PAVED. FOR UNITS & OTHER PAVED AREAS, PROVIDE DRAIN LINES TO CRWS / AG HEADER COLLECTING FUNNEL LOCATED NEAREST TO MANIFOLD.
  7. MAXIMUM 12 NOS. OF SUPPLY LEAD LINES (INCLUDING SPARES) ARE PERMITTED PER SUPPLY MANIFOLD.
  8. SITE FABRICATED MANIFOLD MAY BE SUBSTITUTED BY STANDARD BOUGHT OUT MANIFOLDS WITH GLANDLESS PISTON VALVES. MANIFOLDS CAN BE LOCATED IN HORIZONTAL ORIENTATION ALSO.
  9. MANIFOLD ISOLATION VALVE SHALL BE GLOBE VALVE. ALL OTHER VALVES SHALL BE GLANDLESS PISTON VALVES.
  10. MISSING DIMENSIONS TO BE FINALIZED DURING DETAILED ENGINEERING.



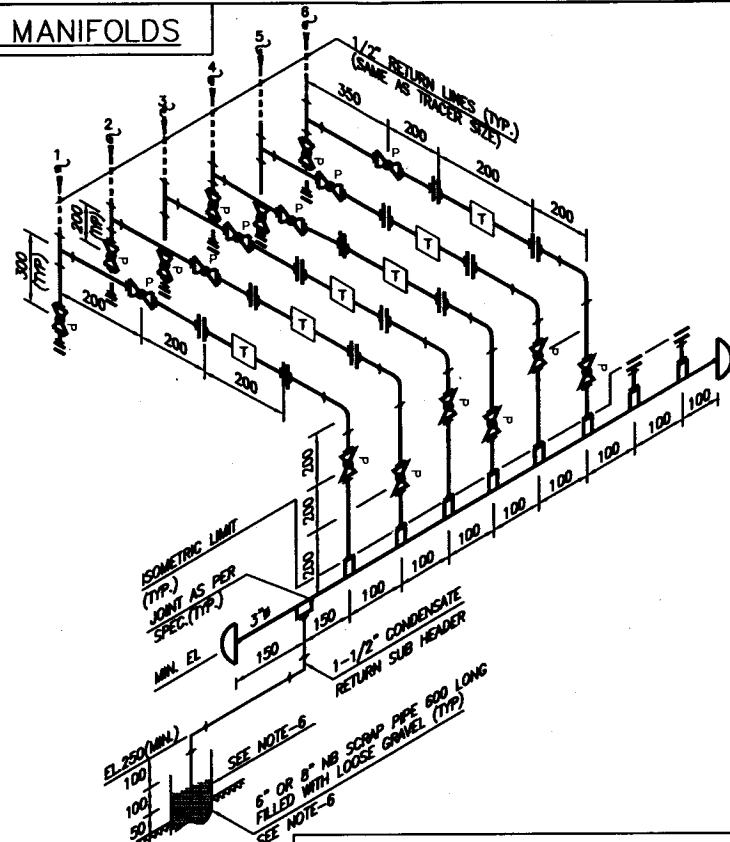
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ANNEXURE-1 STEAM TRACING- SITE FABRICATED MANIFOLDS (TYPICAL DIAGRAMS)	SPECIFICATION No.
	6-44-0007-A1 Rev. 5
	Page 1 of 5

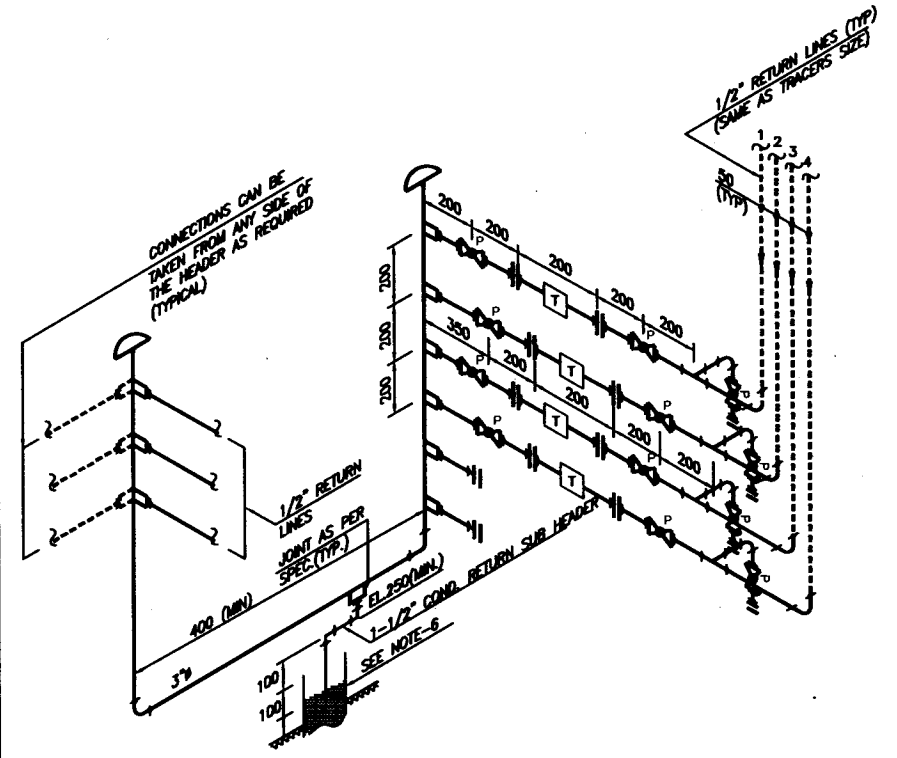
CONDENSATE RECOVERY MANIFOLDS



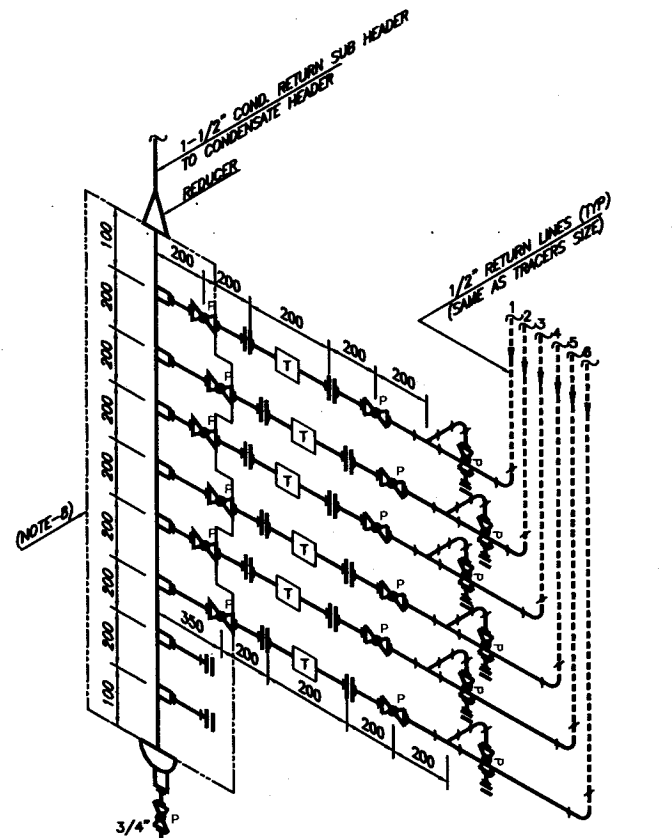
MANIFOLD WITH CONDENSATE RECOVERY



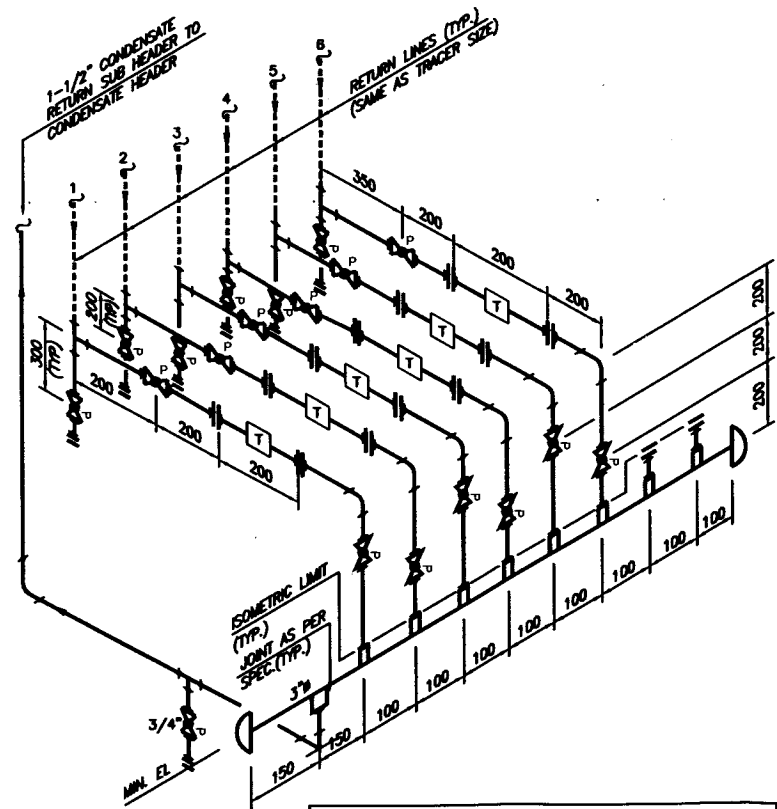
MANIFOLD WITHOUT CONDENSATE RECOVERY



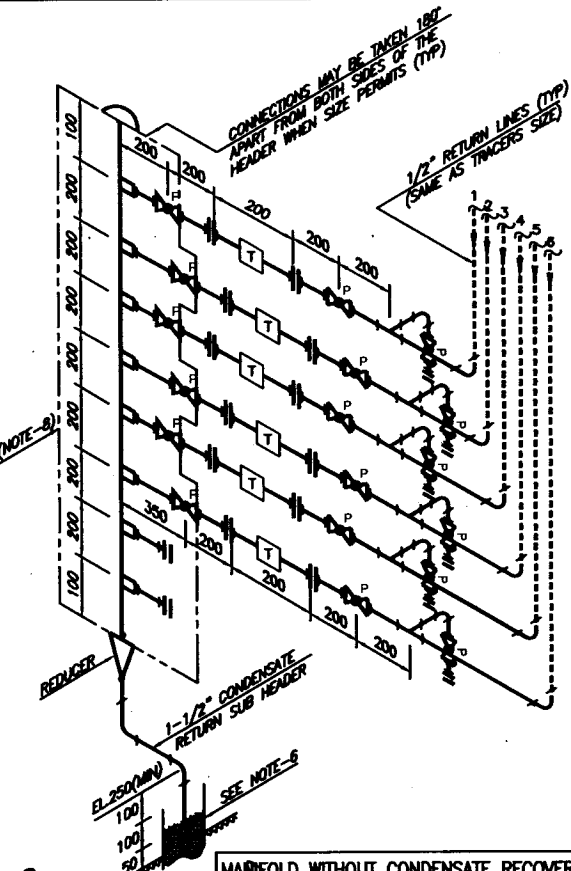
MANIFOLD WITHOUT CONDENSATE RECOVERY



MANIFOLD WITH CONDENSATE RECOVERY



MANIFOLD WITH CONDENSATE RECOVERY



MANIFOLD WITHOUT CONDENSATE RECOVERY

- NOTES :
1. ALL DIMENSIONS ARE IN mm UNLESS OTHERWISE NOTED.
  2. RESERVE APPROX. 20% OF TOTAL NUMBER OF TRACERS FOR FUTURE USE (MINIMUM 2 NOS. OR AS DEFINED IN DESIGN BASIS)
  3. SIZE OF RETURN LINES SHALL BE 1/2" & CONDENSATE SUB HEADERS SHALL BE 1 1/2"
  4. CONDENSATE RETURN MANIFOLDS ARE TO BE NUMBERED. FOR DETAILS REFER PAGE 3 OF 5 OF THIS ANNEXURE.
  5. FOR HORIZONTAL OFFTAKES, SUFFICIENT OPERATING SPACE SHALL BE GIVEN FOR OPERATION OF VALVES
  6. SCRAP PIPE TO BE PROVIDED FOR OFFSITES FOR LOCATIONS WITH NO DITCHES NEARBY & AREAS WHICH ARE NOT PAVED. FOR UNITS & OTHER PAVED AREAS, PROVIDE DRAIN LINES TO CRWS COLLECTING FUNNEL LOCATED NEAREST TO MANIFOLD.
  7. MAXIMUM 12 NOS. OF RETURN LINES(INCLUDING SPARES) ARE PERMITTED PER CONDENSATE RETURN MANIFOLD.
  8. SITE FABRICATED MANIFOLD MAY BE SUBSTITUTED BY STD. BOUGHT OUT MANIFOLDS WITH GLANDLESS PISTON VALVES. MANIFOLDS CAN BE LOCATED IN HORIZONTAL ORIENTATION ALSO.

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 (A Unit of India Undertaking)

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ANNEXURE-1  
 STEAM TRACING-  
 SITE FABRICATED MANIFOLDS  
 (TYPICAL DIAGRAMS)

SPECIFICATION No.  
 6-44-0007-A1 Rev. 5  
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ELEMENTARY DETAILS

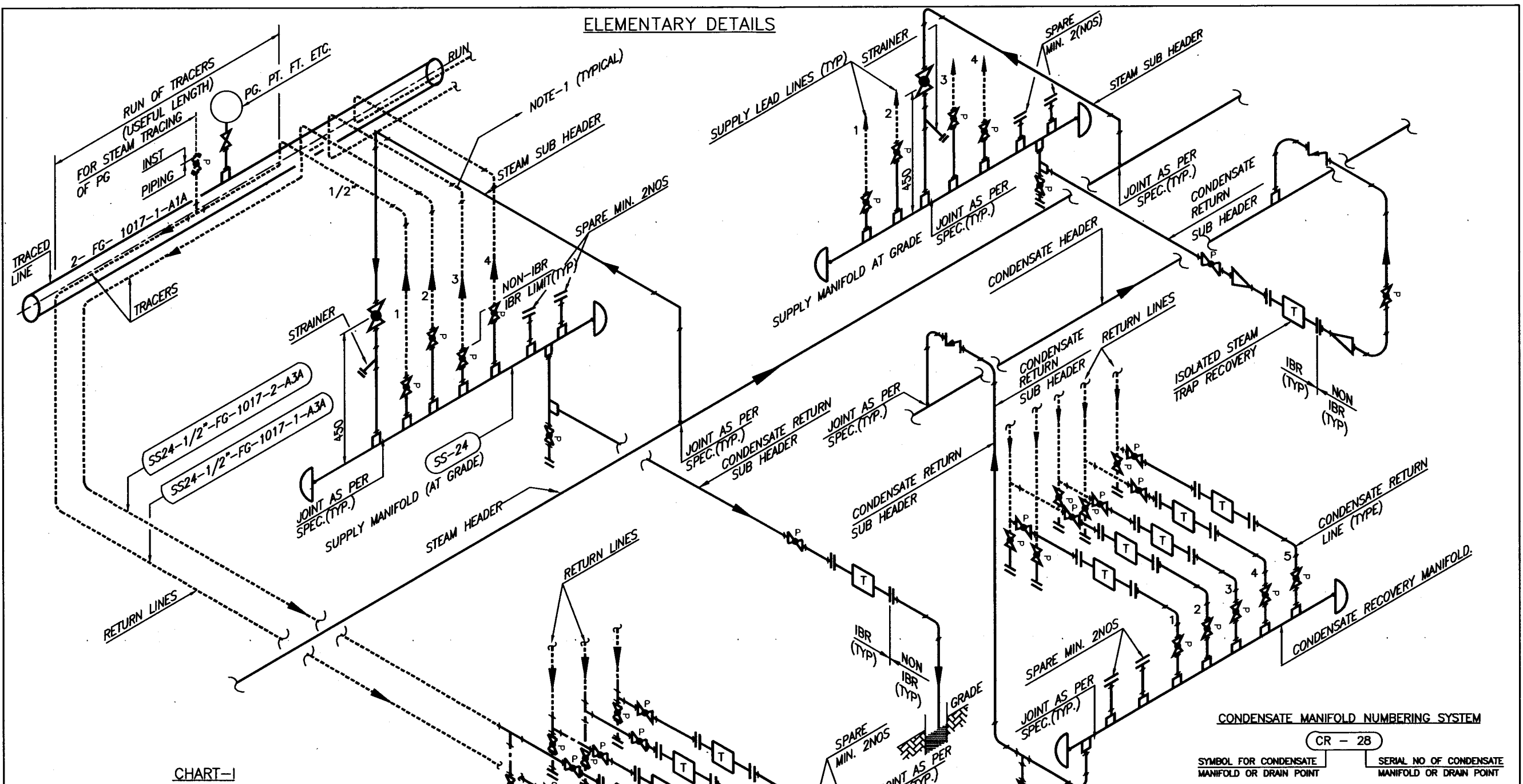


CHART-I

REPRESENTATION OF SUPPLY STATION IN LAYOUT

NO	SUPPLY MANIFOLD NOS	TRACER NO	TRACER FOR LINE NO	TO CONDENSATE MANIFOLD NO.	SUB-HEADER	TRACER SIZE
					1-1/2"	1/2"
					1-1/2"	1/2"

REPRESENTATION OF CONDENSATE MANIFOLD IN LAYOUT

NO	COND. MANIFOLD NOS	TRACER NO	TRACER FOR LINE NO	FROM SUPPLY MANIFOLD NO.	SUB-HEADER	TRACER SIZE
					1-1/2"	1/2"
					1-1/2"	1/2"

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 (A Unit of IIL Group)

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ANNEXURE-1  
 STEAM TRACING-SITE FABRICATED MANIFOLDS  
 (TYPICAL DIAGRAMS)

SPECIFICATION No.  
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 Page 3 of 5

- NOTES:
1. SITE FABRICATED BENDS SHALL BE USED IN PLACE OF FORGED ELBOWS EXCEPT NEAR STEAM SUPPLY AND CONDENSATE RETURN MANIFOLDS
  2. ORIENTATION OF MANIFOLD IS INDICATIVE ONLY. IT CAN BE VERTICAL OR HORIZONTAL.

**CONDENSATE MANIFOLD NUMBERING SYSTEM**  
 CR - 28  
 SYMBOL FOR CONDENSATE MANIFOLD OR DRAIN POINT SERIAL NO. OF CONDENSATE MANIFOLD OR DRAIN POINT

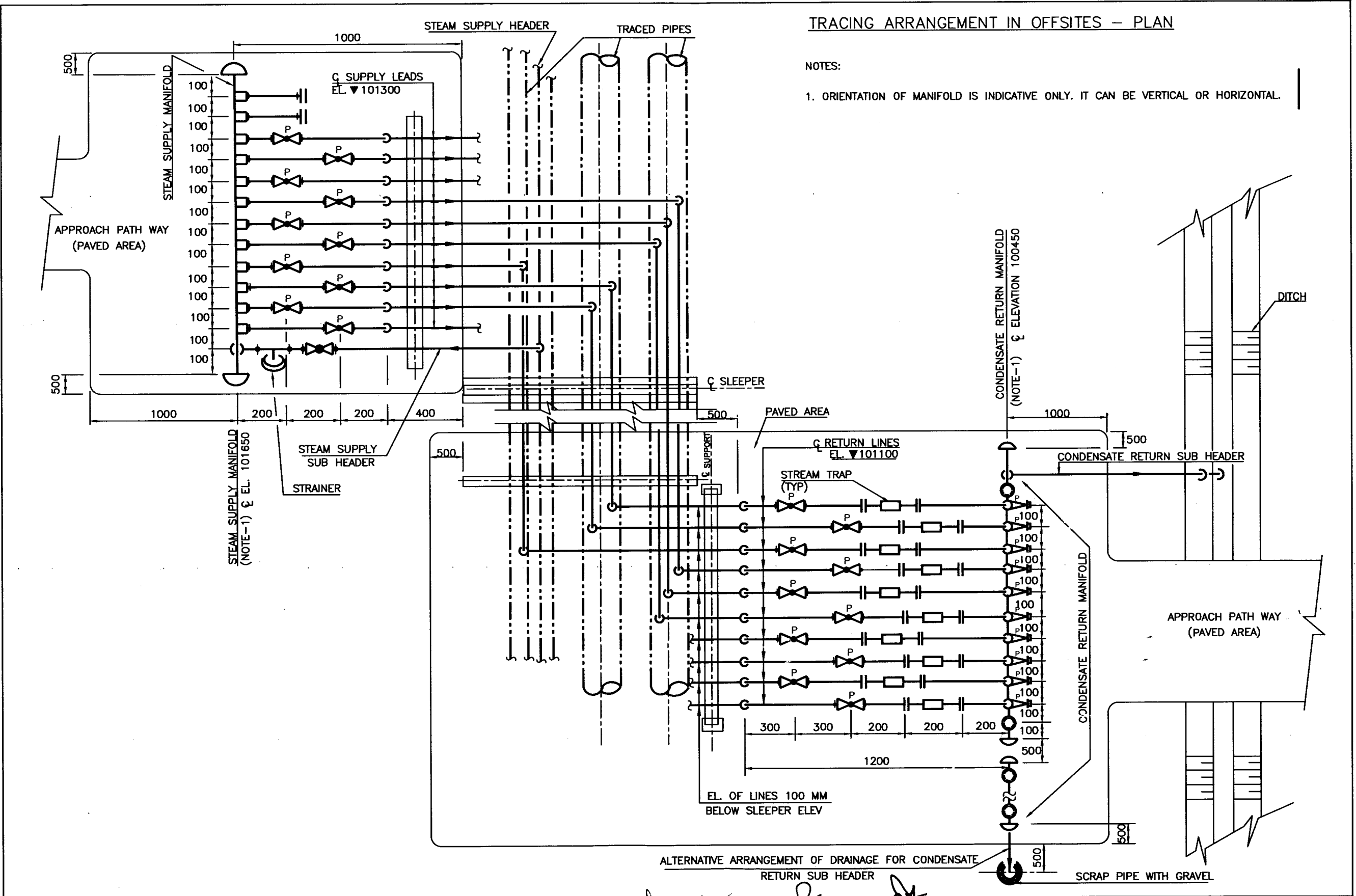
**SUPPLY MANIFOLD NUMBERING SYSTEM**  
 SS - 24  
 SYMBOL FOR STEAM SUPPLY MANIFOLD SERIAL NO. OF SUPPLY MANIFOLD

**SUPPLY LEAD LINE TO TRACERS NUMBERING SYSTEM**  
 SS24-1/2"-FG-1017-1-A3A  
 NO. OF SUPP. STATION TRACER MAT. SPEC.  
 SIZE OF LEAD LINE LINE NO OF TRACED LINE

**TRACER NUMBERING SYSTEM**

TRACING ARRANGEMENT IN OFFSITES – PLAN

NOTES:  
 1. ORIENTATION OF MANIFOLD IS INDICATIVE ONLY. IT CAN BE VERTICAL OR HORIZONTAL.

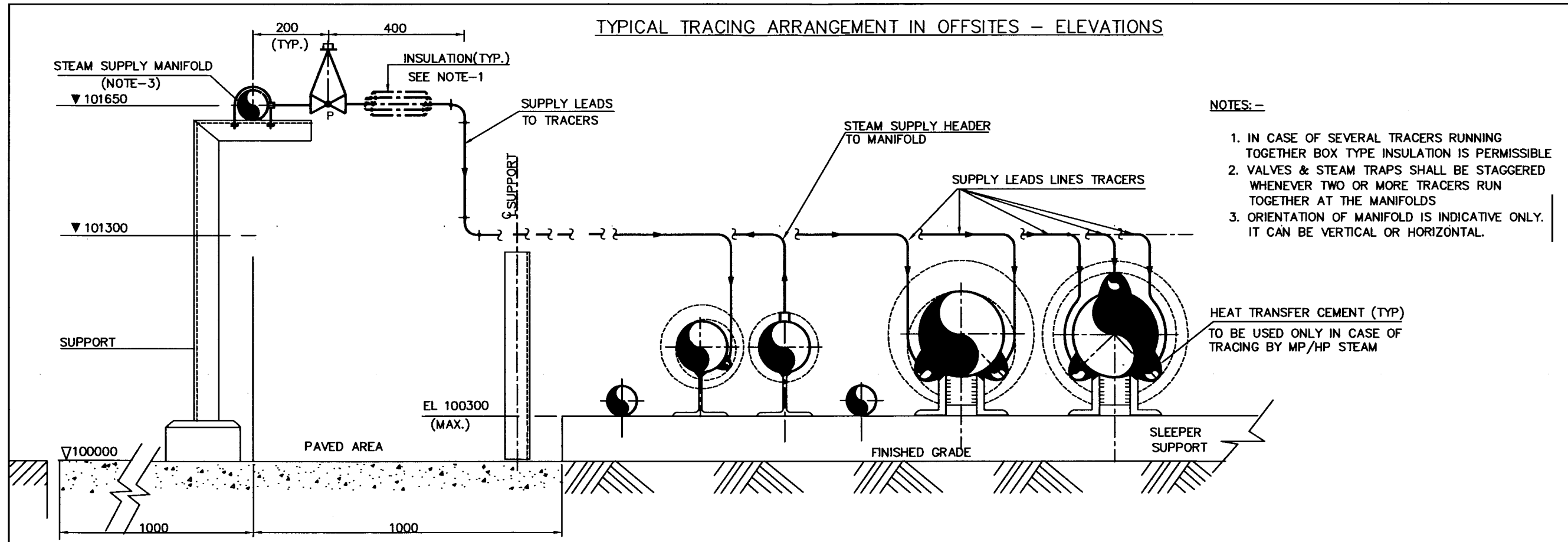


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ANNEXURE-1  
 STEAM TRACING-  
 SITE FABRICATED MANIFOLDS  
 (TYPICAL DIAGRAMS)

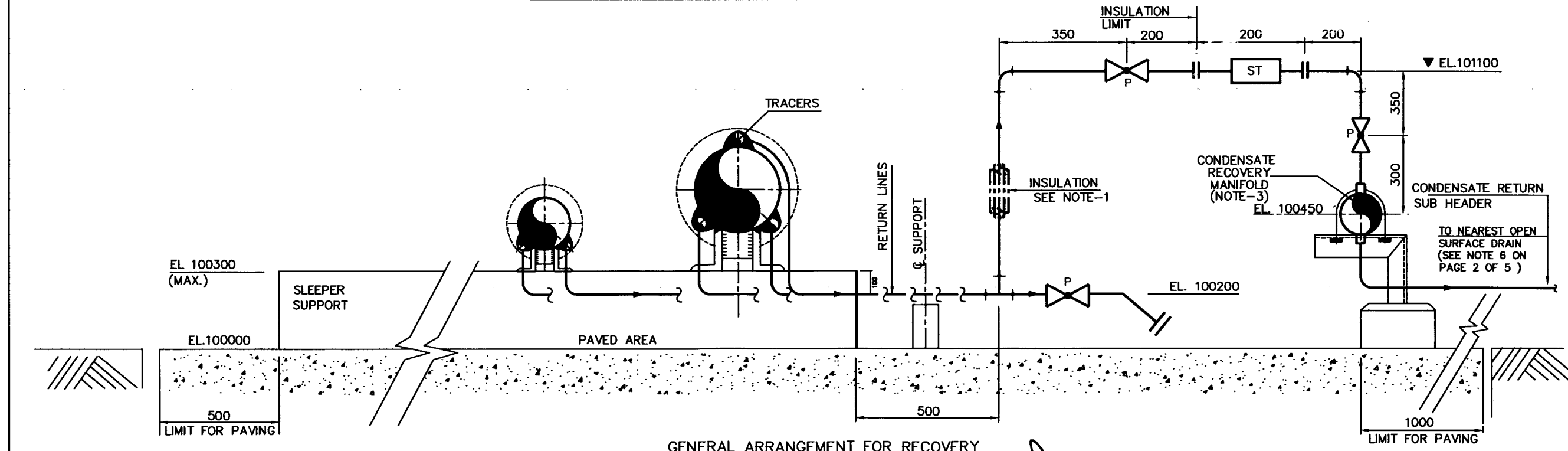
SPECIFICATION No.  
 6-44-0007-A1 Rev. 5  
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TYPICAL TRACING ARRANGEMENT IN OFFSITES – ELEVATIONS



- NOTES:-
1. IN CASE OF SEVERAL TRACERS RUNNING TOGETHER BOX TYPE INSULATION IS PERMISSIBLE
  2. VALVES & STEAM TRAPS SHALL BE STAGGERED WHENEVER TWO OR MORE TRACERS RUN TOGETHER AT THE MANIFOLDS
  3. ORIENTATION OF MANIFOLD IS INDICATIVE ONLY. IT CAN BE VERTICAL OR HORIZONTAL.

GENERAL ARRANGEMENT FOR SUPPLY



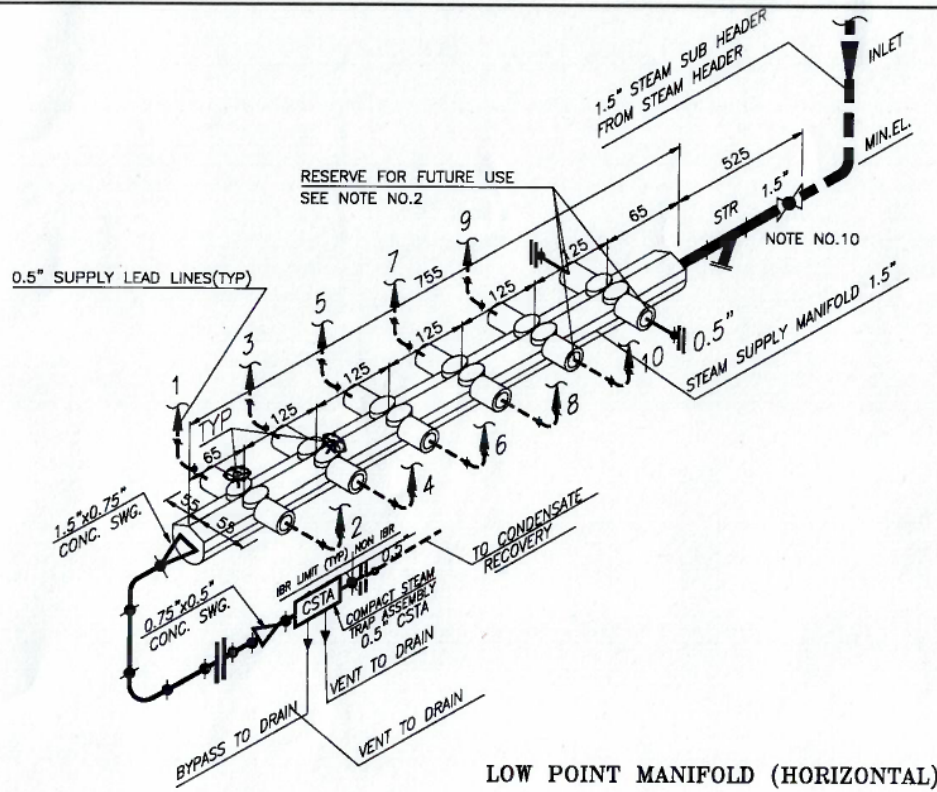
GENERAL ARRANGEMENT FOR RECOVERY



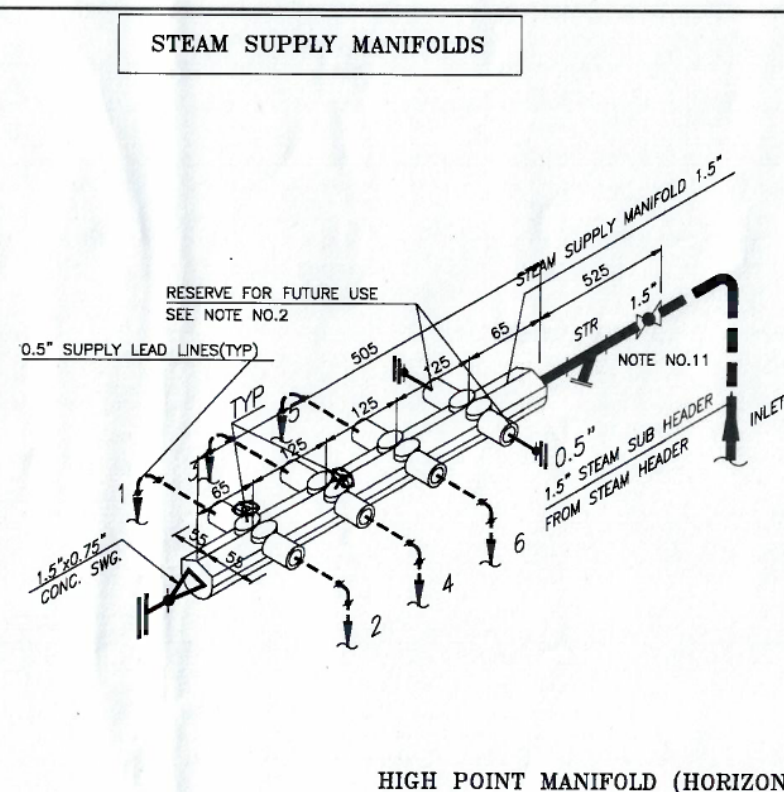
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 (TYPICAL DIAGRAMS)

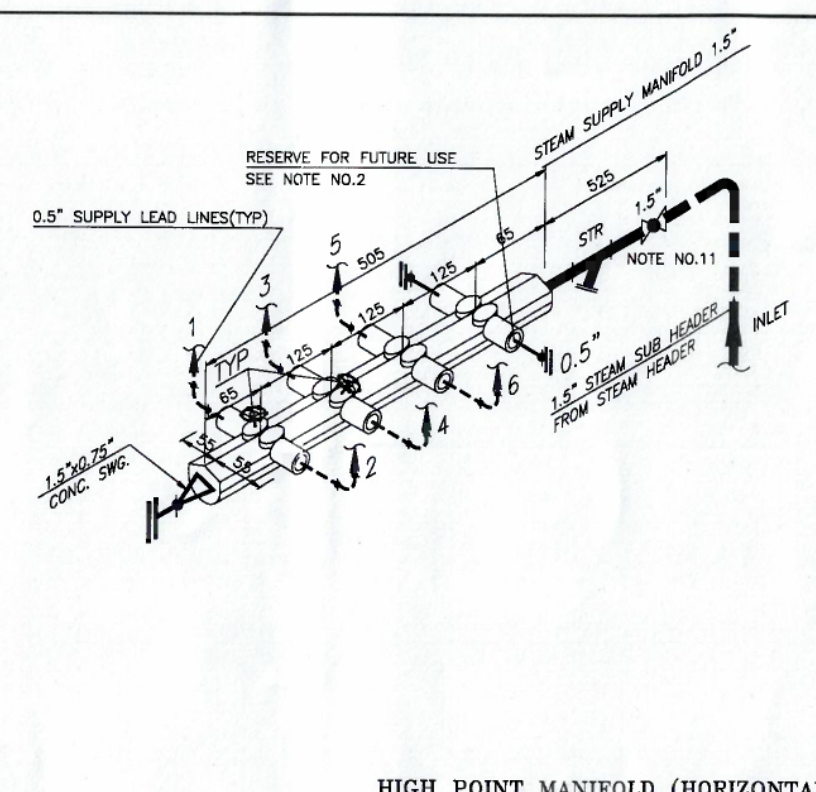
SPECIFICATION No.  
 6-44-0007-A1 Rev. 5  
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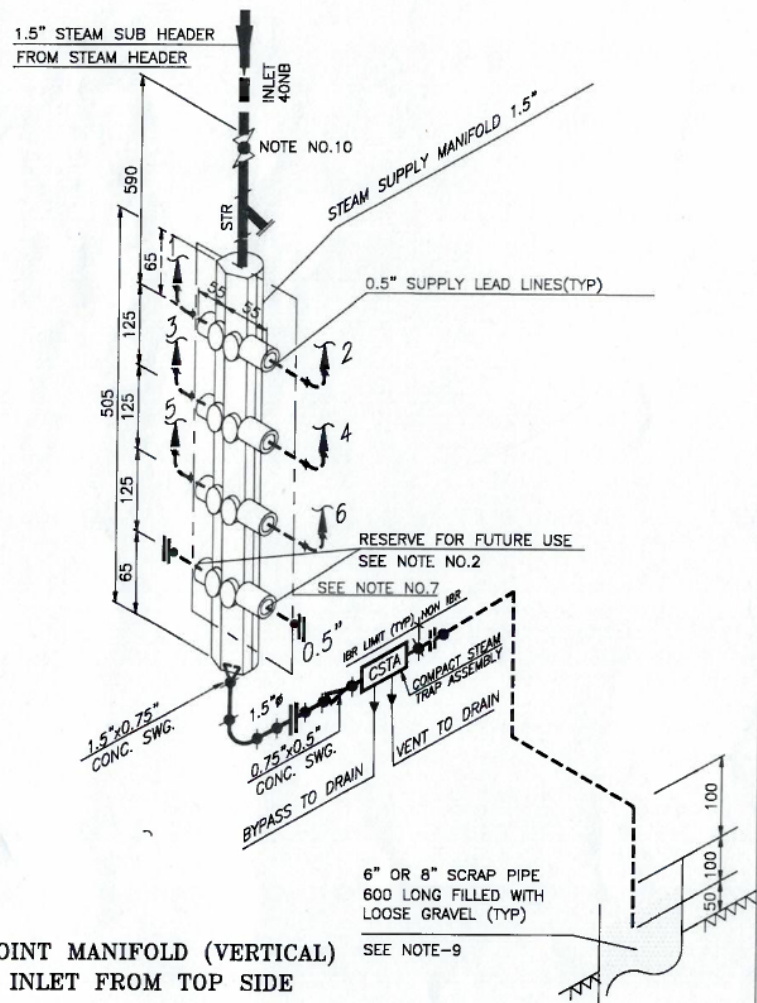
LOW POINT MANIFOLD (HORIZONTAL)



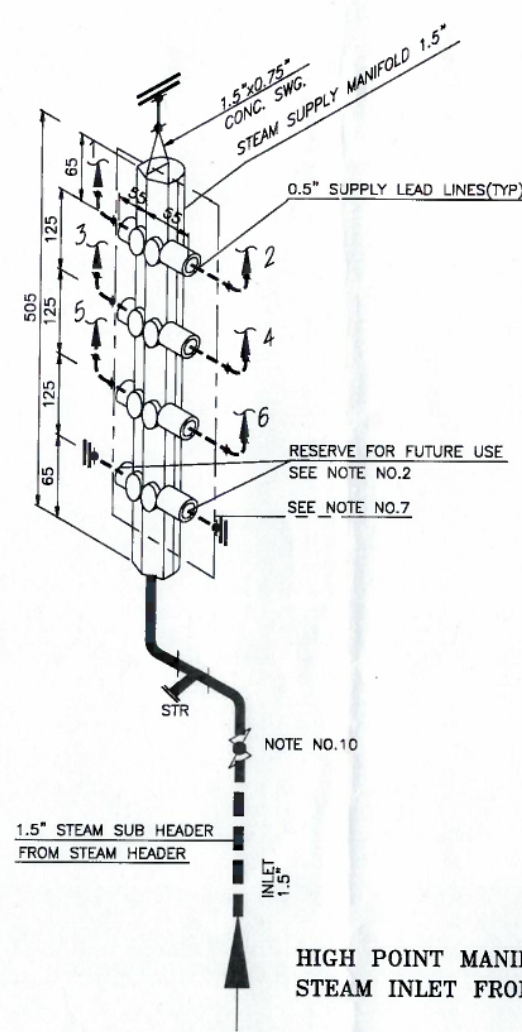
HIGH POINT MANIFOLD (HORIZONTAL)



HIGH POINT MANIFOLD (HORIZONTAL)



LOW POINT MANIFOLD (VERTICAL)  
STEAM INLET FROM TOP SIDE



HIGH POINT MANIFOLD (VERTICAL)  
STEAM INLET FROM BOTTOM SIDE

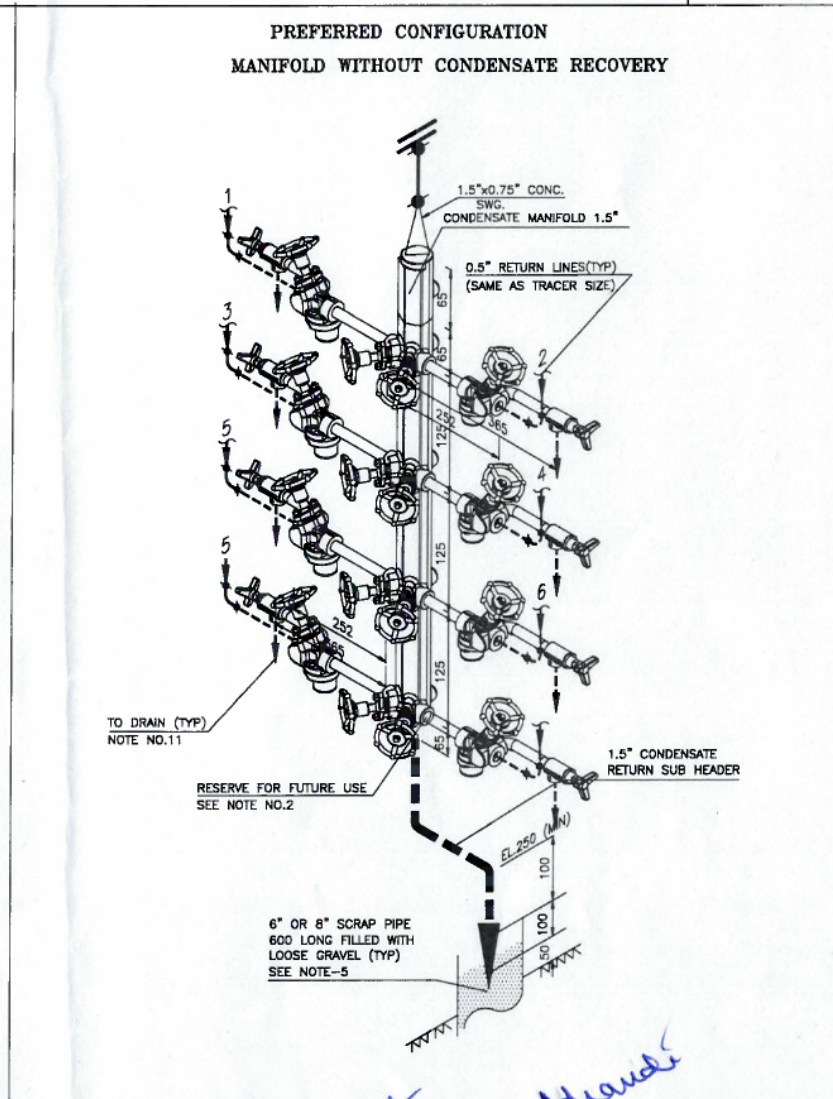
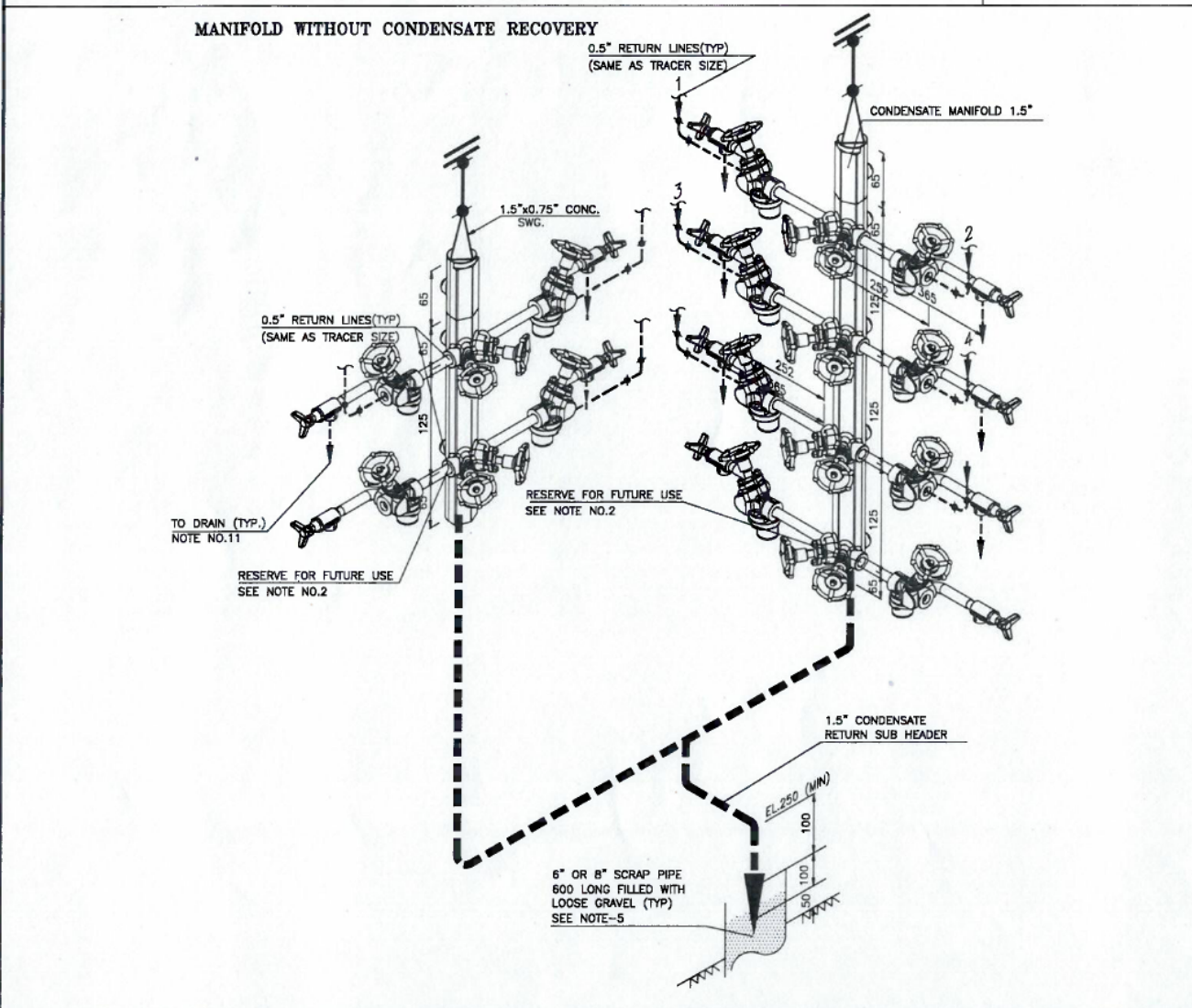
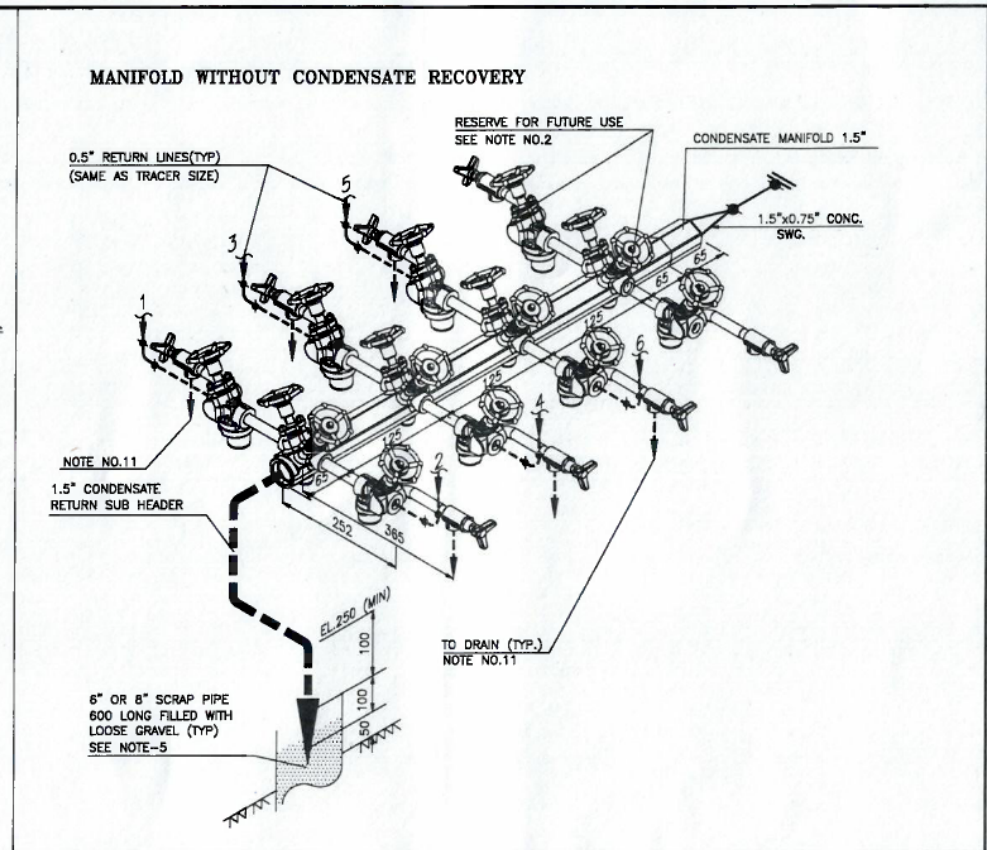
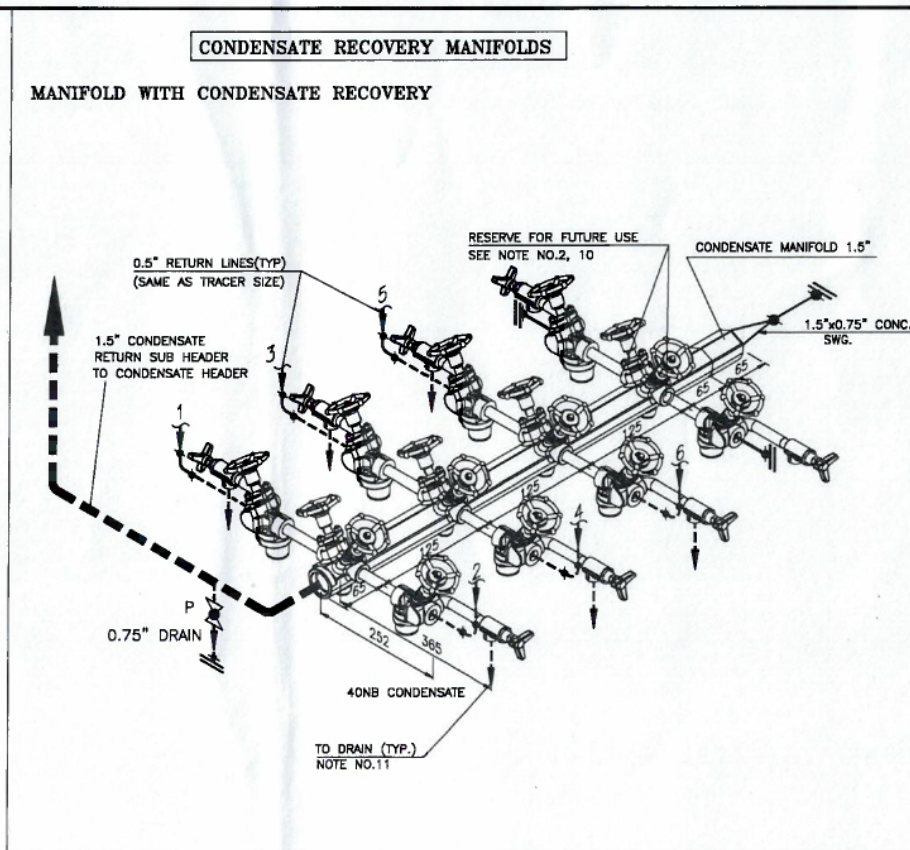
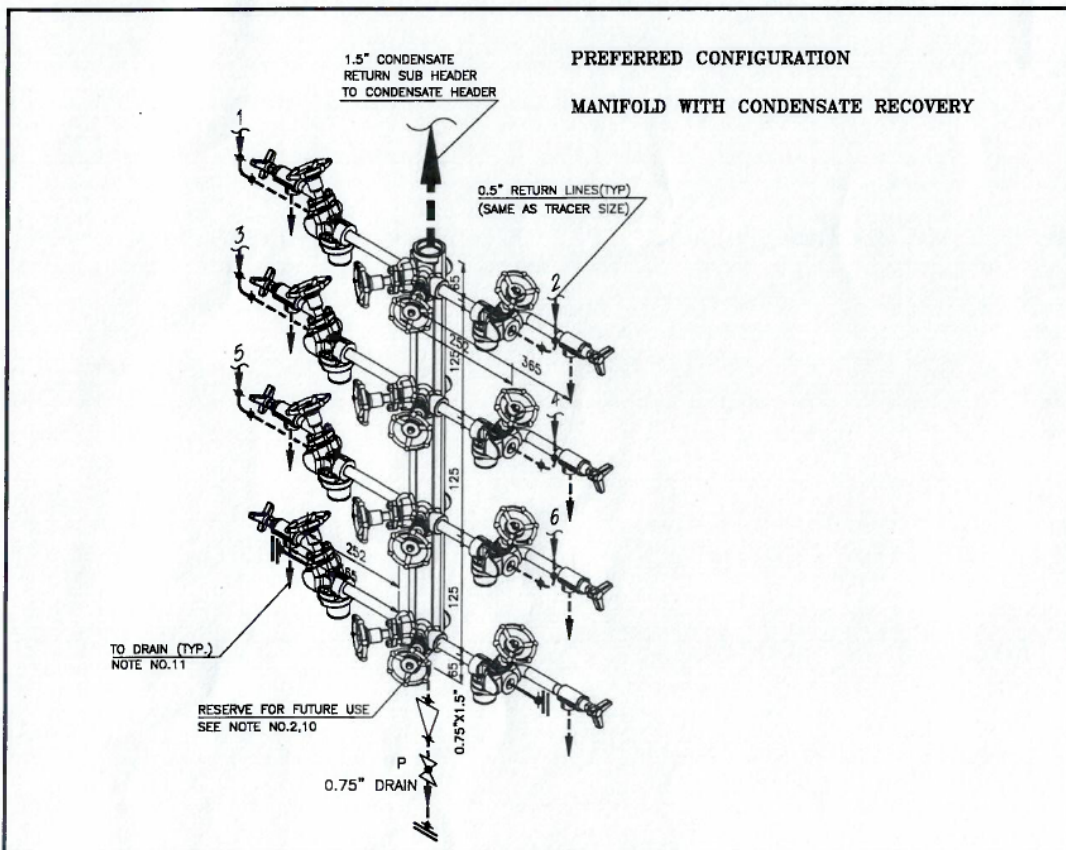
PREFERRED CONFIGURATION

NOTES :-

1. ALL DIMNS ARE IN mm UNLESS OTHERWISE NOTED. THE DIMENSIONS FOR MANIFOLDS ARE INDICATIVE AND MAY VARY AS PER VENDOR SPECIFICATIONS.
2. RESERVE APPROX 20% OF TOTAL NUMBERS FOR FUTURE USE. (MINIMUM 2 NOS. OR AS DEFINED IN DESIGN BASIS)
3. SIZE OF STEAM SUPPLY LEAD LINES SHALL 0.5" & SUPPLY SUB HEADERS SHALL BE 1.5".
4. STEAM SUPPLY MANIFOLDS ARE TO BE NUMBERED. FOR DETAILS REF. PAGE 3 OF 6 OF THIS ANNEXURE.
5. MAXIMUM 12 NOS OF SUPPLY LEAD LINES (INCLUDING SPARES) ARE PERMITTED PER SUPPLY MANIFOLD.
6. COMPACT PREFORGED MANIFOLDS WITH IN BUILT GLANDLESS PISTON VALVES SHALL BE USED.
7. FOR DRAIN TRAP ASSEMBLY, COMPACT STEAM TRAPPING ASSEMBLY CONSISTING UNIVERSAL THERMODYNAMIC TRAP CONNECTED TO PIPELINE CONNECTOR HAVING INBUILT GLANDLESS PISTON TYPE ISOLATION VALVES FOR UPSTREAM ISOLATION,DOWNSTREAM ISOLATION & TRAP BYPASS PURPOSE SHALL BE USED. TYPICAL ARRANGEMENT SHALL BE AS SHOWN IN THE DRAWINGS.
8. MISSING DIMENSIONS TO BE FINALIZED DURING DETAILED ENGINEERING.
9. SCRAP PIPE TO BE PROVIDED FOR OFFSITES FOR LOCATIONS WITH NO DITCHES NEARBY & AREAS WHICH ARE NOT PAVED. FOR UNITS & OTHER PAVED AREAS, PROVIDE DRAIN LINES TO CRWS/AG HEADER COLLECTING FUNNEL LOCATED NEAREST TO MANIFOLD.
10. MANIFOLD ISOLATION VALVE SHALL BE GLOBE VALVE. ALL OTHER VALVES SHALL BE GLANDLESS PISTON VALVES.

STR = STRAINER  
P = PISTON VALVE

4	15-09-25	REVISED & ISSUED AS STANDARD SPECIFICATION	SRG	PK	SH	MN
3	29-09-22	REVISED & ISSUED AS STANDARD SPECIFICATION	PK	SH	GB	SM
Rev. No.	Date	Purpose	Prepared by	Checked by	Stds. Committee Convener	Stds. Bureau Chairman
					Approved by	



- NOTES :-**
1. ALL DIMS ARE IN mm UNLESS OTHERWISE NOTED. THE DIMENSIONS FOR MANIFOLDS ARE INDICATIVE AND MAY VARY AS PER VENDOR SPECIFICATIONS.
  2. RESERVE APPROX 20% OF TOTAL NUMBERS FOR FUTURE USE. (MINIMUM 2 NOS. OR AS DEFINED IN DESIGN BASIS)
  3. SIZE OF RETURN LINES SHALL 0.5" & CONDENSATE SUB HEADERS SHALL BE 1.5".
  4. CONDENSATE RETURN MANIFOLDS ARE TO BE NUMBERED. FOR DETAILS REFER PAGE 3 OF 6 OF THIS ANNEXURE.
  5. SCRAP PIPE TO BE PROVIDED FOR OFFSITES FOR LOCATIONS WITH NO DITCHES NEARBY & AREAS WHICH ARE NOT PAVED . FOR UNITS & OTHER PAVED AREAS . PROVIDE DRAIN LINES TO CRWS / AG HEADER COLLECTING FUNNEL LOCATED NEAREST TO MANIFOLD.
  6. MAXIMUM 12 NOS OF RETURN LINES (INCLUDING SPARES) ARE PERMITTED PER SUPPLY MANIFOLD.
  7. COMPACT PREFORGED MANIFOLDS WITH IN BUILT GLANDLESS PISTON VALVES SHALL BE USED.
  8. MISSING DIMENSIONS TO BE FINALIZED DURING DETAILED ENGINEERING.
  9. 0.5" INLET POINTS IN CR MANIFLD SHALL BE SUITABLY STAGGERED FOR EASE OF PIPING.
  10. SPARE RETURN LEADS SHALL BE BLINDED FOR MANIFOLDS WITH CONDENSATE RECOVERY.
  11. TEMPORARY CONNECTION MAY BE PROVIDED TO ROUTE CONDENSATE RETURN BYPASS TO DRAIN DURING MAINTENANCE.

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ELEMENTARY DETAILS

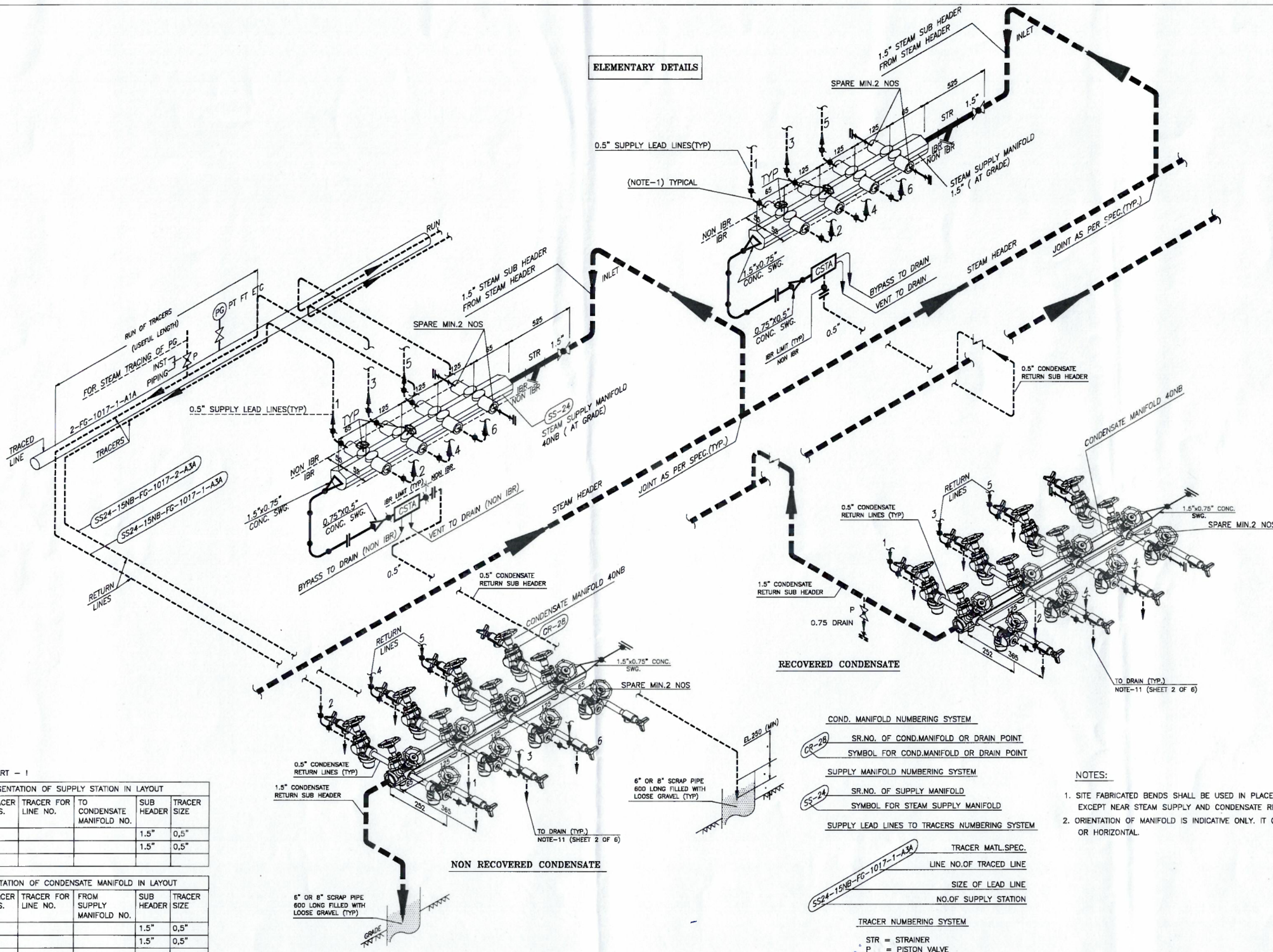


CHART - 1

REPRESENTATION OF SUPPLY STATION IN LAYOUT

NO	SUPPLY MANIFOLD NOS.	TRACER NOS.	TRACER FOR LINE NO.	TO CONDENSATE MANIFOLD NO.	SUB HEADER	TRACER SIZE
					1.5"	0.5"
					1.5"	0.5"

REPRESENTATION OF CONDENSATE MANIFOLD IN LAYOUT

NO	COND. MANIFOLD NOS.	TRACER NOS.	TRACER FOR LINE NO.	FROM SUPPLY MANIFOLD NO.	SUB HEADER	TRACER SIZE
					1.5"	0.5"
					1.5"	0.5"

- COND. MANIFOLD NUMBERING SYSTEM
- CR-2B SR.NO. OF COND.MANIFOLD OR DRAIN POINT SYMBOL FOR COND.MANIFOLD OR DRAIN POINT
- SUPPLY MANIFOLD NUMBERING SYSTEM
- SS-24 SR.NO. OF SUPPLY MANIFOLD SYMBOL FOR STEAM SUPPLY MANIFOLD
- SUPPLY LEAD LINES TO TRACERS NUMBERING SYSTEM
- SS24-15NB-FG-1017-1-A34 TRACER MATL.SPEC. LINE NO.OF TRACED LINE SIZE OF LEAD LINE NO.OF SUPPLY STATION
- TRACER NUMBERING SYSTEM
- STR = STRAINER  
P = PISTON VALVE

- NOTES:
- SITE FABRICATED BENDS SHALL BE USED IN PLACE OF FORGED ELBOWS EXCEPT NEAR STEAM SUPPLY AND CONDENSATE RETURN MANIFOLDS.
  - ORIENTATION OF MANIFOLD IS INDICATIVE ONLY. IT CAN BE VERTICAL OR HORIZONTAL.

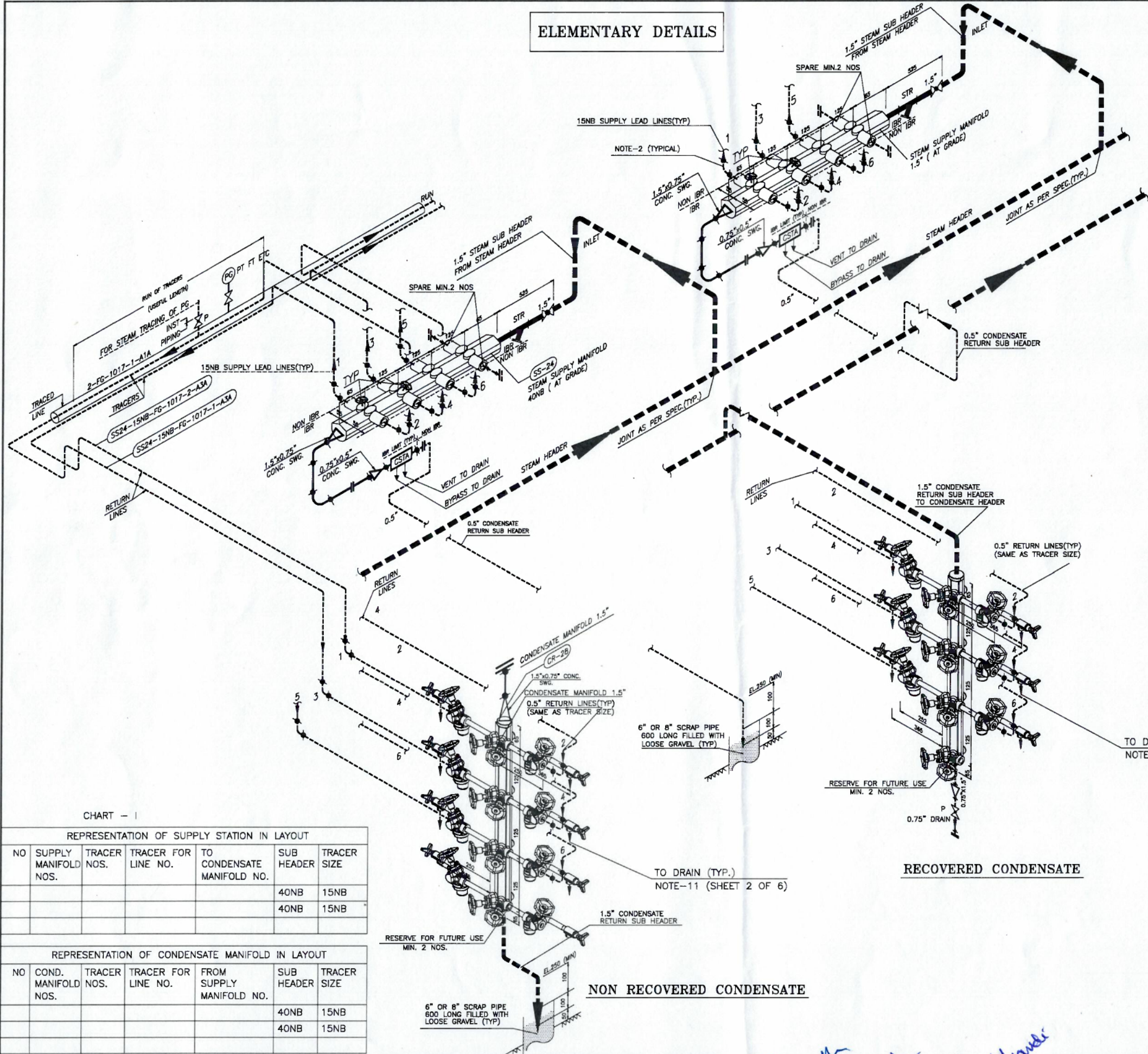
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ANNEXURE-2  
STEAM TRACING-  
BOUGHT OUT MANIFOLDS  
(TYPICAL DIAGRAMS)

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Page 3 OF 6  
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ELEMENTARY DETAILS



- COND. MANIFOLD NUMBERING SYSTEM**
- CR-28 SR.NO. OF COND.MANIFOLD OR DRAIN POINT
  - Symbol for COND.MANIFOLD OR DRAIN POINT
- SUPPLY MANIFOLD NUMBERING SYSTEM**
- SS-24 SR.NO. OF SUPPLY MANIFOLD
  - Symbol for STEAM SUPPLY MANIFOLD
- SUPPLY LEAD LINES TO TRACERS NUMBERING SYSTEM**
- SS24-15NB-FG-1017-1-A3A TRACER MATL.SPEC.
  - Line No. OF TRACED LINE
  - SIZE OF LEAD LINE
  - NO. OF SUPPLY STATION
- TRACER NUMBERING SYSTEM**
- STR = STRAINER
  - P = PISTON VALVE

CHART - I

REPRESENTATION OF SUPPLY STATION IN LAYOUT						
NO	SUPPLY MANIFOLD NOS.	TRACER NOS.	TRACER FOR LINE NO.	TO CONDENSATE MANIFOLD NO.	SUB HEADER	TRACER SIZE
					40NB	15NB
					40NB	15NB

REPRESENTATION OF CONDENSATE MANIFOLD IN LAYOUT						
NO	COND. MANIFOLD NOS.	TRACER FOR LINE NO.	TRACER FOR LINE NO.	FROM SUPPLY MANIFOLD NO.	SUB HEADER	TRACER SIZE
					40NB	15NB
					40NB	15NB

NOTES:

- SITE FABRICATED BENDS SHALL BE USED IN PLACE OF FORGED ELBOWS EXCEPT NEAR STEAM SUPPLY AND CONDENSATE RETURN MANIFOLDS.
- ORIENTATION OF MANIFOLD IS INDICATIVE ONLY. IT CAN BE VERTICAL OR HORIZONTAL.

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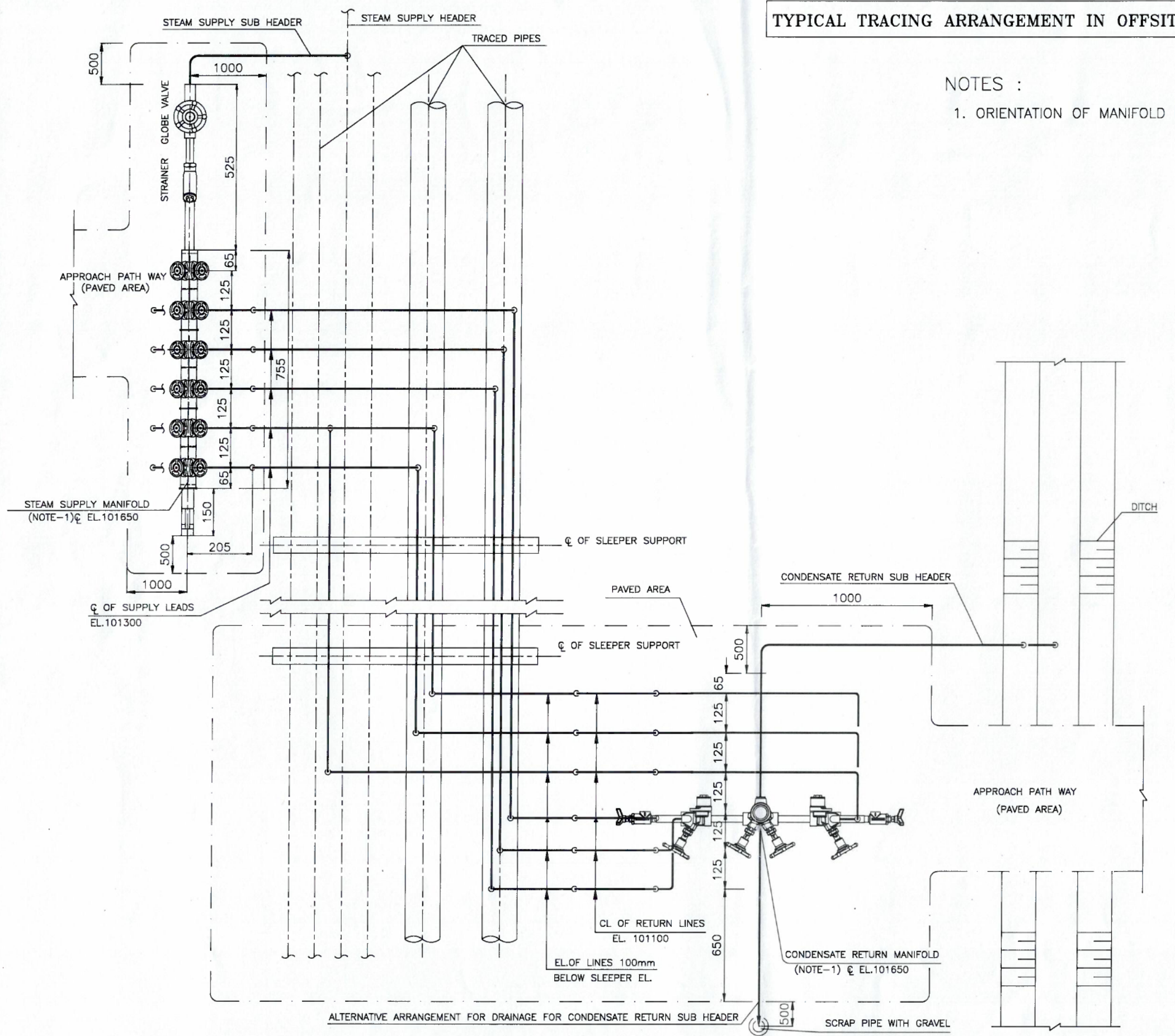
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ANNEXURE-2  
 STEAM TRACING-  
 BOUGHT OUT MANIFOLDS  
 (TYPICAL DIAGRAMS)

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**TYPICAL TRACING ARRANGEMENT IN OFFSITES - PLAN**

NOTES :  
 1. ORIENTATION OF MANIFOLD IS INDICATIVE ONLY. IT CAN BE VERTICAL OR HORIZONTAL.



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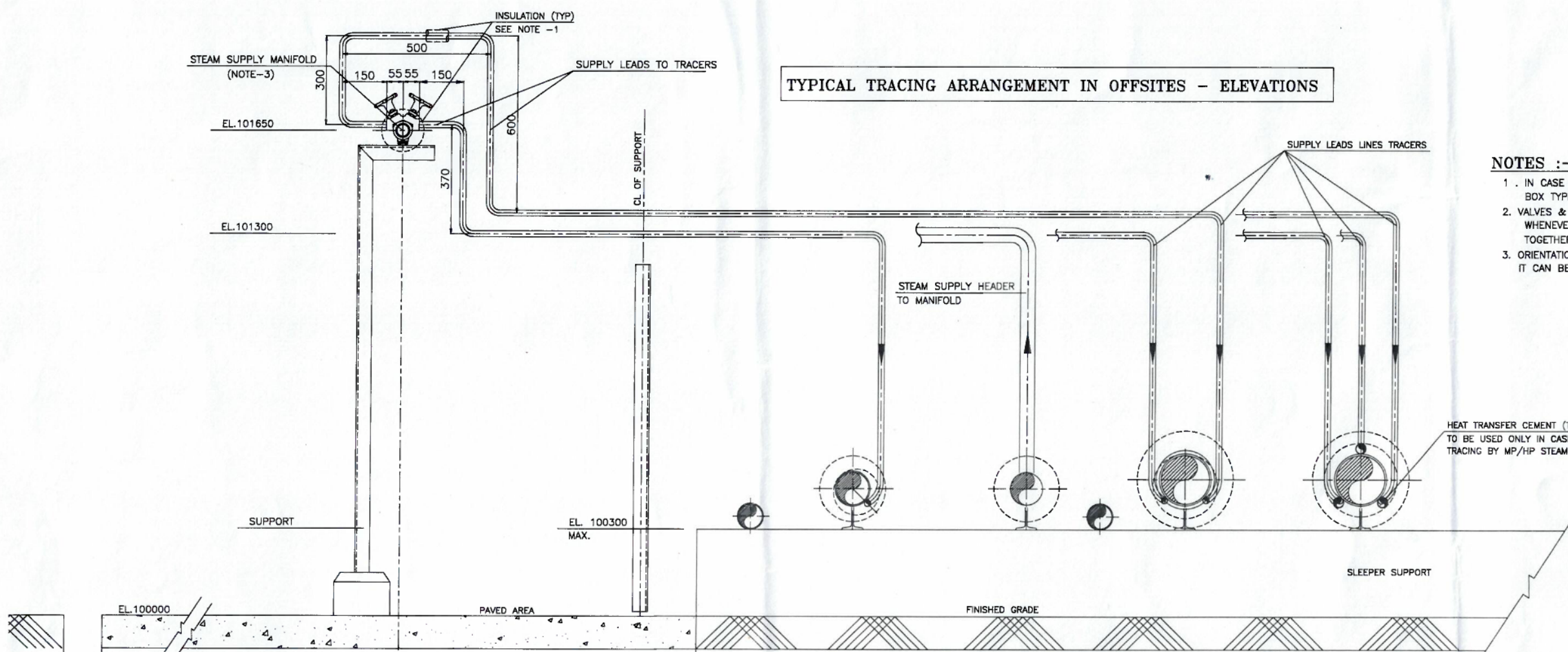
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3	29-09-22	REVISED & ISSUED AS STANDARD SPECIFICATION	PK	SH	GB	SM
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Approved by: *Shandi*

**ANNEXURE-2  
 STEAM TRACING  
 BOUGHT OUT MANIFOLDS  
 (TYPICAL DIAGRAMS)**

STANDARD No.  
**6-44-0007-A2 Rev.4**  
 Page 5 OF 6

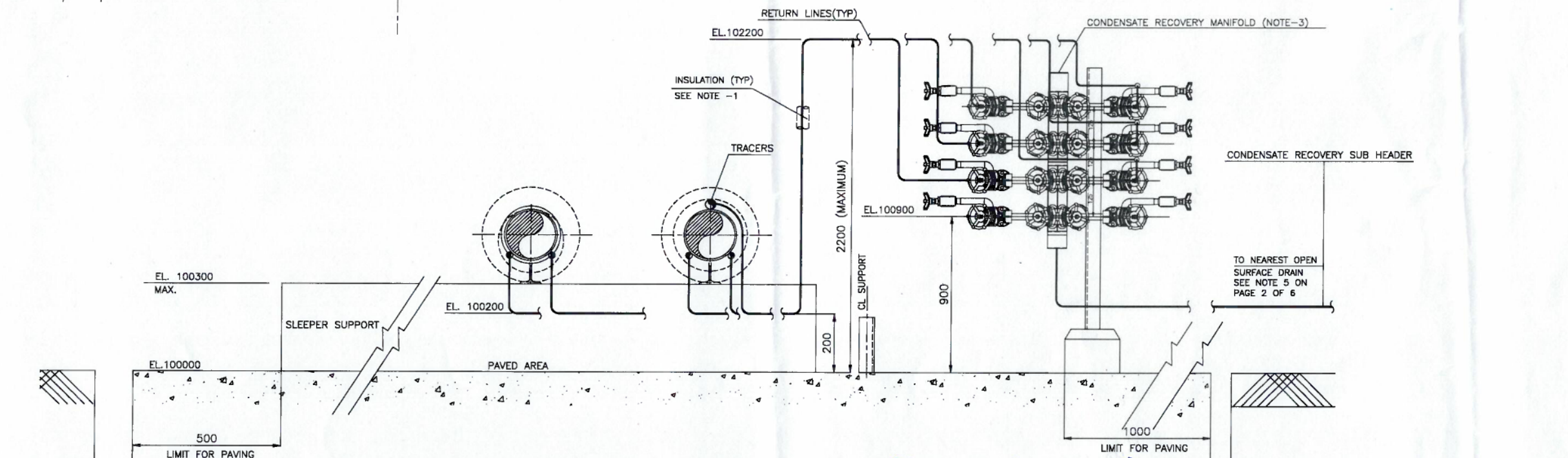
TYPICAL TRACING ARRANGEMENT IN OFFSITES - ELEVATIONS



- NOTES :-**
1. IN CASE OF SEVERAL TRACERS RUNNING TOGETHER BOX TYPE INSULATION IS PERMISSIBLE.
  2. VALVES & STEAM TRAPS SHALL BE STAGGERED WHENEVER TWO OR MORE TRACERS RUN TOGETHER AT THE MANIFOLDS.
  3. ORIENTATION OF MANIFOLD IS INDICATIVE ONLY. IT CAN BE VERTICAL OR HORIZONTAL.

HEAT TRANSFER CEMENT (TYP) TO BE USED ONLY IN CASE OF TRACING BY MP/HP STEAM

GENERAL ARRANGEMENT FOR SUPPLY



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4	15-09-25	REVISED & ISSUED AS STANDARD SPECIFICATION	SRH SRG	PK	SH	MN
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Approved by						

ANNEXURE-2  
 STEAM TRACING-  
 BOUGHT OUT MANIFOLDS  
 (TYPICAL DIAGRAMS)

STANDARD No.  
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पाइपिंग की रचना तथा उत्थापन  
हेतु मानक विनिर्देश

STANDARD SPECIFICATION FOR  
FABRICATION AND ERECTION OF  
PIPING

6	28.03.25	REVISED AND ISSUED AS STANDARD SPECIFICATION	PK	SH	GB	MN
5	31.12.19	REVISED AND ISSUED AS STANDARD SPECIFICATION	PK	SH	MI	RKT
4	30.07.14	REVISED AND ISSUED AS STANDARD SPECIFICATION	SH	AK	RN	ATD SC
3	31.03.09	REVISED AND ISSUED AS STANDARD SPECIFICATION	RN	VKB	SC	ND
2	05.06.03	PMI REQ. INCLUDED AND ISSUED AS STANDARD SPECIFICATION	RN	DM	BN	SKG
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Approved by						

**Abbreviations:**

A.S.	:	Alloy Steel
ASME	:	American Society of Mechanical Engineers
C.I.	:	Cast Iron
C.S.	:	Carbon Steel
IBR	:	Indian Boiler Regulations
LTCS	:	Low Temperature Carbon Steel
NACE	:	National Association of Corrosion Engineers
NB	:	Nominal Bore
NDT	:	Non Destructive Testing
P&ID	:	Piping and Instrumentation Diagram
PMI	:	Positive Material Identification
S.S.	:	Stainless Steel

**Piping Standards Committee**

**Convenor:** Mr. G. Balaji

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Mr. Rameshwar Prasad (Piping)  
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Mr. Harsh Vardhan (Projects)  
Mr. Pankaj Kumar Rai (Construction)  
Mr. T. Kamalakannan (SCM-Inspection)

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4.0	FABRICATION.....	8
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## 1.0 SCOPE

This specification covers general requirements of fabrication and erection of above ground and trench piping systems at site. The specification covers the scope of work of Contractor, basis of work to be carried out by Contractor and standards, specifications and normal practice to be followed during fabrication and erection by the Contractor.

## 2.0 SCOPE OF WORK OF CONTRACTOR

Generally the scope of work of Contractor shall include the following:

2.1 Transportation of required piping materials (as described in Cl.2.1.1), pipe support (material as described in Cl. 2.3) and all other necessary piping materials from Owner's storage point or Contractor's storage point (in case of Contractor's scope of supply) to work site/shop including raising store requisitions for issue of materials in the prescribed format & maintaining an account of the materials received from Owner's stores.

2.1.1 Piping materials include the following but not limited to the same.

- a. Pipes (All sizes and schedule)
- b. Flanges (All sizes, types & Pressure ratings).
- c. Fittings (All sizes, types and schedule)
- d. Valves (All sizes, types and Ratings)
- e. Gaskets (All sizes, types & Ratings)
- f. Bolts, Nuts or M/C Bolts (All types)
- g. Expansion Joint/Bellows (All types)
- h. Specialty items like online filters, ejectors, sample coolers, steam traps, strainers, air traps, springs, silencers, snubbers, steam and condensate manifolds, injection nozzles, MOVs, sight glass, spray nozzles, integrated steam traps, hoses, hose couplings, etc.
- i. Online instruments like control valve, orifice flange, rotameter, safety valves, restriction orifice, rupture disc, de-super heaters, corrosion probes, annubar, magnetic flow meter, ultrasonic flow meter, Coriolis mass flow meters, venturi PG/PT/ Flow transmitter, ejectors, static mixers, flame arrestors, thermal flow switches, pre-fabricated hook-ups etc.
- j. Shut Down Valves with and without fire box.

2.2 Shop & field fabrication and erection of piping in accordance with documents listed under Cl.3.0 i.e. 'BASIS OF WORK' including erection of all piping materials enumerated above.

2.3 Fabrication and erection of pipe supports like shoe, saddle, guide, stops, anchors, clips, cradles, hangers, turn-buckles, supporting fixtures, bracket cantilevers, struts, tee-posts including erection of spring supports, sway braces, dummy pipes, corrosion pads/protection shields, low friction pads, clamps, special support, expansion bellows, steam and condensate manifolds supports etc. Corrosion Pads/Protection shields, stiffeners and stiffening rings, if not covered in the specifications/standards, shall be of the same material as of parent pipes.

## 2.4 Site fabrication of Piping items

Site fabrication of Piping items shall include but not be limited to the following

- 2.4.1 Fabrication of piping specials like special radius bends, reducers, mitres etc.
  - 2.4.2 Fabrication of plain and threaded nipples from pipes as required during erection.
  - 2.4.3 Fabrication of swage nipples as and when required.
  - 2.4.4 Fabrication of odd angle elbow like 60°, 30° or any other angle from 90°/45° elbows as and when required.
  - 2.4.5 Fabrication of flange, reducing flange, blind flange, spectacle blinds as and when required.
  - 2.4.6 Fabrication of stub-in connection with or without reinforcement.
  - 2.4.7 Grinding of edges of pipes, fittings, flanges etc. to match mating edges of uneven/different thickness wherever required.
  - 2.4.8 Fabrication of circular pipe for steam rings, fire water lines, utility lines.
  - 2.4.9 Threading of all small bore piping as per piping material specifications.
  - 2.4.10 Drilling on blind flange for inserting / joining small bore lines.
  - 2.4.11 Fabrication and welding of reinforcement pads at branch pipe locations wherever required.
  - 2.4.12 Equipment nozzle reinforcement with pads, jacket & stiffeners wherever required.
  - 2.4.13 Fabrication of injection nozzles as per details provided wherever required.
  - 2.4.14 Fabrication of chain operation arrangement for valves, wherever required. All material required for this modification shall be supplied by Contractor.
  - 2.4.15 Fabrication and erection in position of funnels required for OWS/ SS/ Condensate blow down system as per direction of Engineer-in-charge.
  - 2.4.16 Grinding/ finishing of uneven surfaces/ joints after welding. Internal grinding of welds of orifice flanges to render smooth surface.
  - 2.4.17 Tapping and drilling of holes in flanges, blind flanges etc. for making piping connections, providing jack screws in tapped and drilled holes, if required.
  - 2.4.18 Providing bird screens at the outlet of lines open to atmosphere.
- 2.5** Modifications like providing additional cleats, extension of stem of valve, locking arrangement of valves etc. as and when required. Seal welding of plugs in orifice flange excess tapings, threaded drain plugs provided in valves as per direction of Engineer in charge.
- 2.6** Piping isometrics for main process/utility lines shall be provided to the Contractor for Units.

Preparation of miscellaneous small bore isometrics with bill of materials for process and utility lines (up to 1½" size) like instruments & pump flushing / cooling, sample connection, purging, pump casing vents & drains, pump base plate drains, control valve drains / vent to flare, instrument drains & vents, steam tracing (non-IBR) from steam supply stations up to

condensate recovery station, and lines specified as field routed within the Unit battery limit as and when required are in Contractor's scope of work. Approval for these isometrics prepared by the Contractor shall be taken from Engineer-in-charge before erection.

Small bore piping isometrics given by Owner shall be rechecked by Contractor before erection and installation.

- 2.7 Obtaining approval for drawings prepared by Contractor from statutory authority, if required. Contractor shall also arrange all necessary permits for hot work etc.
- 2.8 Spun concrete lining of the inside of pipes 3" NB & above including fittings and flanges as required in accordance with specification.
- 2.9 Rubber lining inside pipes, fittings, flanges as and when required, in accordance with specification.
- 2.10 Radiography, stress relieving, dye penetration, magnetic particle test etc. as required in specification.
- 2.11 Performing PMI using alloy analyzers as per 'Standard Specification for Positive Material Identification at Construction Sites, 6-82-0002'.
- 2.12 Casting of concrete pedestals and Fabrication and erection of small structures/ platforms for pipe supports and valve operation / attending some instruments, spectacle blinds etc., providing brackets, modification / extension of platforms, providing additional platforms / ladders for improving / providing accessibility.
- 2.13 Providing insert plates with anchor fasteners in concrete structures / paved floors. Cutting and repair of platform gratings around pipe openings and providing suitable members for support under the platform grating.
- 2.14 Making material reconciliation statement and return of Owner's supply left over materials to Owner's storage.
- 2.15 Flushing and testing of all piping systems as per standard specification for inspection, flushing and testing of piping systems (Specification No. 6-44-0013). The accessories required for blinding the line like flange, blind flange, gasket (all sizes, type and rating), stud-bolts, flexible hoses etc. are to be arranged by the Contractor. During flushing the discharged water / air shall be drained / routed as directed by the Engineer – In Charge.
- 2.16 Contractor shall prepare welding specifications for all weld joints where dissimilar welding will be performed, and obtain approval from EIL.
- 2.17 Contractor to ensure meeting all requirements for carrying out work in shutdown/running plant.
- 2.18 Pickling (as and when applicable) as per Job specification(s) for chemical cleaning of CS suction piping of compressors, SS Piping, Weldments etc, as applicable.
- 2.19 Chemical Cleaning/ Hydro jet cleaning as per marked-up P&IDs with supply of chemicals, consumables, DM water, equipments, boilers, coupons, tools & tackles and other testing equipments required for the same.
- 2.20 For Offsites, only Piping General Arrangement drawings shall be issued. Isometrics, if required, shall be prepared by the Contractor.

### 3.0 BASIS FOR WORK

- 3.1 The complete piping work shall be carried out in accordance with the following:
- 3.1.1 "Approved for Construction" drawings and sketches issued by EIL to the Contractor - Plans and/or Isometrics.
- 3.1.2 "Approved for Construction" drawings and sketches issued by Turn-key bidders to the Contractor - Plans and/or Isometrics.
- 3.1.3 Approved Process Licensor's standards and specifications.
- 3.1.4 Drawings, sketches and documents prepared by Contractor duly approved by Engineer-in-Charge (such as isometrics of small bore piping and offsite piping etc.).
- 3.1.6 EIL specifications/documents as below:
- Process and Instrument Diagram.
  - Job Piping Materials Specification (\*\*\*\*-6-44-0005). \*\*\*\* denotes job number.
  - Piping support, engineering standards.
  - Line list
  - Piping support indices (only in offsite), if supports are not shown in plan.
  - Job specification of Non-destructive Requirement of Piping (\*\*\*\*-6-44-0016)
  - Job Welding Specification Charts for Piping Classes (\*\*\*\*-6-77-0005)
  - Job Welding specification for fabrication of piping (\*\*\*\*-6-77-0001).
  - Any other EIL or OTHER specifications attached with Piping Material Specification or special condition of contract (such as standard for cement lining of pipe, standard of jacketed piping, standard for steam tracing, Dimensional Tolerances etc.)
  - Standard specification for positive material identification (PMI) at construction sites, 6-82-0002
  - Standard Spec for application of torque & hydraulic bolt tension for flange joints (6-76-0002) and its addendum, if any.
- 3.1.7 Following codes, standards and regulations
- ASME B 31.3 : Process Piping
  - ASME Sec. VIII : Code for unfired pressure vessel.
  - IBR Regulations
  - ASME Sec. IX : Qualification standard for welding and brazing procedures, welders, brazers and welding and brazing operators.

- e. NACE Std. : Code for Sour Services material requirements  
MR-0175/MR0103/Job spec(NACE), as applicable

Note : All codes referred shall be latest edition, at the time of award of contract.

### 3.2 Deviations

Where a deviation from the "Basis of Work" and approved job procedure described above is required or where the basis of work does not cover a particular situation, the matter shall be brought to the notice of Engineer-in-Charge and the work carried out only after obtaining written approval from him in each case.

## 4.0 FABRICATION

### 4.1 Piping Material

Pipe, pipe fittings, flanges, valves, gaskets, studs bolts etc. used in a given piping system shall be strictly as per the "Piping Material Specification" for the "Pipe Class" specified for that system. To ensure the above requirement, all piping material supplied by the Owner / Contractor shall have proper identification marks as per relevant standards / EIL specifications / Licensors specification. Contractor shall provide identification marks on left over pipe lengths wherever marked up pipe lengths have been fabricated/erected. Material- traceability is to be maintained for A.S., S.S., NACE, LTCS, material for Hydrogen service and other exotic materials by way of transferring heat number, etc. (hard punching) as per approved procedure. This shall be in addition to colour coding for all piping materials to avoid mix-up.

For the purpose of common understanding the construction job procedure, to be submitted by the Contractor, shall include proposal for

- Maximizing prefabrication, inspection and testing at fabrication shop with minimum field joints.
- Positive material identification, handling, storage & preservation.

### 4.2 Dimensional Tolerances

Dimensional tolerances for piping fabrication shall be as per EIL Standard No. 7-44-0486. The Contractor shall be responsible for working to the dimensions shown on the drawings. However, the Contractor shall bear in mind that there may be variations between the dimensions shown in the drawing and those actually existing at site due to minor variations in the location of equipments, inserts, structures etc. Isometrics, if supplied may have the field welds marked on them. However, it is the responsibility of the Contractor to provide adequate number of field welds. Wherever errors / omissions/ mismatches occur in drawings and Bills of Materials it shall be the Contractor's responsibility to notify the Engineer-in-Charge prior to fabrication or erection.

## 4.3 IBR Piping

- 4.3.1 Contractor shall obtain approval for the piping systems falling under purview of IBR from the statutory Indian Boiler Regulations (IBR) authority of the state where the plant is situated. The Owner shall provide documentation for the IBR System. The Contractor shall carry out the fabrications, erection and testing of this piping as per requirements of Indian Boiler Regulations and to the entire satisfaction of the local Boiler Inspector. The Contractor shall also get the approval of IBR inspector for all fabrication and testing done by him at his own cost. All certificates of approval shall be in proper IBR forms.

- 4.3.2 IBR Package for residual, field routed and site modified steam lines shall be prepared by the Contractor. IBR approval for the same shall be in Contractor's scope, at his own cost.

#### 4.4 Pipe Joints

The piping class of each line specifies the type of pipe joints to be adopted. In general, joining of lines 2" and above in process and utility piping shall be accomplished by butt-welds. Joining of lines 1-1/2" and below shall be by socket welding/butt welding/threaded joints as specified in "Piping Material Specifications". However, in piping 1-1/2" and below where socket welding/ threaded joints are specified butt - welds may be used with the approval of Engineer-in-Charge for pipe to pipe joining in long runs of piping. This is only applicable for non-galvanized piping without lining.

Flange joints shall be used at connections to Vessels, Equipment's, Valves and where required for ease of erection and maintenance as indicated in drawings.

#### 4.5 Butt Welded and Socket Welded Piping

End preparation, alignment and fit-up of pipe pieces to be welded, welding, pre-heating, post-heating and heat treatment shall be as described in the Job welding specification (\*\*\*\*-6-77-0005) and NDT specification (\*\*\*\*-6-44-0016).

#### 4.6 Screwed Piping

In general, Galvanized piping shall have threads as per IS:554 or ANSI B2.1 NPT as required to match threads on fittings, valves etc. All other piping shall have threads as per ANSI B2.1, tapered unless specified otherwise.

Threads shall be clean cut, without any burrs or stripping and the ends shall be reamed. Threading of pipes shall be done preferably after bending, forging or heat treating operations. If this is not possible, threads shall be gauge checked and chased after welding heat treatment etc.

During assembly of threaded joints, all threads of pipes and fittings shall be thoroughly cleaned of cuttings, dirt, oil or any other foreign matter. The male threads shall be coated with thread sealant and the joint tightened sufficiently for the threads to seize and give a leakproof joint. Threaded joints to be seal-welded shall be cleaned of all foreign matter, including sealant and made up to full thread engagement before seal welding.

It is the responsibility of the contractor to ensure leak proof joints and to maintain good workmanship handling or making threads during assembly.

#### 4.7 Flange Connections

All flange facings shall be true and perpendicular to the axis of pipe to which they are attached. Flanged bolt holes shall straddle the normal centerlines unless different orientation is shown in the drawing.

Wherever jack screws are to be provided, drilling and tapping for the jack screws in the flange, shall be done as per EIL Standard before welding it to the pipe.

#### 4.8 Branch Connections

Branch connections shall be as indicated in the piping material specifications. For end preparation, alignment, spacing, fit-up and welding of branch connections refer welding specifications. Templates shall be used wherever required to ensure accurate cutting and proper fit-up.

For all branch connections accomplished either by pipe to pipe connections or by using forged tees the rates quoted for piping shall be inclusive of this work.

Reinforcement pads shall be provided wherever indicated in drawings/ specifications etc. Reinforcement pads shall be pneumatically tested at 1.05 kg/cm<sup>2</sup>g with soap solution. This test shall be carried out before hydrostatic testing.

#### 4.9 Bending

Bending shall be as per ASME B31.3 except that corrugated or creased bends shall not be used.

Cold bends for lines 1-1/2" and below, with a bend radius of 5 times the nominal diameter shall be used as required in place of elbows wherever allowed by piping specifications. Bending of pipes 2" and above may be required in some cases like that for headers around heaters, reactors etc.

The completed bend shall have a smooth surface, free from cracks, buckles, wrinkles, bulges, flat spots and other serious defects. They shall be true to dimensions. The flattening of a bend, as measured by the difference between the maximum and minimum diameters at any cross-section, shall not exceed 8% and 3% of the nominal outside diameter, for internal and external pressure respectively.

#### 4.10 Forging and Forming

Forging and forming of small bore fittings, like reducing nipples for piping 1-1/2" and below, shall be as per ASME B 31.3.

#### 4.11 Mitre Bends and Fabricated Reducers

The specific application of welded mitre bends and fabricated reducers shall be governed by the Piping Material Specifications. Reducers shall be fabricated as per directions of Engineer-in-Charge. The radiographic requirements shall be as per Material Specifications for process and utility systems and NDT Specification for steam piping under IBR, radiographic requirements of IBR shall be complied with.

#### 4.12 Cutting and Trimming of Standard Fittings & Pipes

Components like pipes, elbows, couplings, half-couplings etc. shall be cut / trimmed / edge prepared wherever required to meet fabrication and erection requirements, as per drawings and instructions of Engineer-in-Charge. Nipples as required shall be prepared from straight length piping.

#### 4.13 Galvanized Piping

Galvanized carbon steel piping shall be completely cold worked, so as not to damage galvanized surfaces. This piping involves only threaded joints and additional external threading on pipes may be required to be done as per requirement.

#### 4.14 Jacketed Piping

The Jacketing shall be done in accordance with EIL Specification or Licensors specification as suggested in material specification or special condition of contract.

Pre-assembly of jacketed elements to the maximum extent possible shall be accomplished at shop by Contractor. Position of jump-over and nozzles on the jacket pipes, fittings etc. shall be marked according to pipe disposition and those shall be prefabricated to avoid damaging of inner pipe and obstruction of jacket space. However, valves, flow glasses, in line instruments or even fittings shall be supplied as jacketed.

#### 4.15 Shop Fabrication / Prefabrication

The purpose of shop fabrication or pre-fabrication is to minimize work during erection to the extent possible. Piping spool, after fabrication, shall be stacked with proper identification marks, so as facilitate their withdrawal at any time during erection. During this period all flange (gasket contact faces) and threads shall be adequately fabricated by coating with removable rust preventive. Care shall also be taken to avoid any physical damage to flange faces and threads.

#### 4.16 Miscellaneous

4.16.1 Contractor shall fabricate miscellaneous elements like flash pot, seal pot, sample cooler, supporting elements like turn-buckles, extension of spindles and interlocking arrangement of valves, operating platforms as required by Engineer-in-Charge.

#### 4.16.2 Spun Concrete Lining

The work of inside spun concrete lining of pipes and specials of diameter 3" and above shall be done as per material specifications and special condition contract.

#### 4.16.3 Fabrication of pipes from plate

Pipes shall be fabricated at site as and when required as per the specifications and the actual Piping Material Specification.

### 5.0 ERECTION

#### 5.1 Cleaning of Piping before Erection

Before erection all pre-fabricated spool pieces, pipes, fittings etc. shall be cleaned inside and outside by suitable means. The cleaning process shall include removal of all foreign matter such as scale, sand, weld spatter chips etc. by wire brushes, cleaning tools etc. and blowing with compressed air/or flushing out with water. Special cleaning requirements for some services, if any, shall be as specified in the piping material specification or isometric or line list. S.S jacketed piping requiring pickling shall be pickled to remove oxidation and discolouring due to welding.

#### 5.2 Piping Routing

No deviations from the piping route indicated in drawings shall be permitted without the consent of Engineer-in-Charge.

Pipe to pipe, pipe to structure / equipments distances / clearances as shown in the drawings shall be strictly followed as these clearances may be required for the free expansion of piping

/ equipment. No deviations from these clearances shall be permissible without the approval of Engineer-in-Charge.

In case of fouling of a line with other piping, structure, equipment etc. the matter shall be brought to the notice of Engineer-in-Charge and corrective action shall be taken as per his instructions.

### 5.3 Cold Pull

Wherever cold pull is specified, the Contractor shall maintain the necessary gap, as indicated in the drawing. Confirmation in writing shall be obtained by the Contractor from the Engineer-in-Charge, certifying that the gap between the pipes is as indicated in the drawing, before drawing the cold pull. Stress relieving shall be performed before removing the gadgets for cold pulling.

### 5.4 Slopes

Slopes specified for various lines in the drawings / P&ID shall be maintained by the Contractor. Corrective action shall be taken by the Contractor in consultation with Engineer-in-Charge wherever the Contractor is not able to maintain the specified slope.

### 5.5 Expansion Joints / Bellows

Installation of Expansion Joints/Bellows shall be as follows:

5.5.1 All Expansion joints / Bellows shall be installed in accordance with the specification and installation drawings, supplied to the Contractor.

5.5.2 a. Upon receipt, the Contractor shall remove the Expansion Joints/ Bellows from the case(s) and check for any damage occurred during transit.

b. The Contractor shall bring to the notice of the Engineer-in- Charge any damage done to the bellows / corrugations, hinges, tie-rods, flanges/ weld ends etc.

c. Each Expansion Joint / Bellow shall be blown free of dust / foreign matter with compressed air or cleaned with a piece of cloth.

5.5.3 a. For handling and installation of Expansion Joints, great care shall be taken while aligning. An Expansion Joints shall never be slinged from bellows corrugations/ external shrouds, tie / rods, angles.

b. An Expansion Joints / Bellow shall preferably be slinged from the end pipes / flanges or on the middle pipe.

5.5.4 a. All Expansion Joints shall be delivered to the Contractor at "Installation length", maintained by means of shipping rods, angles welded to the flanges or weld ends or by wooden or metallic stops.

b. Expansion Joints stop blocks shall be carefully removed after hydrostatic testing. Angles welded to the flanges or weld ends shall be trimmed by saw as per manufacturer's instructions and the flanges or weld ends shall be ground smooth.

5.5.5 a. The pipe ends in which the Expansion Joint is to be installed shall be perfectly aligned or shall have specified lateral deflection as noted on the relevant drawings.

b. The pipe ends / flanges shall be spaced at a distance specified in the drawings.

- 5.5.6 The Expansion Joint shall be placed between the mating pipe ends / flanges and shall be tack welded/bolted. The mating pipes shall again be checked for correct alignment.
- 5.5.7 Butt-welding shall be carried out at each end of the expansion joint. For flanged Expansion Joint, the mating flanges shall be bolted.
- 5.5.8 After the Expansion Joint is installed the Contractor shall ensure that the mating pipes and Expansion Joints are in correct alignment and that the pipes are well supported and guided.
- 5.5.9 The Expansion Joint shall not have any lateral deflection. The Contractor shall maintain parallelism of restraining rings or bellows convolutions.
- 5.5.10 Precautions
- For carrying out welding, earthing lead shall not be attached with the Expansion Joint.
  - The Expansion bellow shall be protected from arc weld spot and welding spatter.
  - Hydrostatic Testing of the system having Expansion Joint shall be performed with shipping lugs in position. These lugs shall be removed after testing and certification is over.

## 5.6 Flange Connections

While fitting up mating flanges, care shall be exercised to properly align the pipes and to check the flanges for trueness, so that faces of the flanges can be pulled together, without inducing any stresses in the pipes and the equipment nozzles. Extra care shall be taken for flange connections to pumps, turbines, compressors, cold boxes, air coolers etc. The flange connections to these equipments shall be checked for misalignment, excessive gap etc. after the final alignment of the equipment is over. The joint shall be made up after obtaining approval of Engineer-in-Charge.

Hydraulic bolt tensioning & torque tensioning shall be performed on flange joints as per the requirements specified in "Standard Specification for application of Torque & Hydraulic Bolt Tension for flange joints," 6-76-0002 and its addendum, if any.

Temporary protective covers shall be retained on all flange connections of pumps, turbines, compressors and other similar equipments, until the piping is finally connected, so as to avoid any foreign material from entering these equipments.

The assembly of a flange joint shall be done in such a way that the gasket between these flange faces is uniformly compressed. To achieve this, the bolts shall be tightened in a proper sequence. All bolts shall extend completely through their nuts but not more than 1/4".

Steel to C.I. flange joints, if any, shall be made up with extreme care, tightening the bolts uniformly after bringing flange flush with gaskets with accurate pattern and lateral alignment.

## 5.7 Vents and Drains

High point vents and low point drains shall be provided as per the instructions of Engineer-in-Charge, even if these are not shown in the drawings. The details of vents and drains shall be as per piping material specifications / job standards.

## 5.8 Valves

Valves shall be installed with spindle / actuator orientation / position as shown in the layout drawings. In case of any difficulty in doing this or if the spindle orientation / position is not shown in the drawings, the Engineer-in-Charge shall be consulted and work done as per his instructions. Care shall be exercised to ensure that globe valves, check valves, and other uni-directional valves are installed with the "Flow direction arrow" on the valve body pointing in the correct direction. If the direction of the arrow is not marked on such valves, this shall be done in the presence of Engineer-in-Charge before installation.

Fabrication of stem extensions, locking arrangements, interlocking arrangements of valves (if called for) and change in orientation of spindles (if required as per site conditions) shall be carried out as per drawings/ instructions of Engineer-in-Charge.

## 5.9 Instruments

Installation of in-line instruments such as control valve, orifice flange, rotameter, safety valves, restriction orifice, rupture disc, de-super heaters, corrosion probes, annubar, magnetic flow meter, ultrasonic flow meter, Coriolis mass flow meters, venturi PG/PT/ Flow transmitter, ejectors, etc. and Shut Down Valves with fireboxes shall form a part of piping erection work.

Fabrication and erection of piping upto first block valve / nozzle / flange for installation of offline Instruments for measurement of level, pressure, temperature, flow etc. shall also form part of piping construction work. The limits of piping and instrumentation work will be shown in drawings / standards / specifications. Orientations / locations of take-offs for temperature, pressure, flow, level connections etc. shown in drawings shall be maintained.

Flushing and testing of piping systems which include instruments mentioned above and the precautions to be taken are covered in flushing, testing and inspection of piping (EIL Spec. 6-44-0013). Care shall be exercised and adequate precautions taken to avoid damage and entry foreign matter into instruments during transportation, installation, testing etc.

## 5.10 Line Mounted Equipments / Items

Installation of line mounted items like filters, strainers, steam traps, air traps, desuperheaters, ejectors, samples coolers, mixers, flame arrestors, sight glasses etc including their supporting arrangements shall form part of piping erection work.

## 5.11 Bolts and Nuts

The Contractor shall apply molycoat grease mixed with graphite powder (unless otherwise specified in piping classes) all bolts and nuts during storage, after erection and wherever flange connections are broken and made-up for any purpose whatsoever. The grease and graphite powder shall be supplied by the Contractor within the rates for piping work.

## 5.12 Pipe Supports

Pipe supports are designed and located to effectively sustain the weight and thermal effects of the piping system and to prevent its vibrations. Location and design of pipe supports will be shown in drawings for lines 2" NB & above. For lines 1½"NB & below Contractor shall locate and design pipe supports in line with EIL Stds. In case of IBR Lines 1½"NB & below only indicative supporting shall be provided & detailing of such supports is in Contractor's scope. Contractor shall obtain approval of Engineer - in - Charge on drawings prepared by Contractor, before erection. However, any extra supports desired by Engineer-in-Charge shall also be installed. Upon issue of drawings contractor to prepare BOM for support members in

contractor's scope for procurement action. Pipe shall be erected along with the primary support to the maximum extent to minimize works at height.

No pipe shoe / cradle shall be offset unless specifically shown in the drawings.

Hanger rods shall be installed inclined in a direction opposite to the direction in which the pipe move during expansion.

Piping (including small bore) shall not be supported directly from gratings of platforms including equipment platforms.

Preset pins of all spring supports shall be removed only after hydrostatic testing and insulation is over. Springs shall be checked for the range of movement and adjusted if necessary to obtain the correct positioning in cold condition. These shall be subsequently adjusted to hot setting in operating condition. The following points shall be checked after installation, with the Engineer-in-Charge and necessary confirmation in writing obtained certifying that:

- All restraints have been installed correctly.
- Clearances have been maintained as per support drawings.
- Insulation does not restrict thermal expansion.
- All temporary tack welds provided during erection have been fully removed.
- All welded supports have been fully welded.

### 5.13 Dismantling and Modifications

Dismantling/ modification of erected piping shall be carried out, if required for routing of lines as per revised Isometrics. All necessary clearances have to be taken by contractor from Engineer-in-charge.

पइपिंग निकायों के निरीक्षण, प्रक्षालन तथा  
परीक्षण हेतु मानक विनिर्देश

**STANDARD SPECIFICATION FOR  
INSPECTION, FLUSHING AND  
TESTING OF PIPING SYSTEMS**

6	28.09.23	REVISED & ISSUED AS STANDARD SPECIFICATION	ABA	SH	GB	SM	
5	31.07.18	REAFFIRMED&ISSUED AS STANDARD SPECIFICATION	PK	SH	MI	RKT	
4	01.07.13	REVISED & ISSUED AS STANDARD SPECIFICATION	UK	SH	RN	ATD	DM
3	27.08.07	REVISED & ISSUED AS STANDARD SPECIFICATION	RN	ATD	DM	VC	
2	05.06.03	PMI REQT. INCLUDED AND ISSUED AS STANDARD SPECIFICATION	RN	DM	BN	SKG	
<b>Rev. No</b>	<b>Date</b>	<b>Purpose</b>	<b>Prepared by</b>	<b>Checked by</b>	<b>Standards Committee Convonor</b>	<b>Standards Bureau Chairman</b>	<b>Approved by</b>

**Abbreviations:**

ASME :	The American Society of Mechanical Engineers
IBR :	Indian Boiler Regulations
PMI :	Positive Material Identification
ppm :	Parts per million
SS :	Stainless Steel

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## 1.0 SCOPE

This specification covers the general requirements for inspection, flushing and testing of piping systems. However, testing of steam lines falling under IBR shall also be governed by Indian Boiler Regulations.

Flushing and testing of all piping systems shall be witnessed by the Engineer-In-Charge.

## 2.0 REFERENCES

ASME B31.3	:	Process Piping
IBR	:	Indian Boiler Regulations
6-82-0002	:	Standard Specification for Positive Material Identification (PMI) at Construction Sites

## 3.0 INSPECTION

During various stages and after completion of fabrication and erection, the piping system shall be inspected by the Engineer-In-Charge to ensure that:

- Proper piping material has been used.
- PMI has been performed as per EIL specification '6-82-0002'.
- Piping has been erected as per drawings and instructions of Engineer-In-Charge.
- All supports have been installed correctly.
- Test preparations mentioned in this specification have been carried out.

## 4.0 FLUSHING

Flushing of all lines shall be done before pressure testing.

Flushing shall be done by 'fresh potable water' or by 'dry compressed air wherever water flushing is not desirable to clean the pipe of all dirt, debris or loose foreign material.

Required pressure for water flushing shall meet the fire hydrant pressure or utility water pressure. For air flushing, the line/system shall be pressurized by compressed air at the required pressure which shall be 3.5kg/cm<sup>2</sup>g maximum. The pressure shall then be released by quick opening of a valve, already in line or installed temporarily for this purpose. This procedure shall be repeated as many times as required till the inside of the pipe is fully cleaned.

In line instruments like control valves, orifice plates, rotameters, safety valves and other instruments like thermowells which may interfere with flushing shall not be included in flushing circuit.

The screens/meshes shall be removed from all permanent strainers before flushing. Screens/meshes shall be reinstalled after flushing but before testing.

During flushing temporary strainers shall be retained. These shall be removed, cleaned and reinstalled after flushing, but, before testing.

In case any equipment such as column, vessel, exchanger etc. form part of a piping circuit during flushing, this shall be done with the approval of Engineer-In-Charge. However, equipment thus included in the circuit shall be completely drained and dried with compressed air after flushing is completed.

During flushing discharged water/air shall be drained to the place directed by the Engineer-In-Charge. If necessary, proper temporary drainage shall be provided by the contractor.

Care shall be taken during flushing so as not to damage/spoil work of other agencies. Precautions shall also be taken to prevent entry of water/foreign matter into equipment, electric motors, instruments, electrical installations etc. in the vicinity of lines being flushed.

The contractor shall carry out all the activities required before, during and after the flushing operation, arising because of flushing requirements, such as but not limited to the following:

Dropping of valves, specials, distance pieces, inline instruments and any other piping part before flushing. The flanges to be disengaged for this purpose shall be envisaged by the contractor and approved by the Engineer-In-Charge. These flanges shall be provided with temporary gaskets at the time of flushing.

After flushing is completed and approved, the valve distance pieces, piping specials etc. shall be reinstalled by the contractor with permanent gaskets. However, flanges at equipment nozzles and other places where isolation is required during testing, only temporary gaskets shall be provided.

Records in triplicate shall be prepared and submitted by the contractor for each piping system for the flushing done in the proforma provided/approved by the Engineer-in-Charge.

## 5.0 PRESSURE TESTING

Pressure testing, in general shall be as per clause 345 of ASME B31.3, unless otherwise specified, herein. Lines carrying highly hazardous/poisonous fluids must have a sensitive leak test. For IBR lines, 'IBR Regulations' shall also be followed.

### 5.1 Extent of Testing

With the exclusion of instrumentation, piping systems fabricated or assembled in the field shall be tested irrespective of whether or not they have been pressure tested prior to site welding or fabrication.

To facilitate the testing of piping systems, vessels and other equipment may be included in the system with the prior approval of Engineer-In-Charge if the test pressure specified is equal to or less than that for the vessels and other equipment.

Pumps, compressors and other rotary equipment shall not be subjected to field test pressure.

Lines which are directly open to atmosphere such as vents, drains, safety valves discharge need not be tested, but all joints shall be visually inspected. Wherever necessary, such lines shall be tested by continuous flow of fluid to eliminate the possibility of blockage. However, such lines if provided with block valve shall be pressure tested up to the last block valve.

Seats of all valves shall not be subjected to a pressure in excess of the maximum cold working pressure of the valve. Test pressure applied to valves shall not be greater than the manufacturer's recommendation nor less than that required by the applicable code. Where allowable seat pressure is less than test pressure, test shall be made through an open valve.

Instruments in the system to be tested shall be excluded from the test by isolation or removals, unless approved otherwise by the Engineer-In-Charge.

Restrictions which interfere with filling, venting, draining such as orifice plates etc. shall not be installed unless testing is complete.

Control valves shall not be included in the test system. Where bypasses are provided test shall be performed through the bypass and/or necessary spool shall be used in place of the control valve.

Pressure gauges which are part of the finished system, but cannot withstand test pressure shall not be installed until the system has been tested. Where piping systems to be tested are directly connected at the battery limits to piping for which the responsibility rests with other agencies, the piping to be tested shall be isolated from such piping by physical disconnection such as valve or blinds.

## 5.2 General Requirements / Test Preparation for Testing

Testing shall be carried out with permanent gaskets installed unless specified otherwise or instructed by the Engineer-in-Charge.

No pressure test shall be carried out against closed valve unless approved by the Engineer-in-Charge

The Engineer-in-Charge shall be notified in advance by the Contractor, of the testing sequence and programme, to enable him to be present for witnessing the test. The Contractor shall be fully responsible for making arrangements with the local boiler inspector to witness the tests for steam lines falling under IBR. IBR certificates for these tests shall be obtained in the relevant IBR forms and furnished to the Engineer-in-Charge.

Before testing, all piping shall be cleaned by flushing to make it free from dirt, loose scale, debris and other loose foreign materials.

All piping systems to be hydrostatically tested shall be vented at the high points and the systems purged of air before the test pressure is applied.

Wherever in the line any void exists due to any reasons, like absence of control valves, safety valves, check valves etc. it shall be filled with temporary spools.

All joints welded, screwed or flanged shall be left uninsulated and exposed for examination during the test. Before pressurizing the lines, each weld joint shall be cleaned by wire brush to free it from rust and any other foreign matter. All joints may be primed and painted prior to leak testing unless they are subject to sensitive leak test or testing with soap solution (e.g., reinforcement pads and lines to be pneumatically tested, etc.).

Where a system is to be isolated at a pair of companion flanges, a blank shall be inserted between the companion flanges. Minimum thickness of the blank shall be designed in accordance with applicable design code.

Open ends of piping system where blanks cannot be used, such as pumps, compressors, turbines or wherever equipment or pipe spools have been recovered or disconnected prior to hydrostatic testing, shall be blinded off by using standard blind flanges of same rating as the piping system being tested.

Pressure gauges used in testing shall be installed as close as possible to the lowest point in the piping system to be tested, to avoid overstressing of any of the lower portions of the system.