CONSTRUCTION STANDARD

FOR

PLANT PIPING SYSTEMS

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1. SCOPE

All shop or field fabrication, assembly and installation of process and utility piping system in oil, gas and petrochemical plants shall be performed according to relevant sections of ASME/ANSI B 31.1 and B 31.3 as applicable. Additional requirements are specified in this Standard. In case of conflict between this Standard and above-mentioned ANSI/ASME standards, the requirements of this Standard shall govern.

2. REFERENCES

Throughout this Standard the following standards and codes are referred to. The editions of these standards and codes that are in effect at the time of publication of this Standard shall to the extent specified herein, form a part of this Standard. The applicability of changes in standards and codes that occur after the date of this Standard shall be mutually agreed upon by the Company and the Vendor.

ANSI (AMERICAN NATIONAL STANDARD INSTITUTE)

ANSI/ASME B.1.20.1	"Pipe Threads, General Purpose"
ANSI/ASME B.31.1	"Power Piping"
ANSI/ASME B.31.3	"Chemical Plant and Petroleum Piping"

IPS (IRANIAN PETROLEUM STANDARDS)

IPS-E-TP-100	"Paints"
IPS-C-IN-100/2	"Instrument Installation Procedure"
IPS-C-TP-101	"Surface Preparation"
IPS-C-TP-102	"Painting"
IPS-D-PI-126	"Steam Tracing Details"
IPS-E-PI-240	"Plant Piping Systems"
IPS-C-TP-274	"Coating"
IPS-G-PI-280	"Pipe Supports"
IPS-C-PI-290	"Welding of Plant Piping System"
IPS-C-PI-350	"Plant Piping System Pressure Testing"
IPS-C-PI-410	"Inside Pipe Cleaning"
IPS-C-TP-701	"Thermal Insulating"

3. DEFINITIONS AND TERMINOLOGY

For the purpose of this Standard, the following definitions and terminology shall hold:

3.1 Engineer

The Engineer referred to in this Standard is a person or a body appointed in writing by the Company.

3.2 Executor

Executor is the party which carries out all or part of construction and/or commissioning for the project.

3.3 Inspector

The Inspector referred to in this Standard is a person/persons or a body appointed in writing by the Engineer for the inspection of pipework fabrication and installation.

4. ABBREVIATIONS

4.1 "FW" Denotes "Field Weld".

4.2 "NDT" Denotes "Non-Destructive Testing".

4.3 "PTFE" Denotes "Polytetrafluoroethylene".

5. UNITS

This Standard is based on International System of Units (SI), except where otherwise specified.

6. GENERAL REQUIREMENTS

6.1 Documentations

All documents cited hereunder shall be submitted to the Engineer for his review and/or approval.

6.1.1 Documentations to be prepared before commencement of pipework. The documents shall include but not limited to the following:

6.1.1.1 Quality plan

The quality plan shall include details and the sequence of all examinations that will be performed for control of the executor's work. The names of the individuals responsible for the implementation of all quality assurance and quality control functions shall also be included.

6.1.1.2 Recording system

The Executor shall establish and maintain documented procedures for identification, collection, indexing, access filing, storage, maintenance and disposition of the quality record.

6.1.1.3 Procedures

The procedures shall include but not limited to the following:

a) material take over, handling and storage;
b) material and consumable control;
c) welding;
d) N.D.T.;
e) mechanical working;
f) heat treatment;
g) mechanical cleaning;
h) chemical cleaning;
i) hydrostatic testing;
j) precommissioning and commissioning.

6.1.1.4 Other documents

a) welding procedure qualification record and welder performance qualification record as per IPS-C-PI-290;
b) work program.

6.1.2 Documentations to be prepared during execution of pipework.

The Executor shall maintain the following records:

a) material and consumable control;
b) marked up isometric drawings;
c) visual and dimensional inspection report;
d) N.D.T. reports;
e) post weld heat treatment reports;
f) remedial action reports;
g) hydrotest reports;
h) any agreed deviation from Job Specification;

6.1.3 Documents to be prepared after completion of Pipework:

a) As built drawings,
b) certificate of Compliance with Job Specification.

6.2 On completion of pipework all documents mentioned under 6.1 of this Standard shall be submitted to the Engineer in numbers Specified in Contract.

6.3 All pipework shall be identified by indelible marking, free from sulphur, chloride and other halogens. When spools will be subject to post-weld heat treatment a suitable titanium oxide pigmented heat resisting paint shall be used.

All applied marking shall have a life of at least one year under site condition.

The marking applied shall identify the material and the fabricator and include an item number enabling the spool to be traced to the relevant isometric drawing.

7. FABRICATION

7.1 General

7.1.1 All materials included in the finished piping systems shall be undamaged & fully in accordance with the piping material indicated on Isometric/Piping Plan Drawing. Substitutions including heavier or thicker materials are not permitted without written approval of the Engineer.

7.1.2 All weld numbers and welder's identification number shall be painted close to the weld, to enable traceability of each weld and each welder.

7.1.3 To allow easy and quick reference during handling and storage, the Executor shall maintain the color coding on piping.

7.1.4 The Executor shall provide identification marks on leftover pipe length whenever marked up pipe lengths have been fabricated/erected.

7.1.5 All protective coverings of piping for shipment and shipping containers shall be of sturdy construction to withstand normal shipping abuse.

7.1.6 Piping shall be stored in a relatively clean, dry or well drained area on elevated dunnage and protected against contact with salts or salty water.

7.1.7 On all lines DN 80 (NPS 3) and over, pipe clamps shall be used to maintain alignment when welding pipes together, both in executor's pipe fabrication shop and, on site of overground piping.

7.1.8 All piping shall be fabricated in strict accordance with isometric spool drawings. If spool drawings are not furnished, piping shall be fabricated to the dimensions shown on the piping arrangement drawings.

7.1.9 All "FW" located by dimension shall be held to dimensions noted. Additional field welds, other than those indicated on the spool drawings, which may be required to suit handling may be added by the Executor.

7.1.10 The Executor shall be responsible for working to the dimensions shown on the drawings. However, executor shall bear in mind that there may be variations between the dimensions shown in the drawings & those actually occurring at site due to minor variations in the location of equipment, inserts etc. The executor shall take care of these variations.

Isometric, if supplied, may have the field welds marked on them. However, it is the responsibility of the Executor to provide adequate number of "FW".

Wherever errors/omissions occur in the drawings and bills of material, it shall be the Executor's responsibility to notify the Engineer prior to fabrication or erection.

7.2 Dimensional Tolerances

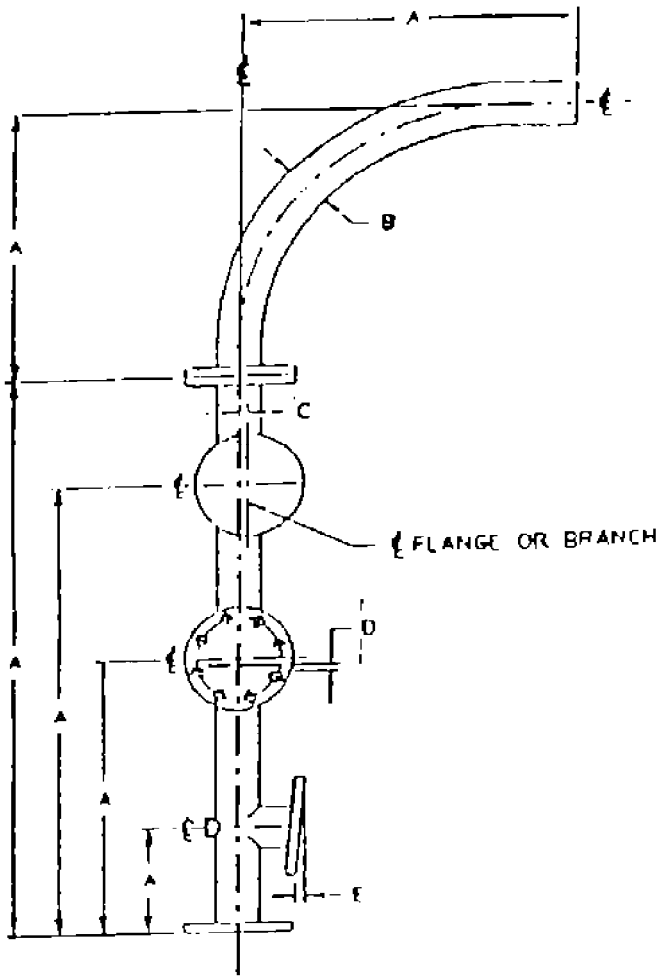
The tolerances listed in the following paragraphs are permissible maximums. These tolerances pertain to all piping including alloy.

7.2.1 General dimensions such as face to face, face or end to end, face or end to center and center to center shall be ±3 mm (see Fig. 1 Item A). Tolerances shall not be cumulative.

7.2.2 Flange Bolt Holes shall straddle to vertical, horizontal or North-South centerline unless otherwise noted. Rotation of flange bolt holes shall not exceed 1.5 mm measured across the flange face parallel to a centerline and between the holes nearest to it. (see Fig. 1 Item D).

7.2.3 Inclination of flange face from true, in any direction shall be 4 mm per meter. (see Fig. 1 Item E).

7.2.4 Displacement of branch connection from indicated location shall be ±1.5 mm. (see Fig. 1 Item C).



ITEM	NORMAL SERVICE CONDITIONS	OPERATION TEMP. > 460°C PN ≥ 150 (RATING 900)
A	±3 mm max. from indicated dimension for face to face, center to face, location of attachments	
B	max. 8% of dia. (for Int. press) max. 3% of dia. (for Ext. press)	max. 2% of dia.
	Flattening measured as difference between the max. and min. diameter at any cross section of bends.	
C	±1.5 mm max. lateral translation of branches or connections	±0.75 mm max. lateral translation of branches or connections
D	±1.5 mm max. rotation of flanges from the indicated position measured as shown	
E	$4\ ^{mm}/_{meter}$	$2\ ^{mm}/_{meter}$

DIMENSIONAL TOLERANCES FOR FABRICATED PIPEWORK
Fig. 1

7.2.5, The difference between maximum and minimum diameter at any cross section of bends performed by the executor shall not be more than 8% of diameter (for internal pressure) and more than 3% of diameter (for external pressure); see Fig. 1, Item B in this respect.

7.3 Pipe Joints

7.3.1 Longitudinal seams in adjoining lengths of welded pipe shall be staggered over a distance of at least 5 times the wall thickness of pipe measured over the circumference of the pipe or by approximately 30 degree off-set, so that they do not form a continuous line at a butt welding joint.

Longitudinal welds shall be located at the top, 90 degree of the pipe spool and shall also clear branch connections and other welded attachments.

7.3.2 The toes of adjacent circumferential butt welds shall be no closer than four times the nominal thickness of the pipe, in the case of DN 300 (NPS 12) and below, with a minimum acceptable separation of 50 mm. For nominal diameter greater than DN 300 (NPS 12) the minimum acceptable separation shall be 100 mm.

7.4 Welding

7.4.1 End preparation, alignment and fit-up of pipe pieces to be welded, preheating, welding, post heating, inspection and post weldheat treatment shall conform to this Standard and IPS-C-PI-290. "Welding of Plant Piping Systems".

7.4.2 Austenitic stainless steel weld deposits shall have a ferrite content of 3 to 10 percent. One deposited weld metal sample shall be taken for every 30 linear meter of welding and shall be checked for carbon, chromium, nickel, silicon, molybdenum, manganese and columbium content. These analyses shall be used to determine the ferrite content by the Schaeffler Diagram. When approved by the Engineer, the ferrite scope may be used as an alternative method to verify ferrite content. The Ferritescope shall be used prior to weld heat treatment.

7.4.3 Branch and non-pressure part attachment welds should not cross longitudinal seams or circumferential butt welds and shall be subject to the toe to toe separation distance specified for circumferential butt welds.

Where such intersections are unavoidable the main weld shall be subject to non-destructive examination prior to making the attachment weld. The extent of examination shall be at least twice the diameter of the branch pipe measured from the center line of the branch.

7.4.4 Joints involving the intersection of more than two welds shall be avoided.

7.4.5 Joints to be seal welded shall be made up clean and without the use of tape or any compound. Welding shall be performed in accordance with the qualified procedure by a qualified welder. All exposed threads shall be covered by the seal weld.

7.5 Screwed Piping (Threaded Joints)

7.5.1 If threading of piping is performed, the threads shall be standard taper pipe threads, concentric with the outside diameter of the pipe in accordance with ANSI B1.20.1.

7.5.2 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 gage checked and chased after welding, heat treatment, etc.

7.5.3 During assembly of threaded joints, all threads of pipes and fittings shall be thoroughly cleaned of cuttings, dirt, oil or any other foreign matter.

7.5.4 A thread compound or lubricant shall be used for all assemblies except where seal welded, in particular to prevent galling with stainless steel bolting. It shall be suitable for the service conditions and not react unfavorably with the service fluid, the bolts, gaskets or piping material.

7.6 Flanged Joints

7.6.1 All flange facings shall be true and perpendicular to the axis of pipe to which they are attached.

7.6.2 Slip-on flanges, when specified, and reducing flanges shall be welded both inside and outside. If the inside weld extends beyond the face of the flange, it shall be finished flush. Flange faces shall be free from weld spatter, mars and scratches.

7.6.3 Orifice flange taps shall be located in the exact orientation shown on the spool drawing and the inside surface of orifice flanges shall be made smooth and clear of any weld spatter that has penetrated through. The sections of pipe to which the orifice flanges are attached shall be smooth and free from blisters and scale.

7.7 Branch Connections

Branch connection and its reinforcement shall be in accordance with IPS-E-PI-240, "Piping Plan and Isometric Drawings".

7.8 Bending and Forming

7.8.1 General

Galvanized carbon steel piping, if required, shall be cold bended so as not to damage galvanized surfaces.

7.8.1.1 Bending of pipes shall only be done where indicated on the isometric drawings.

7.8.1.2 If the pipe contains a longitudinal weld, this weld shall be located in the neutral zone.

7.8.1.3 A detailed bending procedure shall be supplied by the Executor for the Engineer's approval. Bending operations shall not start until procedure has been approved by the Engineer.

The bending procedure shall include the following as a minimum:

a) bending process;
b) heating method, the heating rate, the minimum and maximum bending temperatures;
c) traveling speed of the pipe;
d) method of cooling;
e) inspection procedures, dimensional, visual and nondestructive testing;
f) heat treatments, if applicable.

7.8.2 Cold bending

7.8.2.1 Cold pipe bending, normally up to DN 80 (NPS 3) shall be done in pipe bending machines or presses using formers. No wrinkling, excessive thinning or flattening is allowed. Excessive scratches, gages or die marks shall be grinded for thickness measurement; if the remaining thickness is less than minimum requirement it shall be rejected.

7.8.2.2 Cold bending of ferritic materials shall be done at a temperature below the transformation range. The maximum allowable temperature for cold bending is shown in Table 1.

7.8.2.3 When heating is applied during cold bending of stainless steel pipe the heat shall be applied uniformly and shall be carefully controlled. Local heating by hand held torches, or water cooling, is not permitted.

TABLE 1 - MAX. TEMPERATURE FOR COLD BENDING

MATERIAL	MAX. TEMP. FOR COLD BENDING
Carbon ½% Mo Alloy Steel	640°C
1% Cr ½% Mo Alloy Steel	640°C
1¼% Cr ½% Mo Alloy Steel	640°C
2¼% Cr 1% Mo Alloy Steel	680°C
4 to 6% Cr ½% Mo Alloy Steel	690°C
6 to 8% Cr ½% Mo Alloy Steel	690°C
8 to 10% Cr ½% Mo Alloy Steel	690°C
Austenitic Stainless Steel	425°C
Duplex Stainless Steel	300°C

7.8.3 Hot bending

7.8.3.1 Hot bending shall be done at a temperature above the transformation range and in any case within a temperature range consistent with the material and the intended service. This temperature is normally between 900°C and 1100°C.

7.8.3.2 For hot bending preferably the induction bending process shall be used, which is defined as a hot forming process involving bending machines in which the pipes are passed through and induction coil where successively a narrow band of pipe material is rapidly heated at the required bending temperature using the high frequency induction method:

a) It shall be assured that the bending temperature is uniform for the complete circumference of the bend. (Induction ring with square profile to be used.)

b) The adjacent pipe material shall be kept cool by water and/or air jets, thus providing the necessary support for the heated area without the need of mandrels.

c) The proposed hot bending process shall be prequalified by a test bend, which shall be mechanical and nondestructive inspected. These prequalifications shall be included in the bending procedure to be submitted to the Engineer for approval.

Previous production records which include mechanical and nondestructive testing can also be used as a prequalification.

7.8.3.3 When hot bending technique is used, the bend shall be subsequently heat treated, i.e. annealed or normalized and tempered, according to Table 2 of IPS-C-PI-290.

7.9 Cutting and Trimming of Standard Fittings

Fittings like elbows, coupling, etc., shall be cut/trimmed wherever required to meet fabrication and erection requirements, as per drawings or instructions of the Engineer.

7.10 Jacketed Piping

The Pre-assembly of jacketed elements to the maximum extent possible shall be accomplished at shop by the Executor.

Position of jumpovers 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.

7.11 Shop-Fabrication/Pre-Fabrication

Piping spools, after fabrication, shall be stacked with proper identification marks, so as to facilitate their withdrawal at any time during erection. During this period all flange faces (gaskets contact surfaces) and threads shall be adequately protected by coating with a removable rust preventive. Care shall also be taken to avoid any physical damage to flange faces and threads.

7.12 Piece Marking

Each fabricated spool piece shall have a mark number painted adjacent to 50 mm wide color bands running completely around the pipe, except that for austenitic chrome nickel, nickel, or high nickel alloy, the painted mark number shall be replaced by a metal tag securely attached to the pipe with metal straps.

8. FIELD INSTALLATION

8.1 General Consideration

8.1.1 During installation of stress relieved lines, care must be taken to avoid heating, peening or the development of stress concentration from any cause.

8.1.2 Before erection, all pre-fabricated spool pieces, pipes, fittings, etc., shall be cleaned internally and externally.

8.1.3 Piping to be field pickled, sandblasted, etc. as noted on the spool drawings shall be handled per IPS-C-PI-410. The Executor shall provide ample protection on all such cleaned piping to insure that it will be free and clear from all rust and corrosion products during the interim period between installation and start-up.

8.2 Piping Routing

8.2.1 No deviations from the piping route indicated in drawings shall be permitted without the approval of the Engineer.

8.2.2 Pipe to pipe, pipe to structures/equipment 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 the Engineer.

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

8.2.4 When the term "Field Route" is used on small screwed piping, the Executor shall route the piping in a neat and orderly manner consistent with good piping practice.

8.2.5 Slopes specified for various lines in the drawings shall be maintained by the Executor. Corrective action shall be taken by the Executor in consultation with the Engineer wherever Executor is not able to maintain the specified slope.

8.3 Cold Spring

8.3.1 Wherever cold spring is specified in drawing, the Executor shall maintain the necessary gap.

8.3.2 Before performing final tie-in the Executor shall obtain a written confirmation from the Engineer, indicating that the gap between the pipes is in accordance with drawing dimensions, which have been adjusted to compensate for cold spring.

8.3.3 If cold spring is not called for, lines shall not be sprung and forced into place. If prefabricated piping does not fit, it must be corrected by straightening or rewelded.

8.3.4 Stress relieving of the weld (if necessary) shall be performed before removing the gadgets for cold pulling.

8.4 Delivery, Handling and Installation of Expansion Joints

All expansion joints shall be installed in accordance with following specification and installation drawings, if any, supplied to the Executor.

8.4.1 Upon receipt, the Executor shall check for any damage occurred during transit.

8.4.2 The Executor shall bring to the notice of the Engineer any damage done to the bellows/corrugations, hinges, tie rods, flanges/weld ends, etc.

8.4.3 Each expansion joint shall be blown free of dust/foreign matter with compressed air or shall be cleaned with a piece of cloth.

8.4.4 For handling and installation of expansion joints, great care shall be taken while slinging. An expansion joint shall never be slinged with bellows corrugations/external shrouds, tie rods, angles, etc.

8.4.5 An expansion joint shall preferably be slinged on the end pipes/flanges or on the middle pipe.

8.4.6 All expansion joint shall be delivered to the Executor at "Installation Length" as will be indicated on the drawings. The "Installation Length" is maintained by means of shipping rods, angles welded to the flanges or weld ends or by wooden or metallic stops.

8.4.7 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.

8.4.8 The pipe ends/flanges shall be spaced at distance which will be specified in the drawings.

8.4.9 The expansion joint shall be placed between the mating pipe ends/flanges and shall be tack welded/ bolted for checking correct alignment of the mating pipes.

8.4.10 After the expansion joint is installed, the Executor shall ensure that matching pipes and expansion joint are in correct alignment and that the pipes are well supported and guided.

8.4.11 The expansion joint shall not have any lateral deflection. The Executor shall maintain parallelism rings or bellows convolutions.

8.4.12 Precaution to be taken during welding

8.4.12.1 For carrying out welding, earthing lead shall not be attached with the expansion joint.

8.4.12.2 The expansion bellows shall be protected from arc weld shots and welding spatter.

8.4.13 When an internal sleeve is provided, the bellows should be installed in the vertical position with the sleeve pointing downwards and the convolutions shall be self-draining.

8.4.14 Insulation

Insulation shall not be applied directly to the bellows convolutions.

8.4.15 Lubricants

The use of molybdenum disulphide lubricants shall be avoided on external tie bars, etc., if the bellows operate at a high temperature.

8.4.16 Hydrostatic test

Hydrostatic testing of the system having expansion joint, shall be performed with the shipping lugs in position.

These lugs shall be removed after testing and certification is over.

8.5 Installation of Flanges

8.5.1 Extra care shall be taken for flange connections to pumps, turbines, compressors, cold boxes, air coolers, etc. The flange connections to these equipment 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 the Engineer.

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

8.5.3 The Executor shall apply molycoat grease mixed with graphite powder (unless otherwise specified in piping classes) on all bolts and nuts during storage, after erection and wherever flange connections are broken and made-up for any purpose whatsoever.

8.5.4 On lines and equipment where the operating pressure of hydrogen (H_2) mixtures will be 20.7 bars (300 psig) and over, bolts shall be tightened using torque spanners. Any necessary retorquing shall be carried out after the line is put in service.

8.6 Installation of Valves

8.6.1 Valves shall be installed with spindle/actuators orientation/position as shown in the lay-out drawings. In case of any difficulty in doing this or if the spindle orientation/position is not shown in the drawings, the Engineer shall be consulted and work should be done as per his instructions. However, the location of the valve hand wheel and/or stem shall not obstruct walkways or platforms. In determining valve stem position the following points shall be considered.

8.6.1.1 No horizontally positioned stems in low-temperature service is allowed.

8.6.1.2 Butterfly valves shall not be installed with the spindle in the vertical position for services where collection of dirt in the lower shaft bearing could occur.

8.6.1.3 To avoid accidental blocking owing to a loosened wedge, gate valves installed around safety/relief valves and in flare lines shall be positioned with the stem pointing horizontally.

8.6.2 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 right direction. If the directional arrow is not marked on such valves, this shall be done in the presence of the Engineer before installation.

8.6.3 Fabrication of stem extensions, locking arrangements and interlocking arrangements of valves shall be carried out as per drawings/instructions of the Engineer.

8.6.4 In installation of socket welding or seal welding of ball valves, care shall be taken to avoid damage to the valve seats.

8.7 Installation of Instrument and Related Piping

8.7.1 Installations of in-line instruments (i.e. thermowells restriction orifices, safety valves, control valves, rotameters, orifice flange assembly, venturimeters, flowmeters, etc.), shall form part of piping erection work. They shall be installed according to IPS-C-IN-100/2 "Instrument Installation Procedure".

8.7.2 Care shall be exercised and adequate precautions taken to avoid damage, and entry of foreign matter into instruments during transportation, installation and testing.

8.7.3 Instrument air piping

These piping from air header to different field instruments shall be installed with the following considerations.

8.7.3.1 Where threaded connections are not seal welded they shall be sealed by the use of thread compound or P.T.F.E. (Teflon) tape. P.T.F.E. tape shall not be used where temperatures exceed 230°C (450°F). Wherever thread compound is used on screwed fittings it should be applied to the male thread only.

8.7.3.2 All pipe ends shall be cut square, reamed of all burrs and cleared of all foreign material.

8.7.3.3 Cutting oil shall be used in cutting all threads on galvanized pipe.

8.8 Vents and Drains

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

8.9 Pump, Compressor and Steam Turbine Piping

a) Piping terminations at pumps or compressors shall be installed so that mating flanges are parallel, concentric, and in contact prior to bolting the piping in place.

b) Auxiliary piping shall be neatly routed along the baseplate and shall not extend across the operating floor. This piping shall not obstruct operation handling and inspection covers, bearing caps, upper halves of casing, etc.

c) Luboil lines shall be separated from hot process and hot utility lines in order to avoid a fire hazard, e.g. auto-ignition at 260-320°C.

d) The temporary strainers shall be installed as close to the machinery as possible for initial start-up and commissioning.

8.10 Piping Through Walls and Concrete Floors

Sleeves or holes through walls, floors of buildings and table tops shall have a size permitting the passage of a flange of the relevant pipe size, to facilitate the installation of prefabricated piping and to permit insulating work.

Holes through walls and floors shall be sealed after piping installation.

8.11 Buried Piping

8.11.1 Buried piping shall be kept at a distance from electric power, lighting and instrument signal cables as instructed by the Engineer.

8.11.2 For buried piping system the Executor shall excavate and maintain the trench in which the piping system is to be laid.

8.11.3 The trench shall be sufficiently wide for the pipe to be laid without damaging the pipe protective coating. The minimum trench width shall not be less than pipe diameter plus 400 mm.

8.11.4 The trench shall be excavated to a minimum depth of 100 mm below the bottom of the pipe and the full width of trench shall be graded and padded with sand or other suitable material approved by the Engineer.

8.11.5 The sides of the trench shall be free of rock, loose stones, blasting debris or other spoil likely to fall or be dislodged, blown or swept under, around or on top of the pipe.

8.11.6 Where Rockshield or similar overwrap is used in accordance with IPS-C-TP-274 "Coating". The 100 mm depth of padding may contain loose gravel and rock fragments provided that in the opinion of the Engineer, no damage to the coating would result from the inclusion of such gravel and rock fragments.

8.11.7 Protective coating

Buried pipelines shall have protective coating applied in accordance with IPS-C-TP-274 "Coating".

The grade of protective coating will be as specified in above-mentioned standard.

8.11.8 Laying

8.11.8.1 All brush, skids, pipe, pipe protectors, rocks, large clods, sticks, protecting rocks and other hard objects shall be removed from the bottom of the trench into which the coated and wrapped pipeline is to be lowered, so that the protective coating shall not be punctured or abraded.

8.11.8.2 Pipe shall normally be lowered into the trench immediately after the coating and wrapping has been passed by the Engineer. Wide non-abrasive slings or belts shall be used at all times in handling the pipeline.

8.11.8.3 All coated and wrapped pipe which has been supported in any manner on padded skids, or lowering devices, shall be subjected to close inspection by the Executor to see that the coating is undamaged before the pipe reaches the bottom of the trench. Walking on coated pipe is absolutely forbidden. Backfilling shall be carried out immediately after the pipeline is lowered into the trench but the Executor shall first obtain the approval of the Engineer. If any backfilling is carried out without approval of the Engineer, he will have the right to require the Executor to remove the backfill for examination of the coating and wrapping.

8.11.8.4 The initial backfill around the pipe and to a level of at least 100 mm (4 inches) above the top of the pipe shall be sand or earth free from loose rock, large gravel sticks, branches or other rubbish that may damage the pipe or its coating.

8.11.8.5 Where Rockshield or similar overwrap is used, the initial backfill may contain loose gravel and rock fragments provided that in the opinion of the Engineer, no damage to the coating would result from the inclusion of such gravel and rock fragments.

8.11.8.6 Backfilling of trenches through roads shall be carried out immediately after the pipe has been laid and the backfill shall be compacted and finished level with the road surface. Such sections shall be maintained by the Executor until the works are completed and the road surface shall be finally restored, as far as possible, to the same condition as before work started.

8.12 Pipe Supports

All supports shall be strictly as per drawings and IPS-G-PI-280, "Pipe Supports".

8.13 Winterizing and Steam Tracing

8.13.1 Steam tracing shall be installed in accordance with standard drawing IPS-D-PI-126, "Steam Tracing Details". Piping connections to steam and condensate headers will be shown on the piping arrangement plan drawings, and isometric drawings.

8.13.2 Bends shall be used wherever practical and fittings kept to a minimum. Unions shall be used when an item is traced and its removal is required for frequent maintenance.

8.13.3 No provision shall be made for expansion movement of 13 mm or smaller tracers, since the sag or offset will take care of this amount of expansion.

For tubing or piping tracers larger than 13 mm anchoring shall generally be made at the midway point, and the piping arrangement at the ends of the tracers shall be sufficiently flexible to allow for expansion of tracers.

Where it is impossible to allow for end movements, or in cases where for special reasons the unanchored length of pipe tracer exceeds 40 meters, expansion loops shall be provided. Min. radius of expansion loop shall be six time the outside diameter of the tracers at bends of loop.

8.13.4 Insulation shall be slotted at expansion loops, and at anchored tracer ends where the tracers leave the pipe.

8.13.5 Anchors or guide clips shall be installed on tracers near valves, flanges, expansion loops and turns to avoid damage to insulation due to tracer expansion.

8.13.6 Tracers shall be held in place with steel bands or 1.5 mm (#16 ga) soft galvanized wire loops spaced 1 meter apart. On tracers 19 mm and larger spacing may be increased to 1½ meters.

8.13.7 Lines, instruments, and instruments piping in low bubble point, acid caustic, amine or phenolic water service, or plastic or plastic lined pipe that require tracing should receive special attention to prevent general or localized over heating. Insulated spacer blocks may be installed to keep the tracer 13 mm away from the pipe as shown in detail "I" on drawing IPS-D-PI-126.

8.13.8 Steam traps shall be installed at low points only. All piping shall as far as practicable be self draining, and steam flow through tracers shall always follow a generally descending route, where practical.

8.13.9 Each tracer shall have its own steam supply valve, and steam trap.

8.14 Internal Cleaning

Internal cleaning procedure shall be submitted by the Executor and approved by the Engineer for the followings:

8.14.1 After completion of construction works and before pressure testing, the inside of piping system shall be cleaned either mechanically or by flushing.

8.14.2 If so specified in project specification, chemical cleaning shall be performed after completion of hydrostatic testing in accordance with IPS-C-PI-410.

9. INSPECTION AND TESTING

Prior to initial operation and as the piping erection progresses the piping installation shall be inspected to the extent necessary to assure compliance with the engineering design, drawings, materials, fabrication, assembly and the test requirements of the Codes and Specifications listed under Section 2. "References of this Standard". In addition to the inspection to be performed by the Executor, all work is subject to inspection by the Engineer or his appointed representative. Such inspection shall not relieve the Executor of his responsibilities as specified above.

9.1 Material Check

All materials shall be checked by the Executor or his nominee to assure compliance with the project documents.

9.2 Prefabricated pipe shall be dimensionally checked by the Executor or his nominee against isometric drawings.

9.3 Inspection of Welds

Welds shall be inspected and tested in accordance with IPS-C-PI-290, "Welding of Plant Piping System".

9.4 Pressure Test

After completion of all erection works all piping systems shall be pressure tested in accordance with IPS-C-PI-350 "Plant Piping System Pressure Testing".

10. PAINTING

10.1 Surface Preparation

Outside surface of piping to be painted shall be prepared according to IPS-C-TP-101, "Surface Preparation". They shall always be completely dry and free from burrs, weld spatter, flux, rust, loose scale, dirt, dust, grease, oil and other foreign matter before any paint is applied.

10.2 Color Code

The color of piping system for identifying of carrying fluid shall be in accordance with Table 3 of IPS-E-TP-100, "Paints".

10.3 Field Painting

Field painting of hot and cold uninsulated lines shall be as per IPS-C-TP-102, "Painting".

Insulated lines shall not be painted.

11. INSULATION

Lines to be insulated will be so noted on spool drawings and shall be insulated in accordance with IPS-C-TP-701, "Thermal Insulating".