ELEMENTARY DETAILS

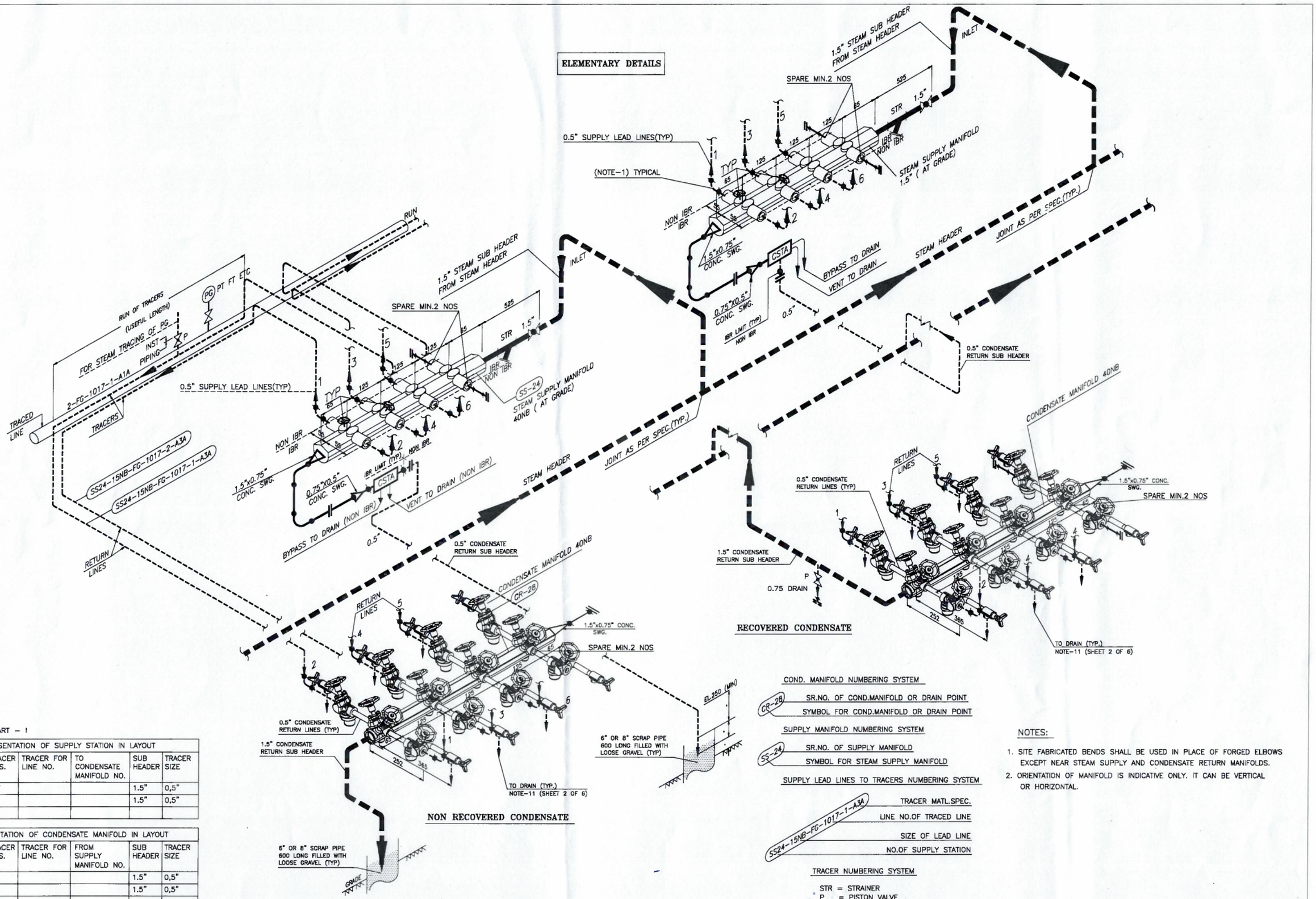

CHART – I

REPRESENTATION OF SUPPLY STATION IN LAYOUT

NO	SUPPLY MANIFOLD NOS.	TRACER NOS.	TRACER FOR LINE NO.	TO CONDENSATE MANIFOLD NO.	SUB HEADER	TRACER SIZE
					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-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

5S24-15NB-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

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.

Rev. No.	Date	Purpose	Prepared by	Checked by	Stds. Committee Convenor	Stds. Bureau Chairman
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
					Approved by	

ENGINEERS INDIA LIMITED (A Govt. of India Undertaking)

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

STANDARD No.
6-44-0007-A2 Rev.4

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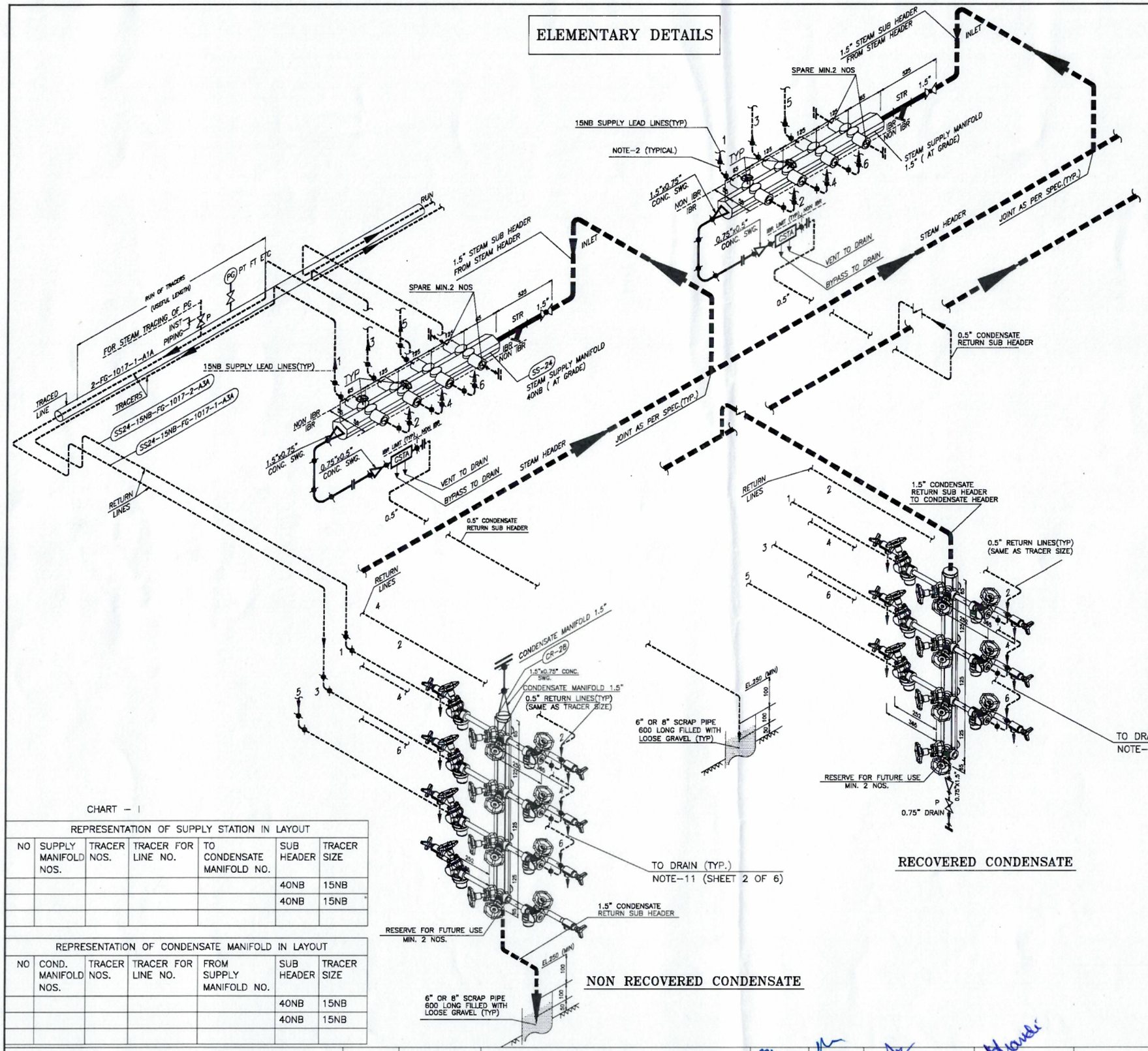
ELEMENTARY DETAILS



NON RECOVERED CONDENSATE

RECOVERED CONDENSATE

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 NOS.	TRACER FOR LINE NO.	FROM SUPPLY MANIFOLD NO.	SUB HEADER	TRACER SIZE
					40NB	15NB
					40NB	15NB

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

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.

ENGINEERS INDIA LIMITED (A Govt. of India Undertaking)

Rev. No.	Date	Purpose	Prepared by	Checked by	Approved by: Stds. Committee Convenor	Approved by: Stds. Bureau Chairman
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

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

STANDARD No.
6-44-0007-A2 Rev.4

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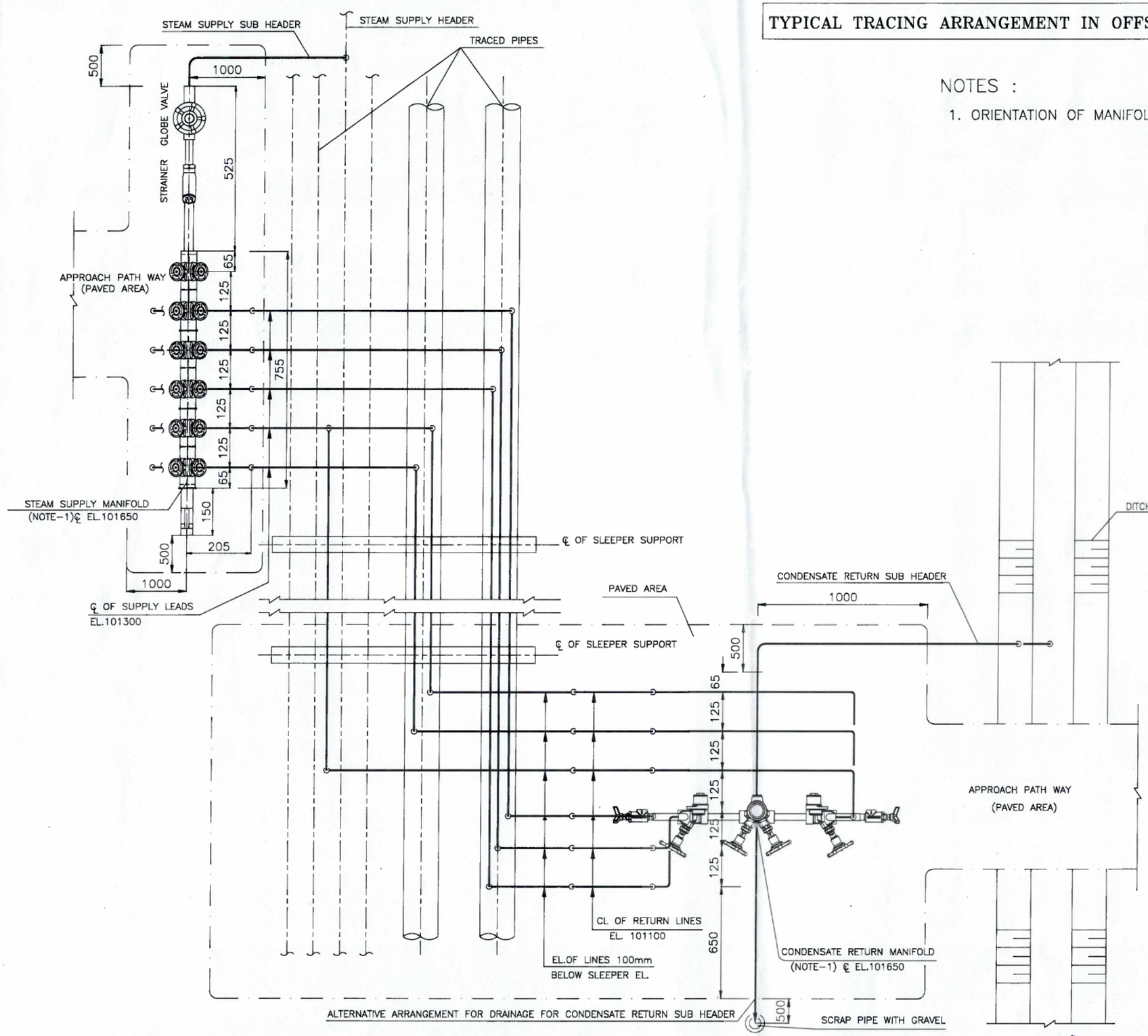
TYPICAL TRACING ARRANGEMENT IN OFFSITES – PLAN

NOTES :

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



Rev. No.	Date	Purpose	Prepared by	Checked by	Stds. Committee Convenor	Stds. Bureau Chairman
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

Approved by

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

STANDARD No.
6-44-0007-A2 Rev.4

Format No. 8-00-0001-F5 Rev. 0

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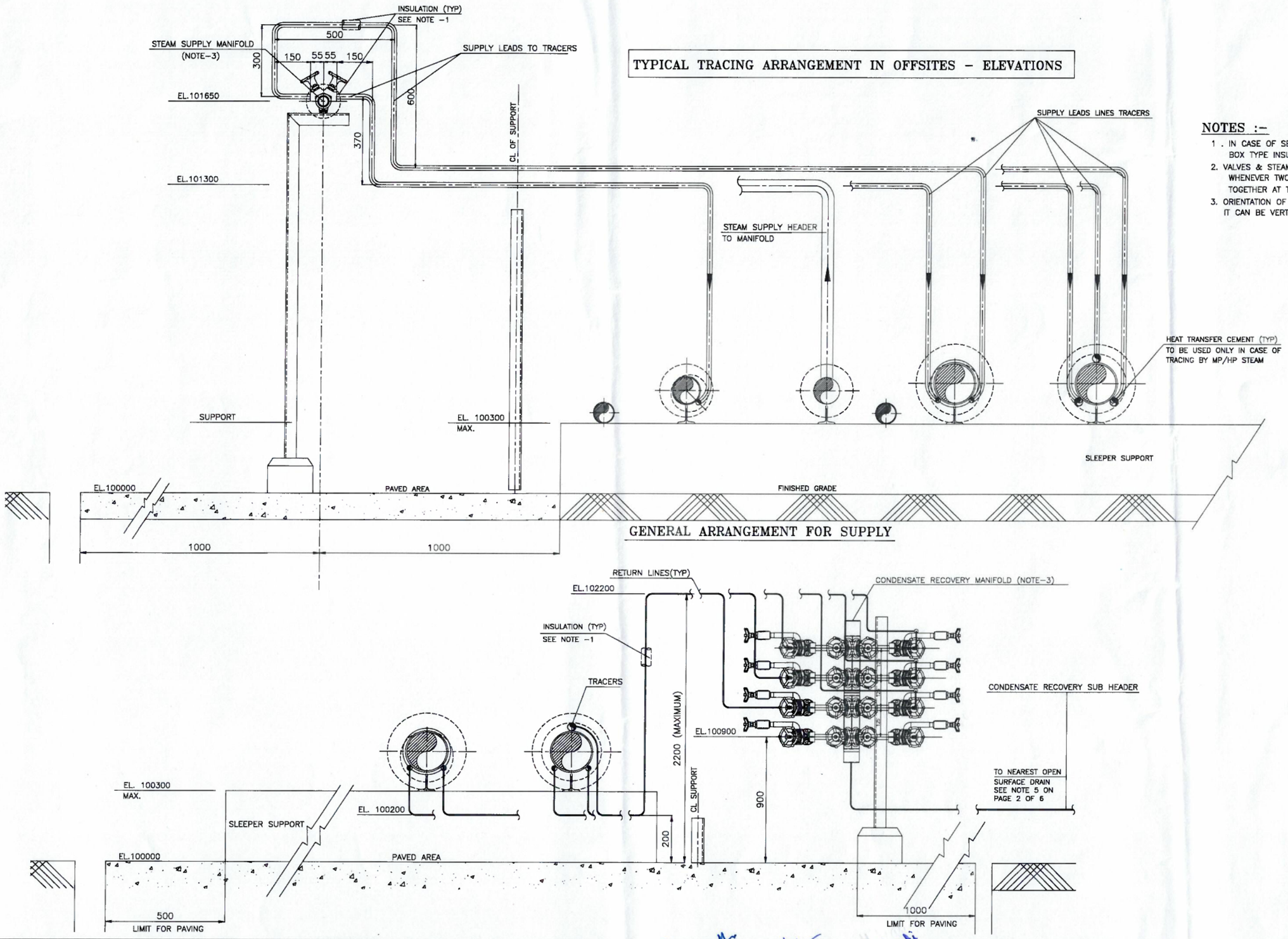
TYPICAL TRACING ARRANGEMENT IN OFFSITES – ELEVATIONS



GENERAL ARRANGEMENT FOR SUPPLY

NOTES :–

1. IN CASE OF SEVERAL TRACERS RUNNING TOGETHER BOX TYPE INSULATION IS PERMISSABLE.
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.

Rev. No.	Date	Purpose	Prepared by	Checked by	Approved by	
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
					Stds. Committee Convenor	Stds. Bureau Chairman

इंजीनियर्स इंडिया लिमिटेड (भारत सरकार का उपक्रम) ENGINEERS INDIA LIMITED (A Govt. of India Undertaking)

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

STANDARD No.
6-44-0007-A2 Rev.4
Page 6 of 6

Format No. 8-00-0001-F5 Rev. 0

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पाइपिंग पर गर्म टैपिंग के लिए मानक विनिर्देश

STANDARD SPECIFICATION FOR HOT TAPPING ON PIPING

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	
1	04.03.25	REVISED & ISSUED AS STANDARD SPECIFICATION	PK	SH	GB	MN
0	31.12.19	ISSUED AS STANDARD SPECIFICATION	PPSW	SH	MI	RKT

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Abbreviations:

API	**American Petroleum Institute**
ASME	**American Society of Mechanical Engineers**
NDE	**Non Destructive Examination**
WPS	**Welding Procedure Specification**
PQR	**Procedure Qualification Record**

Piping Standards Committee

Convenor: Mr. G. Balaji

Members :
Mr. Udayan Chakravarty (Piping)
Ms. Sulakshana Hundekari (Piping)
Mr. Rameshwar Prasad (Piping)
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1.0 SCOPE

This specification covers the minimum requirements of safety, procedure and equipment to be utilized for carrying out hot-tapping work for operational piping systems handling non–sour hydrocarbons in liquid or gaseous phase and utility service fluids.

This specification is not intended to be all inclusive, and the use of guidelines set forth herein does not relieve the Contractor of his responsibility of performing the WORK safely and completing the WORK capable of performing the intended service.

This specification shall be read in conjunction with the conditions of all specifications and documents included in the CONTRACT between Owner and Contractor.

Identification of type of tapping (Hot/ Cold) is not in the purview of this document. Same shall be decided by Owner/ Process.

2.0 REFERENCE CODE

2.1 The hot-tapping works shall be carried out in accordance with the latest edition of API RP- 2201 - "Safe Hot Tapping Practices in the Petroleum & Petrochemical Industries" and this specification. All requirements given in API RP-2201 as "recommendatory" shall be considered as mandatory requirements.

2.2 Reference has also been made in this specification to the latest edition (edition enforce at the time of issue of enquiry) of the following Codes, Standards and Specifications.

ASME B31.3	: Process Piping
MSS-SP-97	: Integrally Reinforced Forged Branch outlet Fittings – Socket Welding, Threaded and Butt Welding Ends.
XXXX-6-44-0005	: Job Piping Material Specification
XXXX-6-44-0016	: Job Specification for Non Destructive Examination
6-77-0001	: Welding specification for fabrication of piping/ Job Welding Specification

In case of conflict between the requirements of API RP-2201 or other Codes / Standards listed above and this specification, the requirements of this specification shall govern.

3.0 MATERIALS

3.1 All materials shall meet the requirements of specification for piping materials, XXXX-6-44-0005, included elsewhere in the CONTRACT between Owner and the Contractor and shall be suitable for the service and applicable Class Rating for which they are to be used. In case, the Contractor proposes to modify certain requirements of these specifications specifically to suit the hot tapping procedure to be adopted, he may do so, after obtaining the Owner/EIL's approval in writing. In any case, prior Owner/EIL approval is required for all materials supplied by the Contractor.

3.2 Material of fitting (split tee, welded outlet fittings) shall be compatible with the material of the Run-pipe to be hot-tapped in terms of metallurgy and weldability. Statutory requirements, if applicable, are to be complied with.

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3.3 Hot-tap welding should not normally be performed on materials, which requires post weld heat treatment. Therefore, material of split tee shall be selected in such a way, that there is no requirement of post weld heat treatment.

3.4 Manufacturer shall submit all the test certificates in respect of the materials supplied as required by the specifications and statutory requirements.

4.0 PROCEDURE

4.1 The Contractor shall obtain necessary permissions from the Owner for all hot-works. For lines requiring statutory approval, Contractor shall obtain approval from the Competent Authority. The Contractor shall ensure that he has requisite permissions from the Competent Authority as well as valid hot work permit before initiating any work whatsoever.

4.2 All taps shall be made using a full-encirclement fitting having a design suitable for Contractor's proposed procedure. Taps of branch size 1.5" and below on headers of sizes 4" and above may be made using weldolets as per MSS-SP-97 in place of full-encirclement fitting.

4.3 Hot tapping shall not be permitted closer than 460 mm to a flange or threaded connection or approximately 80 mm to a welded seam including a longitudinal welded seam of welded pipe.

4.4 Thickness of base pipe shall be determined prior to start of work. This shall be 4.8mm (minimum). However, actual minimum thickness shall be as recommended by Hot tapping equipment manufacturer and shall include a safety factor of 2.4mm (to prevent burn through).

4.5 Prior to starting of work, the Contractor shall submit for Owner/EIL's approval, a detailed procedure proposed to be adopted for hot tapping. Such procedure shall contain, but not limited to, the following details:

- Preparation for hot works, viz., selection of location on pipe for hot tap, ultrasonic testing to check the adequacy of available wall thickness and absence of laminations, imperfections and out of roundness to ensure that pipe at the hot tap location is suitable for welding, pre-heating (if required) and cutting operations, etc.
- Method of ensuring and monitoring recommended minimum and maximum velocity of fluid in the piping.
- Connection details.
- Detailed welding procedure including sequence of welding to be performed.
- Procedure for non-destructive testing of weld and hydrostatic test of assembly including test pressures, etc.
- Details of all materials and equipment
- Hot-tapping procedure.
- Safety instructions, and safety measures viz., gas detection tests, tests for presence of toxic environment, identification of valves which are to be used to isolate section in case of failure etc., and safety measures for installations, equipment, personnel, etc.
- Checklist for Hot Tapping
- Approval from Statutory Authority as applicable.

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Design calculations as per ASME B31.3 for full-encirclement fitting to be used shall also be submitted for review.

Any additional requirements deemed necessary by Owner/EIL or by Authorities having jurisdiction for execution of any or all phases of the work shall be binding on the Contractor.

Contractor shall proceed with construction only after obtaining approval of the procedure from Owner/EIL in writing.

4.6 Contractor shall carry out all checks as recommended by Hot tapping equipment manufacturer, before hot-tapping work is attempted.

4.7 The exact location of the hot tap on the pipe shall be carefully identified and marked in the field and Owner/EIL's approval shall be obtained.

4.8 All necessary gas detection tests shall be conducted by the Contractor to ensure safe environment.

4.9 Adequate safety arrangements shall be made for the protection of adjacent installations, exposed personnel and equipment.

4.10 Contractor shall supply and erect the scaffolding required for the performance of hot tapping. The scaffolding has to be erected in such a way that two separate and independent access will be available for the temporary platforms erected for hot tapping.

4.11 No hot-tapping work shall be performed in adverse conditions of weather, such as rain, fog, high dusty winds, etc., which may be detrimental to the quality of the work performed.

4.12 Contractor shall provide supports wherever required for existing pipe as per site condition to take care of extra load of hot tapping stub, valve, blinds etc.

4.13 Contractor shall prepare safe approaches by filling soil/sand/sand bags/sleepers/wooden blocks etc., for cranes, machineries, personnel to various hot tapping locations as required.

5.0 WELDING

5.1 Methods for welding procedure qualification and qualification of welders shall be prepared and submitted by the Contractor for Owner/EIL's review and approval in accordance with Standard Specification No. 6-77-0001. Upon receipt of approval from Owner/EIL, the Contractor shall prepare for the tests and conduct them in the presence of Owner/EIL's representative. Separate qualification tests shall be carried out for each grade of steel and each size of weld. All welding shall be carried out by qualified welders and qualified welding procedures. For welding of piping, falling under the purview of Statutory Regulations, only those welders certified by/acceptable to the concerned regulatory authority shall be employed.

5.2 The manual arc process of welding using shallow penetration low hydrogen electrodes shall be used.

5.3 Test certificates for each batch of electrodes and other welding materials obtained from the Manufacturer(s) shall be submitted for the approval of Owner/EIL . Additional tests, if any, as per the applicable welding specification chart shall be carried out prior to start of work. Owner/EIL reserves the right to reject such material at any time, in the event these materials do not perform to the requirements of this specification.

5.4 Welds shall be made in the following sequence - longitudinal welds first between two halves of the full encirclement fitting, then one end circumferential weld attaching the full encirclement

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fitting to pipe, then the other end circumferential weld. The longitudinal weld shall be made using a backing strip.

5.5 The heat input shall be controlled during welding operation to prevent undue overheating of pressurized pipe or vessel.

5.6 The surface to be welded shall be smooth, uniform, free of fins, laminations, tears, scales, slag, grease, paint and other deleterious materials, which might adversely affect the welding and its quality.

5.7 All weld joints shall be cleaned of slag and other irregularities before the deposition of the next pass. Defective welds shall be completely removed or repaired in accordance with the qualified welding procedure before further welding and when instructed by Owner/EIL.

5.8 Tack welds, if allowed, shall be executed as per qualified welding procedure. Defective tack welds shall be completely removed prior to final welding.

5.9 Prior to commencement of final welding, Contractor shall obtain approval from Owner/EIL for proper joint fit-up and alignment.

6.0 INSPECTION AND TESTING

6.1 Dye Penetrant / Magnetic particle test shall be performed for the first pass and after completion of all welds. In addition, radiographic and/or ultrasonic tests of the welds shall be carried out. For piping requiring statutory approval, testing/examination required as per statute also shall also be complied with.

6.2 After successful completion of the welding of full-encirclement fitting including acceptance of all applicable NDE as per XXXX-6-44-0016 and before start of the cutting operation, assembly including full bore ball valve/ gate valve, kept in open position, shall be hydrostatically tested to a pressure equal to or greater than the operating pressure and not exceeding the internal design pressure of the run pipe. Hydrotest shall be conducted when the line is at normal operating pressure. The test pressure shall be maintained for a minimum period of one hour. Owner/EIL's representative shall witness and grant approval on satisfactory completion of the hydrostatic test.

6.3 Before using valves in the hot tapping, leak testing is to be done at site to check for any leakage as per valve spec.

6.4 Pneumatic test of reinforcement pads at a pressure of 1.05 Kg/cm^2g with soap solution to be done wherever pads are required in full encirclement fitting as per design calculation.

6.5 All welds, which, in the opinion of Owner/EIL, are found to be defective by hydrostatic testing, pneumatic testing or by NDE, shall be repaired or cut and re-welded, as directed by Owner/EIL, and re-tested. Repair of a repaired weld is not permitted.

7.0 CUTTING OPERATION

7.1 Instructions given by the Manufacturer of the hot-tapping machine shall be strictly followed while installing the machine and during the cutting operation.

7.2 Cutting operation shall begin only after all welds have been tested and approved by Owner/EIL.

7.3 Contractor shall ensure that the full bore ball valve or the gate valve is precisely centered on the tee-connection and is cleaned of all dirt, etc. Plug Valves, Butterfly valves and Globe valves shall not be used.

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7.4 Boring bar of the hot tap equipment shall be run several times through the valve to ensure that the cutter does not jam or drag.

7.5 All bolted joints shall be checked for possible leakage. Packing of hot-tap machine, bleed valve, bolts of cutter, pilot bit and blank catcher shall be checked before starting the cutting operation.

7.6 After the cutting operation is complete, the boring bar shall be extracted, the valve closed and the machine shall be depressurized by opening the bleed valve. Machine shall be dismantled after these operations have been completed and when authorized by Owner/EIL.

7.7 A blind flange shall be provided on the valve after removal of hot tap equipment.

8.0 COMPLETION

8.1 The hot-tap work shall be considered complete when it has been certified in writing by Owner/EIL that all the works have been satisfactorily completed.

8.2 The Contractor shall clear-off the area removing all equipment and left over material, etc. from the job site after completion of the work.

9.0 DOCUMENTATION

9.1 Documentation to be submitted by Vendor/Contractor to Owner/EIL is summarized below.

Number of Copies (Hard copies / soft copies etc.) shall be as indicated in CONTRACT document.

9.2 Following documents shall be submitted:

- Hot Tapping Procedure.
- Approved WPS and PQR.
- General Arrangement Drawings (dimensional drawings)
- Sketches of the location where hot tapping is performed.
- Details/data sheet of components including tees, valves etc. with size, rating, material details and design calculations.
- Welding Records.
- Line pipe material thickness records.
- Weld inspection and NDT records.
- Hydrostatic test Reports.
- Statutory Approvals

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TECHNICAL NOTES FOR PIPES

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	
8	18.06.24	REVISED AND ISSUED AS STANDARD SPECIFICATION	PK	SH	GB	MN
7	16.01.20	REVISED AND ISSUED AS STANDARD SPECIFICATION	PK	SH	MI	RKT
6	25.09.14	REVISED AND ISSUED AS STANDARD SPECIFICATION	SH	AK	RN ATD	SC
5	31.12.13	REVISED AND ISSUED AS STANDARD SPECIFICATION	UK	SH	AK RN	SC
4	04.07.08	REVISED AND ISSUED AS STANDARD SPECIFICATION	RN	SC	DM	VC

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Abbreviations:

ANSI	:	American National Standards Institute
API	:	American Petroleum Institute
ASME	:	American Society of Mechanical Engineers
ASTM	:	American Society for Testing & Materials
BHN	:	Brinell Hardness Number
BIS	:	Bureau of Indian Standards
E.FS.W	:	Electric Fusion Weld
E.R.W	:	Electric Resistance Weld
HAZ	:	Heat Affected Zone
HIC	:	Hydrogen Induced Cracking
IBR	:	Indian Boiler Regulations
IGC	:	Inter Granular Corrosion
IS	:	Indian Standard
LT	:	Low Temperature
MR	:	Material Requisition
NACE MR	:	National Association of Corrosion Engineers : Material Requirement
NB	:	Nominal Bore
NPT	:	Nominal Pipe Thread
PMI	:	Positive Material Identification
PR	:	Purchase Requisition
SMYS	:	Specified Minimum Yield Strength
SS	:	Stainless Steel

Piping Standards Committee

Convenor: Mr. G. Balaji

Members :
Mr. Udayan Chakravarty
Mr. Rameshwar Prasad
Mr. K. Anjaneyulu (SMED)
Mr. Rajesh Chitara (SMMS)
Dr. Sudip Paul (Structural)
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Mr. P.K. Rai (Construction)

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5.0 MARKING AND DESPATCH 10
6.0 REFERENCES 10

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1.0 GENERAL

1.1 All pipes and their dimensions, tolerances, chemical composition, physical properties, heat treatment, hydrostatic test and other testing and marking requirements shall conform to the latest codes and standards specified in the material requisition (MR). In case of any conflict amongst documents attached with the MR, the most stringent shall govern and Owner's/ EIL decision shall be final in this regard.

Supplier shall strictly comply with MR/PR stipulations and no deviations shall be permitted. Post Order Concession/Deviation as mentioned in Cl. 5.17 of Specification for Quality Management System Requirements from Bidders (6-78-0001) is not applicable.

1.2 Testing

1.2.1 Test reports shall be supplied for all mandatory tests as per the applicable material specifications. Test reports shall also be furnished for any supplementary tests as specified in the MR & Clauses 1.11 & 1.12.

1.2.2 Material test certificates (physical property, chemical composition & heat treatment report including Chart) shall also be furnished for the pipes supplied.

1.2.3 PMI shall be performed as per the scope and procedures as defined in the spec for PMI at Supplier's Works (6-81-0001).

1.2.4 Refer to specification nos. 6-81-0002 and 6-81-0003 for Inspection & Test plans for welded pipes and seamless pipes respectively.

1.3 Manufacturing Processes

1.3.1 Steel made by acid Bessemer process shall not be acceptable.

1.3.2 All longitudinally welded pipes should employ only automatic welding.

1.4 Pipe shall be supplied in single or double random length of 4 to 7 and 7 to 14 meters respectively.

1.5 a. Seamless and E.R.W. pipes shall not have any circumferential seam joint in a random length. However, in case of E.Fs.W pipe, in one random length one welded circumferential seam of same quality as longitudinal weld is permitted. This weld shall be at least 2.5 m from either end. The longitudinal seams of the two portions shall be staggered by 90°. Single random length in such cases shall be 5 to 7 m.

b. Unless otherwise mentioned in the respective material code, E.Fs.W pipes < 36" shall not have more than one longitudinal seam joint and E.Fs.W pipes ≥ 36" shall not have more than two longitudinal seam joints.

1.6 Pipes with screwed ends shall have NPT external taper pipe threads conforming to ASME/ANSI B1.20.1.

1.7 Pipe with beveled ends shall be in accordance with ASME B16.25. Weld contours shall be as follows:

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Material	Wall Thickness	Weld Contour
Carbon Steel (Except Low Temp. Carbon Steel)	Up to 22 mm	Figure 2 Type A
	> 22 mm	Figure 3 Type A
Alloy Steel, Stainless Steel & Low Temp. Carbon Steel	Up to 10 mm	Figure 4
	> 10 mm & Up to 25 mm	Figure 5 Type A
	> 25 mm	Figure 6 Type A

1.8 Galvanized pipes shall be coated with zinc by hot dip process conforming to IS 4736 for pipes to Indian Standards and ASTM A53 for pipes to ASTM Standards.

1.9 All austenitic stainless steel pipes shall be supplied in solution annealed condition. All types of 321 or 347 stainless steel pipes shall be in a stabilized heat treated condition. Stabilizing heat treatment shall be carried out subsequent to the normal solution annealing. Soaking time & holding temp. for stabilizing heat treatment shall be 4 hrs & 900°C respectively.

1.10 For welded Carbon steel pipes wherever heat treatment is specified, hardness of weld and HAZ shall be 200 BHN (max.). For welded Alloy steel pipes, maximum hardness of weld and HAZ after heat treatment shall be as per relevant ASTM material specification unless otherwise specified. In addition, for 9Cr-1Mo-V(P91) pipes, a minimum hardness of 190BHN shall also be ensured.

1.11 I.G.C. Test for Stainless Steels

1.11.1 For all austenitic stainless steel pipes inter-granular corrosion test shall have to be conducted as per following:

ASTM A262 Practice "B" with acceptance criteria of "60 mils/year (max.)".

OR

ASTM A262 Practice E : The bent specimen shall be examined under 20X magnification. The acceptance criteria is that there will be no crack or fissure in the bent specimen. The bent specimen shall also be subjected to metallographic examination at 250X magnification to ensure no crack or fissure. The photograph of the bent specimen along with comments shall be submitted for review.

1.11.2 When specifically asked for in MR for high temperature application of some grades of austenitic stainless steel (eg.SS 309, 310, 316, 316H etc.) ASTM A262 Practice "C" with acceptance criteria of "15 mils/year (max.)" shall have to be conducted.

1.11.3 For the IGC test as described in 1.11.1 & 1.11.2, two sets of samples shall be drawn from each solution annealing lot; one set corresponding to highest carbon content and the other set corresponding to the highest pipe thickness.

1.12 All welded pipes indicated as 'CRYO' & 'LT' in MR shall be impact tested per requirement & acceptance criteria of ASME B31.3. The impact test temperature shall be -196°C & -45°C for stainless steel and carbon steel respectively unless specifically mentioned otherwise in MR.

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1.13 NACE/HIC Requirements

1.13.1. Pipes under "NACE" category and those designated as "HIC1" shall meet the requirements given in NACE MR-0103 unless mentioned otherwise.

1.13.2. Pipes made from plates and designated as "HIC1" shall meet the HIC requirements of EIL specification 6-79-0013 unless mentioned otherwise.

1.14 Specified heat treatment for carbon steel and alloy steel and solution annealing for stainless steel pipes shall be carried out after weld repairs. Number of weld repairs at the same spot shall be restricted to maximum two by approved repair procedure.

1.15 For black or galvanized pipes to IS 1239, the minimum percentage of elongation shall be 20%.

1.16 All 1Cr-½Mo and 1¼Cr-½Mo seamless pipes shall be normalised and tempered.

1.17 For all welded alloy steel pipes with mandatory requirement of heat treatment and radiography, radiography shall be performed after heat treatment.

1.18 For Hydrogen service pipes following special requirements shall also be met:

1.18.1. All carbon steel pipes having wall thickness 9.53 mm (0.375") and above shall be normalised. Cold drawn pipes shall be normalised after the final cold draw pass for all thicknesses.

1.18.2. All alloy steel (Cr-Mo) pipes shall be normalised and tempered. The normalising and tempering shall be a separate heating operation and not a part of the hot forming operation. The maximum room temperature tensile strength shall be 100,000 psig.

1.18.3. For carbon steel Pipes, hardness of weld and HAZ shall be 200 BHN (max.). For alloy steel Pipes, hardness of weld and HAZ shall be 225 BHN (max.).

1.18.4. For all Carbon steel and Alloy steel pipes with wall thickness over 20 mm, Charpy-V Notch impact testing shall be carried out in accordance with paragraph UG-84 of ASME Section VIII, Div-1 for weld metal and base metal from the thickest item per heat of material and per heat treating batch. Impact test specimen shall be in complete heat treated condition and accordance with ASTM A370. Impact energies at 0°Celsius shall average greater than 27J (20 ft-lb) per set of three specimens, with a minimum of 20J (15 ft-lb).

1.19 For dual grades of SS where specified, chemical composition and mechanical properties of both grades specified shall be ensured.

2.0 IBR PIPES

2.1 IBR Documentation

2.1.1 Pipes under purview of IBR shall be accompanied with IBR certificate original in Form III-A duly approved and countersigned by IBR authority/local authority empowered by the Central Boiler Board of India (Photocopy of the original certificate duly attested by the local boiler inspector where the supplier is located is the minimum requirement for acceptance) .

2.1.2 For materials 1¼Cr - ½Mo (ASTM A335 Gr.P11 / A691 Gr.1¼Cr), 2¼Cr - 1Mo (ASTM A335 Gr.P22 / A691 Gr.2¼Cr) & 9Cr -1Mo-V (A335 Gr.P91/A691 Gr.91), Form III-A approved by IBR shall include the tabulation of Et, Sc & Sr values for the entire temperature range given below. Et, Sc & Sr values shall be such that throughout the temperature range.

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$$\left.\begin{array}{ll} E_t / 1.5 & \geq \\ S_r / 1.5 & \geq \\ S_c & \geq \end{array}\right| S_A$$

where ,

S_A : Allowable stress at the working metal temperature.
E_t : Yield point (0.2% proof stress at the working metal temperature)
S_c : The average stress to produce elongation of 1%(creep) in 100000 hrs at the working metal temperature.
S_r : The average stress to produce rupture in 100000 hrs at the working metal temperature and in no case more than 1.33 times the lowest stress to produce rupture at this temperature.

S_A (psi)												
Temp(°F) Material	500	600	650	700	750	800	850	900	950	1000	1050	1100
A335 Gr.P11	16200	15700	15400	15100	14800	14400	14000	13600	9300	6300	4200	2800
A691 Gr.1¼Cr	18900	18300	18000	17600	17200	16800	16400	13700	9300	6300	4200	2800
A335 Gr.P22 / A691 Gr.2¼Cr	17900	17900	17900	17900	17900	17700	17100	13600	10800	8000	5700	3800
A335 Gr.P91/ A691 Gr.91	28100	27700	27300	26700	25900	24900	23700	22300	20700	18000	14000	10300

Note : S_A values shall be as per the latest edition of ASME B31.3 prevailing.

2.2 For carbon steel pipes under IBR the chemical composition shall conform to the following:

Carbon (max) : 0.25%
Others (S, P, Mn) : As prescribed in IBR.

The chemical composition as indicated in this clause is not applicable for pipes other than IBR services.

3.0 ACCEPTABLE DEVIATIONS

3.1 Pipes to IS 3589 Gr.410 are acceptable in place of IS 3589 Gr.330.

3.2 Pipes of Grades SS317 of corresponding material are acceptable in place of Grades SS316 or SS316(2.5 Mo min.).

3.3 Pipes of Grades SS317L of corresponding material are acceptable in place of Grades SS316L or SS316L(2.5Mo min.).

3.4 Seamless pipes are acceptable in place of welded pipes except in the case of welded SS321/SS321H pipes with nominal thickness greater than 9.53mm.

3.5 Dual Grade SS304/304L conforming to all chemical composition requirements of SS304L and mechanical properties of SS304 is acceptable in place of SS304L or SS304 grades. Any specific additional requirements given in the MR shall also be complied.

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3.6 Dual Grade SS316/316L conforming to all chemical composition requirements of SS316L and mechanical properties of SS316 is acceptable in place of SS316L or SS316 grades. Any specific additional requirements given in the MR shall also be complied.

4.0 HYDROSTATIC TEST

4.1 All pipes shall be hydrostatically tested.

4.2 The mill test pressure shall be as follows:

4.2.1 Seamless, E.R.W. & Spiral Welded

a) Carbon Steel

Material Std.	Test Pressure Std.
ASTM A106 Gr.B	ASTM A530
API 5L Gr.B, Seamless	API 5L
API 5L, E.R.W.	API 5L
API 5L, Spiral	API 5L
ASTM A333 Gr.3 & 6, Seamless	ASTM A530
ASTM A333 Gr.3 & 6, E.R.W.	ASTM A530

b) Seamless Alloy Steel

Material Std.	Test Pressure Std.
ASTM A335 Gr.P1, P12, P11, P22, P5, P9	ASTM A530
ASTM A268 TP 405, TP410	ASTM A530

c) Seamless Stainless Steel

Material Std.	Test Pressure Std.
ASTM A312 Gr.TP 304, 304L, 304H, 316, 316L, 316H, 321, 347	ASTM A999

d) Seamless Nickel Alloy

Material Std.	Test Pressure Std.
ASTM B161 UNS N02200	ASTM B161
ASTM B165 UNS N04400	ASTM B165
ASTM B167 UNS N06600	ASTM B167
ASTM B444 UNS N06625	ASTM B444
ASTM B407 UNS N08800	ASTM B407
ASTM B423 UNS N08825	ASTM B423

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e) Welded Nickel Alloy

Material Std.	Test Pressure Std.
ASTM B725 UNS N02200, N04400	ASTM B725
ASTM B517 UNS N06600	ASTM B517
ASTM B443/B474 UNS N06625	ASTM B474
ASTM B424/B474 UNS N08825	ASTM B474
ASTM B514 UNS N08800	ASTM B514

4.2.2 Electric Fusion Welded

a) Carbon Steel & Alloy Steel E.FS.W (16" & above)

Material Std.	Test Pressure Std.
API 5L Gr.B ASTM A671 Gr.CC65, 70 (Cl.32) ASTM A672 Gr.C60, 65, 70 (Cl.12,22) ASTM A671 Gr.CF60, 65, 66, 70 (Cl.32) ASTM A691 Gr.½Cr, 1Cr, 1¼Cr, 2¼Cr, 5Cr, 9Cr (Cl.42)	P = 2ST/D S = 90% of SMYS Except for API 5L Gr.B S = 85% of SMYS For API 5L Gr.B T = Nominal Wall Thickness D = O.D of Pipe

b) Stainless Steel E.FS.W (2" to 6")

The hydrostatic test pressure in kg/cm^2 for the following materials shall be as given below :

Material Gr.1 :ASTM A312 TP 304 / 304H / 316 / 316H / 321 / 347 welded.
Material Gr.2 :ASTM A312 TP 304L / 316L welded.

Size	Pipe Schedule : 10S		Pipe Schedule : 40S		Pipe Schedule : 80S	
	Material Gr. 1	Material Gr.2	Material Gr.1	Material Gr.2	Material Gr.1	Material Gr.2
2"	100	80	155	130	230	190
3"	80	60	155	130	230	190
4"	80	50	155	130	230	190
6"	65	35	90	75	155	130

c) Stainless Steel E.FS.W (8" and above).

Material Std.	Test Pressure Std.
ASTM A358 TP 304L, 304, 304H, 316L, 316, 316H, 321, 347 (Classes 1, 3 & 4)	P = 2ST/D S = 85% of SMYS T = Nominal Wall Thickness D = O.D of Pipe
ASTM A358 TP 304L, 304, 304H, 316L, 316, 316H, 321, 347 (Classes 2 & 5)	P = 2ST/D S = 72% of SMYS T = Nominal Wall Thickness D = O.D of Pipe

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4.2.3 Carbon Steel Pipes to BIS Standards

Material Std.	Test Pressure Std.
IS 1239	IS 1239
IS 3589	IS 3589

4.3 Hydrostatic pressure testing shall be performed using iron free water, which is clean and free of silt. Test fluid temperature shall be min. 5 °C. Maximum chloride content in water for hydrostatic testing for SS piping shall be 50 ppm.

5.0 MARKING AND DESPATCH

5.1 All pipes shall be marked in accordance with the applicable codes, standards and specifications. In addition the purchase order number, the item code & special conditions like "IBR", "CRYO", "NACE", "H2" etc. shall also be marked.

5.2 Pipes under "IBR","CRYO", "NACE" & "H2" shall be painted with one circumferential stripe of colour red, light purple brown, canary yellow & white respectively for easy identification. Width of stripe shall be 12mm for pipe sizes less than 3" and 25mm for pipes 3" and above.

5.3 Paint or ink for marking shall not contain any harmful metal or metallic salts such as zinc, lead or copper which cause corrosive attack on heating.

5.4 Pipes shall be dry, clean and free from moisture, dirt and loose foreign materials of any kind.

5.5 Pipes shall be protected from rust & corrosion.

5.6 Rust preventive used on machined surfaces to be welded shall be easily removable with a petroleum solvent and the same shall not be harmful to welding.

5.7 Both ends of the pipe shall be protected with the following material:

Plain end	:	Plastic cap
Bevel end	:	Wood, Metal or plastic cover
Threaded end	:	Metal or plastic threaded cap

5.8 Pipes may be provided with plastic push-fit type end caps/ steel caps without belt wire.

5.9 Steel end protectors to be used on galvanized pipes shall be galvanized. Plastic caps can also be used as end protectors for galvanised pipe ends.

5.10 If pipes are loaded in stacked condition for transport, then they shall be secured suitably to ensure that they can be safely transported without damage and unloaded safely.

6.0 REFERENCES

6.1 6-81-0001: Specification for Positive Material Identification (PMI) at Supplier's Works.

6.2 6-81-0002: Inspection & test plan for welded pipes.

6.3 6-81-0003: Inspection & test plan for seamless pipes.

6.4 6-79-0013: Material requirements for carbon steel components used in sour service for petroleum refinery environments

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TECHNICAL NOTES FOR VALVES

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	
9	09.07.24	REVISED AND ISSUED AS STANDARD SPECIFICATION	PK	SH	GB	MN
8	15.02.23	REVISED AND ISSUED AS STANDARD SPECIFICATION	PK	SH	GB	SM
7	13.07.17	REVISED AND ISSUED AS STANDARD SPECIFICATION	PK	SH	MI	RN
6	04.08.10	REVISED AND ISSUED AS STANDARD SPECIFICATION	RN	ATD	SC	
5	04.07.08	REVISED AND ISSUED AS STANDARD SPECIFICATION	RN	SC	DM	VC
4	15.11.00	REVISED AND ISSUED AS STANDARD SPECIFICATION	RN	BRB	NS	MI

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Abbreviations:

AARH	:	Arithmetic Average Roughness Height
API	:	American Petroleum Institute
ASME	:	American Society of Mechanical Engineers
ASTM	:	American Society for Testing & Materials
BGO	:	Bevel Gear Operator
BHN	:	Brinnel Hardness Number
BIS	:	Bureau of Indian Standards
BS	:	British Standard
BVIS	:	Bureau Veritas Industrial Services
BW	:	Butt Weld
CAT	:	Category
CEIL	:	Certification Engineers International Limited
CS	:	Carbon Steel
DFT	:	Dry Film Thickness
DNV	:	Det Norske Veritas
DP	:	Dye-Penetrant
eDMS	:	Electronic Document Management System
IBR	:	Indian Boiler Regulations
IGC	:	Inter Granular Corrosion
IS	:	Indian Standard
ISO	:	International Organisation for Standardisation
LC	:	Lock Closed
LO	:	Lock Open
LT	:	Low Temperature
LTCS	:	Low Temperature Carbon Steel
MOV	:	Motor Operated Valve
MP	:	Magnetic Particle
MR	:	Material Requisition
NACE	:	National Association for Corrosion engineers
NDT	:	Non Destructive Testing
NPT	:	National Pipe Thread
PMI	:	Positive Material Identification
PO	:	Purchase Order
PR	:	Purchase Requisition
Ra	:	Roughness average
RFQ	:	Request for Quotation
SCRD	:	Screwed
SS	:	Stainless Steel
SW	:	Socket Weld
TUV	:	Technischer Überwachungsverein
WAFL	:	Lugged Wafer Type

Piping Standards Committee

Convenor: Mr. G. Balaji

Members:
Mr. Udayan Chakravarty
Mr. Rameshwar Prasad
Mr. K. Anjaneyulu (SMED)
Mr. Rajesh Chitara (SMMS)
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1.0 GENERAL

1.1 Vendor shall supply valves in accordance with the valve specification sheets along with auxiliaries, if any, such as gear operator, bypasses, drains, locking etc. wherever specified in the specification sheets, subject notes and other enclosures to the material requisition (MR).

1.2 Vendor shall quote in strict accordance with the valve data / specification sheets, subject technical notes and all other enclosures to the MR. For 'Cat-I valves', no deviations whatsoever shall be accepted. For Cat-II Valves, if exceptions/ deviations become absolutely must, the same shall be requested as explained in clause 2.3.6 giving reasons for seeking such exceptions/ deviations. In case Post order concessions/ deviations are unavoidable, the request must be made by BIDDER through online system of EIL eDMS in accordance with 6-78-0001.

1.3 All codes and standards for manufacture, testing, inspection etc. shall be of latest editions as on issue date of RFQ.

1.4 In case of any conflict amongst documents attached with the MR, the most stringent shall govern and Owner's/ EIL decision shall be final in this regard.

2.0 DOCUMENTATION

2.1 All document submissions to EIL shall be through EIL eDMS.

2.2 For 'Cat-I' valves, no documents shall be submitted with the offer.

2.3 For 'Cat-II' valves, vendor shall submit the following documents with the offer:

2.3.1 Manufacturer's complete descriptive and illustrative catalogue / literature.

2.3.2 Detailed dimensioned cross section drawing with parts / material lists, weight etc.

2.3.3 Drawings for valves with accessories like gear operator, hydraulic / pneumatic operator, motor, extension bonnet, extended stems with stands, bypass etc. giving major salient dimensions and weights.

2.3.4 One copy of the valve specification sheets signed as "Accepted" by the manufacturer. Deviations, if any shall be marked as applicable on the valve specification sheet.

2.3.5 If the valve is regretted or has no deviation, the manufacturer shall write clearly on valve specification sheets as "Regret" or "No Deviation".

2.3.6 If there is any deviation, the same shall be listed clausewise.

2.3.7 On failure to submit documents as specified in clauses 2.3.1 to 2.3.6 above, the offer is likely to be rejected.

2.4 The following documents shall be submitted through eDMS of EIL after placement of the order:

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2.4.1 For Cat-I valves of size 2" and above where end-to-end/ face-to-face dimensions are to manufacturers' standards, detailed dimensioned cross section drawing with parts, materials, weight, etc. shall be submitted for records/ information.

2.4.2 For 'Cat-II' valves, Vendor shall submit for review drawings mentioned in clauses 2.3.2 & 2.3.3 before start of manufacture. No other drawings shall be submitted for review unless otherwise mentioned in MR.

2.4.3 Test report shall be supplied for all mandatory tests as per the applicable code. Test reports shall also be furnished for any supplementary tests as specified in clauses 3.13, 3.14 & 3.15.

2.4.4 Material test certificates (physical properties, chemical composition & heat treatment report including Chart) of the pressure containing parts shall be furnished for the valves supplied. Material test certificates for the other parts shall also be furnished for verification during inspection.

2.5 In addition to submissions through EIL eDMS, Catalogues/Drawings shall be in submitted in hard copies (6 sets) and soft copies (2 CDs/DVDs) along with delivery for Purchaser's record for all categories/types of valves.

3.0 DESIGN AND CONSTRUCTION

3.1 Valve shall be designed, manufactured, tested, inspected and marked as per the manufacturing standards, design codes and standards indicated in the respective valve specification sheets. Any conflict between the requisition, enclosures, specification sheets and referred standards/ codes shall be brought to the notice of the purchaser for clarifications and resolution, before proceeding with the manufacture. The purchaser's decision shall be final and binding to the vendor. The drawings submitted for review shall not include any deviations except as communicated in writing in Deviation permits. The Drawings shall be reviewed only for design and construction features.

3.2 All flanged valves shall have flanges integral (except forged valves) with the valve body. Flange face finish shall be normally specified in the valve specification sheet as 125 AARH etc. The interpretation for range of face finish shall be as follows:

Stock Finish	:	1000 μ in AARH max.
125 AARH	:	Serrations with 125 to 250 μ in AARH
63 AARH	:	32 to 63 μ in AARH

3.3 For all weld end valves with bevel end as per ASME B16.25, the contour of bevel shall be as follows:

Material	Wall Thickness	Weld Contour
Carbon Steel (Except Low Temp. Carbon Steel)	Upto 22 mm	Figure 2 Type A
	> 22 mm	Figure 3 Type A
Alloy Steel, Stainless Steel & Low Temp. Carbon Steel	Upto 10 mm	Figure 4
	> 10 mm & Upto 25 mm	Figure 5 Type A
	> 25 mm	Figure 6 Type A

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Valve ends shall match thickness of the connecting pipe. Sloping of inside contour of valves shall be done wherever necessary to achieve this.

3.4 For flanged valves with ring joint flanges the hardness shall be as follows:

Flange Material	Min. Hardness of Groove (BHN)
Carbon Steel	140
1% Cr to 5% Cr, 9% Cr	150
9Cr-1Mo-V	190
Type 304, 316, 321, 347	160
Type 304L, 316L	150
Inconel UNS N06625	220
Incoloy UNS N08825	210
Duplex SS UNS S32205, UNS S31803	250

3.5 Following requirements for check valves shall be met over and above the valve specification sheet requirements:

3.5.1 Unless specified otherwise in the data sheet all check valves 3" & above (except in Class 900, Class 1500 & Class 2500 rating) shall have a drain boss at location "G" (Refer Fig.No.1 of ASME B16.34) where pocket is formed in valve body. A tapped drain hole with plug shall be provided as per ASME B16.34. Threads shall be as per ASME B1.20.1 (Taper) NPT.

3.5.2 For heavy check valves, provisions shall be available for lifting by way of lugs, eye bolts and other such standard devices.

3.6 If an overlay weld-deposit is used for the body seat ring seating surface, the corrosion resistance of the seat ring base material shall be at least equal to the corrosion resistance of the material of the shell.

3.7 Following valve bypass requirements shall be met:

3.7.1 By-pass requirement for Gate valves shall be as follows unless otherwise mentioned.

ASME 150 Class	On sizes 26" and above
ASME 300 Class	On sizes 16" and above
ASME 600 Class	On sizes 6" and above
ASME 900 Class	On sizes 4" and above
ASME 1500 Class	On sizes 4" and above
ASME 2500 Class	On sizes 3" and above

3.7.2 The by-pass piping arrangement shall be such that clearance between main valve body and by-pass assembly shall be the minimum possible for layout reasons. Vendor shall follow the sketch enclosed in Specification No. 6-44-0052-A1.

3.7.3 By-pass valve shall be a globe valve. The sizes shall be as under:

On main valve ≤ 4" : 1/2"

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On main valve 6" to 8" : 3/4"
On main valve 10"& above : 1"

By-pass piping shall be of same metallurgy as main valve. The by-pass piping, fittings and valve tag numbers shall be as specified in Specification No. 6-44-0052-A2. In case details of by-pass arrangement for any Valve tag number is missing, Vendor shall bring the same to notice of EIL and provide by-pass as per details specified. Bends are not acceptable in place of elbows except in the location specified in 6-44-0052-A1.

3.7.4 Vendor shall supply the by-pass valve duly tested and fitted to the main valve with proper supporting from the main valve body, as required. Valves with by-pass shall have the direction of flow marked on the bypass valve only. By-pass attachment to the main valve body shall not be screwed. All fillet welds for by-pass installation shall be 100% examined by DP/MP test and Butt-weld joints shall be 100% examined by radiography.

3.8 Valve body / bonnet shall be forged / cast as specified. Forgings are acceptable in place of casting but not vice-versa.

3.9 Stem shall be forged or machined from forged / rolled bar. No casting is permitted. However, integral stem of cast material is acceptable for Plug valves.

3.10 Stelliting / hardfacing by deposition, shall be minimum 1.6 mm.

3.11 Renewable seat rings shall be seal welded for valves of size 3" and above to prevent loosening in service.

3.12 For Low Temperature & Cryogenic valve requirements, refer Specification. No. 6-44-0052-A3 unless otherwise specified.

3.13 For Hydrogen service valve requirements, refer Specification. No. 6-44-0052-A4 unless otherwise specified.

3.14 Valves under 'NACE' category shall meet the requirements specified in MR-0103 unless otherwise specified.

3.15 For all austenitic stainless steel valves Inter Granular Corrosion (IGC) test shall be conducted as per the following:

3.15.1 ASTM A262 Practice 'B' with acceptance criteria of '60 mils/year (max.)' for all materials - forged, rolled, wrought and casting.

Or

ASTM A262 Practice 'E' with acceptance criteria of 'No cracks as observed from 20X magnification' for all materials other than castings. 'Microscopic structure to be observed from 250X magnification' in addition.

3.15.2 When specifically asked for in MR for high temperature application of some grades of austenitic stainless steel (eg. SS309, 310, 316, 316H etc.) ASTM A262 Practice 'C' with acceptance criteria of '15 mils/year (max.)' shall be conducted.

3.15.3 For the IGC test as described in Clauses 3.15.1 & 3.15.2, two sets of samples shall be drawn from each solution annealing lot. One set shall correspond to the highest Carbon content and the other to the highest pressure rating. When testing is conducted as per practice 'E', photograph of the microscopic structure shall be submitted for record.

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3.16 All types of 321 or 347 stainless steel valves shall be in a stabilised heat treated condition. Stabilising heat treatment shall be carried out subsequent to the normal solution annealing. Soaking temperature and holding time for stabilising heat treatment shall be 900°C and 4 hours respectively.

3.17 Spiral wound bonnet gaskets are to be provided with inner/outer ring except when encapsulated gaskets type body-bonnet joints are employed. Outer ring may be avoided in case of non-circular spiral wound gasket used in Class 150 valve provided the outermost layer of spiral touches the bolts ascertaining the centering.

3.18 All Stainless Steel Castings shall be solution heat treated.

3.19 Only normalized and tempered material shall be used in the following specifications:

Castings : A217 Gr.WC1, A217 Gr.WC4, A217 Gr.WC5, A217 Gr.WC6, A217 Gr.WC9, A217 Gr.C5, A217 Gr.C12

Forgings : A182 Gr.F11 Cl.2, A182 Gr.F12 Cl.2

3.20 Ball / Plug / Butterfly Valves

3.20.1 As a prequalification, fire safe test as per API 607 / API 6FA / BS EN ISO 10497 (Supersedes BS 6755 Part II) shall be carried out on soft seated ball, plug & butterfly valves and also on lubricated plug valves. The test shall be witnessed and certified by a third party inspection agency like Lloyds, BVIS, DNV, TUV or EIL/ CEIL unless otherwise specified. The vendor has to submit test certificate for the particular design of the valve offered, if fire safe design is required as per the Valve Material Specification sheet.

3.20.2 Each valve shall be supplied with a lever / wrench except for gear operated / motor operated valves.

3.20.3 Soft-seated ball, plug & butterfly valves shall be supplied with antistatic devices.

3.20.4 BW / SW end ball valves shall have a 100 mm long seamless pipe nipple welded to each end of the valve. Nipples are to be welded prior to assembling soft seats / seals. Specifications of the nipples shall be as indicated in the MR.

3.20.5 The ball of ball valve shall not protrude outside the end flanges of valve.

3.20.6 Ball valves shall be of floating ball/trunnion mounted type as per following:

Class 150	8" & below	Floating ball
	10" & above	Trunnion mounted
Class 300	4" & below	Floating ball
	6" & above	Trunnion mounted
Class 600 & above	1.5" & below	Floating ball
	2" & above	Trunnion mounted

3.20.7 Unless otherwise specified in the data sheets, bore of all reduced bore ball valves shall be limited to one size lower than the nominal bore.

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3.20.8 In case of ball valves, the ball shall have a cylindrical bore and shall be of solid construction except in the case of rising stem ball valves or where otherwise specified.

3.21 Motor Operated Valves:

3.21.1 The MOVs are to be installed in an open area and the actuators shall be suitable for all weather conditions. The testing of complete assemblies of MOVs along with the actuators shall be done by the supplier at his works.

3.21.2 Vendor shall be solely responsible for selection of suitable actuators & actuator control system. Vendor shall be single point responsible for the complete system (i.e. valves, actuators, actuators control system etc.).

3.21.3 Valve with motorized actuators shall be suitable for installation in horizontal/vertical lines.

3.21.4 All MOVs shall be provided with hand wheel for manual operation.

3.22 In case flange dimension standard / Butt weld end thickness have not been specified in Valve Material Specification attached with the MR, Vendor to obtain the same from EIL and supply strictly in line with specifications.

3.23 Yoke material shall be same as bonnet material where maximum temperature specified is more than 427°C.

3.24 Face to Face / End to End Dimensions of Valves:

The Face to Face dimensions for Flanged valves and End to End Dimensions for Butt Welded Valves shall be strictly as given below unless otherwise specified in the VMS sheet. Valves with Face-to-Face/End-to-End dimensions as per Manufacturers' Standards are acceptable only where not covered in the Dimension Standards listed below.

3.24.1 Gate Valves:

Type	Face-to-Face/End-to-End Dimension
Flanged End	Dimension 'A' for Solid Wedge & Double Disc Gate Valves as per ASME B16.10
Butt Welding End	Dimension 'B' for Short Pattern Gate Valves up to the sizes covered in ASME B16.10. For sizes not covered under Short Pattern, Dimension 'B' for Long Pattern Gate Valves as per ASME B16.10 shall be followed.

3.24.2 Globe Valves:

Type	Face-to-Face/End-to-End Dimension
Flanged End	Dimension 'A' for Globe Valves as per ASME B16.10
Butt Welding End	Dimension 'B' for Short Pattern Globe Valves up to the sizes covered in ASME B16.10. For sizes not covered under Short pattern, Dimension 'B' for Long Pattern Globe Valves as per ASME B16.10 shall be followed.

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3.24.3 Check Valves:

Type	Face-to-Face/End-to-End Dimension
Flanged End Swing Check	Dimension 'A' for Swing Check Valves as per ASME B16.10
Butt Welding End Swing Check	Dimension 'B' for Short Pattern Swing Check Valves up to the sizes covered in ASME B16.10. For sizes not covered under short pattern, Dimension 'B' for Long Pattern Swing Check Valves as per ASME B16.10 shall be followed.
Lugged/Double Flanged Dual Plate Check Valves	As per API 594

3.24.4 Ball Valves:

The face-to-face dimensions of all ball valves shall be same as those of gate valves of the corresponding ASME Class rating as given in Clause 3.24.1 (except 10" onwards in Class 150 where the face-to-face dimensions shall be as per ASME B16.10 long pattern).

3.24.5 Plug Valves:

Class Rating	Face-to-Face Dimension
Class 150	Short Pattern as per ASME B16.10 up to 12" Venturi Pattern as per ASME B16.10 for above 12"
Class 300 & 600	Short Pattern as per ASME B16.10 up to 4" Venturi Pattern as per ASME B16.10 for above 4"

3.24.6 Butterfly Valves:

The face to face dimensions for butterfly valves shall be as per BS EN 558/API 609. For Class 150 Butterfly valves, Series 13 shall be followed and for Class 300 Butterfly valves, Series 14 shall be followed, unless otherwise specified.

3.25 In addition to all types of BW/SW ball valves, any other type of soft seated BW / SW end valve shall have a 100 mm long seamless pipe nipple welded to each end of the valve. Nipples are to be welded prior to assembling soft seats / seals. Specifications of the nipples shall be as indicated in the MR.

3.26 All Butt welds shall be 100% radiographed and all socket welds shall be 100% DP/MP tested.

3.27 Fugitive Emission Requirements:

Unless otherwise mentioned in VMS sheet, all valves with stem packing shall comply with the fugitive emission requirements detailed below as a pre-qualification.

3.27.1 Gate valves as per API-600 and all Gate/Globe valves as per API-602 shall comply with fugitive emission requirements of API 624.

Gate valves of Class rating 900 & above, Gate valves of size 26" & above and Globe valves of size 2" & above or valves where API-624 is not applicable due to non-graphite stem packing material, shall comply with Fugitive emission requirement of ISO-15848-1.

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3.27.2 Quarter turn valves shall comply with Fugitive emission requirement of API 641.Quarter turn valves where API-641 is not applicable due to non-graphite stem packing material, shall comply with Fugitive emission requirement of ISO-15848-1.

3.27.3 As a prequalification, Fugitive emission type test as per Cl. 3.27.1 & 3.27.2 above shall have been carried out and the test shall have been witnessed and certified by a third party inspection agency like Lloyds, BVIS, DNV, TUV or EIL/ CEIL unless otherwise specified. The vendor has to submit test certificate covering the entire range of valves to be supplied.

Vendors who do not have Fugitive emission type test certificate covering the range of valves to be supplied, shall conduct the requisite test within 12 weeks from the date of purchase order or within contractual delivery date, whichever is earlier.

In case of non-conductance of Fugitive emission type test(s) within time frame specified above or failure in the test(s) conducted after receipt of order, the owner reserves the right to invoke any of the provisions of the purchase order including cancellation of the purchase order at the risk and cost of vendor.

3.28 Valves specified as LO (Lock open) and LC (Lock closed) shall be supplied with suitable arrangement for locking in open as well as in closed position. Lock is included in vendor's scope of supply.

3.29 For Lugged Wafer Type (WAFL) Butterfly Valves, lug shall be provided for each bolt.

3.30 For butterfly valves, where bolting for tapped hole in body is being supplied by Vendor and diameter of the bolting is more than or equal to 1", the bolting supplied shall be studs to ASME B18.2.1 with two nuts.

3.31 For Gate and Globe valves, the stem surface area in contact with the packing shall have a surface finish, Ra, of 0.80μm (32μin.) or smoother, unless otherwise specified.

4.0 OPERATION

4.1 Gear operation shall be provided as under as a minimum, unless otherwise specified:

Valve Type	Class	Size Requiring Gear-Operator
Gate Valve, Globe Valve & Diaphragm Valve	150 Class	12" and larger
	300 Class	12" and larger
	600 Class	10" and larger
	900 Class	6" and larger
	1500 Class	3" and larger
	2500 Class	3" and larger
Ball Valve / Plug Valve (Other than pressure balance plug valves)	150 Class	6" and larger
	300 Class	6" and larger
	600 Class	4" and larger
Ball Valve / Plug Valve (Other than pressure balance plug valves)	900 Class	3" and larger
	1500 Class	3" and larger
Butterfly Valve	150, 300 Class	6" and larger

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For sizes lower than these ranges, hand wheel / lever / wrench shall be provided. For pressure balance plug valves manufacturer's recommendation shall be acceptable provided the requirements specified in clause 4.6 are met.

4.2 Gear operator shall be provided, with position indicators for open / close positions and with limit stops. (Limit stops are not applicable for gate valves). Gear box shall be fully encased and weather proof.

4.3 Where gear operator is not called for as per Clause 4.1 but vendor recommends a gear operator, the same shall be highlighted.

4.4 Gear operator shall be so designed as to operate effectively with the differential pressure across the closed valve equal to the cold non-shock pressure rating.

4.5 Ball, plug and butterfly valves, shall have "Open" position indicators with limit stops.

4.6 Hand-wheel diameter shall not exceed 750mm and lever length shall not exceed 500mm on either side. Effort to operate shall not exceed 35 Kg at hand-wheel periphery. However, failing to meet the above requirements, vendor shall offer gear operated valve and quote as per clause 4.3.

5.0 INSPECTION AND TESTING

5.1 Every valve shall be subjected to all the mandatory tests and checks called in the respective codes / data sheet by EIL inspection or any third party as approved by the purchaser. For IBR valves refer clause 7.0.

5.2 Every valve, its components and auxiliaries must be subjected to all the mandatory tests and checks called for in the respective codes, data sheets etc. by the manufacturer.

5.3 Though the extent of inspection shall be as under, exact extent with hold points shall be decided by EIL regional inspection office and recorded in the form of inspection plan. In case of third party inspection, the inspection plan shall be approved by the purchaser.

Forged Valves:

1. Visual and dimensional inspection.
2. Review of material test certificates.
3. Any mandatory or supplementary test.
4. Hydrostatic test on 10% valves selected on random basis.
5. Strip check is required for 1% of total ordered quantity of Gate & Globe valves (min. 1 No.) for each Valve sheet no., however, strip check is not required for CS/ Brass/ Bronze material valves with 13% Cr/ Brass/ Bronze trims.
6. Type test certificate for Fugitive Emissions as per Cl. 3.27.3.
7. Positive Material Identification
8. Type test certificates for cryogenic & Fire safe test to be submitted.

Cast Steel Valves:

1. Visual inspection with acceptance standards as per MSS SP-55 and dimensional inspection.
2. Review of material test certificates.

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3. Review of radiographs and radiographic reports or any other NDT tests wherever applicable as per data sheet.
4. Any mandatory or supplementary test.
5. Hydrostatic test 100% for body, 10% other test.
6. Strip check is required for 1% of total ordered quantity of Gate & Globe valves (min. 1 No.) for each Valve sheet no., however, strip check is not required for CS/ Brass/ Bronze material valves with 13% Cr/ Brass/ Bronze trims.
7. Type test certificate for Fugitive Emissions as per Cl. 3.27.3.
8. Positive Material Identification
9. Type test certificates for cryogenic & Fire safe test to be submitted.

Samples for strip check shall be selected at random and shall generally be in the highest size in the lot.

5.4 In case of motor operated or actuator operated valves, functional / operational checks as per the requirements of the specifications shall be made on each valve.

6.0 RADIOGRAPHY OF CAST VALVES

6.1 Valve castings shall undergo radiographic examination as specified below.

Material	Rating	Size Range	Radiography
All	Class 150	24" and below	NIL**
		26" and above*	100%
	Class 300	16" and below	NIL**
		18" and above	100%
	Class 600& above	All sizes	100%

* No radiography is required for valves of size 26" and above in cooling water service.

**For sizes 24" & below in Class 150 and 16" & below in Class 300, radiography percentage if specifically mentioned in individual valve material spec sheet shall govern.

Radiography specified as random 10% or 20% etc. in the respective valve data sheet implies 10% or 20% etc. of number of valves ordered against each item number with a minimum of one valve against each item.

6.2 Radiography procedure, areas of casting to be radiographed shall be as per ASME B16.34 and acceptance criteria shall be as per ASME B16.34. However for areas of casting to be radiographed for types of valves not covered in ASME B16.34, vendor shall radiograph castings in line with ASME B16.34.

6.3 For random radiography wherever specified in individual data sheets, the sampling shall be per size of the quantity ordered for each foundry.

6.4 Radiography wherever specified in the data sheets or as per clause 6.1 shall be done by X-ray / γ-ray to get the required sensitivity.

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7.0 IBR CERTIFICATION

7.1 For valves described "IBR", valves shall be in accordance with the latest IBR (Indian Boiler Regulation) including the requirements specified in the specification.

7.2 For SW / BW end carbon steel valves under IBR, the chemical composition shall conform to the following:

Carbon (Max)	:	0.25%
Others (S, P, Mn)	:	As per IBR

7.3 Valves coming under the purview of "IBR" (Indian Boiler Regulations) shall each be individually accompanied by IBR certificate original in Form III-C duly approved by IBR authority / local authority empowered by the Central Boiler Board of India. Photocopy of original certificate duly attested by the local boiler inspector where the supplier is located is the minimum requirement for acceptance.

7.4 All "IBR" valves shall be painted red in body-bonnet / body-cover joint.

8.0 MARKING

8.1 Valve markings, symbols, abbreviations etc. shall be in accordance with MSS-SP-25 or the standard referred in specification sheet as applicable. Vendor's name, valve rating, material designation, nominal size, direction of flow (if any) etc. shall be integral on the body.

8.2 Each valve shall have a corrosion resistant tag giving size, valve tag / code no., securely attached to the valve body.

8.3 Paint or ink for marking shall not contain any harmful metal or metal salts such as zinc, lead or copper which cause corrosive attack on heating.

8.4 Carbon Steel / Alloy Steel valves shall be painted with one coat of inorganic zinc silicate (minimum DFT 65 to 75 microns).

9.0 DESPATCH

9.1 Valve shall be dry, clean and free from moisture, dirt and loose foreign materials of any kind.

9.2 Valves shall be protected from rust, corrosion and any mechanical damage during transportation, shipment and storage.

9.3 Rust preventive on machined surfaces to be welded shall be easily removable with a petroleum solvent or shall not be harmful to welding.

9.4 Each end of valve shall be protected with the following materials:

Flange Face	:	Wood or Plastic Cover
Bevelled End	:	Wood or Plastic Cover
SW & SCRD. End	:	Plastic Cap

9.5 End protectors of wood / plastic to be used on flange faces shall be attached by at least three bolts and shall not be smaller than the outside diameter of the flange. However, plastic caps for SW & SCRD end valves shall be press fit type.

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9.6 End protectors to be used on bevelled end shall be securely and tightly attached.

9.7 For special service valves additional requirement for despatch shall be as prescribed in data sheet.

10.0 ATTACHMENTS

6-44-0052-A1	:	Bypass Piping Arrangement
6-44-0052-A2	:	Specifications for Bypass Piping, Fittings and Valves
6-44-0052-A3	:	Special Requirements for Low Temperature and Cryogenic Valves
6-44-0052-A4	:	Special Requirements for Hydrogen Service Valves

11.0 REFERENCES

6-78-0001	:	Specification for Quality management system requirements from bidders
6-78-0003	:	Specification for documentation requirements from suppliers
6-81-0001	:	Specification for Positive Material Identification (PMI) at Supplier's Works
6-81-0004	:	Inspection and Test plan for Valves

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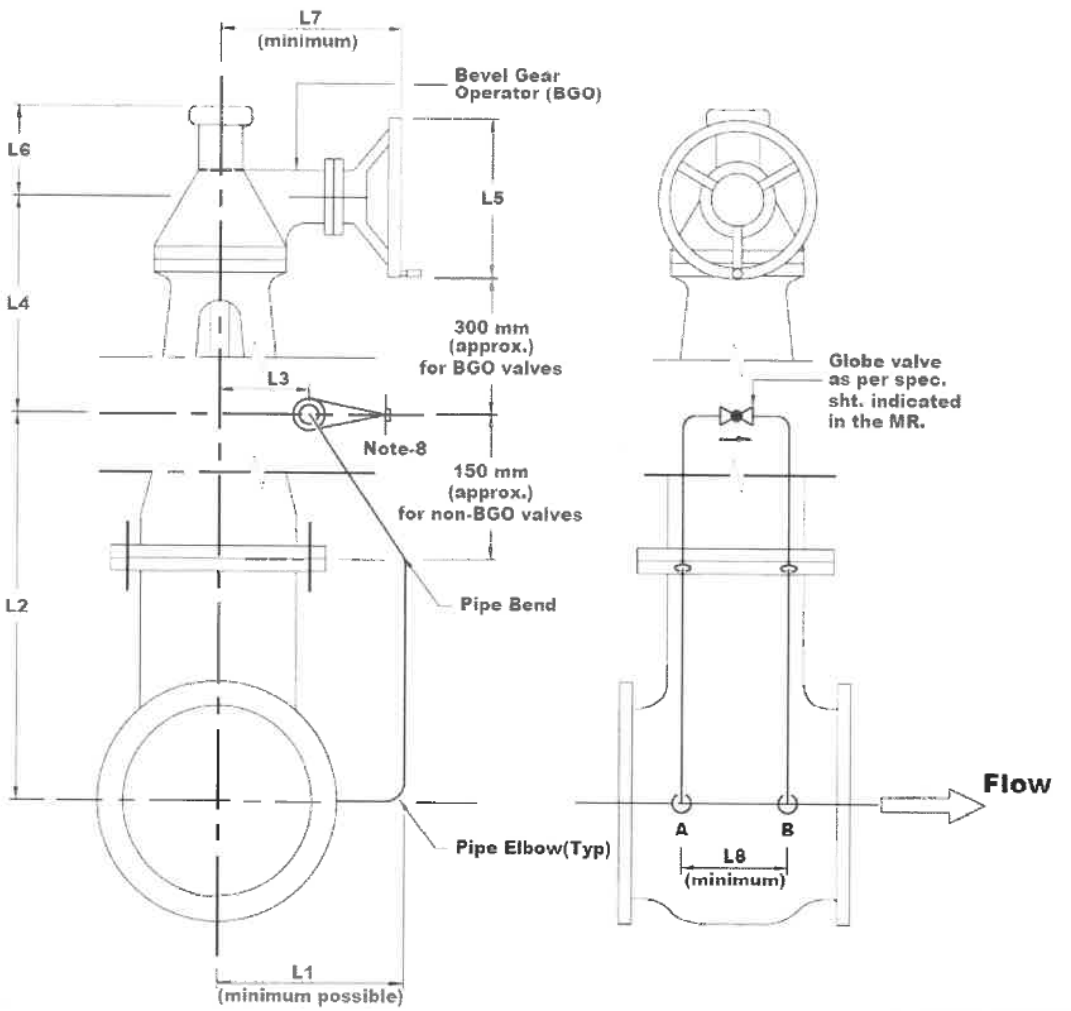
BYPASS PIPING ARRANGEMENT



NOTES:

1. The orientation & location of handwheel of bevel gear operator & the bypass arrangement shall be strictly as per this sketch.
2. The bypass connection ends including connection to boss in main valve body shall be socket welded upto 600# and butt welded for 900# and above rating.
3. The bypass arrangement shall be properly clamped to & supported by the body of the main valve.
4. Basic design of bypass shall be to MSS-SP-45.
5. Material of bypass pipe & 90° elbows shall be same or equivalent to the body material as indicated in Specification No. 6-44-0052-A2.
6. This sketch is applicable for both BGO & NON-BGO Valves.
7. Vendor shall furnish dimensions L1 to L8.
8. Stem shall not be horizontal in the case of CRYO Valves.

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SPECIFICATIONS FOR BYPASS PIPING, FITTINGS AND VALVES

Class (Main Valve Sht.no.)	Pipe	Fittings	Bypass Valve Sht.no.	Remarks
A1A(51301), A3A(51321), A39A (51321), A9A(51301), A11A(51301), A33A(51301), B1A(51401), B9A(51401), D1A(51501), D9A (51501)	ASTM A106 Gr.B (SMLS) 0.5"-1.5": S160	ASTM A105 0.5"-1.5": SW 6000#	52001	
A6A(51301), B6A(51401)	ASTM A106 Gr.B (SMLS) 0.5"-0.5" : XXS 0.75"-1.5": S160	ASTM A105 0.5"-0.5" : SW 9000# 0.75"-1.5": SW 6000#	52001	
A13A(51301), B13A(51401)	ASTM A106 Gr.B (SMLS) 0.5"-1.5" : XXS	ASTM A105 0.5"-1.5" : SW 9000#	52001	
A2A(51302), B2A(51402), D2A (51502)	ASTM A106 Gr.B (SMLS)- IBR 0.5"-0.75": S160 1.0"-1.5" : XS	ASTM A105 - IBR 0.5"-0.75": SW 6000# 1.0"-1.5" : SW 3000#	52002	
A4A (51303), B4A (51403), D4A (51503)	ASTM A333 Gr.6 (SMLS)- LT 0.5"-0.75": S160 1.0"-1.5" : XS	ASTM A350Gr.LF2CL.1-LT 0.5"-0.75": SW 6000# 1.0"-1.5" : SW 3000#	52003	
B5A (51404), D5A (51504)	ASTM A106 Gr.B (SMLS) -H2 0.5"-0.75": S160 1.0"-1.5": XS	ASTM A105 - H2 0.5"-0.75": SW 6000# 1.0"-1.5" : SW 3000#	52004	Note-1
A7A (51307)	ASTM A106 Gr.B (SMLS) 0.5"-0.75" : S160 1.0"-1.5": XS	ASTM A105 0.5"-0.75": SW 6000# 1.0"-1.5" : SW 3000#	52007	
A16A (51311), B16A (51411), D16A (51511)	ASTM A106 Gr.B (SMLS) - NACE 0.5"-0.75" : XXS 1.0"-1.5": S160	ASTM A105 - NACE 0.5"-0.75" : SW 9000# 1.0"-1.5": SW 6000#	52011	Note-1
A19A (51313), B19A (51413), D19A (51513)	ASTM A106 Gr.B (SMLS) 0.5"-1.5" : S160	ASTM A105 0.5"-1.5": SW 6000#	52013	Note-1
E1A (51601), F1A (51701)	ASTM A106 Gr.B (SMLS) 0.5"-1.5" : S160	ASTM A234 Gr.WPB/ ASTM A105 0.5"-1.5" : BW, S160	52101	
E2A (51602), F2A (51702)	ASTM A106 Gr.B (SMLS) - IBR 0.5"-1.5" : S160	ASTM A234 Gr.WPB/ ASTM A105 - IBR 0.5"-1.5" : BW, S160	52102	
E5A (51604), F5A (51704)	ASTM A106 Gr.B (SMLS) - H2 0.5"-1.5" : S160	ASTM A234 Gr.WPB/ ASTM A105 - H2 0.5"-1.5" : BW, S160	52104	Note-1
E9A (51605), F9A (51705)	ASTM A106 Gr.B (SMLS) 0.5"-1.5" : SCH XXS	ASTM A234 Gr.WPB/ ASTM A105 0.5"-1.5" : BW, SCH XXS	52105	

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Class (Main Valve Sht.no.)	Pipe	Fittings	Bypass Valve Sht.no.	Remarks
E19A (51613), F19A (51713)	ASTM A106 Gr.B (SMLS) 0.5"-1.5" : SCH XXS	ASTM A234 Gr.WPB/ ASTM A105 0.5"-1.5" : BW, SCH XXS	52113	Note-1
A5Y (51384), A33Y (51384)	ASTM A106 Gr.B (SMLS) 0.5"-0.75" : S160 1.0"-1.5": XS	ASTM A105 0.5"-0.75": SW 6000# 1.0"-1.5" : SW 3000#	52085	
B1D (51430), D1D (51530)	ASTM A335Gr.P11(SMLS) 0.5"-0.75" : S160 1.0"-1.5": XS	ASTM A182 Gr.F11Cl.2 0.5"-0.75": SW 6000# 1.0"-1.5" : SW 3000#	52030	
D2D (51531)	ASTM A335Gr.P11 (SMLS) - IBR 0.5"-0.75" : S160 1.0"-1.5": XS	ASTM A182 Gr.F11Cl.2 - IBR 0.5"-0.75": SW 6000# 1.0"-1.5" : SW 3000#	52031	Note-1
B5D (51432), D5D (51532)	ASTM 335Gr.P11(SMLS)- H2 0.5"-0.75" : S160 1.0"-1.5": XS	ASTM A182 Gr.F11Cl.2 - H2 0.5"-0.75": SW 6000# 1.0"-1.5" : SW 3000#	52032	Note-1
B1E (51433)	ASTM A335Gr.P22(SMLS) 0.5"-0.75" : S160 1.0"-1.5": XS	ASTM A182 Gr.F22Cl.3 0.5"-0.75": SW 6000# 1.0"-1.5" : SW 3000#	52033	
D5E (51534)	ASTM A335Gr.P22(SMLS) - H2 0.5"-0.75" : S160 1.0"-1.5": XS	ASTM A182 Gr.F22Cl.3 - H2 0.5"-0.75": SW 6000# 1.0"-1.5" : SW 3000#	52034	Note-1
A4F (51336), B4F (51436)	ASTM A335 Gr.P5(SMLS) 0.5"-0.75" : S160 1.0"-1.5": XS	ASTM A182 Gr.F5 0.5"-0.75": SW 6000# 1.0"-1.5" : SW 3000#	52036	Note-1
B3F (51436)	ASTM A335 Gr.P5(SMLS) 0.5"-1.5" : XXS	ASTM A182 Gr.F5 0.5"-1.5" : SW 9000#	52036	Note-1
A4G (51339), B4G (51439)	ASTM A335 Gr.P9(SMLS) 0.5"-0.75" : S160 1.0"-1.5": XS	ASTM A182 Gr.F9 0.5"-0.75": SW 6000# 1.0"-1.5" : SW 3000#	52039	Note-1
F2D (51731)	ASTM A335 Gr.P11 (SMLS) - IBR 0.5"-1.5" : S160	ASTM A234Gr.WP11Cl.1/ A182 Gr.F11Cl.2 - IBR 0.5"-1.5" : BW, S160	52131	Note-1
F2G (517GG)	ASTM A335 Gr.P91 (SMLS) - IBR 0.5"-0.75" : S160 1.0"-1.5": XS	ASTM A234Gr.WP91/ A182 Gr.F91 - IBR 0.5"-0.75" : S160 1.0"-1.5": XS	52140	Note-1
G2G (518GG)	ASTM A335 Gr.P91 (SMLS) - IBR 0.5"-1.0" : S160 1.5"-1.5": XXS	ASTM A234Gr.WP91/ A182 Gr.F91 - IBR 0.5"-1.0" : S160 1.5"-1.5": XXS	52240	Note-1
E5E (51634)	ASTM A335 Gr.P22(SMLS) - H2 0.5"-0.75" : S160 1.0"-1.5": XS	ASTM A234Gr.WP22Cl.1/ A182 Gr.F22Cl.3 - H2 0.5"-0.75" : BW, S160 1.0"-1.5" : BW, XS	52134	Note-1

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Class (Main Valve Sht.no.)	Pipe	Fittings	Bypass Valve Sht.no.	Remarks
A1K (51345), A3K (51345), B1K (51445), D1K (51545)	ASTM A312TP304(SMLS) 0.5"-0.75" : 80S 1.0"-1.5": 40S	ASTM A182 Gr.F304 0.5"-1.5" : SW 3000#	52045	
A2K (51346), B2K (51446), D2K (51546)	ASTM A312TP304(SMLS) - CRYO 0.5"-0.75" : 80S 1.0"-1.5": 40S	ASTM A182 Gr.F304 - CRYO 0.5"-1.5" : SW 3000#	52046	
B4K (51448), B5K (51448)	ASTM A312TP304H(SMLS) 0.5"-1.5" : 80S	ASTM A182 Gr.F304H 0.5"-1.5": SW 3000#	52048	
A6K (51350), A11K (51350), B6K (51450)	ASTMA312TP304L(SMLS) 0.5"-0.75" : 80S 1.0"-1.5": 40S	ASTM A182 Gr.F304L 0.5"-1.5": SW 3000#	52050	
A1M (51361), B1M (51461)	ASTM A312 TP316(SMLS) 0.5"-0.75" : 80S 1.0"-1.5": 40S	ASTM A182 Gr.F316 0.5"-1.5": SW 3000#	52061	
B5M (51462)	ASTMA312TP316H(SMLS) - H2 0.5"-0.75" : 80S 1.0"-1.5": 40S	ASTM A182 Gr.F316H - H2 0.5"-1.5": SW 3000#	52062	
B3M (51463)	ASTM A312 TP321(SMLS) 0.5"-0.75" : 80S 1.0"-1.5": 40S	ASTM A182 Gr.F321 0.5"-1.5": SW 3000#	52063	
A1N (51366), B1N (51466)	ASTMA312TP316L(SMLS) 0.5"-0.75" : 80S 1.0"-1.5": 40S	ASTM A182 Gr.F316L 0.5"-1.5": SW 3000#	52066	
B6N (51471)	ASTM A312 TP316L (SMLS) 0.5"-0.75" : 80S 1.0"-1.5": 40S	ASTM A182 Gr.F316L 0.5"0.5"-1.5": SW 3000#	52071	

In case specifications for bypass of any specific VMS sheets are not available in the MR, Vendor to obtain the same from EIL and supply strictly in line with specifications.

Notes:

1. All welded joints shall be post weld heat treated. Procedure for Post weld heat treatment shall be in accordance with ASME B31.3.

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SPECIAL REQUIREMENTS FOR LOW TEMPERATURE & CRYOGENIC VALVES

1.0 SCOPE

All valves of Low Temperature Carbon Steel (LTCS) and all grades of austenitic SS (CRYO) material are categorized as cryogenic valves. All these valves shall have extended bonnet. The bonnet extension shall be as per VMS sheets (BS 6364/ BS EN ISO 28921-1) except check valves.

2.0 QUALIFICATION CRITERIA

For Limited Enquiries (Non NIT enquiries)

2.1 Vendors who satisfy both the requirements given below shall be considered qualified :

a. Vendor should be enlisted with EIL for any cryogenic valve irrespective of type, size, rating and metallurgy

b. Vendors should be enlisted with EIL for the same type, material, size and rating of non-cryogenic/cryogenic valve as the cryogenic valve quoted for

2.2 Qualified Vendors who do not have cryogenic test reports covering the range of Cryogenic valves quoted for, shall conduct cryogenic test per clauses 3.0 within 12 weeks from the date of purchase order.

2.3 Clauses 2.1 and 2.2 of this Annexure shall be read in conjunction.

3.0 CRYOGENIC TEST

3.1 Vendors to furnish copies of cryogenic test certificate for tests as per details given below:

3.1.1 Test shall be as per VMS sheets (BS 6364/ BS EN ISO 28921-2).

3.1.2 Test temperature, unless specifically called for otherwise in the individual MR, shall be -45°C for LTCS and -196°C for all grades of austenitic stainless steel.

3.1.3 Tests carried out on a particular size of one type of valve, pressure rating and material shall qualify all sizes equal to and below the test valve size for the same type, pressure rating and material. In case of austenitic SS any one grade would qualify for all other grades of austenitic SS.

3.1.4 Tests should have been witnessed and certified by any third party inspection agencies like M/s Lloyd, BV, DNV, TUV or EIL/ CEIL.

3.1.5 Test conducted previously and witnessed by inspection agencies listed above shall be considered acceptable and need not be repeated.

3.2 Post Order Testing Procedure

3.2.1. Before conducting post order testing, vendor shall obtain approval for the following from TPIA:

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a. Test procedure and Schematic of test rig with complete details as per standard specified in VMS sheet (BS 6364/ BS EN ISO 28921-2).

b. Cross-section drawing of the valve with material of construction.

3.2.2. Test has to be conducted irrespective of the service on largest size for each type of valve and for each material and class rating. Vendor shall offer one, two or three valves for selection of test valve by inspector depending upon whether quantity of largest valve in the order is one, two or three and more than three respectively.

In the event of failure of the test valve to meet the specification requirements, the vendor shall conduct test on two more valves. These two valves which pass test successfully, are of lower size, then the qualification will be valid only to sizes upto which test has been conducted successfully.

3.2.3. In case of non-conductance of cryogenic test(s) within 12 weeks or failure in the test(s) conducted after receipt of order, the owner reserves the right to invoke any of the provisions of the purchase order including cancellation of the purchase order at the risk and cost of vendor.

4.0 Bonnet extension, wherever specified in the valve sheet shall be for "non cold box application" unless otherwise specified in the MR. Even if not called for in VMS, valves indicated as "LT" or "CRYO" shall be supplied with bonnet extension.
If the valves are supplied in accordance with BS EN ISO 28921-1, Bonnet extension in LT service shall be as per values specified for -51 Deg.C to -109 Deg.C.

5.0 Bonnet and Gland extension joints shall be of butt welded/integrally cast construction.

6.0 Repair welding procedure for austenitic stainless steel valves in "CRYO" service shall have to be qualified for impact test as per ASME B31.3. Minimum acceptable impact energy shall be 20 J or lateral expansion of 0.38 mm at temperature of -196°C.

7.0 Wherever impact test of SS studs / nuts is called for in the data sheet, the impact value shall be 27 J at the intended service temperature specified in the data sheets.

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SPECIAL REQUIREMENTS FOR HYDROGEN SERVICE

1.0 GENERAL

1.1 These requirements are applicable for valves used in Hydrogen service. These are in addition to the requirements described in "Technical Notes for Valves" Spec. No. 6-44-0052, and shall be read in conjunction with this specification.

1.2 All cast valve flanges & bodies with flange rating of Class 900 or greater shall be examined in accordance with paragraphs 7.2 through 7.5 of Appendix-VII of ASME SEC-VIII, DIV.1, regardless of casting quality factor.

1.3 Body / bonnet / cover joints & stuffing box of all valves shall have low emission. One valve per metallurgy, per rating, per size shall be helium leak tested as per ASME Sec.V, Subsection A, Article 10 (Detector Probe Technique), Appendix IV at a minimum of 25% of the allowable (rated) cold working pressure. Selection of valves for helium leak test shall be at random. Test duration shall be as follows:

Test Duration in Minutes					
Nominal Size	Pressure Class				
	Upto 300	600	800 & 900	1500	2500
Upto 2"	3	6	9	12	12
3" to 6"	6	9	12	15	18
8" to 16"	9	9	12	15	18
18" to 24"	9	12	15	18	21

The valve shall show no leakage. No leakage is defined as a total leakage rate of less than 0.0001 ml/s of helium.

2.0 Only normalized and tempered material shall be used in the following specifications:

Castings : A217 Gr.WC1, A217 Gr.WC4, A217 Gr.WC5, A217 Gr.WC6, A217 Gr.WC9, A217 Gr.C5, A217 Gr.C12

Forgings : A182 Gr.F11 Cl.2

3.0 CS & AS VALVES

3.1 Bend test and Magnetic Particle inspection of the entire surface of body and bonnet casting shall be in accordance with ASTM A217. Supplementary requirement S3 & S4 evaluation of magnetic particle, inspection shall be in accordance with MSS-SP-53 except that no linear discontinuities shall be allowed.

3.2 The Brinell hardness of heat treated casting shall not exceed 200 BHN for carbon steel & 225 BHN for alloy steel.

3.3 Repair to defective casting shall be outlined in writing to the purchaser before repair starts. Repair method to be approved prior to welding.

3.4 Casting shall be preheated to a minimum of 400°F prior to welding and all Chromium-Molybdenum alloys shall be postweld heat treated after welding is complete. Stress relieving is essential for welds.

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3.5 Carbon steel shall be normalised and alloy steels shall be normalised & tempered.

3.6 Dye Penetrant test of welds shall be in accordance with ASTM B165 Procedure B-2. Interpretation as per Appendix-8 of ASME-VIII Div.1.

3.7 The tensile stress for AS shall be less than 100,000 psi.

3.8 Charpy V-notch impact testing is to be done for valve material (average 20 ft-lb for set of 3 [minimum value 15 ft-lb] at 30°F).

3.9 For radiography and acceptance criteria for valve castings, refer Cl. 4.2.

4.0 SS VALVES

4.1 Valve casting shall be in solution heat treated and pickled condition.

4.2 Critical body and bonnet casing section typically defined by ASME B16.34 shall be radiographed and shall meet ASTM E446 (upto 2" thick) Category A, B & CA Level 2, Category CB, OC & CD Level 3, Category D, B & F Level 0. For wall thickness 2" to 4.5" comparable plates of ASTM E186 shall be used. ASTM E94 and ASTM E142 shall be used for recommended practice & controlling quality of radiography as guide. The entire surface of all castings shall be dye-penetrant inspected after pickling.

4.3 Repair Welds shall be 100% radiographed and evaluated in accordance with paragraph 344.5 of ASME B31.3 with a minimum casting quality factor of 0.95. Dye Penetration test shall be as per ASTM E165 Procedure B-2, Interpretation as per Appendix-8 of ASME-VIII Div.1.

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फ्लैंजों, स्पैक्टेकल ब्लाइंडों एवं ड्रिप रिंगों के लिए तकनीकी टिप्पणियाँ

TECHNICAL NOTES FOR FLANGES, SPECTACLE BLINDS AND DRIP RINGS

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	
8	15.03.24	REVISED & ISSUED AS STD SPECIFICATION	PK	SH	GB	MN
7	16.01.20	REVISED & ISSUED AS STD SPECIFICATION	PK	SH	MI	RKT
6	25.09.14	REVISED & ISSUED AS STD SPECIFICATION	UK	SH	AK RN	SC
5	31.12.13	REVISED & ISSUED AS STD SPECIFICATION	UK	SH	AK RN	SC
4	04.07.08	REVISED & ISSUED AS STD SPECIFICATION	RN	SC	DM	VC

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Abbreviations:

AARH	:	Arithmetic Average Roughness Height
ANSI	:	American National Standards Institute
API	:	American Petroleum Institute
ASME	:	American Society of Mechanical Engineers
ASTM	:	American Society for Testing & Materials
AWWA	:	American Water Works Association
BHN	:	Brinell Hardness Number
HIC	:	Hydrogen Induced Cracking
IBR	:	Indian Boiler Regulations
IGC	:	Inter Granular Corrosion
IS	:	Indian Standard
MR	:	Material Requisition
MSS	:	Manufacturer's Standardization Society
NACE MR	:	National Association of Corrosion Engineers : Material Requirement
PMI	:	Positive Material Identification

Piping Standards Committee

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Members :
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Mr. Rameshwar Prasad
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1.0 GENERAL

1.1 All items, their dimensions, tolerances, chemical composition, physical properties, heat treatment and testing etc. shall conform to the latest codes and standards specified in the requisition. In case of any conflict amongst documents attached with the MR, the most stringent shall govern and Owner's/ EIL decision shall be final in this regard.

Supplier shall strictly comply with MR/PR stipulations and no deviations shall be permitted. Post Order Concession/Deviation as mentioned in Cl. 5.17 of Specification for Quality Management System Requirements from Bidders (6-78-0001) is not applicable.

1.2 Testing

1.2.1 Test reports shall be supplied for all mandatory tests as per the relevant material specifications/ MR. Test reports shall also be furnished for any supplementary tests as specified in the requisition & Clauses 1.11, 1.12 & 1.15.

1.2.2 Material test certificates (physical property, chemical composition & heat treatment report including Chart) shall also be furnished for the flanges supplied.

1.2.3 Positive Material Identification (PMI) shall be performed as per the scope and procedures as defined in the 'Specification for Positive Material Identification (PMI) at Supplier's Works' (No. 6-81-0001).

1.2.4 Refer to specification no. 6-81-0006 for Inspection and Test plans for flanges, spectacle blinds & drip rings.

1.3 Ends of weld neck flanges shall be beveled to suit the schedule / thickness of matching pipe, as specified in the requisition.

1.4 Bevel end details for welding neck flanges shall be as per ASME B16.25. Contour of bevel end shall be as follows:

Material	Wall Thickness	Weld Contour
Carbon Steel (Except Low Temp. Carbon Steel)	Upto 22 mm	Figure 2 Type A
	> 22 mm	Figure 3 Type A
Alloy Steel, Stainless Steel & Low Temp. Carbon Steel	Upto 10 mm	Figure 4
	> 10 mm & Upto 25 mm	Figure 5 Type A
	> 25 mm	Figure 6 Type A

1.5 Bore of socket weld flanges & reducing blind flanges shall suit the outside diameter and schedule / thickness of matching pipe.

1.6 Bore of slip on flanges shall suit the outside diameter of matching pipe.

1.7 Flange face finish shall be normally specified in the requisition as serrated finish, 125 AARH etc. The interpretation for range of face finish shall be as follows:

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Stock Finish	:	1000 µ in AARH max.
Serrated Finish/125 AARH	:	Serrations with 125 to 250µin AARH
63 AARH	:	32 TO 63 µ in AARH

1.8 Galvanized flanges shall be coated with zinc by hot dip process conforming to IS 4736 / ASTM A153.

1.9 Ends of screwed flanges unless otherwise specified shall have taper threads as per ASME/ANSI B1.20.1.

1.10 For ring joint flanges, blinds and spacers the hardness shall be as follows:

Flange Material	Min. Hardness of Groove (BHN)
Carbon Steel	140
1% Cr to 5%, 9% Cr	150
9Cr-1Mo-V	190
Type 304, 316, 321, 347	160
Type 304L, 316L	150
Inconel UNS N06625	220
Incoloy UNS N08825	210
Duplex SS UNS S32205, S31803	250

1.11 For ring joint flanges, blinds and spacers, the hardness shall be recorded in the test report.

1.12 NACE/HIC Requirements

1.12.1 Flanges, blinds, drip rings under "NACE" category and those designated as "HIC1" shall meet the requirements given in NACE MR-0103 unless otherwise specified.

1.12.2 Flanges, blinds, drip rings made from plates and designated as "HIC1" shall meet the HIC requirements of EIL Specification 6-79-0013 unless otherwise specified.

1.13 All austenitic stainless steel flanges shall be supplied in solution annealed condition.

1.14 I.G.C. Test for Stainless Steels:

1.14.1 For all austenitic stainless steel flanges, blinds, drip rings & Fig.8 flanges intergranular corrosion test shall have to be conducted as per following:

ASTM A262 Practice 'B' with acceptance criteria of "60 mils/year (max.)".

OR

ASTM A262 Practice E : The bent specimen shall be examined under 20X magnification. The acceptance criteria is that there will be no crack or fissure in the bent specimen. The bent specimen shall also be subjected to metallographic examination at 250X magnification to ensure no crack or fissure. The photograph of the bent specimen along with comments shall be submitted for review.

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1.14.2 When specifically asked for in requisition for high temperature application of some grades of austenitic stainless steel (like SS309, 310, 316, 316H etc.) ASTM A262 Practice 'C' with acceptance criteria of "15 mils/year" shall have to be conducted.

1.14.3 For the IGC test as described in 1.14.1 & 1.14.2 two sets of samples shall be drawn from each solution treatment lot; one set corresponding to highest carbon content and the other corresponding to the highest rating / thickness.

1.15 All types of 321 or 347 stainless steel flanges shall be in a stabilized heat treated condition. Stabilizing heat treatment shall be carried out subsequent to the normal solution annealing. Soaking temperature and holding time for stabilizing heat treatment shall be 900 C and 4 hours respectively.

1.16 For dual grades of SS where specified, chemical composition and mechanical properties of both grades specified shall be ensured.

1.17 AWWA C207 flanges shall be ring type.

1.18 Dimensions for handle projection for Spacers & Blinds shall be as specified in EIL Std. 7-44-0166.

1.19 Where ever two sizes have been specified in the MR for flanges, it shall be considered a reducing flange.

1.20 All 1Cr-½Mo and 1¼Cr-½Mo flanges shall be normalised and tempered.

1.21 Ring Joint Fig-8 Flanges, Spacers & Blinds shall be female type only.

1.22 The handle for spacers & blinds for classes 900# & above shall be designed by the vendor. The handle may be integral or attached to the line blank / spacer by welding. In case of attachment by welding heat treatment & welding shall be in accordance with B31.3.

1.23 For Hydrogen service following special requirements shall also be met:

a. All carbon steel flanges having wall thickness 9.53 mm and above shall be normalised. The normalising heat treatment shall be a separate heat treatment operation and not a part of the hot forming operation.

b. All alloy steel (Cr-Mo) flanges shall be normalised and tempered. The normalising and tempering shall be a separate heat treatment operation and not a part of the hot forming operation.

c. For all carbon steels and alloy steels with wall thickness over 20mm, Charpy-V Notch impact testing shall be carried out in accordance with paragraph UG-84 of ASME Section VIII, Div-1 per heat of material and per heat treating batch. Impact test specimen shall be in accordance with ASTM A370. Impact energies at 0 C shall average greater than 27J (20 ft-lb) per set of 3 specimens, with a minimum of 20J (15ft-lb).

2.0 IBR REQUIREMENTS

2.1 IBR Documentation

2.1.1 Flanges coming under the purview of IBR (Indian Boiler Regulations) shall be accompanied with IBR Certificate original in Form III G duly approved and countersigned by IBR authority/ local authority empowered by Central Boiler Board of India. Photocopy of original

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certificate duly attested by the local boiler inspector where the supplier is located is the minimum requirement for acceptance.

2.2 For carbon steel flanges under IBR the chemical composition shall conform to the following:

Carbon (max) : 0.25%
Others (S, P, Mn) : As prescribed in IBR.

The chemical composition as indicated in this clause is not applicable for flanges other than IBR services.

3.0 ACCEPTABLE DEVIATIONS

3.1 Blind Flanges and Spacers & Blinds if specified as plate materials are acceptable in forging materials also in the corresponding material grades.

3.2 Flanges/Spectacle Blinds/Drip rings of Grades SS317 of corresponding material are acceptable in place of Grades SS316 or SS316 (2.5Mo min.).

3.3 Flanges/Spectacle Blinds/Drip rings of Grades SS317L of corresponding material are acceptable in place of Grades SS316L or SS316L (2.5Mo min.).

3.4 Dual Grade SS304/304L conforming to all chemical composition requirements of SS304L and mechanical properties of SS304 is acceptable in place of SS304L or SS304 grades. Any specific additional requirements given in the MR shall also be complied.

3.5 Dual Grade SS316/316L conforming to all chemical composition requirements of SS316L and mechanical properties of SS316 is acceptable in place of SS316L or SS316 grades. Any specific additional requirements given in the MR shall also be complied.

4.0 MARKING AND DESPATCH

4.1 All items shall be legibly and conspicuously stamped in accordance with the requirements of applicable ASME, API and MSS Standards. In addition, EIL item code, purchase order number & special conditions like "IBR", "CRYO", "NACE" "H2" etc. shall also be stamped.

4.2 All items coming under the purview of "IBR", "CRYO" , "NACE" & "H2" (hydrogen) shall be painted with one stripe of colour red, light purple brown, canary yellow & white respectively for easy identification. Width of stripe shall be 25mm and it shall be painted longitudinally across the complete thickness of flange other than hub.

4.3 Paint or ink for marking shall not contain any harmful metal or metal salts such as zinc, lead or copper which cause corrosive attack on heating.

4.4 All items shall be dry, clean and free from moisture, dirt and loose foreign materials of any kind.

4.5 All items shall be protected from rust, corrosion and mechanical damage during transportation, shipment and storage.

4.6 Rust preventive on machined surfaces to be welded shall be easily removable with a petroleum solvent and the same shall not be harmful to welding.

4.7 Each end of flange shall be protected with the following materials:

Flange face : Wood, metal or plastic cover

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Bevelled end	:	Wood, metal or plastic cover
Threaded end	:	Plastic plug
Socket welding end	:	Plastic cover or plug

4.8 Each size of flanges, blinds, etc. shall be supplied in separate packagings marked with the purchase order number, item code number, material specification, size and rating.

5.0 REFERENCES

6-81-0001	:	Specification for Positive Material Identification (PMI) at Supplier's Works.
6-81-0006	:	Inspection & test plan for flanges, spectacle blinds & drip rings
6-79-0013	:	Material requirements for carbon steel components used in sour service for petroleum refinery environments
7-44-0162	:	Standard for Spacers & Blinds ≥ 26" (150CL, 300CL & 600CL FF)
7-44-0164	:	Standard for Spacers & Blinds ≥ 26" (For AWWA Flanges)
7-44-0166	:	Dimensions for Handle projection for Spacers & Blinds ≥ ½"-24"

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बट वैल्डेड, साकेट वैल्डेड एवं पेंच फिटिंगों के लिए तकनीकी टिप्पणियाँ

TECHNICAL NOTES FOR BUTT WELDED, SOCKET WELDED AND SCREWED FITTINGS

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	
8	18.06.24	REVISED AND ISSUED AS STD SPECN	PK	SH	GB	MN
7	20.01.20	REVISED AND ISSUED AS STD SPECN	PK	SH	MI	RKT
6	25.09.14	REVISED AND ISSUED AS STD SPECN	SH	AK	RN ATD	SC
5	31.12.13	REVISED AND ISSUED AS STD SPECN	UK	SH	AK RN	SC
4	04.07.08	REVISED AND ISSUED AS STD SPECN	RN	SC	DM	VC

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Abbreviations:

AARH	:	ArithmeticAverage Roughness Height
ANSI	:	American National Standards Institute
API	:	American Petroleum Institute
ASME	:	American Society of Mechanical Engineers
ASTM	:	American Society for Testing & Materials
BHN	:	Brinell Hardness Number
CS	:	Carbon Steel
DP	:	Dye Penetrant
HAZ	:	Heat Affected Zone
HIC	:	Hydrogen Induced Cracking
IBR	:	Indian Boiler Regulations
IGC	:	Inter Granular Corrosion
IS	:	Indian Standard
LT	:	Low Temperature
MP	:	Magnetic Particle
MR	:	Material Requisition
MSS	:	Manufacturer's Standardisation Society
NACE MR	:	National Association of Corrosion Engineers : Material Requirement
NB	:	Nominal Bore
PMI	:	Positive Material Identification
PO	:	Purchase Order
PR	:	Purchase Requisition
SMYS	:	Specified Minimum Yield Strength
SS	:	Stainless Steel

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1.0 GENERAL

1.1 Chemical composition, physical properties, tests, dimensions and tolerances, heat treatment and marking shall conform to the applicable latest codes / standards / specifications as specified in the material requisition (MR). In case of any conflict amongst documents attached with the MR, the most stringent shall govern and Owner's/ EIL decision shall be final in this regard.

Supplier shall strictly comply with MR/PR stipulations and no deviations shall be permitted. Post Order Concession/Deviation as mentioned in Cl. 5.17 of Specification for Quality Management System Requirements from Bidders (6-78-0001) is not applicable.

1.2 Testing

1.2.1 Test reports shall be supplied for all mandatory tests as per the relevant material specifications/ MR. Test reports shall also be furnished for any supplementary tests as specified in the MR & Clauses 1.7, 1.8, 1.9, 1.10 & 1.11. Material test certificates (physical properties, chemical composition & heat treatment report including chart) shall also be furnished for fittings supplied.

1.2.2 Positive Material Identification (PMI) shall be performed as per scope and procedures defined in the Specification for Positive Material Identification (PMI) at Supplier's Works (6-81-0001).

1.2.3 Refer to specification no. 6-81-0005 for Inspection and Test plan for forged, seamless and welded fittings.

1.3 All fittings shall be seamless in construction unless otherwise specified. If fittings are specified as welded, the same shall conform to clause 1.7.

1.4 Outside diameters and wall thickness (unless otherwise mentioned) of butt welded fittings shall be in accordance with ASME B36.10 and ASME B36.19 as applicable.

1.5 For reducing butt weld fittings having different wall thicknesses at each end, the greater wall thickness of the fitting shall be employed and inside bore at each end shall be matched with the specified inside diameter.

1.6 Beveled ends for all fittings shall conform to ASME B16.25. Contour of bevel shall be as follows:

Material	Wall Thickness	Weld Contour
Carbon Steel (Except Low Temp. Carbon Steel)	Upto 22 mm	Figure 2 Type A
	> 22 mm	Figure 3 Type A
Alloy Steel, Stainless Steel & Low Temp. Carbon Steel	Upto 10 mm	Figure 4
	> 10 mm &Upto 25 mm	Figure 5 Type A
	> 25 mm	Figure 6 Type A

1.7 Welded Fittings

1.7.1 All welded fittings shall be double welded. Inside weld projection shall not exceed 1.6 mm. Welds shall be ground smooth at least 25 mm from the ends.

1.7.2 For fittings made out of welded pipe, the welded pipe shall be double welded type & shall be manufactured with the addition of filler metal.

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1.7.3 Welded tees/Lateral Tees shall not be of fabricated (stub-in/stub-on) type unless otherwise specified in the MR.

1.7.4 All welded fittings shall be normalized & 100% radiographed by X-ray on all welds made by fitting manufacturers & also welds on the parent materials. Radiography by Gamma rays is also acceptable for thickness 8mm & above.

1.7.5 Welded pipes employed for manufacture of fittings shall be made by automatic welding only.

1.7.6 Specified heat treatment for carbon steel & alloy steel fittings shall be carried out again after weld repairs.

1.7.7 Irrespective of the material code requirement, all welded fittings indicated in the MR as "Cryo"& "LT" shall meet impact test requirements of ASME B31.3. The impact test temperature shall be -196°C & -45°C for stainless steel & carbon steel respectively unless specifically mentioned otherwise in the MR.

1.7.8 For welded Carbon steel fittings wherever heat treatment is specified, hardness of weld and HAZ shall be 200 BHN (max.). For welded Alloy steel fittings, hardness after heat treatment shall be as per relevant ASTM material specification unless otherwise specified.

1.8 Stainless Steel Fittings

1.8.1 All stainless steel fittings shall be supplied in solution heat treated condition.

1.8.2 Solution annealing for stainless steel fittings shall be carried out again after weld repairs.

1.8.3 For all stainless steel fittings Inter Granular Corrosion (IGC) test shall have to be conducted as per the following:

ASTM A 262 Practice "B" with acceptance criteria of "60 mils/year (max.)".

Or

ASTM A262 Practice E : The bent specimen shall be examined under 20X magnification. The acceptance criteria is that there will be no crack or fissure in the bent specimen. The bent specimen shall also be subjected to metallographic examination at 250X magnification to ensure no crack or fissure.

1.8.4 When specifically asked for in MR for high temperature application of some grades of austenitic stainless steel (eg. SS309, 310,316,316H etc.) ASTM A 262 Practice "C" with acceptance criteria of "15 mils/year" shall have to be conducted.

1.8.5 For the IGC test as described in Clauses 1.8.3 & 1.8.4, two sets of samples shall be drawn from each solution treatment lot, one set corresponding to the highest carbon content and other set to the highest fitting thickness. When testing is conducted as per ASTM A 262 Practice "E", the photograph of the bent specimen along with comments shall be submitted for review.

1.8.6 For dual grades of SS where specified, chemical composition and mechanical properties of both grades specified shall be ensured.

1.9 NACE/HIC Requirements

1.9.1 Fittings under "NACE" category or those designated as "HIC1" shall meet the requirements of NACE MR-0103 unless otherwise specified.

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1.9.2 Fittings made from plates and designated as "HIC1" shall meet the HIC requirements of EIL specification 6-79-0013 unless otherwise specified.

1.10 Thickness/schedule lower or higher than specified for the finished product shall not be accepted.

1.11 The gasket contact surfaces of stub ends shall be flat with face finish specified in the requisition. Interpretation on the specified face finish is as follows:
125 AARH : Serrations with 125 to 250 µ in AARH

1.12 Seamless stub ends shall not have any welds on the body. Stub ends shall be long pattern type.

1.13 Galvanized fittings shall be coated with zinc by hot dip process conforming to IS 4736 / ASTM A153.

1.14 Threaded ends shall have NPT taper threads in accordance with ASME/ANSI B1.20.1 up to 1.5" NB & IS 554 from 2" to 6" NB.

1.15 Unless and otherwise specified in the MR, all socket welded and screwed fittings shall be in accordance with ASME B16.11 to the extent covered in the specification except for unions which shall be in accordance with MSS-SP-83.

1.16 Special fittings like weldolet, sockolet, sweepolet, latrolet, elbolet etc., the dimensions of which are not covered in ASME, MSS-SP & EIL Standards, shall be as per manufacturer's std. Contours of these fittings shall meet the requirements of ASME B31.3.Manufacturer shall submit drawings / catalogues of these items for records after acceptance of offer.

1.17 Length of all long half couplings shall be 100 mm unless otherwise specified in the MR.

1.18 For reducers to manufacturers' standard, length of reducer shall not be less than 0.7D where D is the outside diameter of the larger end.

1.19 All seamless pipes employed for manufacturing of fittings shall be required to have undergone hydrostatic test to ASTM A 530. Welded pipes employed for manufacture of fittings shall be tested as given below :

Welded Pipe Employed For Manufacture Of Welded Fittings.	Test Criteria
ASTM A671 Gr. C65,70 (Cl.32) ASTM A672 Gr. C60,65,70 (Cl.12, 22) ASTM A671 Gr. CF60,65,70,66 (Cl.32) ASTM A691 Gr. ½Cr, 1Cr, 1¼Cr, 2¼Cr, 5Cr, 9Cr (Cl.42), 91 (Cl.42)	P = 2ST / D S = 90% of SMYS. T = Nom. Wall Thickness D = 0.D. of Pipe.
API 5L ASTM A358 TP 304, 304L, 304H, 318, 318L, 318H, 321, 347 (Cl.1, 3, 4)	P = 2ST / D S = 85% of SMYS. T = Nom. Wall Thickness D = 0.D. of Pipe.
ASTM B725	ASTM B725
ASTM B517	ASTM B517
ASTM B514	ASTM B514

1.20 The bevel ends of all butt weld fittings shall undergo 100% MP / DP test.

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1.21 Abbreviations for ends of swages and nipples shall be as follows:

PBE	:	Plain Both Ends
TBE	:	Threaded Both Ends
TOE	:	Threaded One End
TSE	:	Threaded Small End
TLE	:	Threaded Large End

1.22 All types of SS321 or SS347 fittings shall be in stabilized heat treated condition. Stabilizing heat treatment shall be carried out subsequent to normal solution annealing. Soaking temperature and holding time for stabilizing heat treatment shall be 900°C and 4 hours respectively.

1.23 For Hydrogen service fittings following special requirements shall also be met:

a. All carbon steel fittings having wall thickness 9.53 mm (0.375") and above shall be normalised. Cold drawn fittings shall be normalised after the final cold draw pass for all thicknesses. In addition, fittings made from forgings shall have Carbon- 0.35 % max. and Silicon- 0.35 % max. The normalising heat treatment shall be a separate heating operation and not a part of the hot forming operation

b. All alloy steel (Cr-Mo) fittings shall be normalised and tempered. The normalising and tempering shall be a separate heating operation and not a part of the hot forming operation. The maximum room temperature tensile strength shall be 100,000 psi.

c. For carbon steel fittings, hardness of weld and HAZ shall be 200 BHN (max.). For alloy steel fittings, hardness of weld and HAZ shall be 225 BHN (max.).

d. For all Carbon steel and Alloy steel fittings with wall thickness over 20 mm, Charpy-V Notch impact testing shall be carried out in accordance with paragraph UG-84 of ASME Section VIII, Div-1 for weld metal and base metal from the thickest item per heat of material and per heat treating batch. Impact test specimen shall be in complete heat treated condition and accordance with ASTM A370. Impact energies at 0°Celsius shall average greater than 27J (20 ft-lb) per set of three specimens, with a minimum of 20J(15 ft-lb).

1.24 For all welded alloy steel fittings with mandatory requirements of heat treatment and radiography, radiography shall be performed after heat treatment.

1.25 All 1Cr-0.5Mo & 1.25Cr-0.5Mo fittings shall be normalized and tempered. All 2.25Cr-1Mo, 5Cr-0.5Mo, 9Cr- 1 Mo & 9Cr-lMo-V welded fittings shall be normalized and tempered.

1.26 Fitting material as per ASTM A234 Gr. WP11/WP22/ WP5/WP9/WP91, wherever specified, shall be as per 'Cl.1', unless otherwise specified.

1.27 Materials designated as structural steel grades like IS 2062, SA 36 etc. or similar specification are not permitted for manufacture of fittings.

1.28 Pipe Bends (Other than Elbows)

Bending shall be as per ASME B31.3 except that corrugated or creased bends shall not be used. Final Wall thickness after bending process shall not be less than 87.5% of the thickness specified. All other tolerances shall be as per PFI ES-24.

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2.0 IBR REQUIREMENTS

2.1 IBR Documentation Required

2.1.1 Fittings under the purview of "IBR" (Indian Boiler Regulations) shall be accompanied with original IBR certificate in Form III-C duly approved and countersigned by IBR authority / local authority empowered by Central Boiler Board of India. Photocopy of the original certificate duly attested by the local boiler inspector where the supplier is located is the minimum requirement for acceptance.

2.1.2 For materials 1¼Cr - ½Mo (ASTM A 234Gr.WP11 Cl.1 & ASTM A234 Gr.WP11W Cl.1) & 2¼Cr - 1Mo (ASTM A 234 Gr.WP22 Cl.1 & ASTM A234 Gr. WP22W Cl.1) & 9Cr-1Mo-V (A234 Gr.WP91/A234Gr.WP91W),where fittings are manufactured from pipe, Form III-C approved by IBR shall include the tabulation of E_t, S_c, &S_r values for the entire temperature range given below. E_t, S_c, &S_r values shall be such that throughout the temperature range

$$\left.\begin{array}{ll} E_t / 1.5 & \geq \\ S_r / 1.5 & \geq \\ S_c & \geq \end{array}\right| S_A$$

S_A : Allowable stress at the working metal temperature.
E_t : Yield point (0.2% proof stress at the working metal temperature)
S_c : The average stress to produce elongation of 1%(creep) in 100000 hrs at the working metal temperature.
S_r : The average stress to produce rupture in 100000 hrs at the working metal temperature and in no case more than 1.33 times the lowest stress to produce rupture at this temperature.

	S_A (psi)											
Temp(F) Material	500	600	650	700	750	800	850	900	950	1000	1050	1100
A234Gr.WP11 Cl.1/ A234Gr.WP11W Cl.1	16200	15700	15400	15100	14800	14400	14000	13600	9300	6300	4200	2800
A234Gr.WP22 Cl.1 /A234Gr.WP22W Cl.1	17900	17900	17900	17900	17900	17700	17100	13600	10800	8000	5700	3800
A234Gr.WP91/ A234Gr.WP91W	28100	27700	27300	26700	25900	24900	23700	22300	20700	18000	14000	10300

Note : S_A values shall be as per the latest edition of ASME B31.3 prevailing.

2.2 For carbon steel Fittings under IBR the chemical composition shall conform to the following:

Carbon (max) : 0.25%
Others (S, P, Mn) : As prescribed in IBR.

The chemical composition as indicated in this clause is not applicable for fittings other than IBR services.

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3.0 ACCEPTABLE DEVIATIONS

3.1 Seamless fittings are acceptable in place of welded fittings, however, welded fittings are not acceptable in place of seamless fittings. Forged fittings are acceptable in place of wrought fittings. However, wrought seamless fittings are acceptable in place of forgings only in case of swages.

3.2 Fittings of Grades SS317 of corresponding material are acceptable in place of Grades SS316 or SS316(2.5Mo min.).

3.3 Fittings of Grades SS317L of corresponding material are acceptable in place of Grades SS316L or SS316L(2.5Mo min.).

3.4 Dual Grade SS304/304L conforming to all chemical composition requirements of SS304L and mechanical properties of SS304 is acceptable in place of SS304L or SS304 grades. Any specific additional requirements given in the MR shall also be complied.

3.5 Dual Grade SS316/316L conforming to all chemical composition requirements of SS316L and mechanical properties of SS316 is acceptable in place of SS316L or SS316 grades. Any specific additional requirements given in the MR shall also be complied.

4.0 MARKING AND DESPATCH

4.1 Each fitting shall be legibly and conspicuously stamped in accordance with the requirements of applicable standards along with special condition like "IBR", "Cryo", "NACE" and "H2" etc.

4.2 Steel die marking with round bottom punch may be permitted on body of butt weld CS & lower alloy steel fittings, but for SS & higher alloy steel fittings, the same should be marked by electro-etching only.

4.3 Paint or ink for marking shall not contain any harmful metals or metal salts such as Zinc, Lead or Copper which causes corrosive attack on heating.

4.4 Fittings shall be dry, clean and free of moisture, dirt and loose foreign materials of any kind.

4.5 Fittings shall be protected from rust, corrosion and mechanical damage during transportation, shipment and storage.

4.6 Rust preventive used on machined surfaces to be welded shall be easily removable with a petroleum solvent and the same shall not be harmful to welding.

4.7 Fittings coming under the purview of "IBR", "CRYO" , "NACE" & "H2"(hydrogen) shall be painted with one circumferential stripe of colour red, light purple brown, canary yellow & white respectively for easy identification. Width of stripe shall be 12mm for sizes less than 3" and 25mm for sizes 3" and above. Stripe shall be located centrally for elbows, diagonally for caps, at the larger end for reducing fittings, longitudinally for couplings and at one end near to the bevel/socket/screwed end for other fittings.

4.8 Each end of fitting shall be protected with a wood, metal or plastic cover.

4.9 Each size of fitting shall be supplied in separate packaging marked with the purchase order number, item code number, material specification, size and schedule / thickness / rating. For small quantities, fittings of different sizes may be packed in separate packing size-wise and these packing may be packed in a bigger package/ container clearly identifying the contents.

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5.0 REFERENCES

6-81-0001	:	Specification for Positive Material Identification (PMI) at Supplier's Works
6-81-0005	:	Inspection & test plan for forged, seamless and welded fittings
6-79-0013	:	Material requirements for carbon steel components used in sour service for petroleum refinery environments

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गास्केट्स के लिए तकनीकी टिप्पणियाँ

TECHNICAL NOTES FOR GASKETS

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	
7	15.03.24	REVISED & ISSUED AS STANDARD SPECIFICATION	PK	SH	GB	MN
6	11.08.21	REVISED & ISSUED AS STANDARD SPECIFICATION	PK	SH	GB	SM
5	30.03.18	REVISED & ISSUED AS STANDARD SPECIFICATION	PK	SH	MI	RN
4	21.03.13	REVISED & ISSUED AS STANDARD SPECIFICATION	UK	SH	RN ATD	DM
3	23.07.07	REVISED & ISSUED AS STANDARD SPECIFICATION	RN	ATD	DM	VC

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Abbreviations:

AARH	:	Average Arithmetic Root Height
BHN	:	Brinnel Hardness Number
CS	:	Carbon Steel
MR	:	Material Requisition
PMI	:	Positive Material Identification
RTJ	:	Ring Type Joint

Piping Standards Committee

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Mr. Rameshwar Prasad
Mr. K. Anjaneyulu (SMED)
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Mr. P.K. Rai (Construction)

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1.0 GENERAL

1.1 All gaskets shall conform to the codes/standards and specifications given in the requisition. In case of any conflict amongst documents attached with the MR, the most stringent shall govern and Owner's/ EIL decision shall be final in this regard.

Supplier shall strictly comply with MR/PR stipulations and no deviations shall be permitted.

1.2 Process of manufacture, dimensions and tolerances not specified in requisition shall be in accordance with the requirements of the manufacturer's standards.

1.3 Testing

1.3.1 Test reports shall be supplied for all mandatory tests for gaskets as per the standards specified in the requisition.

1.3.2 Chemical composition and hardness of RTJ gaskets shall also be furnished in the form of test reports on samples.

1.3.3 For Spiral wound material following shall be furnished:

a. Manufacturer's test certificate for filler material and spiral material as per the relevant material specifications/ MR.

b. Manufacturer's test certificate for raw materials and tests for compressibility/ seal-ability & recovery as per the relevant material specifications/ MR.

1.3.4 PMI shall be performed as per the scope and procedures defined in the Specification for PMI at Supplier's Works (6-81-0001) for ring type joint gaskets.

1.3.5 Refer Specification no 6-81-0008 for 'Inspection & Test Plan for Gaskets'.

1.4 Full face gaskets shall have bolt holes punched out.

1.5 Filler material for spiral wound gaskets shall not have any colour or dye.

1.6 All spiral wound gaskets shall be supplied with Outer ring. Material of the outer ring shall be CS unless otherwise specified in the MR.

1.7 Inner rings shall be provided for all Spiral Wound Gaskets. For spiral wound gaskets, material of Inner Compression ring shall be same as Spiral Strip material.

1.8 Hardness of metallic RTJ gaskets shall not exceed the values specified below unless otherwise specified in MR:

Ring Gasket Material	**Maximum Hardness (BHN)**
Soft Iron	90
Carbon steel	120
5 Cr. ½ Mo	130
Type 304, 316, 321, 347	140

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Type 304L, 316L	135
Inconel UNS N06625	200
Incoloy UNS N08825	190
Duplex SS UNS S32205, S31803	230

1.9 Face finish of metallic RTJ gaskets shall be 32 to 63 AARH.

1.10 Gaskets of different types and sizes shall be placed in separate shipping containers and each container clearly marked with the size, rating, material specification and item code.

1.11 All items shall be inspected and approved by EIL Inspector or any other agency authorized by EIL.

1.12 Any additional requirements specified in the requisition, shall be fully complied with.

1.13 Non-metallic ring gaskets as per ASME B16.21 shall match flanges to ASME B16.5 upto 24" and to ASME B16.47B above 24" unless specified otherwise.

1.14 Spiral wound gasket as per ASME B16.20 shall match flanges to ASME B16.5 upto 24" and to ASME B16.47B above 24" unless specifically mentioned otherwise.

1.15 The following abbreviations have been used in the Material Requisition for Spiral Wound Gaskets :

(I)	:	Inner Ring
(O)	:	Outer Ring
GRAFIL	:	Grafoil Filler

1.16 Specialties mentioned in item description like "IBR", "LT", "HIC1", "H2", "CRYO" etc. shall be ignored.

2.0 REFERENCES

6-81-0001	Specification for Positive Material Identification (PMI) at Supplier's Works
6-81-0008	Inspection & Test Plan for Gaskets
6-78-0001	Specification for Quality Management System Requirements from Bidders

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बोल्ट्स एवम नट्स के लिए तकनीकी टिप्पणियाँ

TECHNICAL NOTES FOR BOLTS AND NUTS

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	
7	15.03.24	REVISED & ISSUED AS STANDARD SPECIFICATION	PK	SH	GB	MN
6	28.03.23	REVISED & ISSUED AS STANDARD SPECIFICATION	PK	SH	GB	SM
5	30.03.18	REVISED & ISSUED AS STANDARD SPECIFICATION	PK	SH	MI	RN
4	21.03.13	REVISED & ISSUED AS STANDARD SPECIFICATION	UK	SH	RN ATD	DM
3	23.07.07	REVISED & ISSUED AS STANDARD SPECIFICATION	RN	ATD	DM	VC

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Abbreviations:

ASME	:	The American Society of Mechanical Engineers
ASTM	:	The American Society for Testing and Materials
GALV	:	Galvanized
HDG	:	Hot Dip Galvanized
MR	:	Material Requisition
PMI	:	Positive Material Identification
SS	:	Stainless Steel

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1.0 GENERAL

1.1 The process of manufacture, heat treatment, chemical & mechanical requirements and marking for all stud bolts, m/c bolts, jack screws & nuts shall be in accordance with the codes/standards and specifications given in the requisition. Supplier shall strictly comply with MR stipulations and no deviations shall be permitted. In case of any conflict amongst documents attached with the MR, the most stringent shall govern and Owner's/ EIL decision shall be final in this regard.

All codes and standards for manufacture, testing, inspection etc. shall be of latest editions as on issue date of RFQ.

1.2 Testing

1.2.1 Test reports shall be supplied for all mandatory tests as per the relevant material specifications/ MR.

1.2.2 Material test certificate shall also be furnished. (Heat Analysis, Product Analysis, Mechanical Requirement and any other testing as per MR).

1.2.3 PMI shall be performed as per the scope and procedures defined in the Specification for PMI at Supplier's Works (6-81-0001).

1.2.4 Stress Rupture Test as detailed in ASTM A453 shall be carried out for all ASTM A453 bolting material irrespective of the temperature.

1.2.5 Refer Specification no 6-81-0007 for 'Inspection & Test Plan for Bolting Material'.

1.3 All bolting shall be as per ASME B 18.2.1 for studs, M/c bolts and jackscrews and ASME B18.2.2 for nuts.

1.4 Threads shall be unified (UNC for up to 1" dia and 8UN for > 1" dia) as per ASME B1.1 with class 2A fit for studs, M/c bolts and jackscrews and class 2B fit for nuts.

1.5 Stud bolts shall be threaded full length with two heavy hexagonal nuts unless otherwise specified. Length tolerance shall be in accordance with the requirement of ASME B 16.5.

1.6 The nuts shall be double chamfered, semi-finished, heavy hexagonal type and shall be made by the hot forged process and stamped as per respective material specification.

1.7 Heads of jackscrews and m/c bolts shall be heavy hexagonal type. Jackscrew end shall be rounded.

1.8 All items shall be inspected and approved (stage-wise) by EIL inspector or any other agency authorized by EIL.

1.9 The heat treatment for stud bolts & nuts shall be as per code unless mentioned otherwise.

1.10 All austenitic stainless steel bolts, nuts, screws shall be supplied in solution annealed condition unless specified otherwise in the material specification.

1.11 Any additional requirements specified in the requisition shall be fully complied with.

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1.12 Stud bolts, nuts & jackscrews shall be impact tested wherever specified in the material specification and also where the material specification is indicated as "CRYO". For S.S. nuts and bolts minimum impact energy absorption shall be 27 Joules and test temperature shall be -196°C unless mentioned otherwise. For other materials impact energy and test shall be as per respective code.

1.13 Bolts/nuts of material of construction B7M/2HM shall be 100% Hardness tested as per supplementary requirement S3 of ASTM A193.

1.14 When specified as "GALV.", the studs, M/C bolts and nuts shall be 'hot dip zinc coated' in accordance with requirements of 'class C' of 'ASTM A 153'. As an alternative, electro-galvanizing as per IS 1573, 'Service Grade Number 2' is also acceptable. However, for bolting where "HDG" has been specified, only 'hot dip zinc coating' in accordance with requirements of 'class C' of 'ASTM A 153' is acceptable.

1.15 All Stud Bolts of Bolt diameter size 1" and above shall be provided with three nuts irrespective of whatever has been specified elsewhere in the MR.

1.16 For stud bolt diameters not covered in ASTM A320, mechanical properties shall match the values specified for the matching grades and stud bolt diameters in ASTM A193.

1.17 In cases where the lengths of Stud/Machine bolts specified in the MR are not multiples of 0.25", the length supplied shall be equal to the specified length rounded up to the next higher 0.25".

1.18 All Specialties mentioned in item description like "IBR", "LT", "H2", etc. other than **"CRYO"& "NACE"** shall be ignored.

1.19 'Nuts' to ASTM A194Gr.7 to be supplied wherever ASTM A194Gr.4 is specified in the MR/PR.

2.0 ACCEPTABLE DEVIATIONS

2.1 Stud Bolts to ASTM A453 Gr.660 Cl.B are acceptable in lieu of ASTM A453 Gr. 660 Cl.A and vice versa.

2.2 In case of ASTM A453 Gr.660, Nuts machined from raw material duly heat treated & tested (including stress rupture test) as per relevant material specifications are acceptable. However, all tests required as per MR shall be repeated on finished product.

3.0 MARKING AND DESPATCH

3.1 Bolting shall be protected by non-corrosive oil or grease before dispatch to prevent rusting.

3.2 The applicable identification symbol in accordance with the material specification shall be stamped on each bolt and nut.

3.3 Each size of studs & m/c bolts with nuts and jackscrews shall be supplied in assembled condition in separate containers. Each container shall be clearly marked with the size, material specification, and item code. 'CRYO' shall be marked additionally in case 'CRYO' is specified in the requisition. Packing of studs/bolts and nuts separately are not acceptable.

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4.0 REFERENCES

6-81-0001	Specification for Positive Material Identification (PMI) at Supplier's Works
6-81-0007	Inspection & Test Plan for Bolting Material
6-78-0001	Specification for Quality Management System Requirements from Bidders
6-78-0003:	Specification for documentation requirements from suppliers

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फ्लैंज जोड़ों के लिए बल-आघूर्ण (टॉर्क) तथा हाइड्रोलिक बोल्ट टेंशन के अनुप्रयोग हेतु मानक विनिर्देश

STANDARD SPECIFICATION FOR APPLICATION OF TORQUE AND HYDRAULIC BOLT TENSION FOR FLANGE JOINTS

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	
3	30-06-2021	Revised and reissued for Implementation	PVK	PG	VM	SM
2	04-05-2016	Issued for Implementation	PG	SVRS	RP	RN
1	26-05-2008	Issued for Implementation	PG	KPS	AA	VC
0	15-05-2003	Issued for Implementation	PG	KPS	VC	SKG

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Abbreviations:

ASME	American Society of Mechanical Engineers
PMS	Piping Material Specification

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1.0 PURPOSE

The purpose of this specification is to describe the methodology for preparation of bolted flange joints by controlled bolt tightening during construction and commissioning stage of process plant piping. This specification shall be used in conjunction with the other process/project specific requirements and the licensor/vendor recommendations.

2.0 SCOPE

This specification covers ASME B16.5 and ASME B16.47 Series B bolted flanged joints, involving identical pair of flanges, which are tightened by means of either hydraulic bolt tensioning or calibrated torque wrenches.

3.0 REFERENCES

EIL Spec no. 6-44-0005 Rev 7	-	Standard Piping Material Specification
ASME B16.5	-	Pipe Flanges and Flanged Fittings (1/2" to 24" NPS)
ASME B16.47 Series B	-	Pipe Flanges and Flanged Fittings (26" to 60" NPS)
ASME B31.3	-	Process Piping
BP RP 42-2	-	British Petroleum Recommended Practice: Bolting for flange joints
ASME Section VIII Division 1 and Division 2	-	Boiler and Pressure Vessel Code

4.0 DEFINITIONS

None.

5.0 METHODOLOGIES AND CONTROL

5.1 Identification of joints for controlled bolt tightening

Controlled bolt tightening can be done either by application of calculated bolt tension with hydraulic tensioner or by application of calculated bolt torque with calibrated torque wrenches. The criteria for selection of joints for these two application procedure are given below.

5.1.1 Hydraulic Bolt tensioning

Hydraulic bolt tensioning shall be applied for all joints where the bolt sizes match the criteria outlined in Table 1, except those in the category 'D' services. Category 'D' service is defined in ASME B31.3.

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**Table 1: Criteria for Bolt Tensioning –
Not applicable for flange joints in category 'D' services**

Nominal Bolt diameter	Condition	Remarks
All	When specified by the Process licensor/ vendor / project specifications	
50 mm and above	All joints	
38 mm and above, but less than 50 mm	Class 600 and above	
	Hydrogen service	(See Note-1 below)
	Category 'M' fluid services	Refer ASME B31.3
	Joints with leakage potential	(See Note-2 below)
	Critical joints with equipments	(See Note-3 below)
25 mm and above, but less than 38 mm	Joints with leakage potential	(See Note-2 below)
	Critical joints with equipments	(See Note-3 below)

Note-1: Hydrogen Service

In absence of project specific definition, Hydrogen service may be defined as service in contact with Hydrogen or gaseous mixtures containing Hydrogen in which the partial pressure of Hydrogen is 7 bar (100 psi) abs. or more.

Note-2: Joints with leakage potential shall include

a) Joints involving tapped holes.
b) Joints not subjected to hydro test e.g. joints for equipment manholes, equipment mounted temperature, pressure and level instruments, line mounted temperature connections, on line instrument joints like control valves and safety valves, compressor volume bottles.
c) Items involving two sets of gaskets with one set of bolt e.g. orifice flange joint, joints with spectacle blind, spacer, flangeless wafer check valve, wafer type butterfly valves.
d) Tie-in joints with other contractors and package vendors.
e) High temperature (above 371°C) joints in hydrocarbon services.

Note-3: Critical joints with the equipments shall include the inlet and the outlet flanges of pumps, compressors and turbines.

5.1.2 Application of torque

Controlled bolt torque, with calculated torque values, shall be applied using calibrated torque wrench. Joints those qualify for hydraulic bolt tensioning per 5.1.1 shall not be considered for torque application. Controlled bolt torque should be applied for the joints meeting the criteria given in Table 2. Joints fulfilling the criteria for Hydraulic bolt tensioning need not be checked for these criteria

Table 2: Criteria for Bolt Torque application

Service	Joints
Hydrogen service	All joints (Note-1)
Category 'M' services	All joints (Note-1)
Other services	Class 600 and above

Note-1: Joints, those qualify for hydraulic bolt tensioning as per cl. 5.1.1, shall not be considered for torque application.

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5.2 Pre-bolting Operations

5.2.1 Design

a) Flange connection with bolting of nominal diameter 25 mm and above shall have sufficient clearances and access to allow the use of hydraulic tensioning equipment (wherever hydraulic bolt tensioning is being used).

b) Stud bolts shall be longer by one diameter to suit the bolt tensioners for hydraulic bolt tensioning. Excess threads shall be protected by using nut, threaded cap etc. On bolts at ambient temperature duty the cap should have a grease nipple.

c) All flanges on hydrogen service must be left exposed unless otherwise agreed.

d) Interface joints shall be system pressure tested as per the relevant code to ensure their integrity.

5.2.2 General

a) Use of right type of gasket, fasteners etc. conforming to the specifications as per design and drawings should be ensured.

b) The Vickers hardness number of ring joint gaskets should be 30 to 40 less than that of the mating face of the flange.

c) All non-ring joint gaskets shall be replaced with the new ones whenever an opened joint is to be re-closed during construction and commissioning stage. Ring joint gaskets normally can be re-used provided they are inspected and are free from any damage

d) Shop tested flange joints should not be disturbed at site. In case the joint is opened, the Contractor shall be responsible for final hook-up joints including bolt tensioning if applicable.

5.2.3 Visual inspection

a) Condition of flange faces should be checked. Those shall be free from dirt, scale, remnant gasket, and protrusions. Faces with pitting, indentations or radial tool marks, or scratches are not desirable. Surface finish should conform to specifications.

b) Flanges should be aligned properly. Flange faces shall be parallel and boltholes shall match so that the studs can be inserted freely.

c) Visual examination of gaskets should be carried out prior to installation to ensure that these are free of any defects such as bends, crease or loose spiral windings etc.

d) Gasket position should be checked.

e) Studs and nuts shall be free from dirt, nicks, burrs and chips. Studs shall be straight and nuts shall turn freely on the stud.

f) No external load shall be used to align the flanges.

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5.2.4 Corrective measures

a) Faces with pitting, indentations or radial tool marks, or scratches that form leakage paths or with the surface finish not in accordance with design requirements shall be replaced or re-machined to specified surface finish.

b) If necessary, gasket seating face should be cleaned using wire brush (SS bristles on alloy components) and/or suitable solvent.

c) Damaged gaskets shall be replaced.

d) If holding gasket in place after installation is a problem, a thin adhesive tape should be used along the outside edge of gasket.

5.2.5 Lubrication/anti-seize compound

a) Threads and nuts to flange contact face should be lubricated with suitable lubricant. Thread compound or lubricant, suitable for line temperature, may be used.

b) Gaskets should not be lubricated.

c) Lubricant shall not be applied on bolts, used in oxygen services.

d) Some of the types of lubricants used are as follows:

Molybdenum Lead oxide (graphite based)
Molykote G-n plus
Molykote P37
Molykote HSC Plus / Never Seez nickel special
API SA2
Molykote 1000
Machine oil
Graphite grease

5.2.6 Assembly

a) Suitable lubricant (refer cl. 5.2.5) to be applied to the threads and the face of the nut that contacts the flange.

b) Four studs should be placed in positions 1, 2, 3 and 4 according to "Stud Tightening Pattern" in Fig.1, as centring guides for the gasket.

c) Balance studs should be inserted next.

d) Nuts should be run down by hand in such a way that an equal number of threads project at each end.

5.2.7 Torque/tension calculation

a) Bolting load calculation and stress analysis used for computation of the listed tightening torque and tension values primarily follow the procedures outlined in ASME Section VIII Division 1/ Division 2.

b) Basic formulae used for torque calculation takes care of friction between bolt threads and nut threads as well as that between nut and back face of flange.

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c) A frictional co-efficient of 0.15 is assumed for calculation of torque values for the lubricant - graphite grease. When a lubricant with different co-efficient of friction (μ) is used, the calculated values get multiplied by the ratio μ/0.15. The approximate μ values of some of the lubricants are as follows:

Type of Lubricant	Co-efficient of friction (μ)
Molybdenum lead oxide + graphite based	0.085
Molykote G-n plus	0.09
Molykote P37	0.10
Molykote HSC Plus / Never Seez nickel special	0.11
API SA2	0.117
Molykote 1000	0.13
Graphite grease / Machine oil	0.15

However, it is advisable to obtain the appropriate co-efficient of friction (μ) value from the lubricant manufacturer.

5.2.8 The PMS classes included in this specification are given in Table 3.

Table 3: PMS classes included in this specification

Sl. no	Piping class	Sl. no	Piping class	Sl. no	Piping class	Sl. no	Piping class
From Standard PMS (6-44-0005 rev 7)							
1	A1A	26	B1A	51	B6N	76	F2D
2	A2A	27	B2A	52	D1A	77	F2G
3	A4A	28	B4A	53	D2A	78	G2G
4	A6A	29	B5A	54	D4A		
5	A7A	30	B6A	55	D5A		
6	A8A	31	B9A	56	D9A		
7	A9A	32	B13A	57	D16A		
8	A11A	33	B16A	58	D19A		
9	A13A	34	B19A	59	D1D		
10	A15A	35	B32A	60	D2D		
11	A16A	36	B1D	61	D5D		
12	A19A	37	B5D	62	D5E		
13	A20A	38	B1E	63	D1K		
14	A32A	39	B3F	64	D2K		
15	A33A	40	B4F	65	E1A		
16	A4F	41	B4G	66	E2A		
17	A4G	42	B1K	67	E5A		
18	A1K	43	B2K	68	E9A		
19	A2K	44	B4K	69	E19A		
20	A6K	45	B5K	70	E5E		
21	A11K	46	B6K	71	F1A		
22	A1M	47	B1M	72	F2A		
23	A1N	48	B3M	73	F5A		
24	A4Y	49	B5M	74	F9A		
25	A33Y	50	B1N	75	F19A		

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5.2.9 Torque and tension values

Table 4 contains the tension and torque values to be used for bolt tightening of each bolt using hydraulic bolt tensioner and torque wrench respectively. These values are listed PMS class and flange size wise. The tension values specified are the target load per bolt intended after the bolt tensioning operation is complete. This means any allowance inherent in bolt tensioning equipment (viz. backlash etc.) shall also to be taken care of as recommended by the equipment manufacturer.

5.2.10 Notes to Torque and tension values in Table 4

a) The **maximum allowed** design pressure & temperature combination and test pressure values are listed in Table 4. These values corresponds to PMS rating table values, except as stated in c) below. **Recalculation** of torque and tension is necessary if the design condition exceeds these limits.

b) Values in the table are **not** valid if the design condition for pipe wall thickness calculation is lower than 80% of the class rating condition. **Recalculation** of torque and tension is necessary in such cases.

c) It may be noted that for the sizes above 24" and rating class above 150 (except Lists B-1 and B-2), the calculations are carried out for 80% of the pressure used for sizes up to 24".

d) Torque / tension computation of sizes and pipe thickness, which are not covered in the respective classes of the standard PMS, are carried out based on approximate calculated pipe thickness for the specified pressure and temperature condition.

e) The "Flange Std" column of table 4 is the standard rating class followed by a suffix. Suffixes to the rating class numbers denote the flange dimensional standard and are as follows:

S - ASME B16.5 B - ASME B16.47 Series B

f) The values in the tables are not valid for non-standard flanges or flanges conforming to any other dimensional standards, e.g., ASME B16.47 Series A, AWWA (American Water Works association) etc.

g) All pressure values are in kg/cm^2 (g) and all temperature values are in °C

h) Bolt tightening torque or tension values at equipment interface flanges, if specified by the equipment vendor, shall be used.

5.3 Bolting Operation

5.3.1 General

a) Categorisation of joints for tension or torque application shall be as per cl. 5.1.

b) Bolt tightening tension or torque value shall be as per cl. 5.2.9.

c) Guidelines and safety requirements provided by the manufacturer bolt tightening equipment should be followed.

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5.3.2 Hydraulic bolt tension application

a) Hydraulic pressure adequate to get the target bolt load can be calculated dividing the bolt load by the load cell hydraulic seal area. This pressure should be applied simultaneously to all load cells.

b) 4 load cells equally spaced should be used.

c) Nuts should be run down to flange surface manually.

d) Load cells should be shifted following the Criss-cross Pattern shown in Fig. 1 but in-groups of 4 bolts each (i.e. 1-2-3-4, 5-6-7-8, 9-10-11-12 etc.) and the tensioning of all bolts should be completed.

e) Tensioning operations should be repeated once again applying the same pressure.

5.3.3 Stud bolt torque application

a) Bolt torque application sequence shall be in accordance with "Criss-cross Stud Tightening Pattern" (Fig. 1).

b) Properly calibrated torque wrenches should be used.

c) Torque wrench should be held perpendicular to the axis of the bolt and if hydraulic wrench is used, it has to be ensured that it reacts against a rigid support parallel to the axis of bolt.

d) Torque should be applied using a minimum of following five steps:

i. All the nuts should be made snug tight with a short wrench (Criss-cross Pattern – Fig.1).

Flange should be bearing uniformly on the gasket (Distance between mating flanges shall be uniform).

ii. Tightening to 30% of the final torque value (Criss-cross Pattern – Fig. 1).

Flange should be bearing uniformly on the gasket (Distance between mating flanges shall be uniform).

iii. Tightening to 60% of the final torque value (Criss-cross Pattern – Fig.1).

Flange should be bearing uniformly on the gasket (Distance between mating flanges shall be uniform).

iv. Tightening to the final torque value (Criss-cross Pattern – Fig. 1).

Flange should be bearing uniformly on the gasket (Distance between mating flanges shall be uniform).

v. Tightening should be continued with the final torque in a clockwise manner (bolt to bolt) until no further rotation is observed.

e) In the event of nut seizure, the nut should be backed off and additional lubricant should be applied or the nut or/and bolt should be replaced, if necessary.

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5.3.4 Testing of joints

Checking up of the individual joints for any leak during system pressure testing should be carried out using special tapes, soap solutions.

6.0 RESPONSIBILITIES / APPROVALS

6.1 All procedures/documents to be used during Construction should be submitted by the Contractor to Engineer-in-charge at site in advance.

6.2 The equipment supplier shall be subjected to EIL/Owner approval.

6.3 The details of hydraulic tensioner equipment to be used for tightening shall be intimated to Engineer-in-charge before application.

6.4 Boxing up and tightening of flange joints shall be done by skilled technicians, qualified and approved by Contractor and EIL/Owner.

6.5 Any conflict between the requirements of this standard specification and applicable codes, licensor specification, standards, data sheets, drawings, requisitions etc. shall be referred to client/ consultant. Agency carrying out bolt tightening shall list and describe all the deviations from this standard specification and the related reference documents.

7.0 DOCUMENTATION

7.1 History sheet for flange joints shall be maintained as per Annexure-I.

7.2 Sequence of the activities involved for reopening/ making/ blinding/ de-blinding/ wedge opening of flange joints shall be as per Annexure-II.

7.3 All joints shall be boxed-up and the record shall be maintained of salient points and names of the persons involved in the execution/inspection of boxing-up operation.

7.4 All critical joints shall be boxed-up under the supervision of the Contractor's representative and EIL's Engineer-in-charge or his representative and separate records shall be maintained for such joints.

7.5 Box up records of interface joints and on-line instrument joints, like control valves, safety valves, turbine flow meters etc., which are not subjected to hydro test shall be maintained separately.

7.6 If mentioned in project specification, complete set of Bolt Tensioning Equipment/ Torque Wrenches shall be supplied by Contractor to the Owner, after commissioning of the plant, as mandatory spares.

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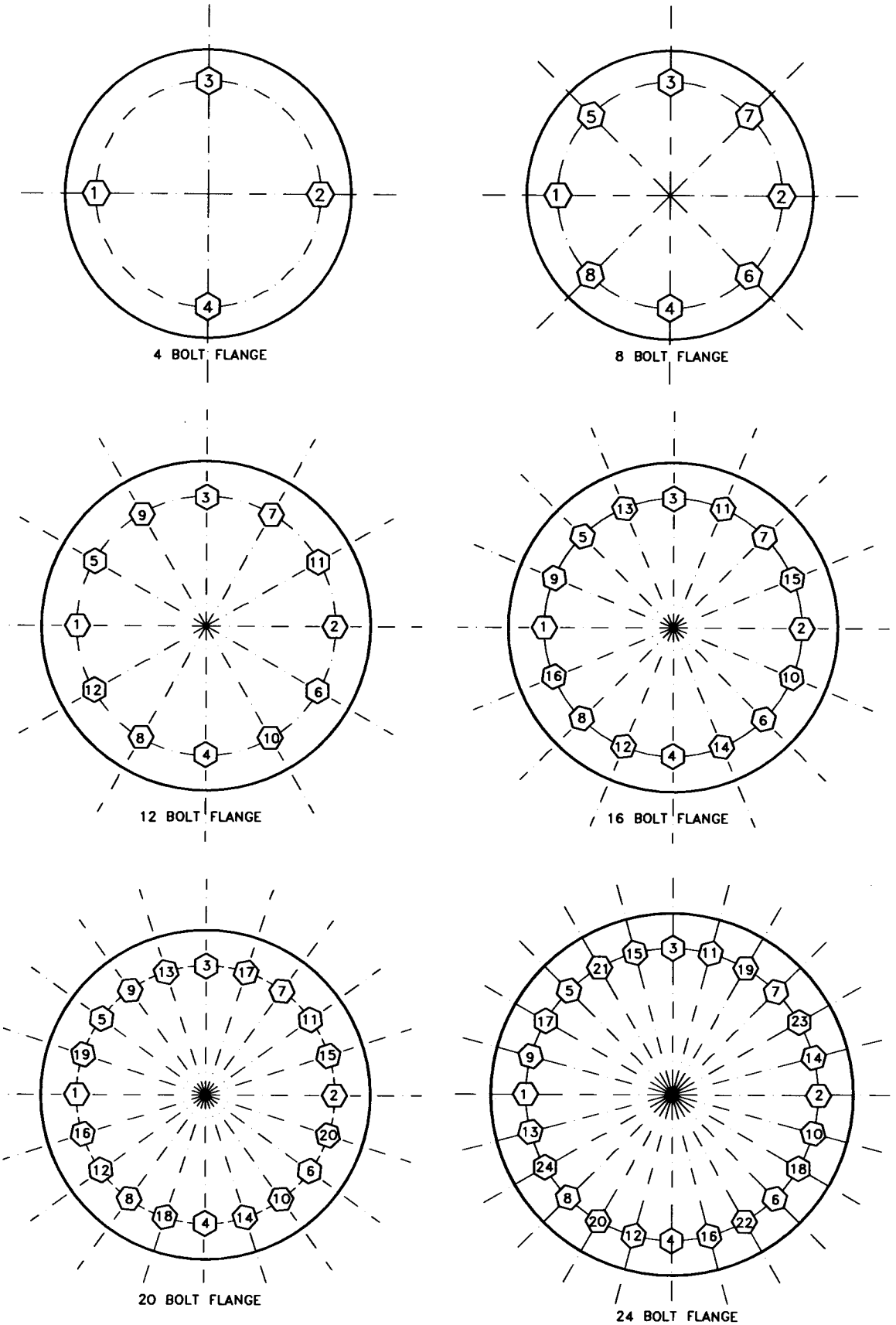

Figure 1 Typical "Criss-cross" Bolt tightening/Torque application pattern

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Table 4: Bolt Tension and Torque Values

Refer cl. 5.2.8, 5.2.9 and 5.2.10 for applicability of these values

PMS class data					Calculation Data								
Piping Class	Temperature, pressure, materials and size range				Des Pressure kg/cm²(g)	Des Temp. °C	Test Pressure kg/cm²(g)	Flange Std	Flange size inch	Bolt Dia inch	No. of Bolts	Tension kg	Torque kg-m
	Flange	Bolt	Gasket	Pipe									
LIST A-1													
A1A	PMS rated Temperature / Pressure		371 / 7.73	Up to 48"	7.73	371	30.05	150S	1/2	1/2	4	684	2.1
	A105	A193 Gr. B7	Spiral wound SS	A106 Gr. B	7.73	371	30.05	150S	3/4	1/2	4	855	2.6
				A672 Gr. B60	7.73	371	30.05	150S	1	1/2	4	1027	3.1
A2A	PMS rated Temperature / Pressure		371 / 7.73	Up to 36"	7.73	371	30.05	150S	1-1/2	1/2	4	1597	4.8
	A105	A193 Gr. B7	Spiral wound SS	A106 Gr. B	7.73	371	30.05	150S	2	5/8	4	2562	9.4
				A672 Gr. B60	7.73	371	30.05	150S	3	5/8	4	3020	11.1
A6A	PMS rated Temperature / Pressure		371 / 7.73	Up to 24"	7.73	371	30.05	150S	4	5/8	8	2471	9.1
	A105	A193 Gr. B7	Spiral wound SS	A106 Gr. B	7.73	371	30.05	150S	6	3/4	8	3972	17.2
				A672 Gr. B60	7.73	371	30.05	150S	8	3/4	8	4931	21.3
A7A	PMS rated Temperature / Pressure		371 / 7.73	Up to 24"	7.73	371	30.05	150S	10	7/8	12	5135	25.5
	A105	A193 Gr. B7	Spiral wound SS	A106 Gr. B	7.73	371	30.05	150S	12	7/8	12	5326	26.5
				A672 Gr. B60	7.73	371	30.05	150S	14	1	12	6249	35.2
A9A	PMS rated Temperature / Pressure		371 / 7.73	Up to 36"	7.73	371	30.05	150S	16	1	16	5999	33.8
	A105	A193 Gr. B7	Spiral wound SS	A106 Gr. B	7.73	371	30.05	150S	18	1-1/8	16	8583	53.7
				A672 Gr. B60	7.73	371	30.05	150S	20	1-1/8	20	8583	53.7
A11A	PMS rated Temperature / Pressure		371 / 7.5	Up to 48"	7.73	371	30.05	150S	24	1-1/4	20	11379	78.3
	A105	A193 Gr. B7	Spiral wound SS	A106 Gr. B	7.73	371	30.05	150B	26	3/4	36	4111	17.7
				A672 Gr. B60	7.73	371	30.05	150B	28	3/4	40	4111	17.7
A13A	PMS rated Temperature / Pressure		371 / 7.73	Up to 24"	7.73	371	30.05	150B	30	3/4	44	4385	18.9
	A105	A193 Gr. B7	Spiral wound SS	A106 Gr. B	7.73	371	30.05	150B	32	3/4	48	4522	19.5
				A672 Gr. B60	7.73	371	30.05	150B	34	7/8	40	6274	31.2
A19A	PMS rated Temperature / Pressure		371 / 7.73	Up to 36"	7.73	371	30.05	150B	36	7/8	44	6274	31.2
	A105	A193 Gr. B7	Spiral wound SS	A106 Gr. B	7.73	371	30.05	150B	38	1	40	7750	43.7
				A 672 Gr.B 60 Cl.22	7.73	371	30.05	150B	40	1	44	7750	43.7
					7.73	371	30.05	150B	42	1	48	7750	43.7
					7.73	371	30.05	150B	44	1	52	7750	43.7
					7.73	371	30.05	150B	46	1-1/8	40	11230	70.3
					7.73	371	30.05	150B	48	1-1/8	44	10570	66.2

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PMS class data					Calculation Data								
Piping Class	Temperature, pressure, materials and size range				Des Pressure kg/cm²(g)	Des Temp. °C	Test Pressure kg/cm²(g)	Flange Std	Flange size inch	Bolt Dia inch	No. of Bolts	Tension kg	Torque kg-m
	Flange	Bolt	Gasket	Pipe									
					7.73	371	30.05	150B	**50**	1-1/8	48	**10570**	**66.2**
					7.73	371	30.05	150B	**52**	1-1/8	52	**10240**	**64.1**
					7.73	371	30.05	150B	**54**	1-1/8	56	**10240**	**64.1**
					7.73	371	30.05	150B	**56**	1-1/8	60	**10240**	**64.1**
					7.73	371	30.05	150B	**58**	1-1/4	48	**13488**	**92.8**
					7.73	371	30.05	150B	**60**	1-1/4	52	**13488**	**92.8**
LIST A-2													
A4Y	PMS rated Temperature / Pressure		50 / 10.55	Up to 12"	10.55	186	15.80	150S	**1/2**	1/2	4	**684**	**2.1**
	A105	A307 GR.B	BUTYL RUBBER	API 5L GR.B PSL1	10.55	186	15.80	150S	**3/4**	1/2	4	**855**	**2.6**
					10.55	186	15.80	150S	**1**	1/2	4	**1027**	**3.1**
					10.55	186	15.80	150S	**1-1/2**	1/2	4	**1255**	**3.8**
					10.55	186	15.80	150S	**2**	5/8	4	**2013**	**7.4**
					10.55	186	15.80	150S	**3**	5/8	4	**2013**	**7.4**
					10.55	186	15.80	150S	**4**	5/8	8	**2013**	**7.4**
					10.55	186	15.80	150S	**6**	3/4	8	**3014**	**13.0**
					10.55	186	15.80	150S	**8**	3/4	8	**3014**	**13.0**
					10.55	186	15.80	150S	**10**	7/8	12	**4184**	**20.8**
					10.55	186	15.80	150S	**12**	7/8	12	**4184**	**20.8**
					10.55	186	15.80	150S	**14**	1	12	**5499**	**31.0**
					10.55	186	15.80	150S	**16**	1	16	**5499**	**31.0**
					10.55	186	15.80	150S	**18**	1-1/8	16	**7263**	**45.5**
					10.55	186	15.80	150S	**20**	1-1/8	20	**7263**	**45.5**
					10.55	186	15.80	150S	**24**	1-1/4	20	**9272**	**63.8**
LIST A-3													
A4A	PMS rated Temperature / Pressure		204 / 14.06	Up to 48"	14.06	204	27.95	150S	**1/2**	1/2	4	**684**	**2.1**
	A 350 GR.LF2 CL.1	A320 GR.L7	Spiral wound SS	A 333 GR.6	14.06	204	27.95	150S	**3/4**	1/2	4	**855**	**2.6**
				A 671 GR.CC60 CL.32	14.06	204	27.95	150S	**1**	1/2	4	**1027**	**3.1**
					14.06	204	27.95	150S	**1-1/2**	1/2	4	**1597**	**4.8**
					14.06	204	27.95	150S	**2**	5/8	4	**2562**	**9.4**
					14.06	204	27.95	150S	**3**	5/8	4	**3020**	**11.1**
					14.06	204	27.95	150S	**4**	5/8	8	**2471**	**9.1**
					14.06	204	27.95	150S	**6**	3/4	8	**3972**	**17.2**
					14.06	204	27.95	150S	**8**	3/4	8	**4931**	**21.3**

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PMS class data					Calculation Data								
Piping Class	Temperature, pressure, materials and size range				Des Pressure kg/cm²(g)	Des Temp. °C	Test Pressure kg/cm²(g)	Flange Std	Flange size inch	Bolt Dia inch	No. of Bolts	Tension kg	Torque kg-m
	Flange	Bolt	Gasket	Pipe									
					14.06	204	27.95	150S	10	7/8	12	5135	25.5
					14.06	204	27.95	150S	12	7/8	12	5326	26.5
					14.06	204	27.95	150S	14	1	12	6249	35.2
					14.06	204	27.95	150S	16	1	16	5999	33.8
					14.06	204	27.95	150S	18	1-1/8	16	8583	53.7
					14.06	204	27.95	150S	20	1-1/8	20	8583	53.7
					14.06	204	27.95	150S	24	1-1/4	20	11379	78.3
					14.06	204	27.95	150B	26	3/4	36	4111	17.7
					14.06	204	27.95	150B	28	3/4	40	4111	17.7
					14.06	204	27.95	150B	30	3/4	44	4385	18.9
					14.06	204	27.95	150B	32	3/4	48	4522	19.5
					14.06	204	27.95	150B	34	7/8	40	6274	31.2
					14.06	204	27.95	150B	36	7/8	44	6274	31.2
					14.06	204	27.95	150B	38	1	40	7750	43.7
					14.06	204	27.95	150B	40	1	44	7750	43.7
					14.06	204	27.95	150B	42	1	48	7750	43.7
					14.06	204	27.95	150B	44	1	52	7750	43.7
					14.06	204	27.95	150B	46	1-1/8	40	11230	70.3
					14.06	204	27.95	150B	48	1-1/8	44	10570	66.2
LIST A-4													
A8A	PMS rated Temperature / Pressure		65 / 19.17	Up to 6"	8.78	343	30.05	150S	1/2	1/2	4	684	2.1
	A105	A193 GR.B7	BS7531 GR X	A 106 GR.B	8.78	343	30.05	150S	3/4	1/2	4	855	2.6
					8.78	343	30.05	150S	1	1/2	4	1027	3.1
A15A	PMS rated Temperature / Pressure		343 / 8.78	Up to 16"	8.78	343	30.05	150S	1-1/2	1/2	4	1597	4.8
	A105	A193 GR.B7	BS7531 GR X	A 106 GR.B	8.78	343	30.05	150S	2	5/8	4	2562	9.4
				A672 Gr. B60	8.78	343	30.05	150S	3	5/8	4	3020	11.1
A20A	PMS rated Temperature / Pressure		343 / 8.78	Up to 18"	8.78	343	30.05	150S	4	5/8	8	2471	9.1
	A105	A193 GR.B7	BS7531 GR X	A 106 GR.B	8.78	343	30.05	150S	6	3/4	8	3972	17.2
				A672 Gr. B60	8.78	343	30.05	150S	8	3/4	8	4931	21.3
A32A	PMS rated Temperature / Pressure		280 / 11.19	Up to 3"	8.78	343	30.05	150S	10	7/8	12	5135	25.5
	A105	A193 GR.B7	BS7531 GR X	A 106 GR.B	8.78	343	30.05	150S	12	7/8	12	5326	26.5
					8.78	343	30.05	150S	14	1	12	6249	35.2

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PMS class data					Calculation Data								
Piping Class	Temperature, pressure, materials and size range				Des Pressure kg/cm²(g)	Des Temp. °C	Test Pressure kg/cm²(g)	Flange Std	Flange size inch	Bolt Dia inch	No. of Bolts	Tension kg	Torque kg-m
	Flange	Bolt	Gasket	Pipe									
A33A	PMS rated Temperature / Pressure		65 / 18.9	Up to 48"	8.78	343	30.05	150S	16	1	16	5999	33.8
	A105	A193 GR.B7	BS7531 GR X	A 106 GR.B	8.78	343	30.05	150S	18	1-1/8	16	8583	53.7
				IS-3589 GR.410	8.78	343	30.05	150S	20	1-1/8	20	8583	53.7
A33Y	PMS rated Temperature / Pressure		65 / 18.9	Up to 48"	8.78	343	30.05	150S	24	1-1/4	20	11379	78.3
	A105	A193 GR.B7	BS7531 GR X	A 106 GR.B	8.78	343	30.05	150B	26	3/4	36	4111	17.7
				IS-3589 GR.410	8.78	343	30.05	150B	28	3/4	40	4111	17.7
					8.78	343	30.05	150B	30	3/4	44	4385	18.9
					8.78	343	30.05	150B	32	3/4	48	4522	19.5
					8.78	343	30.05	150B	34	7/8	40	6274	31.2
					8.78	343	30.05	150B	36	7/8	44	6274	31.2
					8.78	343	30.05	150B	38	1	40	7750	43.7
					8.78	343	30.05	150B	40	1	44	7750	43.7
					8.78	343	30.05	150B	42	1	48	7750	43.7
					8.78	343	30.05	150B	44	1	52	7750	43.7
					8.78	343	30.05	150B	46	1-1/8	40	11230	70.3
					8.78	343	30.05	150B	48	1-1/8	44	10570	66.2
					8.78	343	30.05	150B	50	1-1/8	48	10570	66.2
					8.78	343	30.05	150B	52	1-1/8	52	10240	64.1
					8.78	343	30.05	150B	54	1-1/8	56	10240	64.1
					8.78	343	30.05	150B	56	1-1/8	60	10240	64.1
					8.78	343	30.05	150B	58	1-1/4	48	13488	92.8
					8.78	343	30.05	150B	60	1-1/4	52	13488	92.8
LIST A-5													
A16A	PMS rated Temperature / Pressure		371 / 7.73	Up to 24"	7.73	371	30.05	150S	1/2	1/2	4	684	2.1
	A105	A193 Gr. B7M	Spiral wound SS	A106 Gr. B	7.73	371	30.05	150S	3/4	1/2	4	855	2.6
				A672 Gr. B60	7.73	371	30.05	150S	1	1/2	4	1027	3.1
					7.73	371	30.05	150S	1-1/2	1/2	4	1597	4.8
					7.73	371	30.05	150S	2	5/8	4	2562	9.4
					7.73	371	30.05	150S	3	5/8	4	3020	11.1
					7.73	371	30.05	150S	4	5/8	8	2471	9.1
					7.73	371	30.05	150S	6	3/4	8	3972	17.2
					7.73	371	30.05	150S	8	3/4	8	4931	21.3
					7.73	371	30.05	150S	10	7/8	12	5135	25.5

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PMS class data					Calculation Data								
Piping Class	Temperature, pressure, materials and size range				Des Pressure kg/cm²(g)	Des Temp. °C	Test Pressure kg/cm²(g)	Flange Std	Flange size inch	Bolt Dia inch	No. of Bolts	Tension kg	Torque kg-m
	Flange	Bolt	Gasket	Pipe									
					7.73	371	30.05	150S	12	7/8	12	5326	26.5
					7.73	371	30.05	150S	14	1	12	6249	35.2
					7.73	371	30.05	150S	16	1	16	5999	33.8
					7.73	371	30.05	150S	18	1-1/8	16	8583	53.7
					7.73	371	30.05	150S	20	1-1/8	20	8583	53.7
					7.73	371	30.05	150S	24	1-1/4	20	11379	78.3
LIST A-6													
A4F	PMS rated Temperature / Pressure		371 / 7.73	Up to 24"	7.73	371	30.57	150S	1/2	1/2	4	798	2.4
	A182 Gr.F5	A193 Gr.B16	Spiral wound SS	A 335 GR.P5	7.73	371	30.57	150S	3/4	1/2	4	970	2.9
				A 691 GR.5Cr CL.42	7.73	371	30.57	150S	1	1/2	4	1141	3.4
					7.73	371	30.57	150S	1-1/2	1/2	4	1540	4.6
					7.73	371	30.57	150S	2	5/8	4	2745	10.1
					7.73	371	30.57	150S	3	5/8	4	3020	11.1
					7.73	371	30.57	150S	4	5/8	8	3020	11.1
					7.73	371	30.57	150S	6	3/4	8	5205	22.5
					7.73	371	30.57	150S	8	3/4	8	5274	22.8
					7.73	371	30.57	150S	10	7/8	12	6277	31.2
					7.73	371	30.57	150S	12	7/8	12	6277	31.2
					7.73	371	30.57	150S	14	1	12	8249	46.5
					7.73	371	30.57	150S	16	1	16	7249	40.9
					7.73	371	30.57	150S	18	1-1/8	16	11885	74.4
					7.73	371	30.57	150S	20	1-1/8	20	11554	72.4
					7.73	371	30.57	150S	24	1-1/4	20	14751	101.5
					7.73	371	30.57	150B	26	3/4	36	4109	17.7
					7.73	371	30.57	150B	28	3/4	40	4383	18.9
					7.73	371	30.57	150B	30	3/4	44	4520	19.5
					7.73	371	30.57	150B	32	3/4	48	4794	20.7
					7.73	371	30.57	150B	34	7/8	40	6847	34.0
					7.73	371	30.57	150B	36	7/8	44	7037	35.0
					7.73	371	30.57	150B	38	1	40	8748	49.3
					7.73	371	30.57	150B	40	1	44	8748	49.3
					7.73	371	30.57	150B	42	1	48	8498	47.9

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PMS class data					Calculation Data								
Piping Class	Temperature, pressure, materials and size range				Des Pressure kg/cm²(g)	Des Temp. °C	Test Pressure kg/cm²(g)	Flange Std	Flange size inch	Bolt Dia inch	No. of Bolts	Tension kg	Torque kg-m
	Flange	Bolt	Gasket	Pipe									
LIST A-7													
A4G	PMS rated Temperature / Pressure		371 / 7.73	Up to 24"	7.73	371	30.57	150S	1/2	1/2	4	798	2.4
	A182 Gr.F9	A193 Gr.B16	Spiral wound SS	A 335 GR.P9	7.73	371	30.57	150S	3/4	1/2	4	970	2.9
				A 691 GR.9Cr CL.42	7.73	371	30.57	150S	1	1/2	4	1255	3.8
					7.73	371	30.57	150S	1-1/2	1/2	4	1825	5.5
					7.73	371	30.57	150S	2	5/8	4	3203	11.8
					7.73	371	30.57	150S	3	5/8	4	3386	12.4
					7.73	371	30.57	150S	4	5/8	8	3386	12.4
					7.73	371	30.57	150S	6	3/4	8	5342	23.1
					7.73	371	30.57	150S	8	3/4	8	5342	23.1
					7.73	371	30.57	150S	10	7/8	12	7037	35.0
					7.73	371	30.57	150S	12	7/8	12	6847	34.0
					7.73	371	30.57	150S	14	1	12	8748	49.3
					7.73	371	30.57	150S	16	1	16	7999	45.1
					7.73	371	30.57	150S	18	1-1/8	16	12215	76.5
					7.73	371	30.57	150S	20	1-1/8	20	11885	74.4
					7.73	371	30.57	150S	24	1-1/4	20	15594	107.3
					7.73	371	30.57	150B	26	3/4	36	4383	18.9
					7.73	371	30.57	150B	28	3/4	40	4589	19.8
					7.73	371	30.57	150B	30	3/4	44	4726	20.4
					7.73	371	30.57	150B	32	3/4	48	5137	22.2
					7.73	371	30.57	150B	34	7/8	40	7132	35.5
					7.73	371	30.57	150B	36	7/8	44	7132	35.5
					7.73	371	30.57	150B	38	1	40	9123	51.4
					7.73	371	30.57	150B	40	1	44	9123	51.4
					7.73	371	30.57	150B	42	1	48	8998	50.7
LIST A-8													
A2K	PMS rated Temperature / Pressure		120 / 15.32	Up to 24"	15.32	120	29.00	150S	1/2	1/2	4	570	1.7
	A 182 GR.F304	A320 GR.B8CL.2	Spiral wound SS	A 312 TP304	15.32	120	29.00	150S	3/4	1/2	4	855	2.6
				A 358 GR.304	15.32	120	29.00	150S	1	1/2	4	1141	3.4
					15.32	120	29.00	150S	1-1/2	1/2	4	1597	4.8
					15.32	120	29.00	150S	2	5/8	4	2379	8.7
					15.32	120	29.00	150S	3	5/8	4	3203	11.8

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PMS class data					Calculation Data								
Piping Class	Temperature, pressure, materials and size range				Des Pressure kg/cm²(g)	Des Temp. °C	Test Pressure kg/cm²(g)	Flange Std	Flange size inch	Bolt Dia inch	No. of Bolts	Tension kg	Torque kg-m
	Flange	Bolt	Gasket	Pipe									
					15.32	120	29.00	150S	4	5/8	8	2837	10.4
					15.32	120	29.00	150S	6	3/4	8	4383	18.9
					15.32	120	29.00	150S	8	3/4	8	5068	21.9
					15.32	120	29.00	150S	10	7/8	12	5516	27.4
					15.32	120	29.00	150S	12	7/8	12	5896	29.3
					15.32	120	29.00	150S	14	1	12	7499	42.3
					15.32	120	29.00	150S	16	1	16	6749	38.1
					15.32	120	29.00	150S	18	1-1/8	16	9574	59.9
					15.32	120	29.00	150S	20	1-1/8	20	9574	59.9
					15.32	120	29.00	150S	24	1-1/4	20	12644	87.0
					15.32	120	29.00	150B	26	3/4	36	4109	17.7
					15.32	120	29.00	150B	28	3/4	40	4246	18.3
					15.32	120	29.00	150B	30	3/4	44	4383	18.9
					15.32	120	29.00	150B	32	3/4	48	4520	19.5
					15.32	120	29.00	150B	34	7/8	40	5896	29.3
					15.32	120	29.00	150B	36	7/8	44	5991	29.8
LIST A-9													
A1K	PMS rated Temperature / Pressure		371 / 7.73	Up to 24"	7.73	371	29.00	150S	1/2	1/2	4	570	1.7
	A 182 GR.F304	A193 GR.B7	Spiral wound SS	A 312 TP304	7.73	371	29.00	150S	3/4	1/2	4	798	2.4
				A 358 GR.304	7.73	371	29.00	150S	1	1/2	4	913	2.7
A6K	PMS rated Temperature / Pressure		371 / 7.73	Up to 24"	7.73	371	29.00	150S	1-1/2	1/2	4	1141	3.4
	A 182 GR.F304L	A193 GR.B7	Spiral wound SS	A 312 TP304L	7.73	371	29.00	150S	2	5/8	4	2562	9.4
				A 358 GR.304L	7.73	371	29.00	150S	3	5/8	4	3020	11.1
A11K	PMS rated Temperature / Pressure		371 / 7.73	Up to 24"	7.73	371	29.00	150S	4	5/8	8	2471	9.1
	A 182 GR.F304L	A193 GR.B7	Spiral wound SS	A 312 TP304L	7.73	371	29.00	150S	6	3/4	8	3972	17.2
				A 358 GR.304L	7.73	371	29.00	150S	8	3/4	8	4931	21.3
					7.73	371	29.00	150S	10	7/8	12	5135	25.5
					7.73	371	29.00	150S	12	7/8	12	5326	26.5
					7.73	371	29.00	150S	14	1	12	6249	35.2
					7.73	371	29.00	150S	16	1	16	5999	33.8
					7.73	371	29.00	150S	18	1-1/8	16	8583	53.7
					7.73	371	29.00	150S	20	1-1/8	20	8583	53.7
					7.73	371	29.00	150S	24	1-1/4	20	11379	78.3

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Piping Class	PMS class data: Temperature, pressure, materials and size range				Calculation Data								
	Flange	Bolt	Gasket	Pipe	Des Pressure kg/cm²(g)	Des Temp. °C	Test Pressure kg/cm²(g)	Flange Std	Flange size inch	Bolt Dia inch	No. of Bolts	Tension kg	Torque kg-m
LIST A-10													
A1M	PMS rated Temperature / Pressure		371 / 7.73	Up to 24"	7.73	371	29.00	150S	1/2	1/2	4	570	1.7
	A 182 GR.F316	A193 GR.B7	Spiral wound SS	A 312 TP316	7.73	371	29.00	150S	3/4	1/2	4	798	2.4
				A 358 GR.316	7.73	371	29.00	150S	1	1/2	4	913	2.7
					7.73	371	29.00	150S	1-1/2	1/2	4	1141	3.4
					7.73	371	29.00	150S	2	5/8	4	2562	9.4
					7.73	371	29.00	150S	3	5/8	4	3020	11.1
					7.73	371	29.00	150S	4	5/8	8	2471	9.1
					7.73	371	29.00	150S	6	3/4	8	3972	17.2
					7.73	371	29.00	150S	8	3/4	8	4931	21.3
					7.73	371	29.00	150S	10	7/8	12	5135	25.5
					7.73	371	29.00	150S	12	7/8	12	5326	26.5
					7.73	371	29.00	150S	14	1	12	6249	35.2
					7.73	371	29.00	150S	16	1	16	5999	33.8
					7.73	371	29.00	150S	18	1-1/8	16	8583	53.7
					7.73	371	29.00	150S	20	1-1/8	20	8583	53.7
					7.73	371	29.00	150S	24	1-1/4	20	11379	78.3
LIST A-11													
A1N	PMS rated Temperature / Pressure		371 / 7.73	Up to 24"	7.73	371	24.26	150S	1/2	1/2	4	570	1.7
	A 182 GR.F316L	A193 GR.B7	Spiral wound SS	A 312 TP316L	7.73	371	24.26	150S	3/4	1/2	4	798	2.4
				A 358 GR.316L	7.73	371	24.26	150S	1	1/2	4	913	2.7
					7.73	371	24.26	150S	1-1/2	1/2	4	1426	4.3
					7.73	371	24.26	150S	2	5/8	4	2562	9.4
					7.73	371	24.26	150S	3	5/8	4	3020	11.1
					7.73	371	24.26	150S	4	5/8	8	2471	9.1
					7.73	371	24.26	150S	6	3/4	8	3972	17.2
					7.73	371	24.26	150S	8	3/4	8	4931	21.3
					7.73	371	24.26	150S	10	7/8	12	5135	25.5
					7.73	371	24.26	150S	12	7/8	12	5326	26.5
					7.73	371	24.26	150S	14	1	12	6249	35.2
					7.73	371	24.26	150S	16	1	16	5999	33.8
					7.73	371	24.26	150S	18	1-1/8	16	8583	53.7
					7.73	371	24.26	150S	20	1-1/8	20	8583	53.7

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PMS class data					Calculation Data								
Piping Class	Temperature, pressure, materials and size range				Des Pressure kg/cm²(g)	Des Temp. °C	Test Pressure kg/cm²(g)	Flange Std	Flange size inch	Bolt Dia inch	No. of Bolts	Tension kg	Torque kg-m
	Flange	Bolt	Gasket	Pipe									
					7.73	371	24.26	150S	24	1-1/4	20	11379	78.3
LIST B-1													
B1A	PMS rated Temperature / Pressure		427 / 28.82	Up to 24"	28.82	427	79.10	300S	1/2	1/2	4	741	2.2
	A105	A193 GR.B7	Spiral wound SS	A 106 GR.B	28.82	427	79.10	300S	3/4	5/8	4	1373	5.0
				A 672 GR.B60 CL.12	28.82	427	79.10	300S	1	5/8	4	1647	6.0
B2A	PMS rated Temperature / Pressure		427 / 28.82	Up to 24"	28.82	427	79.10	300S	1-1/2	3/4	4	2740	11.8
	A105	A193 GR.B7	Spiral wound SS	A 106 GR.B	28.82	427	79.10	300S	2	5/8	8	2105	7.7
				A 672 GR.B60 CL.12	28.82	427	79.10	300S	3	3/4	8	3972	17.2
B5A	PMS rated Temperature / Pressure		230 / 43.66	Up to 24"	28.82	427	79.10	300S	4	3/4	8	5205	22.5
	A105	A193 GR.B7	Spiral wound SS	A 106 GR.B	28.82	427	79.10	300S	6	3/4	12	5205	22.5
				A 672 GR.B60 CL.32	28.82	427	79.10	300S	8	7/8	12	7608	37.8
B6A	PMS rated Temperature / Pressure		427 / 28.82	Up to 24"	28.82	427	79.10	300S	10	1	16	8748	49.3
	A105	A193 GR.B7	Spiral wound SS	A 106 GR.B	28.82	427	79.10	300S	12	1-1/8	16	11554	72.4
				A 672 GR.B60 CL.12	28.82	427	79.10	300S	14	1-1/8	20	8913	55.8
B9A	PMS rated Temperature / Pressure		427 / 28.82	Up to 24"	28.82	427	79.10	300S	16	1-1/4	20	10958	75.4
	A105	A193 GR.B7	Spiral wound SS	A 106 GR.B	28.82	427	79.10	300S	18	1-1/4	24	11801	81.2
				A 672 GR.B60 CL.12	28.82	427	79.10	300S	20	1-1/4	24	14330	98.6
B13A	PMS rated Temperature / Pressure		427 / 28.82	Up to 24"	28.82	427	79.10	300S	24	1-1/2	24	17849	144.9
	A105	A193 GR.B7	Spiral wound SS	A 106 GR.B	28.82	427	79.10	300B	26	1-1/4	32	13065	89.9
				A 672 GR.B60 CL.12	28.82	427	79.10	300B	28	1-1/4	36	13065	89.9
B19A	PMS rated Temperature / Pressure		427 / 28.82	Up to 24"	28.82	427	79.10	300B	30	1-3/8	36	15197	114.0
	A105	A193 GR.B7	Spiral wound SS	A 106 GR.B	28.82	427	79.10	300B	32	1-1/2	32	18487	150.1
				A 672 GR.B60 CL.22	28.82	427	79.10	300B	34	1-1/2	36	18168	147.5
B32A	PMS rated Temperature / Pressure		427 / 28.82	Up to 3"	28.82	427	79.10	300B	36	1-5/8	32	23630	206.5
	A105	A193 GR.B7	Spiral wound SS	A 106 GR.B	28.82	427	79.10	300B	38	1-5/8	36	25154	219.9
				A 672 GR.B60 CL.12	28.82	427	79.10	300B	40	1-5/8	40	24392	213.2
					28.82	427	79.10	300B	42	1-3/4	36	29631	277.5
LIST B-2													
B4A	PMS rated Temperature / Pressure		204 / 43.23	Up to 24"	28.82	427	79.10	300S	1/2	1/2	4	741	2.2
	A350 Gr.LF2 CL.1	A320 Gr.L7	Spiral wound SS	A333 Gr.6	28.82	427	79.10	300S	3/4	5/8	4	1373	5.0
				A671 Gr.CC60 CL.32	28.82	427	79.10	300S	1	5/8	4	1647	6.0
B16A	PMS rated Temperature / Pressure		427 / 28.82	Up to 24"	28.82	427	79.10	300S	1-1/2	3/4	4	2740	11.8
	A105	A193 Gr.B7M	Spiral wound SS	A106 Gr.B	28.82	427	79.10	300S	2	5/8	8	2105	7.7

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PMS class data					Calculation Data								
Piping Class	Temperature, pressure, materials and size range				Des Pressure kg/cm²(g)	Des Temp. °C	Test Pressure kg/cm²(g)	Flange Std	Flange size inch	Bolt Dia inch	No. of Bolts	Tension kg	Torque kg-m
	Flange	Bolt	Gasket	Pipe									
				A672 Gr.B60 CL.22	28.82	427	79.10	300S	3	3/4	8	3972	17.2
					28.82	427	79.10	300S	4	3/4	8	5205	22.5
					28.82	427	79.10	300S	6	3/4	12	5205	22.5
					28.82	427	79.10	300S	8	7/8	12	7608	37.8
					28.82	427	79.10	300S	10	1	16	8748	49.3
					28.82	427	79.10	300S	12	1-1/8	16	11554	72.4
					28.82	427	79.10	300S	14	1-1/8	20	8913	55.8
					28.82	427	79.10	300S	16	1-1/4	20	10958	75.4
					28.82	427	79.10	300S	18	1-1/4	24	11801	81.2
					28.82	427	79.10	300S	20	1-1/4	24	14330	98.6
					28.82	427	79.10	300S	24	1-1/2	24	17849	144.9
					28.82	427	79.10	300B	26	1-1/4	32	13065	89.9
					28.82	427	79.10	300B	28	1-1/4	36	13065	89.9
					28.82	427	79.10	300B	30	1-3/8	36	15197	114.0
LIST B-3													
B1D	PMS rated Temperature / Pressure		538 / 15.11	Up to 24"	15.11	538	79.10	300S	1/2	1/2	4	741	2.2
	A182 Gr. F11 Cl. 2	A193 Gr. B16	Spiral wound SS	A335 Gr. P11	15.11	538	79.10	300S	3/4	5/8	4	1007	3.7
				A691 Gr.1.25Cr Cl.42	15.11	538	79.10	300S	1	5/8	4	1647	6.0
B5D	PMS rated Temperature / Pressure		538 / 15.11	Up to 24"	15.11	538	79.10	300S	1-1/2	3/4	4	3014	13.0
	A182 Gr. F11 Cl. 2	A193 Gr. B16	Spiral wound SS	A335 Gr. P11	15.11	538	79.10	300S	2	5/8	8	2196	8.1
				A691 Gr.1.25Cr Cl.42	15.11	538	79.10	300S	3	3/4	8	4794	20.7
B3F	PMS rated Temperature / Pressure		538 / 14.06	Up to 24"	15.11	538	79.10	300S	4	3/4	8	5205	22.5
	A 182 GR.F5	A193 GR.B16	Spiral wound SS	A 335 GR.P5	15.11	538	79.10	300S	6	3/4	12	5205	22.5
				A 691 GR5CR CL.42	15.11	538	79.10	300S	8	7/8	12	7228	35.9
B4F	PMS rated Temperature / Pressure		538 / 14.06	Up to 24"	15.11	538	79.10	300S	10	1	16	9498	53.6
	A 182 GR.F5	A193 GR.B16	Spiral wound SS	A 335 GR.P5	15.11	538	79.10	300S	12	1-1/8	16	11885	74.4
				A 691 Gr. 5CR CL.42	15.11	538	79.10	300S	14	1-1/8	20	9574	59.9
					15.11	538	79.10	300S	16	1-1/4	20	11801	81.2
					15.11	538	79.10	300S	18	1-1/4	24	12222	84.1
					15.11	538	79.10	300S	20	1-1/4	24	14751	101.5
					15.11	538	79.10	300S	24	1-1/2	24	17849	144.9
					12.09	538	63.28	300B	26	1-1/4	32	10958	75.4
					12.09	538	63.28	300B	28	1-1/4	36	10958	75.4

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PMS class data					Calculation Data								
Piping Class	Temperature, pressure, materials and size range				Des Pressure kg/cm²(g)	Des Temp. °C	Test Pressure kg/cm²(g)	Flange Std	Flange size inch	Bolt Dia inch	No. of Bolts	Tension kg	Torque kg-m
	Flange	Bolt	Gasket	Pipe									
					12.09	538	63.28	300B	30	1-3/8	36	12577	94.3
					12.09	538	63.28	300B	32	1-1/2	32	15937	129.4
					12.09	538	63.28	300B	34	1-1/2	36	15299	124.2
					12.09	538	63.28	300B	36	1-5/8	32	19819	173.2
					12.09	538	63.28	300B	38	1-5/8	36	22105	193.2
					12.09	538	63.28	300B	40	1-5/8	40	21343	186.5
					12.09	538	63.28	300B	42	1-3/4	36	26937	252.3
LIST B-4													
B1E	PMS rated Temperature / Pressure		538 / 18.63	Up to 24"	18.63	538	79.10	300S	1/2	1/2	4	855	2.6
	A 182 GR.F22 CL.3	A193 Gr. B16	Spiral wound SS	A335 Gr. P22	18.63	538	79.10	300S	3/4	5/8	4	1098	4.0
				A691 Gr.2.25Cr Cl.42	18.63	538	79.10	300S	1	5/8	4	1830	6.7
B4G	PMS rated Temperature / Pressure		538 / 17,92	Up to 24"	18.63	538	79.10	300S	1-1/2	3/4	4	3287	14.2
	A 182 GR.F9	A193 GR.B16	Spiral wound SS	A 335 GR.P9	18.63	538	79.10	300S	2	5/8	8	2288	8.4
				A 691 GR9CR CL.42	18.63	538	79.10	300S	3	3/4	8	4931	21.3
					18.63	538	79.10	300S	4	3/4	8	5342	23.1
					18.63	538	79.10	300S	6	3/4	12	5342	23.1
					18.63	538	79.10	300S	8	7/8	12	7418	36.9
					18.63	538	79.10	300S	10	1	16	9748	55.0
					18.63	538	79.10	300S	12	1-1/8	16	12215	76.5
					18.63	538	79.10	300S	14	1-1/8	20	10234	64.1
					18.63	538	79.10	300S	16	1-1/4	20	12644	87.0
					18.63	538	79.10	300S	18	1-1/4	24	13065	89.9
					18.63	538	79.10	300S	20	1-1/4	24	15173	104.4
					18.63	538	79.10	300S	24	1-1/2	24	18487	150.1
					14.90	538	63.28	300B	26	1-1/4	32	11801	81.2
					14.90	538	63.28	300B	28	1-1/4	36	11801	81.2
					14.90	538	63.28	300B	30	1-3/8	36	13625	102.2
					14.90	538	63.28	300B	32	1-1/2	32	17212	139.8
					14.90	538	63.28	300B	34	1-1/2	36	16574	134.6
					14.90	538	63.28	300B	36	1-5/8	32	21343	186.5
					14.90	538	63.28	300B	38	1-5/8	36	23630	206.5
					14.90	538	63.28	300B	40	1-5/8	40	22868	199.9
					14.90	538	63.28	300B	42	1-3/4	36	28733	269.1

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PMS class data					Calculation Data								
Piping Class	Temperature, pressure, materials and size range				Des Pressure kg/cm²(g)	Des Temp. °C	Test Pressure kg/cm²(g)	Flange Std	Flange size inch	Bolt Dia inch	No. of Bolts	Tension kg	Torque kg-m
	Flange	Bolt	Gasket	Pipe									
LIST B-5													
B6K	PMS rated Temperature / Pressure		427 / 24.25	Up to 24"	24.25	427	63.27	300S	1/2	1/2	4	570	1.7
	A 182 GR.F304L	A193 GR.B7	Spiral wound SS	A 312 TP304L	24.25	427	63.27	300S	3/4	5/8	4	915	3.4
				A 358 TP304L CL.1	24.25	427	63.27	300S	1	5/8	4	1281	4.7
					24.25	427	63.27	300S	1-1/2	3/4	4	2192	9.5
					24.25	427	63.27	300S	2	5/8	8	1464	5.4
					24.25	427	63.27	300S	3	3/4	8	2466	10.6
					24.25	427	63.27	300S	4	3/4	8	2740	11.8
					24.25	427	63.27	300S	6	3/4	12	3150	13.6
					24.25	427	63.27	300S	8	7/8	12	4945	24.6
					24.25	427	63.27	300S	10	1	16	5249	29.6
					24.25	427	63.27	300S	12	1-1/8	16	7263	45.5
					24.25	427	63.27	300S	14	1-1/8	20	6933	43.4
					24.25	427	63.27	300S	16	1-1/4	20	8851	60.9
					24.25	427	63.27	300S	18	1-1/4	24	9694	66.7
					24.25	427	63.27	300S	20	1-1/4	24	11379	78.3
					24.25	427	63.27	300S	24	1-1/2	24	14662	119.1
LIST B-6													
B1K	PMS rated Temperature / Pressure		454 / 27.77	Up to 24"	5.97	704	75.93	300S	1/2	1/2	4	798	2.4
	A 182 GR.F304	A193 GR.B7	Spiral wound SS	A 312 TP304	5.97	704	75.93	300S	3/4	5/8	4	1281	4.7
				A 358 TP304 CL.1	5.97	704	75.93	300S	1	5/8	4	1464	5.4
B2K	PMS rated Temperature / Pressure		120 / 40.14	Up to 24"	5.97	704	75.93	300S	1-1/2	3/4	4	2740	11.8
	A 182 GR.F304	A320 GR.B8CL.2	Spiral wound SS	A 312 TP304	5.97	704	75.93	300S	2	5/8	8	2105	7.7
				A 358 TP316L CL.1	5.97	704	75.93	300S	3	3/4	8	3561	15.4
B4K	PMS rated Temperature / Pressure		704 /8.08	Up to 24"	5.97	704	75.93	300S	4	3/4	8	3972	17.2
	A 182 GR.F304H	A453 GR.660CL.A	Spiral wound SS	A 312 TP304H	5.97	704	75.93	300S	6	3/4	12	4109	17.7
					5.97	704	75.93	300S	8	7/8	12	6086	30.3
B5K	PMS rated Temperature / Pressure		704/8.08	Up to 24"	5.97	704	75.93	300S	10	1	16	7499	42.3
	A 182 GR.F304H	A453 GR.660CL.A	Spiral wound SS	A 312 TP304H	5.97	704	75.93	300S	12	1-1/8	16	9574	59.9
					5.97	704	75.93	300S	14	1-1/8	20	8253	51.7
					5.97	704	75.93	300S	16	1-1/4	20	10537	72.5
					5.97	704	75.93	300S	18	1-1/4	24	11379	78.3
					5.97	704	75.93	300S	20	1-1/4	24	12644	87.0

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PMS class data					Calculation Data								
Piping Class	Temperature, pressure, materials and size range				Des Pressure kg/cm²(g)	Des Temp. °C	Test Pressure kg/cm²(g)	Flange Std	Flange size inch	Bolt Dia inch	No. of Bolts	Tension kg	Torque kg-m
	Flange	Bolt	Gasket	Pipe									
					5.97	704	75.93	300S	24	1-1/2	24	15937	129.4
					4.78	704	60.74	300B	26	1-1/4	32	10537	72.5
					4.78	704	60.74	300B	28	1-1/4	36	11801	81.2
					4.78	704	60.74	300B	30	1-3/8	36	12577	94.3
					4.78	704	60.74	300B	32	1-1/2	32	15937	129.4
					4.78	704	60.74	300B	34	1-1/2	36	15937	129.4
					4.78	704	60.74	300B	36	1-5/8	32	19819	173.2
					4.78	704	60.74	300B	38	1-5/8	36	20581	179.9
					4.78	704	60.74	300B	40	1-5/8	40	19819	173.2
					4.78	704	60.74	300B	42	1-3/4	36	25142	235.5
LIST B-7													
B1M	PMS rated Temperature / Pressure		427 / 29.52	Up to 24"	26.66	538	75.95	300S	1/2	1/2	4	570	1.7
	A 182 GR.F316	A193 GR.B7	Spiral wound SS	A 312 TP316	26.66	538	75.95	300S	3/4	5/8	4	1373	5.0
				A 358 TP316 CL.1	26.66	538	75.95	300S	1	5/8	4	1373	5.0
B3M	PMS rated Temperature / Pressure		538 / 25.66	Up to 24"	26.66	538	75.95	300S	1-1/2	3/4	4	2192	9.5
	A 182 GR.F321	A453 GR.660CL.A	Spiral wound SS	A 312 TP321	26.66	538	75.95	300S	2	5/8	8	1556	5.7
				A 358 TP321 CL.1	26.66	538	75.95	300S	3	3/4	8	2603	11.2
B5M	PMS rated Temperature / Pressure		538 / 24.60	Up to 24"	26.66	538	75.95	300S	4	3/4	8	3972	17.2
	A 182 GR.F316H	A453 GR.660CL.A	Spiral wound SS	A 312 TP316H	26.66	538	75.95	300S	6	3/4	12	3972	17.2
					26.66	538	75.95	300S	8	7/8	12	5706	28.4
					26.66	538	75.95	300S	10	1	16	6999	39.5
					26.66	538	75.95	300S	12	1-1/8	16	8253	51.7
					26.66	538	75.95	300S	14	1-1/8	20	7593	47.5
					26.66	538	75.95	300S	16	1-1/4	20	9694	66.7
					26.66	538	75.95	300S	18	1-1/4	24	10537	72.5
					26.66	538	75.95	300S	20	1-1/4	24	12222	84.1
					26.66	538	75.95	300S	24	1-1/2	24	16256	132.0
					20.53	538	60.82	300B	26	1-1/4	32	10537	72.5
					20.53	538	60.82	300B	28	1-1/4	36	10537	72.5
					20.53	538	60.82	300B	30	1-3/8	36	11791	88.4
					20.53	538	60.82	300B	32	1-1/2	32	14981	121.6
					20.53	538	60.82	300B	34	1-1/2	36	14343	116.5
					20.53	538	60.82	300B	36	1-5/8	32	17913	156.6

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Piping Class	PMS class data: Temperature, pressure, materials and size range				Calculation Data								
	Flange	Bolt	Gasket	Pipe	Des Pressure kg/cm²(g)	Des Temp. °C	Test Pressure kg/cm²(g)	Flange Std	Flange size inch	Bolt Dia inch	No. of Bolts	Tension kg	Torque kg-m
					20.53	538	60.82	300B	38	1-5/8	36	19056	166.6
					20.53	538	60.82	300B	40	1-5/8	40	18294	159.9
					20.53	538	60.82	300B	42	1-3/4	36	22897	214.4
LIST B-8													
B1N	PMS rated Temperature / Pressure		454 / 23.90	Up to 24"	23.90	454	63.27	300S	1/2	1/2	4	570	1.7
	A 182 GR.F316L	A193 GR.B7	Spiral wound SS	A 312 TP316L	23.90	454	63.27	300S	3/4	5/8	4	915	3.4
				A 358 TP 316L CL.1	23.90	454	63.27	300S	1	5/8	4	1281	4.7
B6N	PMS rated Temperature / Pressure		427 / 24.25	Up to 24"	23.90	454	63.27	300S	1-1/2	3/4	4	2192	9.5
	A 182 GR.F316L	A193 GR.B7	Spiral wound SS	A 312 TP316L	23.90	454	63.27	300S	2	5/8	8	1464	5.4
				A 358 TP 316L CL.1	23.90	454	63.27	300S	3	3/4	8	2466	10.6
					23.90	454	63.27	300S	4	3/4	8	2740	11.8
					23.90	454	63.27	300S	6	3/4	12	3150	13.6
					23.90	454	63.27	300S	8	7/8	12	4945	24.6
					23.90	454	63.27	300S	10	1	16	5249	29.6
					23.90	454	63.27	300S	12	1-1/8	16	7263	45.5
					23.90	454	63.27	300S	14	1-1/8	20	6933	43.4
					23.90	454	63.27	300S	16	1-1/4	20	8851	60.9
					23.90	454	63.27	300S	18	1-1/4	24	9694	66.7
					23.90	454	63.27	300S	20	1-1/4	24	11379	78.3
					23.90	454	63.27	300S	24	1-1/2	24	14662	119.1
LIST D-1													
D1A	PMS rated Temperature / Pressure		427 / 58.00	Up to 24"	58.00	427	156.08	600S	1/2	1/2	4	970	2.9
	A105	A193 GR.B7	Spiral wound SS	A 106 GR.B	58.00	427	156.08	600S	3/4	5/8	4	1373	5.0
				A 672 GR.B60 CL.12	58.00	427	156.08	600S	1	5/8	4	2013	7.4
D2A	PMS rated Temperature / Pressure		427 / 58.00	Up to 24"	58.00	427	156.08	600S	1-1/2	3/4	4	4520	19.5
	A105	A193 GR.B7	Spiral wound SS	A 106 GR.B	58.00	427	156.08	600S	2	5/8	8	3112	11.4
				A 672 GR.B60 CL.12	58.00	427	156.08	600S	3	3/4	8	5205	22.5
D5A	PMS rated Temperature / Pressure		230 / 86.96	Up to 24"	58.00	427	156.08	600S	4	7/8	8	7228	35.9
	A105	A193 GR.B7	Spiral wound SS	A 106 GR.B	58.00	427	156.08	600S	6	1	12	8998	50.7
				A 672 GR.B60 CL.32	58.00	427	156.08	600S	8	1-1/8	12	12875	80.6
D9A	PMS rated Temperature / Pressure		427 / 58.00	Up to 24"	58.00	427	156.08	600S	10	1-1/4	16	14751	101.5
	A105	A193 GR.B7	Spiral wound SS	A 106 GR.B	58.00	427	156.08	600S	12	1-1/4	20	14751	101.5
				A 672 GR.B60 CL.12	58.00	427	156.08	600S	14	1-3/8	20	17294	129.7

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PMS class data					Calculation Data								
Piping Class	Temperature, pressure, materials and size range				Des Pressure kg/cm²(g)	Des Temp. °C	Test Pressure kg/cm²(g)	Flange Std	Flange size inch	Bolt Dia inch	No. of Bolts	Tension kg	Torque kg-m
	Flange	Bolt	Gasket	Pipe									
D16A	PMS rated Temperature / Pressure		427 / 58.00	Up to 24"	58.00	427	156.08	600S	16	1-1/2	20	21037	170.8
	A105	A193 GR.B7M	Spiral wound SS	A 106 GR.B	58.00	427	156.08	600S	18	1-5/8	20	27441	239.8
				A 672 GR.B60 CL.22	58.00	427	156.08	600S	20	1-5/8	24	26679	233.2
D19A	PMS rated Temperature / Pressure		427 / 58.00	Up to 24"	58.00	427	156.08	600S	24	1-7/8	24	34482	343.7
	A105	A193 GR.B7	Spiral wound SS	A 106 GR.B	46.40	427	124.90	600B	26	1-5/8	28	25917	226.5
				A 672 GR.B60 CL.22	46.40	427	124.90	600B	28	1-3/4	28	28733	269.1
					46.40	427	124.90	600B	30	1-7/8	28	35527	354.2
					46.40	427	124.90	600B	32	2	28	39708	420.7
					46.40	427	124.90	600B	34	2-1/4	24	55895	661.6
					46.40	427	124.90	600B	36	2-1/4	28	49684	588.1
					46.40	427	124.90	600B	38	2-1/4	28	54342	643.2
					46.40	427	124.90	600B	40	2-1/4	32	51237	606.4
					46.40	427	124.90	600B	42	2-1/2	28	66195	865.9
LIST D-2													
D4A	PMS rated Temperature / Pressure		204 / 86.47	Up to 24"	86.47	204	147.05	600S	1/2	1/2	4	970	2.9
	A 350 GR.LF2 CL.1	A320 GR.L7	Spiral wound SS	A 333 GR.6	86.47	204	147.05	600S	3/4	5/8	4	1373	5.0
				A 671 GR.CC60 CL.32	86.47	204	147.05	600S	1	5/8	4	2013	7.4
					86.47	204	147.05	600S	1-1/2	3/4	4	4520	19.5
					86.47	204	147.05	600S	2	5/8	8	3112	11.4
					86.47	204	147.05	600S	3	3/4	8	5205	22.5
					86.47	204	147.05	600S	4	7/8	8	7228	35.9
					86.47	204	147.05	600S	6	1	12	8998	50.7
					86.47	204	147.05	600S	8	1-1/8	12	12875	80.6
					86.47	204	147.05	600S	10	1-1/4	16	14751	101.5
					86.47	204	147.05	600S	12	1-1/4	20	14751	101.5
					86.47	204	147.05	600S	14	1-3/8	20	17294	129.7
					86.47	204	147.05	600S	16	1-1/2	20	21037	170.8
					86.47	204	147.05	600S	18	1-5/8	20	27441	239.8
					86.47	204	147.05	600S	20	1-5/8	24	26679	233.2
					86.47	204	147.05	600S	24	1-7/8	24	34482	343.7

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PMS class data					Calculation Data								
Piping Class	Temperature, pressure, materials and size range				Des Pressure kg/cm²(g)	Des Temp. °C	Test Pressure kg/cm²(g)	Flange Std	Flange size inch	Bolt Dia inch	No. of Bolts	Tension kg	Torque kg-m
	Flange	Bolt	Gasket	Pipe									
LIST D-3													
D1D	PMS rated Temperature / Pressure		538 / 30.23	Up to 24"	30.23	538	158.20	600S	1/2	1/2	4	1084	3.3
	A 182 GR.F11 CL.2	A193 GR.B16	Spiral wound SS	A 335 GR.P11	30.23	538	158.20	600S	3/4	5/8	4	1373	5.0
				A 691 GR.1.25Cr CL.42	30.23	538	158.20	600S	1	5/8	4	2196	8.1
D2D	PMS rated Temperature / Pressure		538 / 30.23	Up to 24"	30.23	538	158.20	600S	1-1/2	3/4	4	4246	18.3
	A 182 GR.F11 CL.2	A193 GR.B16	Spiral wound SS	A 335 GR.P11	30.23	538	158.20	600S	2	5/8	8	3295	12.1
				A 691 GR.1.25Cr CL.42	30.23	538	158.20	600S	3	3/4	8	5342	23.1
D5D	PMS rated Temperature / Pressure		538 / 30.23	Up to 24"	30.23	538	158.20	600S	4	7/8	8	7798	38.8
	A 182 GR.F11 CL.2	A193 GR.B16	Spiral wound SS	A 335 GR.P11	30.23	538	158.20	600S	6	1	12	9498	53.6
				A 691 GR.1.25Cr CL.42	30.23	538	158.20	600S	8	1-1/8	12	13535	84.8
					30.23	538	158.20	600S	10	1-1/4	16	16016	110.2
					30.23	538	158.20	600S	12	1-1/4	20	15594	107.3
					30.23	538	158.20	600S	14	1-3/8	20	18342	137.6
					30.23	538	158.20	600S	16	1-1/2	20	21674	176.0
					30.23	538	158.20	600S	18	1-5/8	20	28966	253.2
					30.23	538	158.20	600S	20	1-5/8	24	28203	246.5
					30.23	538	158.20	600S	24	1-7/8	24	36572	364.6
					24.19	538	126.56	600B	26	1-5/8	28	26679	233.2
					24.19	538	126.56	600B	28	1-3/4	28	30529	285.9
					24.19	538	126.56	600B	30	1-7/8	28	35527	354.2
					24.19	538	126.56	600B	32	2	28	40911	433.4
					24.19	538	126.56	600B	34	2-1/4	24	55895	661.6
					24.19	538	126.56	600B	36	2-1/4	28	49684	588.1
LIST D-4													
D5E	PMS rated Temperature / Pressure		538 / 37.61	Up to 24"	37.61	538	158.20	600S	1/2	1/2	4	1255	3.8
	A182 Gr. F22 Cl. 3	A193 Gr. B16	Spiral wound SS	A335 Gr. P22	37.61	538	158.20	600S	3/4	5/8	4	1556	5.7
				A 691 GR2.25CR CL.42	37.61	538	158.20	600S	1	5/8	4	2471	9.1
					37.61	538	158.20	600S	1-1/2	3/4	4	4657	20.1
					37.61	538	158.20	600S	2	5/8	8	3478	12.8
					37.61	538	158.20	600S	3	3/4	8	5479	23.7
					37.61	538	158.20	600S	4	7/8	8	7798	38.8
					37.61	538	158.20	600S	6	1	12	9748	55.0
					37.61	538	158.20	600S	8	1-1/8	12	13535	84.8

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PMS class data					Calculation Data								
Piping Class	Temperature, pressure, materials and size range				Des Pressure kg/cm²(g)	Des Temp. °C	Test Pressure kg/cm²(g)	Flange Std	Flange size inch	Bolt Dia inch	No. of Bolts	Tension kg	Torque kg-m
	Flange	Bolt	Gasket	Pipe									
					37.61	538	158.20	600S	10	1-1/4	16	16437	113.1
					37.61	538	158.20	600S	12	1-1/4	20	16437	113.1
					37.61	538	158.20	600S	14	1-3/8	20	19914	149.3
					37.61	538	158.20	600S	16	1-1/2	20	22949	186.3
					37.61	538	158.20	600S	18	1-5/8	20	29728	259.8
					37.61	538	158.20	600S	20	1-5/8	24	28966	253.2
					37.61	538	158.20	600S	24	1-7/8	24	38662	385.4
					30.09	538	126.60	600B	26	1-5/8	28	28203	246.5
					30.09	538	126.60	600B	28	1-3/4	28	32325	302.7
					30.09	538	126.60	600B	30	1-7/8	28	37617	375.0
					30.09	538	126.60	600B	32	2	28	43318	458.9
					30.09	538	126.60	600B	34	2-1/4	24	59000	698.3
					30.09	538	126.60	600B	36	2-1/4	28	52789	624.8
LIST D-5													
D1K	PMS rated Temperature / Pressure		454 / 55.54	Up to 24"	55.54	454	114.00	600S	1/2	1/2	4	627	1.9
	A 182 GR.F304	A193 GR.B7	Spiral wound SS	A 312 TP304	55.54	454	114.00	600S	3/4	5/8	4	915	3.4
				A 358 TP304 CL.1	55.54	454	114.00	600S	1	5/8	4	1281	4.7
D2K	PMS rated Temperature / Pressure		120 / 80.12	Up to 24"	55.54	454	114.00	600S	1-1/2	3/4	4	2466	10.6
	A 182 GR.F304	A320 GR.B8CL.2	Spiral wound SS	A 312 TP304	55.54	454	114.00	600S	2	5/8	8	1647	6.0
				A 358 TP304 CL.1	55.54	454	114.00	600S	3	3/4	8	3150	13.6
					55.54	454	114.00	600S	4	7/8	8	5135	25.5
					55.54	454	114.00	600S	6	1	12	6249	35.2
					55.54	454	114.00	600S	8	1-1/8	12	8913	55.8
					55.54	454	114.00	600S	10	1-1/4	16	9272	63.8
					55.54	454	114.00	600S	12	1-1/4	20	10115	69.6
					55.54	454	114.00	600S	14	1-3/8	20	12053	90.4
					55.54	454	114.00	600S	16	1-1/2	20	15299	124.2
					55.54	454	114.00	600S	18	1-5/8	20	19056	166.6
					55.54	454	114.00	600S	20	1-5/8	24	19056	166.6
					55.54	454	114.00	600S	24	1-7/8	24	25078	250.0
					44.44	454	91.20	600B	26	1-5/8	28	18294	159.9
					44.44	454	91.20	600B	28	1-3/4	28	20652	193.4
					44.44	454	91.20	600B	30	1-7/8	28	24033	239.6

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Piping Class	PMS class data: Temperature, pressure, materials and size range				Calculation Data								
	Flange	Bolt	Gasket	Pipe	Des Pressure kg/cm²(g)	Des Temp. °C	Test Pressure kg/cm²(g)	Flange Std	Flange size inch	Bolt Dia inch	No. of Bolts	Tension kg	Torque kg-m
LIST E-1													
E1A	PMS rated Temperature / Pressure		427 / 86.83	Up to 24"	86.83	427	234.12	900S	1/2	3/4	4	2877	11.9
	A105	A193 GR.B7	RTJ - Soft Iron	A 106 GR.B	86.83	427	234.12	900S	3/4	3/4	4	3698	15.3
				A 672 GR.B60 CL. 12	86.83	427	234.12	900S	1	7/8	4	4565	21.7
E2A	PMS rated Temperature / Pressure		427 / 86.83	Up to 24"	86.83	427	234.12	900S	1-1/2	1	4	6999	37.7
	A105	A193 GR.B7	RTJ - Soft Iron	A 106 GR.B	86.83	427	234.12	900S	2	7/8	8	5135	24.4
				A 672 GR.B60 CL. 12	86.83	427	234.12	900S	3	7/8	8	6847	32.6
E5A	PMS rated Temperature / Pressure		230 / 130.63	Up to 24"	86.83	427	234.12	900S	4	1-1/8	8	8583	51.4
	A105	A193 GR.B7	RTJ - Soft Iron	A 106 GR.B	86.83	427	234.12	900S	6	1-1/8	12	10234	61.3
				A 672 GR.B60 CL. 32	86.83	427	234.12	900S	8	1-3/8	12	15197	109.0
E9A	PMS rated Temperature / Pressure		427 / 86.83	Up to 24"	86.83	427	234.12	900S	10	1-3/8	16	16245	116.5
	A105	A193 GR.B7	RTJ - Soft Iron	A 106 GR.B	86.83	427	234.12	900S	12	1-3/8	20	17294	124.1
				A 672 GR.B60 CL. 22	86.83	427	234.12	900S	14	1-1/2	20	21674	168.3
E19A	PMS rated Temperature / Pressure		427 / 86.83	Up to 24"	86.83	427	234.12	900S	16	1-5/8	20	26679	223.0
	A105	A193 GR.B7	RTJ - Soft Iron	A 106 GR.B	86.83	427	234.12	900S	18	1-7/8	20	35527	338.8
				A 672 GR.B60 CL. 22	86.83	427	234.12	900S	20	2	20	40911	414.6
					86.83	427	234.12	900S	24	2-1/2	20	62301	779.5
					69.47	427	187.30	900B	26	2-1/2	20	60354	755.2
					69.47	427	187.30	900B	28	2-3/4	20	66799	915.6
					69.47	427	187.30	900B	30	3	20	77472	1152.8
LIST E-2													
E5E	PMS rated Temperature / Pressure		538 / 56.24	Up to 24"	56.24	538	237.28	900S	1/2	3/4	4	3150	13.0
	A182 Gr. F22 Cl. 3	A193 Gr. B16	RTJ - 5Cr-0.5Mo	A335 Gr. P22	56.24	538	237.28	900S	3/4	3/4	4	3835	15.8
				A 691 GR2.25CR CL.42	56.24	538	237.28	900S	1	7/8	4	5326	25.3
					56.24	538	237.28	900S	1-1/2	1	4	7749	41.8
					56.24	538	237.28	900S	2	7/8	8	5896	28.0
					56.24	538	237.28	900S	3	7/8	8	6467	30.7
					56.24	538	237.28	900S	4	1-1/8	8	9904	59.3
					56.24	538	237.28	900S	6	1-1/8	12	10894	65.3
					56.24	538	237.28	900S	8	1-3/8	12	16245	116.5
					56.24	538	237.28	900S	10	1-3/8	16	16770	120.3
					56.24	538	237.28	900S	12	1-3/8	20	17818	127.8
					56.24	538	237.28	900S	14	1-1/2	20	22949	178.2

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PMS class data					Calculation Data								
Piping Class	Temperature, pressure, materials and size range				Des Pressure kg/cm²(g)	Des Temp. °C	Test Pressure kg/cm²(g)	Flange Std	Flange size inch	Bolt Dia inch	No. of Bolts	Tension kg	Torque kg-m
	Flange	Bolt	Gasket	Pipe									
					56.24	538	237.28	900S	16	1-5/8	20	28203	235.8
					56.24	538	237.28	900S	18	1-7/8	20	36572	348.7
					56.24	538	237.28	900S	20	2	20	44521	451.1
					56.24	538	237.28	900S	24	2-1/2	20	68142	852.6
					56.24	538	189.83	900B	26	2-1/2	20	64248	803.9
					56.24	538	189.83	900B	28	2-3/4	20	73956	1013.8
					56.24	538	189.83	900B	30	3	20	83211	1238.2
LIST F-1													
F1A	PMS rated Temperature / Pressure		427 / 144.83	Up to 24"	144.83	427	390.74	1500S	1/2	3/4	4	3014	12.4
	A105	A193 GR.B7	RTJ - Soft Iron	A 106 GR.B	144.83	427	390.74	1500S	3/4	3/4	4	3972	16.4
				A 672 GR.B60 CL.12	144.83	427	390.74	1500S	1	7/8	4	4945	23.5
F2A	PMS rated Temperature / Pressure		427 / 144.46	Up to 24"	144.83	427	390.74	1500S	1-1/2	1	4	7499	40.4
	A105	A193 GR.B7	RTJ - Soft Iron	A 106 GR.B	144.83	427	390.74	1500S	2	7/8	8	6467	30.7
				A 672 GR.B60 CL.22	144.83	427	390.74	1500S	3	1-1/8	8	12215	73.2
F5A	PMS rated Temperature / Pressure		230 / 217.79	Up to 24"	144.83	427	390.74	1500S	4	1-1/4	8	16016	105.4
	A105	A193 GR.B7	RTJ - Soft Iron	A 106 GR.B	144.83	427	390.74	1500S	6	1-3/8	12	19914	142.8
				A672 Gr. B60 Cl. 22	144.83	427	390.74	1500S	8	1-5/8	12	29728	248.5
F9A	PMS rated Temperature / Pressure		427 / 144.83	Up to 24"	144.83	427	390.74	1500S	10	1-7/8	12	41797	398.5
	A105	A193 GR.B7	RTJ - Soft Iron	A 106 GR.B	144.83	427	390.74	1500S	12	2	16	43318	439.0
				A 672 GR.B60 CL.12	144.83	427	390.74	1500S	14	2-1/4	16	55895	632.8
F19A	PMS rated Temperature / Pressure		427 / 144.83	Up to 24"	144.83	427	390.74	1500S	16	2-1/2	16	70089	877.0
	A105	A193 GR.B7	RTJ - Soft Iron	A 106 GR.B	144.83	427	390.74	1500S	18	2-3/4	16	85884	1177.3
				A672 Gr. B60 Cl. 22	144.83	427	390.74	1500S	20	3	16	103296	1537.0
					144.83	427	390.74	1500S	24	3-1/2	16	142889	2467.4
LIST F-2													
F2D	PMS rated Temperature / Pressure		538 / 75.93	Up to 24"	75.93	538	395.48	1500S	1/2	3/4	4	3972	16.4
	A 182 GR.F11 CL.2	A193 GR.B16	RTJ - 5Cr-0.5Mo	A 335 GR.P11	75.93	538	395.48	1500S	3/4	3/4	4	4931	20.4
				A 691 GR.1.25Cr CL.42	75.93	538	395.48	1500S	1	7/8	4	6277	29.8
					75.93	538	395.48	1500S	1-1/2	1	4	9248	49.9
					75.93	538	395.48	1500S	2	7/8	8	7037	33.5
					75.93	538	395.48	1500S	3	1-1/8	8	13205	79.1
					75.93	538	395.48	1500S	4	1-1/4	8	16858	110.9
					75.93	538	395.48	1500S	6	1-3/8	12	20962	150.4

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PMS class data					Calculation Data								
Piping Class	Temperature, pressure, materials and size range				Des Pressure kg/cm²(g)	Des Temp. °C	Test Pressure kg/cm²(g)	Flange Std	Flange size inch	Bolt Dia inch	No. of Bolts	Tension kg	Torque kg-m
	Flange	Bolt	Gasket	Pipe									
					75.93	538	395.48	1500S	8	1-5/8	12	30490	254.9
					75.93	538	395.48	1500S	10	1-7/8	12	41797	398.5
					75.93	538	395.48	1500S	12	2	16	46927	475.5
					75.93	538	395.48	1500S	14	2-1/4	16	55895	632.8
					75.93	538	395.48	1500S	16	2-1/2	16	72036	901.3
					75.93	538	395.48	1500S	18	2-3/4	16	88270	1210.0
					75.93	538	395.48	1500S	20	3	16	106165	1579.7
					75.93	538	395.48	1500S	24	3-1/2	16	146858	2535.9
LIST F-3													
F2G	PMS rated Temperature / Pressure		538 / 127.95	Up to 24"	127.95	538	395.48	1500S	1/2	3/4	4	3972	16.4
	A182 Gr. F91	A193 GR.B16	RTJ - 9Cr-1Mo	A 335 GR.P91	127.95	538	395.48	1500S	3/4	3/4	4	4931	20.4
				A 691 GR.P91 CL.42	127.95	538	395.48	1500S	1	7/8	4	6277	29.8
					127.95	538	395.48	1500S	1-1/2	1	4	9248	49.9
					127.95	538	395.48	1500S	2	7/8	8	7037	33.5
					127.95	538	395.48	1500S	3	1-1/8	8	13205	79.1
					127.95	538	395.48	1500S	4	1-1/4	8	16858	110.9
					127.95	538	395.48	1500S	6	1-3/8	12	20962	150.4
					127.95	538	395.48	1500S	8	1-5/8	12	30490	254.9
					127.95	538	395.48	1500S	10	1-7/8	12	41797	398.5
					127.95	538	395.48	1500S	12	2	16	46927	475.5
					127.95	538	395.48	1500S	14	2-1/4	16	55895	632.8
					127.95	538	395.48	1500S	16	2-1/2	16	72036	901.3
					127.95	538	395.48	1500S	18	2-3/4	16	88270	1210.0
					127.95	538	395.48	1500S	20	3	16	106165	1579.7
					127.95	538	395.48	1500S	24	3-1/2	16	146858	2535.9
LIST G-1													
G2G	PMS rated Temperature / Pressure		538 / 213.02	Up to 12"	213.02	538	510.00	2500S	1/2	3/4	4	5068	20.9
	A182 Gr. F91	A193 GR.B16	RTJ - 5Cr-0.5Mo	A 335 GR.P91	213.02	538	510.00	2500S	3/4	3/4	4	5479	22.6
				A 691 GR.P91 CL.42	213.02	538	510.00	2500S	1	7/8	4	7228	34.4
					213.02	538	510.00	2500S	1-1/2	1-1/8	4	13535	81.1
					213.02	538	510.00	2500S	2	1	8	9748	52.6
					213.02	538	510.00	2500S	3	1-1/4	8	15594	102.6
					213.02	538	510.00	2500S	4	1-1/2	8	24224	188.1

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PMS class data					Calculation Data								
Piping Class	Temperature, pressure, materials and size range				Des Pressure $kg/cm^2(g)$	Des Temp. °C	Test Pressure $kg/cm^2(g)$	Flange Std	Flange size inch	Bolt Dia inch	No. of Bolts	Tension kg	Torque kg-m
	Flange	Bolt	Gasket	Pipe									
					213.02	538	510.00	2500S	6	2	8	46927	475.5
					213.02	538	510.00	2500S	8	2	12	46927	475.5
					213.02	538	510.00	2500S	10	2-1/2	12	70089	877.0
					213.02	538	510.00	2500S	12	2-3/4	12	95426	1308.1

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HISTORY SHEET FOR FLANGE JOINTS

Annexure - I

Project : _____
Unit : _____
System/Sub System Description : _____
Line No. : _____

Test loop No. : _____
ISO Drawing No.: _____
Connected P & ID No.: _____

Flange Joint No.	Flange Parallelity OK/Not OK		Flange Dia & Rating	Gasket		Studs *				Nuts		Torque Value	Bolt Tension Value	Flange joint Acceptance	
	Upstream	Down Stream		Spec.	OK/ Not OK	Size	Spec	Total Nos.	Accepted/ Nos Accepted	Spec.	Nos Accepted			Contractor	Owner/ EIL

* Special Care to be taken for tapped hole and it is to be certified by Contractor that full engagement of stud is there to the tapped hole. Contractor to carry out 100% verification

Acceptance by Licensor/Owner.

1. Pre-commissioning .....
   (Signature with Name and Date)
2. Commissioning .....
   (Signature with Name and Date)

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Annexure - II

SEQUENCE OF ACTIVITIES INVOLVED FOR REOPENING / MAKING / BLINDING / DEBLINDING / WEDGE OPENING OF FLANGE JOINTS

Sl. No.	Activity	Checked by Contractor (Signature)
1	Compliance of all check points.	
2	Availability and use of recommended tools i.e. Standard tools / Non-sparking tools/Pneumatic of Hydraulic torque wrench with suitable sockets and other accessories / Hydraulic bolt tensioner etc depending upon service pressure temperature rating of the line on which job is to be carried out.	
3	Skilled manpower with protective clothing, safety shoes etc.	
4	Proper access to flange joints for all bolts, proper scaffolding etc if required.	
5	Proper escape route	
6	Readiness of proper type, size & rating of blinds/gaskets/wedges & fasteners etc	
7	Loosening of the flange joints, starting from 6 '0' clock position (vertical joints)	
8	Check for leakage of any hot water / gas / steam / hydrocarbon etc and wait for depressurization of line, if any product leakage is observed.	
9	Complete opening of flange joint with recommended tools	
10	Removal of gasket / blind / wedge etc. and checking of old gaskets for improper loading from marking on gasket surface.	
11	Checking of old fasteners for proper metallurgy, sizing, length etc and ensure replacement of fasteners based on observations during final box up and also ensure that all fasteners to be of same size for uniform loading.	
12	Making gap in flange joints with proper tools (flange spreader etc.) For proper observations of gasket sitting area. Ensure proper cleaning of gasket seating surface with suitable non-sparking tools and inspection of gasket face.	
13	Ensure use of recommended gaskets of proper type and size for blinding / final box up	
14	Placing of fasteners in bottom half of flange joint (vertical joints).	
15	In case of blinding ensure that tail of the blind is vertically upward and blind is of proper size and not interfering with studs movement.	
16	Ensure proper placement of gasket on raised face/ring groove/serrated area.	
17	Ensuring slight tightening of studs in random in bottom half vertical joint(s) for holding of gasket in proper position	
18	Fixing all fasteners in position and tightening of nuts by hand to ensure uniform stud length on both sides.	
19	Tightening of all studs as per tightening sequence by recommended tools.	

ACCEPTANCE BY OWNER / EIL

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फ़ोर्जड, सीमलेस और वेल्डेड फिटिंग के लिए

निरीक्षण व परीक्षण योजना

INSPECTION AND TEST PLAN FOR FORGED, SEAMLESS & WELDED FITTINGS

Rev. No.	Date	Purpose	Prepared by	Checked by	Standards Committee Convener	Standards Bureau Chairman
					Approved by	
9	26.12.2024	REVISED AND RE-ISSUED	AA	CS	RK	MN
8.	01.06.2019	REVISED AND RE-ISSUED	AA	RS	RKS	RKT

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Abbreviations:

CEIL	:	Certification Engineers International Limited	MRT	:	Mechanical Run Test
CIMFR	:	Central Institute of Mining & Fuel Research	NDT	:	Non Destructive Testing
CE	:	Carbon Equivalent	NPSH	:	Net Positive Suction Head
DFT	:	Dry Film Thickness	PO	:	Purchase Order
DPT	:	Dye Penetrant Testing	PESO	:	Petroleum Explosive Safety Organization
DHT	:	De-hydrogen Heat Treatment	PQR	:	Procedure Qualification Record
ERTL	:	Electronics Regional Test Laboratory	PR	:	Purchase Requisition
FCRI	:	Fluid Control Research Institute	PMI	:	Positive Material Identification
HT	:	Heat Treatment	RT	:	Radiography Testing
HIC	:	Hydrogen Induced Cracking	SSCC	:	Sulphide Stress Corrosion Cracking
ITP	:	Inspection and Test Plan	TC	:	Test Certificate
IP	:	Ingress Protection	TPI or TPIA	:	Third Party Inspection Agency
IHT	:	Intermediate Heat Treatment	UT	:	Ultrasonic Testing
IC	:	Inspection Certificate	VDR	:	Vendor Data Requirement
IGC	:	Inter Granular Corrosion	WPS	:	Welding Procedure Specification
MPT/MT	:	Magnetic Particle Testing	WPQ	:	Welders Performance Qualification
MTC	:	Material Test Certificate			

Inspection Standards Committee

Convener: Mr. Rajeev Kumar

Members:

Mr. Suresh G
Mr. Muthuramalingam
Mr. Mahendra Mittal
Mr. Himangshu Pal
Mr. Avdhesh Agrawal
Ms. Sulakshana Hundeikari
Mr. Chandrashekhar
Mr. Anil Kumar

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1.0 SCOPE

This Inspection and Test Plan covers the minimum testing requirements of Forged, Seamless & Welded Fittings.

2.0 REFERENCE DOCUMENTS

PO/PR/Standards referred therein/ Job specifications /Approved documents.

3.0 INSPECTION AND TEST REQUIREMENTS

SL NO.	STAGE/ ACTIVITY	CHARACTERISTICS	QUANTUM OF CHECK	RECORD	SCOPE OF INSPECTION		
					SUB SUPPLIER	SUPPLIER	EIL/TPIA
1.0	**Procedure**						
1.1	Heat Treatment / NDT	Documented Procedures	100%	Procedure Documents	-	H	R
1.2	WPS, PQR, WPQ	Welding Parameters & Welding &	100%	WPS, PQR &WPQ	-	H	W- New R- Existing
1.3	NDE Operator Qualification records & Calibration records of measuring instruments & testing equipment	NDE operator qualification certificates & calibration certificates	100%	NDE & Calibration summery	-	H	R
2.0	**Material Inspection**						

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SL NO.	STAGE/ ACTIVITY	CHARACTERISTICS	QUANTUM OF CHECK	RECORD	SCOPE OF INSPECTION		
					SUB SUPPLIER	SUPPLIER	EIL/TPIA
2.1	Raw Material Identification (Billets, Rounds, Pipes, Coil, Plates, etc.) (*For pipes, coils & plates of Alloy steels and Special services like NACE, H2, HIC, Wet H2S, LTCS, UOP, AXEN etc.)	Chemical and Mechanical Properties, Size & Steel making practice etc.	100%	Mill test certificate, Supplier's Inspection Report	-	H	W* / R
3.0	**In Process Inspection**						
3.1	Forming &Welding	Forming & Welding Parameters	100%	Supplier's records	-	H	-
3.2	Ferrite Check of SS Welds (If Applicable)	% Ferrite Check	100%	Inspection Report	-	H	R
3.3	Heat Treatment	Stress Reliving, Normalizing, Tempering, Solution Annealing, Stabilization Heat Treatment etc. as applicable	100%	HT chart / Report	-	H	R
3.4	NDT-RT As Applicable	Surface & Internal Imperfections	As per PR/Purchase Specification	RT Films & Reports	-	H	R (Films Review)

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SL NO.	STAGE/ ACTIVITY	CHARACTERISTICS	QUANTUM OF CHECK	RECORD	SCOPE OF INSPECTION		
					SUB SUPPLIER	SUPPLIER	EIL/TPIA
3.5	NDT – UT (as applicable)	Surface & Internal Imperfections	As per PR/Purchase Specification	UT Report	-	H	R
3.6	NDT – DPT/MPT on Bevel Ends (as applicable)	Surface & Internal Imperfections	100%	Test Report	-	H	RW
3.7	Identification of Test Samples	Product Chemical, Mechanical, Impact, IGC and another test as applicable	Per heat, per heat treatment lot (Note-4)	Test Reports	-	H	H
3.8	Product Analysis	Chemical Composition	As per PR/Purchase Specification	Test Reports	-	H	R
3.9	Destructive Testing	Mechanical, Impact, IGC, Hardness and Other test as applicable	100%	Test Reports	-	H	H
3.10	Galvanizing (If Applicable)	Integrity Of Galvanized Coating	100%	Inspection Report	-	H	R
4.0	**Final Inspection**						
4.1	Visual and Dimension	Size, Thickness / Schedule, Dimensions, Surface quality, Marking, etc.	100%	Inspection Report	-	H	RW

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SL NO.	STAGE/ ACTIVITY	CHARACTERISTICS	QUANTUM OF CHECK	RECORD	SCOPE OF INSPECTION		
					SUB SUPPLIER	SUPPLIER	EIL/TPIA
4.2	Hardness testing on finished fittings of Alloy steels and Special services (like NACE, H2, HIC, Wet H2S, UOP, AXEN etc.) & any other services as applicable.	Hardness value of Base metal & Welds/HAZ.	Random 10%	Test Report	-	H	RW
4.3	PMI Check	Chemical Check	As Per EIL Spec. 6-81-0001	Inspection report	-	H	RW
4.4	Final Stamping	Stamping Of Accepted Fittings	Stamping of Fittings which are witnessed by EIL/TPIA.	Inspection Report	-	H	H
5.0	**Painting**						
5.1	Rust Preventive Coating & Color Coding	Visual & Color Coding as applicable	100%	Inspection Report	-	W	-
6.0	**Documentation & IC**						
6.1	Documentation & Inspection Certificate (IC)	Review of Stage Inspection Reports / Test Reports & Issue of IC	100%	Supplier TC & IC	-	H	H

Legend: H- Hold (Do not proceed without approval), P-Perform, RW - Random Witness (As specified or 10% (min.1 no. of each size and type of Bulk item)), R-Review, W-Witness (Give due notice, work may proceed after scheduled date).

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NOTES (As applicable):

1. This document describes the generic test requirements. Any additional test or Inspection scope if specified in contract documents shall also be applicable (unless otherwise agreed upon).
2. Acceptance Norms for all the activities shall be as per PO/PR/STANDARDS referred there in /Job Specification /Approved Documents.
3. For orders placed on stockiest, items shall be accepted based on manufacturer's TC with EN10204 type 3.2 certification from EIL approved suppliers.
4. Test piece marking shall be carried out from the product for each heat of raw material and for each heat treatment batch at shop floor.

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पाइपिंग सामग्री के रंग कोड हेतु मानक विनिर्देशन

STANDARD SPECIFICATION FOR COLOUR CODING OF PIPING MATERIAL

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	
4	24/07/2024	Revised and Updated	DK	SBB	RKS	MN
3	10/07/2019	Revised and Updated	SKG	AP	AKK	RKT
2	25/06/2014	Revised and updated	SM	DJ	RKD	SC
1	10/07/2009	Revised and updated	SM	SM	RKD	ND
0	30/05/2003	Issued as Standard Specification	RKN	MPJ	RSG	SKG

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Abbreviations:

API	:	American Petroleum Institute
ASTM	:	American Society for Testing & Materials
BIS	:	Bureau of Indian Standards
EIL	:	Engineers India Limited
IBR	:	Indian Boiler Regulatory
IS	:	Indian Standard

Construction Standards Committee

Convenor: Sh. R K Singh, ED (Construction)

Members:
Sh. D S N Murthy, GGM (Projects)
Sh. Chinmoy Kapuria, CGM (SCM)
Sh. Udayan Chakravarty, CGM (Piping)
Sh. S.B. Burman, Sr.GM (Construction)
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Sh. Pankaj Kumar Rai, DGM (Construction)
Sh. Dhananjay, AGM (Construction)

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1.0 SCOPE

This standard covers the method of identification of the piping materials by coloring using paints in order to avoid mix-up between materials of different metallurgy but similar in physical appearance.

2.0 REFERENCES

The following Code shall be referred to as and when required for resolution of colour shades.

IS: 5-2007: Colours for ready Mixed Paints and Enamels

RAL K5 Classic Edition

3.0 GENERAL GUIDELINES FOR IDENTIFICATION BY COLOUR CODING

i. Materials shall be painted with one colour or combination of colours as set out in this specification.

ii. Paints used for colour coding shall be of quality so as to last for at least 5 years.

iii. Studs/Bolts and Nuts shall be painted.

iv. Colour Identification is not required on Austenitic Steel.

v. Colour identification is not required on galvanized-materials and non-ferrous metals such as copper, lead, aluminum because they are easily distinguished by their specific color and character.

vi. Special items like bellows, strainer, steam traps, valves do not require colour identification as these items are tagged with their identification.

vii. Specified colour shall be marked on the inner and outer surface of pipes & fittings.

viii. Job specific colour coding covered under MR/PR for Piping items shall be referred for any additional requirements.

4.0 IDENTIFICATION COLOURS

i. Paint colours to be used for identification shall be in accordance with Table-1.

ii. Application of various colours for identification shall be as per clause 5.0 of this standard.

5.0 METHOD OF COLOUR CODING

i. Colours and locations of colour identification on pipes, fittings, flanges, gaskets, studs/bolts, nuts shall be in accordance with Table-2 to 4 and Annexure-1.

ii. The identification colour on gaskets shall be painted on the peripheral face of each gasket (refer Annexure-1).

iii. Ends of the materials to be welded shall not be painted.

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iv. Width of colour band shall be a minimum of 12 mm for less than 3-inch size components and 25mm for 3 inch and larger sizes, unless otherwise specified.

The length of inner surface painting

- Shall be not less than 4 inch (100 mm) at both ends of pipes and shall start 2 inch (50mm) from pipe ends.
- Shall be about 2 inch (50 mm) at any one end of fittings.

v. Wherever combination of two or more colours is specified, materials shall be painted in parallel colour bands as close to each other as possible (Refer Annexure-1).

vi. Paints containing chlorine, chlorides, sulphur, lead, zinc or any contents detrimental to materials are not acceptable. The contractor shall satisfy and produce documents/carry out tests as required by the owner/EIL.

vii. EIL approval shall be obtained for paint materials which are not covered by this specification.

6.0 TABLE: THE FOLLOWING TABLES SHALL FORM AN INTEGRAL PART OF THIS SPECIFICATION

Table No.	*Tittle*
1.	Basic colour of identification
2.	Colour identification on pipes, fitting and flanges
3.	Colour identification on Bolts/Nuts/studs
4.	Colour identification on Gaskets
Annexure-1	Schematic representation of colour identification

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TABLE – 1

BASIC COLOURS FOR IDENTIFICATION (REF. IS: 5 (2007) APPROXIMATE MUNSELL VALUE REFERENCE)

Name of Colour shade	Sl.No.	Indian standard colour (ISC) No.	'Munsell' Value		Equivalent RAL Codes (*)	
			Hue	Value/Chroma	NAME	RAL Code
Dove gray	100	694	2.3 G	5.53/0.48	Mouse Grey	RAL7005
Salmon Pink	68	443	2.5 YR	6.31/4.7	Beige Red	RAL3012
India Brown	65	415	2.7 YR	3.76/3.02	Mahogany brown	RAL 8016
Canary yellow	39	309	4.8 Y	7.89/11.02	Zinc Yellow	RAL1018
Deep orange	87	591	8.9 R	5.04/10.38	Red Orange	RAL2001
Lincoln Green	27	276	0.3 G	3.53/2.81	Fir Green	RAL6009
Sea Green	14	217	6.2 GY	6.12/6.15	Yellow Green	RAL6018
Sky Blue	1	101	8.3G	6.09/2.86	Water Blue	RAL5021
Navy Blue	6	106	6.2 PB	2.61/0.95	Cobalt Blue	RAL5013
Light Purple Brown	73	449	3.2 R	3.07/2.14	Pale brown	RAL8025
Dark Violet	104	796	6.1 P	3.5/4.27	Traffic purple	RAL4006
Chocolate	74	451	3.5 YR	2.82/0.67	Chocolate Brown	RAL8017
Maroon	83	541	1.3 R	2.9/1.36	Wine Red	RAL3005
Post Office Red	81	538	4.2 R	3.55/8.39	Carmine Red	RAL3002

NOTE: ** The Colours are based on RAL K5 Classic Edition by RAL, Deutsches institut, incorporated for international jobs.*

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TABLE – 2

COLOUR CODES FOR PIPES, FITTINGS & FORGINGS

Sl. No.	Pipe	Elbows, Reducers, Tee's Caps	Flange/Blind Flange	Sl. No. (As per Table-1)	Colour No. (As per Table-1)	Colour
1		A-234 Gr WPB/WPBW-IBR	A-105 A-182	---	---	----
2		A-234 Gr WPB/WPBW-NON IBR		---	---	None
3		A-234 Gr WPBW-NON IBR &NORMALISED				None
4	API 5L Gr B – Seamless	---	---	---	---	None
5	API 5L Gr B – EFSW	---	---	---	---	None
6	API 5L Gr B – ERW	---	---	6/65	106/415	Navy Blue & India Brown
7	A 106 Gr B	---	---	87	591	Deep Orange
8	A 106 Gr B (Normalized)	A-234 Gr WPB(N)	---	87/14	591/217	Deep Orange & Sea Green
		A-234 WPBW (N)		87/14	591/217	Deep Orange & Sea Green
9	IS 1239/IS 3589 Gr 410			100	694	Dove Grey
10	IS 3589 Gr 330			100/6	694/106	Dove Grey & Navy Blue
11	A 333 Gr 6 (LTCS)	A-420 WPL 6		83	541	Maroon
		A-420 WPL 6W		83	541	Maroon
12	A 335 Gr P1	A-234 WP1	A 182 F1	65	443	Salmon Pink
		A-234 WP1W		65	443	Salmon Pink
13	Stainless steel					No Paint

NOTE i) For Hydrogen service, white colour band shall be applied in addition to above

ii) For IBR material, Post Office red shall be applied in addition to above.

iii) Equivalent RAL Codes shall be used for international jobs for above colour codes as per Table -1

iv) For NACE Service, Canary Yellow shall be applied in addition to above.

v) For CRYO Service, Light Purple brown shall be applied in addition to above.

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TABLE - 2
COLOUR CODES FOR PIPES, FITTINGS & FORGINGS (.... Contd.)

Sl. No.	Pipe	Elbows, Reducers, Tee's Caps	Flange/Blind Flange	Sl. No.	Colour No.	Colour
14	A 335 Gr P11	A-234 WP11	A 182 F11	27	276	Lincoln Green
	A 691 Gr 1.25 Cr CL.42 (EFW)	A-234 WP11W		27	276	Lincoln Green
15	A 335 Gr P12	A-234 WP12	A 182 F12	1	101	Sky Blue
		A-234 WP12W	---	1	101	Sky Blue
16	A 335 Gr P22	A-234 WP22	A 182 F22	14	217	Sea Green
	A 691 Gr 2.25 Cr CL.42 (EFW)	A 234 WP22W	---	14	217	Sea Green
17	A 335 Gr P5	A-234 WP5	A 182 F5	6	106	Navy Blue
		A-234 WP5W	---	6	106	Navy Blue
18	A 335 Gr P9	A-234 WP9	A 182 F9	104	796	Dark Violet
		A-234 WP9W	---	104	796	Dark Violet
19	A335Gr P91	A-234 WP91	A182F91	74	451	Chocolate
		A-234 WP91W	---	74	451	Chocolate

NOTE: i) For schematic representation, Refer Annexure-1
ii) Equivalent RAL Codes shall be used for international jobs for above colour codes as per Table -1

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TABLE - 3

COLOUR CODE - STUDS/BOLTS AND NUTS

	ASTM DESIGNATION	SL.NO.	INDIAN STD. COLOUR (ISC) NO.	COLOUR SHADES
Bolt	A 193 GR B 7	39	309	Canary Yellow
Nut	A 194 GR 2 H	39	309	Canary Yellow
Bolt	A 307 GR B	65	415	India Brown
Nut	A 307 GR B	65	415	India Brown
Bolt	A 193 GR B 16	27	276	Lincoln Green
Nut	A 194 GR 4	27	276	Lincoln Green
Bolt	A 320 GR L 7	74	451	Chocolate
Bolt	A 320 GR B 8	73	449	Light Purple Brown
Nut	A 194 GR 8	73	449	Light Purple Brown

NOTE: i) For schematic representation, Refer Annexure-1
ii) Equivalent RAL Codes shall be used for international jobs for above colour codes as per Table -1

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TABLE - 4
COLOUR CODE FOR GASKETS

TYPE	PART	ASTM DESIGNATION/DESCRIPTION	SL.NO.	INDIAN STD. COLOUR (ISC) NO.	COLOUR SHADES
Compressed Fibre (Ring & Full Face)	Gasket	BS7531 GR.X (FULL FACE)	100	694	Dove Gray
		BS7531 GR.X (RING)	---	---	None
Spiral Wound	Gasket	SS 304 H + Grafoil Filler	68	443	Salmon Pink
		SS 304 + Grafoil Filler	73	449	Light Purple Brown
		SS 304 + Teflon Filler	65	415	India Brown
		SS 304 L SPR WND + Grafoil Filler	83	541	Maroon
		SS 316 SPRWND + Grafoil Filler	87	591	Deep Orange
		SS 316 L SPR. WND + Grafoil Filler	27	276	Lincoln Green
		SS 316 H SPR. WND + Grafoil Filler	39	309	Canary Yellow
		Teflon Jacketed SPR. WND	104	796	Dark Violet
		SS321 Spr WND + Grafoil filler	14	217	Sea Green
		SS347 Spr WND + Grafoil FIller		101	Sky Blue
OCT. Ring Gasket	Gasket	5 Cr,1/2 Mo (Max. 120 BHN)	27	276	Lincoln Green
		Soft Iron (Max. 90 BHN)	100	694	Dove Gray

NOTE: i) For schematic representation, Refer Annexure-1

ii) Equivalent RAL Codes shall be used for international jobs for above colour codes as per Table -1

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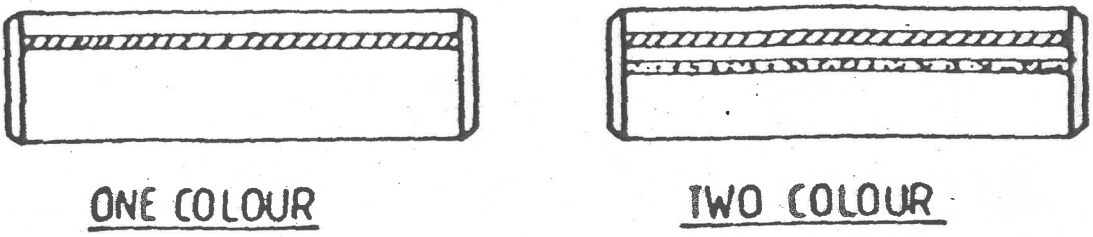
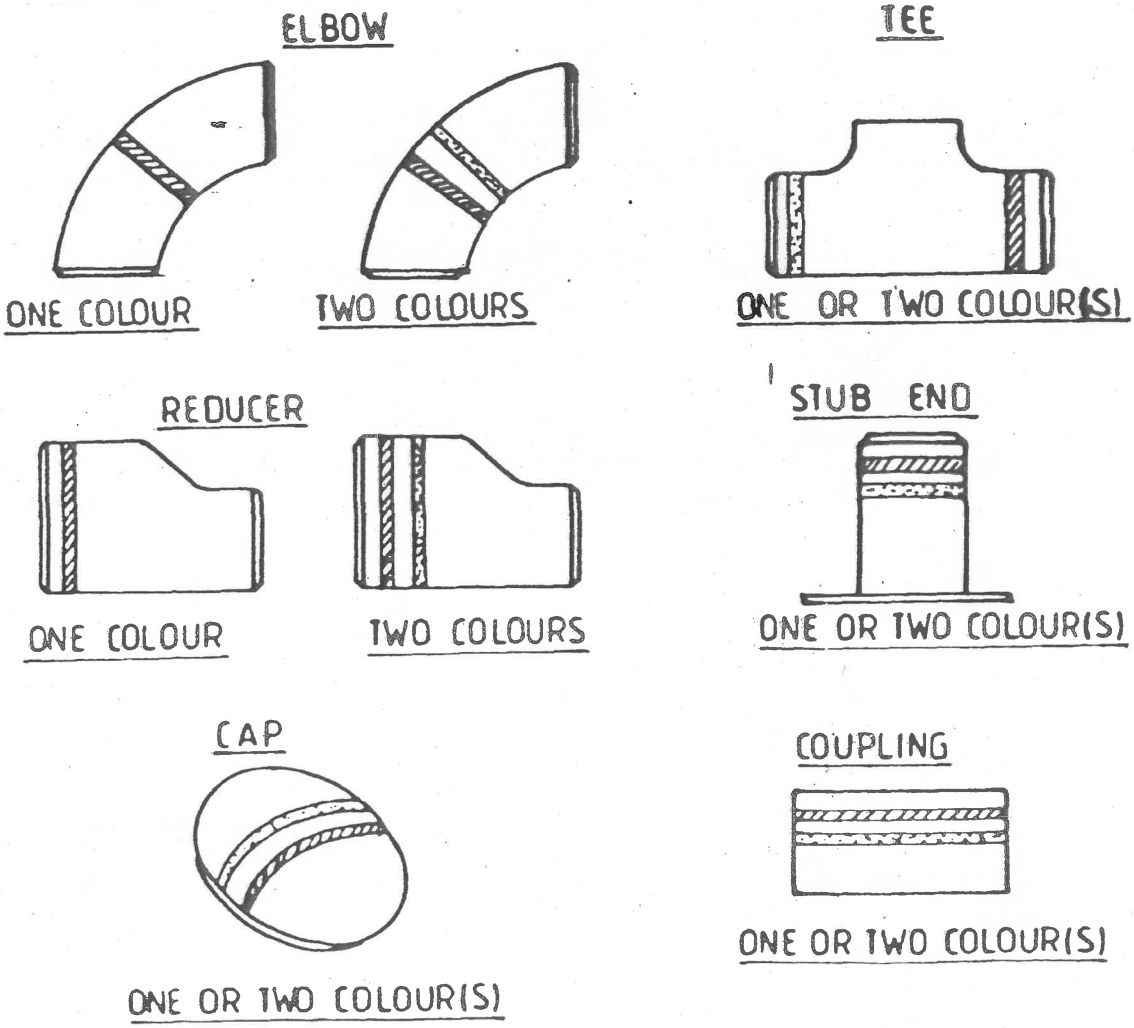
ANNEXURE-1

SCHEMATIC REPRESENTATION OF COLOUR IDENTIFICATION

A. COLOUR IDENTIFICATION OF PIPES



B. COLOUR IDENTIFICATION OF FITTINGS



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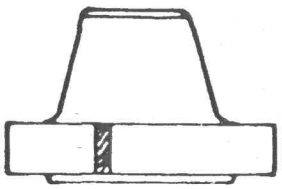
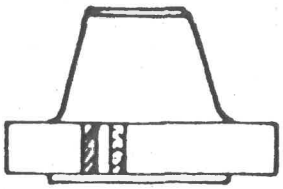
SCHEMATIC REPRESENTATION OF COLOUR IDENTIFICATION (Contd...)

C. COLOUR IDENTIFICATION OF FLANGES

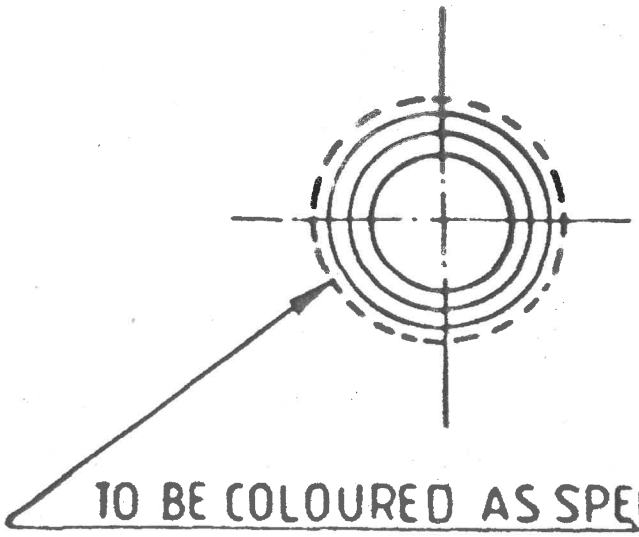


ONE COLOUR

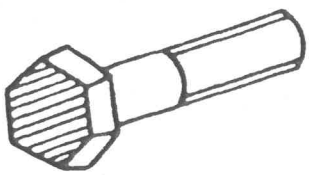


TWO COLOURS

D. COLOUR IDENTIFICATION OF GASKET

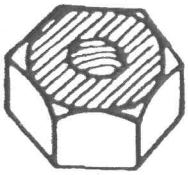


E. COLOUR IDENTIFICATION OF STUDS/BOLTS & NUTS



MACHINE BOLT

STUD BOLT



NUT

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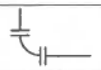
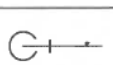
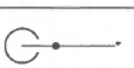
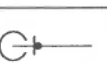
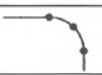
DESCRIPTION	FLANGED	SCREWED	WELDED (NOTE–1)	SOCKET WELD
90° ELBOW				
ELBOW (TURNED UP)				
ELBOW (TURNED DOWN)				
MITERED BEND 90°				
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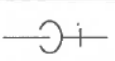
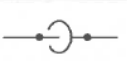
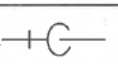
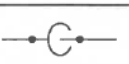
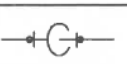
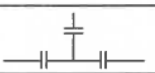
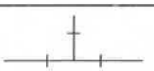
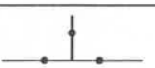
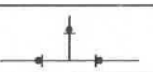
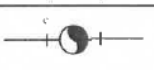
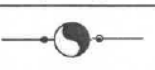
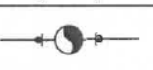
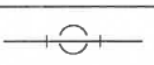
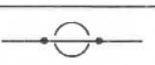
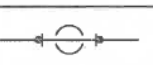
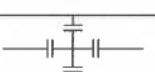
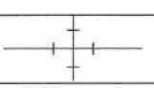
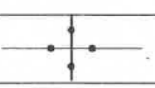
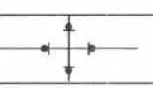
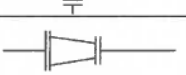
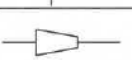
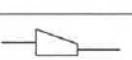
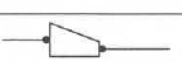
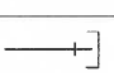
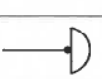
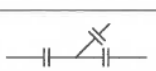
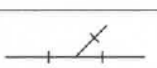
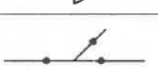
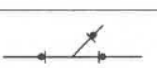
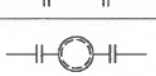
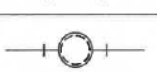
45° ELBOW				
45° ELBOW (TURNED UP)				
45° ELBOW (TURNED DOWN)				
TEE EQUAL/UNEQUAL				
TEE (OUTLET UP)				
TEE (OUTLET DOWN)				
CROSS				
CONCENTRIC REDUCER				
ECCENTRIC REDUCER				
DEAD END				
LATERAL				
SIGHT GLASS				
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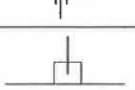
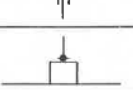
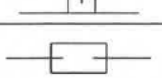
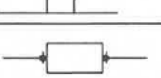
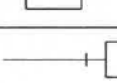
HALF COUPLING				
FULL COUPLING				
HOSE COUPLING				

Rev. No.	Date	Purpose	Prepared by	Checked by	Stds. Committee Convenor	Stds. Bureau Chairman
6	31.12.24	REAFFIRMED & ISSUED AS STANDARD	PK	SH	SB	MN
5	06.12.19	REAFFIRMED & ISSUED AS STANDARD	SG	SH	MI	RKT

Approved by

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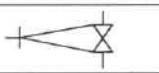
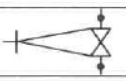
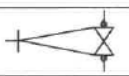
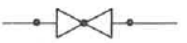
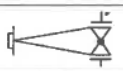
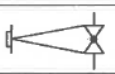
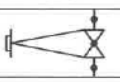
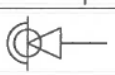
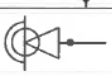
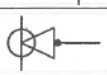
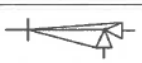
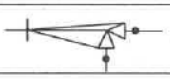
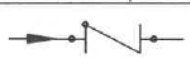
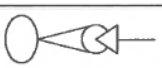
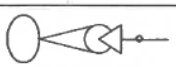
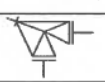
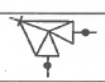
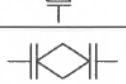
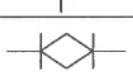
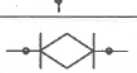
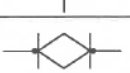
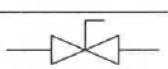
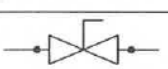
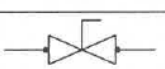
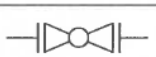
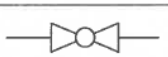
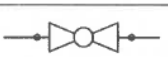
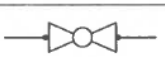
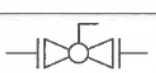
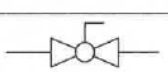
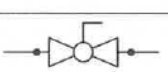
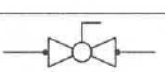
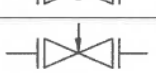
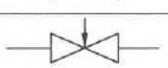
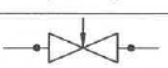
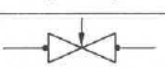
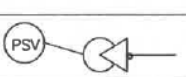
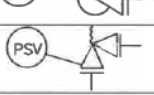
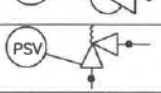
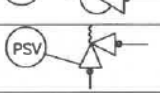
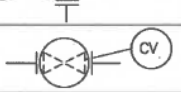
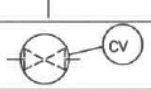
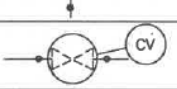
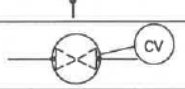
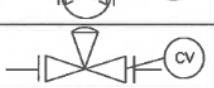
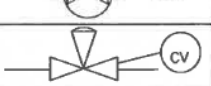
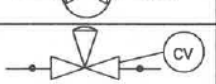
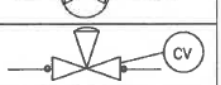
DESCRIPTION	FLANGED	SCREWED	WELDED (NOTE)	SOCKET WELD
GATE VALVE (PLAN)				
GATE VALVE (ELEVATION)				
GLOBE VALVE (PLAN)				
GLOBE VALVE (ELEVATION)				
ANGLE VALVE (PLAN)				
ANGLE VALVE (ELEVATION)				
CHECK VALVE (PLAN OR ELEVATION)				
ANGLE STOP CHECK VALVE (PLAN)				
ANGLE STOP CHECK VALVE (ELEVATION)				
PLUG VALVE (PLAN)				
PLUG VALVE (ELEVATION)				
BALL VALVE (PLAN)				
BALL VALVE (ELEVATION)				
NEEDLE VALVE (PLAN OR ELEVATION)				
RELIEF VALVE (PLAN)				
RELIEF VALVE (ELEVATION)				
CONTROL VALVE GLOBE TYPE (PLAN)				
CONTROL VALVE GLOBE TYPE (ELEV)				
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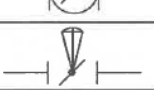
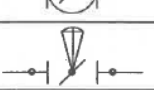
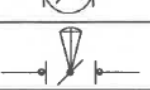
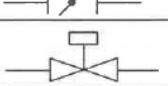
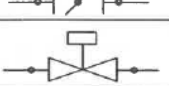
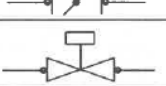
CONTROL VALVE BUTTERFLY TYPE(ELEV)				
SOLENOID OPERATED VALVE (PLAN OR ELEV)				
BUTTERFLY VALVE (PLAN OR ELEVATION)				

Rev. No.	Date	Purpose	Prepared by	Checked by	Stds. Committee Convenor	Stds. Bureau Chairman
6	31.12.24	REAFFIRMED & ISSUED AS STANDARD	PK	SH		MN
5	06.12.19	REAFFIRMED & ISSUED AS STANDARD	SG	SH	MI	RKT

Approved by

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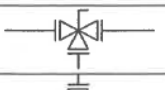
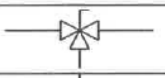
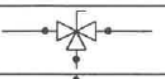
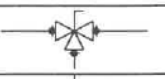
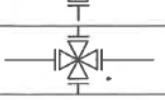
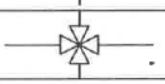
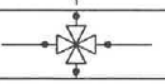
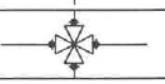
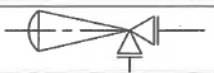
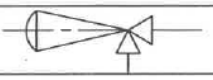
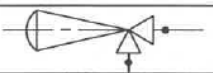
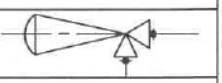
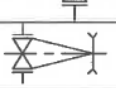
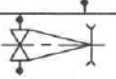
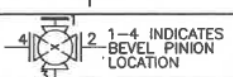
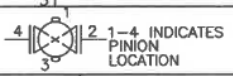
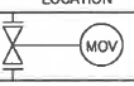
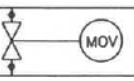
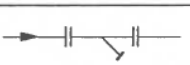
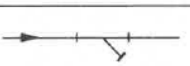
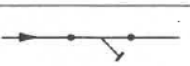
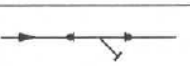
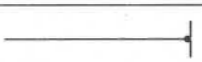
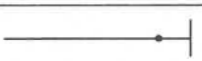
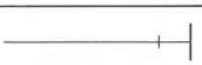
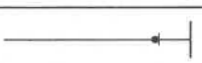
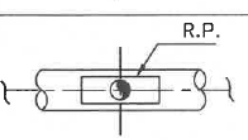
DESCRIPTION	FLANGED	SCREWED	WELDED (NOTE–1)	SOCKET WELD
DIAPHRAGM VALVE (PLAN OR ELEVATION)				
3–WAY PLUG VALVE (PLAN OR ELEVATION)				
4–WAY PLUG VALVE (PLAN OR ELEVATION)				
EXPANSION JOINT				
ANGLE CONTROL VALVE				
CHAIN OPERATING VALVE (TYP)				
GEAR OPERATED VALVE (BEVEL GEAR) PLAN				
GEAR OPERATED VALVE (SPUR GEAR) PLAN				
MOTOR OPERATING VALVE				
STEAM TRAP				
Y–STRAINER				

DESCRIPTION	SYMBOL	DESCRIPTION	SYMBOL
SLIP–ON FLANGE		STUB – IN (WITH OR WITHOUT REINF)	
WELDNECK FLANGE			
SCREWED FLANGE		STUB – IN (SADDLE REINF)	
SOCKET WELD FLANGE			
SPACER		STUB – IN WITH REINF (IN PLAN)	
SPACER BLIND			
SPECTACLE FIG. 8 (BLIND)		INSULATED (LINES 12" AND BELOW)	
SPECTACLE FIG. 8 (OPEN)			

Rev. No.	Date	Purpose	Prepared by	Checked by	Stds. Committee Convenor	Stds. Bureau Chairman
6	31.12.24	REAFFIRMED & ISSUED AS STANDARD	PK	SH	SB	MN
5	06.12.19	REAFFIRMED & ISSUED AS STANDARD	SG	SH	MI	RKT

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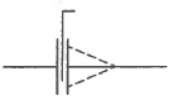
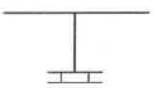
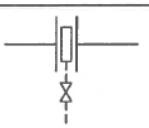
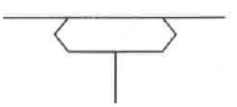
DESCRIPTION	SYMBOL	DESCRIPTION	SYMBOL
CONICAL STRAINER		INSULATED (LINES 14" & ABOVE)	
T–TYPE STRAINER	 T–STRAINER	STEAM TRACED	
DRIP–RING		WELDOLET	

NOTES :

1. WELD DOTS NOT TO BE SHOWN ON PIPING G.A.Ds.
2. FOR SYMBOLS/LEGENDS RELATED TO CIVIL ENGINEERING/UNDERGROUND PIPING WORK, REFER CIVIL ENGINEERING STANDARD 7–65–0001.

Rev. No.	Date	Purpose	Prepared by	Checked by	Stds. Committee Convenor	Stds. Bureau Chairman
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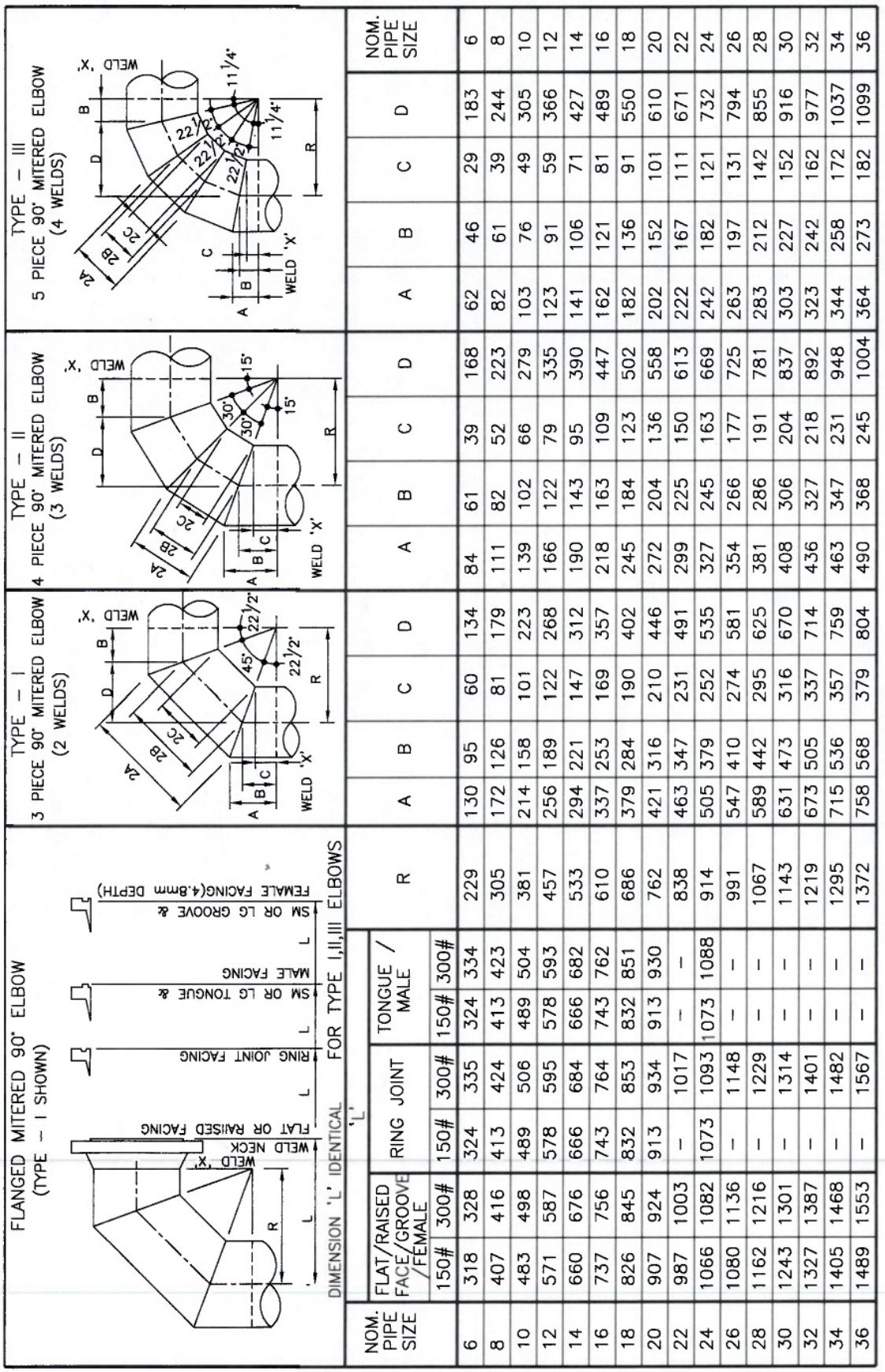
DETAILS OF MITERED ELBOW



NOM. PIPE SIZE	FLAT/RAISED FACE/GROOVE /FEMALE		RING JOINT		TONGUE / MALE		R	TYPE – I				TYPE – II				TYPE – III				NOM. PIPE SIZE
	150#	300#	150#	300#	150#	300#		A	B	C	D	A	B	C	D	A	B	C	D	
6	318	328	324	335	324	334	229	130	95	60	134	84	61	39	168	62	46	29	183	6
8	407	416	413	424	413	423	305	172	126	81	179	111	82	52	223	82	61	39	244	8
10	483	498	489	506	489	504	381	214	158	101	223	139	102	66	279	103	76	49	305	10
12	571	587	578	595	578	593	457	256	189	122	268	166	122	79	335	123	91	59	366	12
14	660	676	666	684	666	682	533	294	221	147	312	190	143	95	390	141	106	71	427	14
16	737	756	743	764	743	762	610	337	253	169	357	218	163	109	447	162	121	81	489	16
18	826	845	832	853	832	851	686	379	284	190	402	245	184	123	502	182	136	91	550	18
20	907	924	913	934	913	930	762	421	316	210	446	272	204	136	558	202	152	101	610	20
22	987	1003	–	1017	–	–	838	463	347	231	491	299	225	150	613	222	167	111	671	22
24	1066	1082	1073	1093	1073	1088	914	505	379	252	535	327	245	163	669	242	182	121	732	24
26	1080	1136	–	1148	–	–	991	547	410	274	581	354	266	177	725	263	197	131	794	26
28	1162	1216	–	1229	–	–	1067	589	442	295	625	381	286	191	781	283	212	142	855	28
30	1243	1301	–	1314	–	–	1143	631	473	316	670	408	306	204	837	303	227	152	916	30
32	1327	1387	–	1401	–	–	1219	673	505	337	714	436	327	218	892	323	242	162	977	32
34	1405	1468	–	1482	–	–	1295	715	536	357	759	463	347	231	948	344	258	172	1037	34
36	1489	1553	–	1567	–	–	1372	758	568	379	804	490	368	245	1004	364	273	182	1099	36

NOTES:–

1. MITERED ELBOWS WITH LESS THAN 90° DEFLECTION MAY BE ADOPTED FROM THE DETAILS SHOWN. A TWO PIECE (ONE WELD) 45° MITERED ELBOW SHOULD BE SIMILAR TO TYPE – I. A THREE PIECE (TWO WELDS) 45° MITERED ELBOW WOULD BE SIMILER TO TYPE – III IN ANY CASE. THE TABULATED DIMENSIONS FOR 'A','B','C', & 'R' SHOULD BE MAINTAINED.
2. ALL DIMENSIONS ARE IN mm CALCULATED AND ROUNDED OFF TO THE NEAREST 1 mm
3. DIMENSION 'L' COMBINES ELBOW DIMENSION 'R' WITH LENGTH OF WELD NECK FLANGES ESTABLISHED AS PER ASME B16.5 FOR SIZES UP TO NPS 24 AND AS PER ASME B16.47B FOR SIZES NPS 26 AND ABOVE.
4. WELD 'X' SHALL BE OMITTED EXCEPT WHEN FITTING OR FLANGE ARE USED WITH THE MITERED ELBOW OR IF THE JOINT MUST BE FIELD WELDED.
5. WHEN WELD 'X' IS A FIELD WELDED JOINT, THE END OF THE MITERED ELBOW SHALL BE BEVELED BY SHOP.
6. NUMBER OF PIECES OF MITRES (N) SHALL BE AS PER PIPING MATERIAL SPECIFICATION (PMS). DIMENSIONS FOR MITRE FABRICATION SHALL BE AS FOLLOWS : B=R×TAN[45/(N–1)]; A=(R+r)×TAN[45/(N–1)]; C=(R–r)×TAN[45/(N–1)]; WHERE r=RADIUS OF PIPE AND ANGLE IS IN DEGREES.

Rev. No.	Date	Purpose	Prepared by	Checked by	Stds. Committee Convenor	Stds. Bureau Chairman
					Approved by	
7	09.10.25	REVISED & ISSUED AS STANDARD	SRG	PK	SH	MN
6	23.09.20	REVISED & ISSUED AS STANDARD	SG	SH	GB	SM

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FOR FIGURES

REF. EIL STANDARD NO. 7-44-0033 (SHT. 1 OF 2)

NOM. PIPE SIZE	'L' FOR FF OR RF		'R' FOR ALL TYPES	TYPE-I				TYPE-II				TYPE-III				NOM. PIPE SIZE
	150#	300#		A	B	C	D	A	B	C	D	A	B	C	D	
38	1572	1640	1448	800	600	400	848	517	388	259	1060	384	288	192	1160	38
40	1653	1722	1524	842	631	421	893	544	408	273	1116	404	303	202	1221	40
42	1733	1805	1600	884	663	442	937	572	429	286	1171	424	318	213	1282	42
44	1813	1890	1676	926	694	463	982	599	449	299	1227	445	333	222	1343	44
46	1898	1975	1753	968	726	484	1027	626	470	313	1283	465	349	233	1404	46
48	1978	2053	1829	1010	758	505	1071	653	490	327	1339	485	363	243	1465	48
50	2059	2140	1905	1052	789	526	1116	681	510	340	1395	505	379	253	1526	50
52	2138	2224	1981	1094	821	547	1160	708	531	354	1450	525	394	263	1587	52
54	2219	2297	2057	1136	852	568	1205	735	551	367	1506	546	409	273	1648	54
56	2301	2402	2134	1178	884	589	1250	762	572	381	1562	566	424	283	1710	56
58	2385	2485	2210	1220	915	610	1295	790	592	395	1618	586	440	293	1770	58
60	2465	2558	2286	1263	947	631	1339	817	613	408	1673	606	455	303	1831	60

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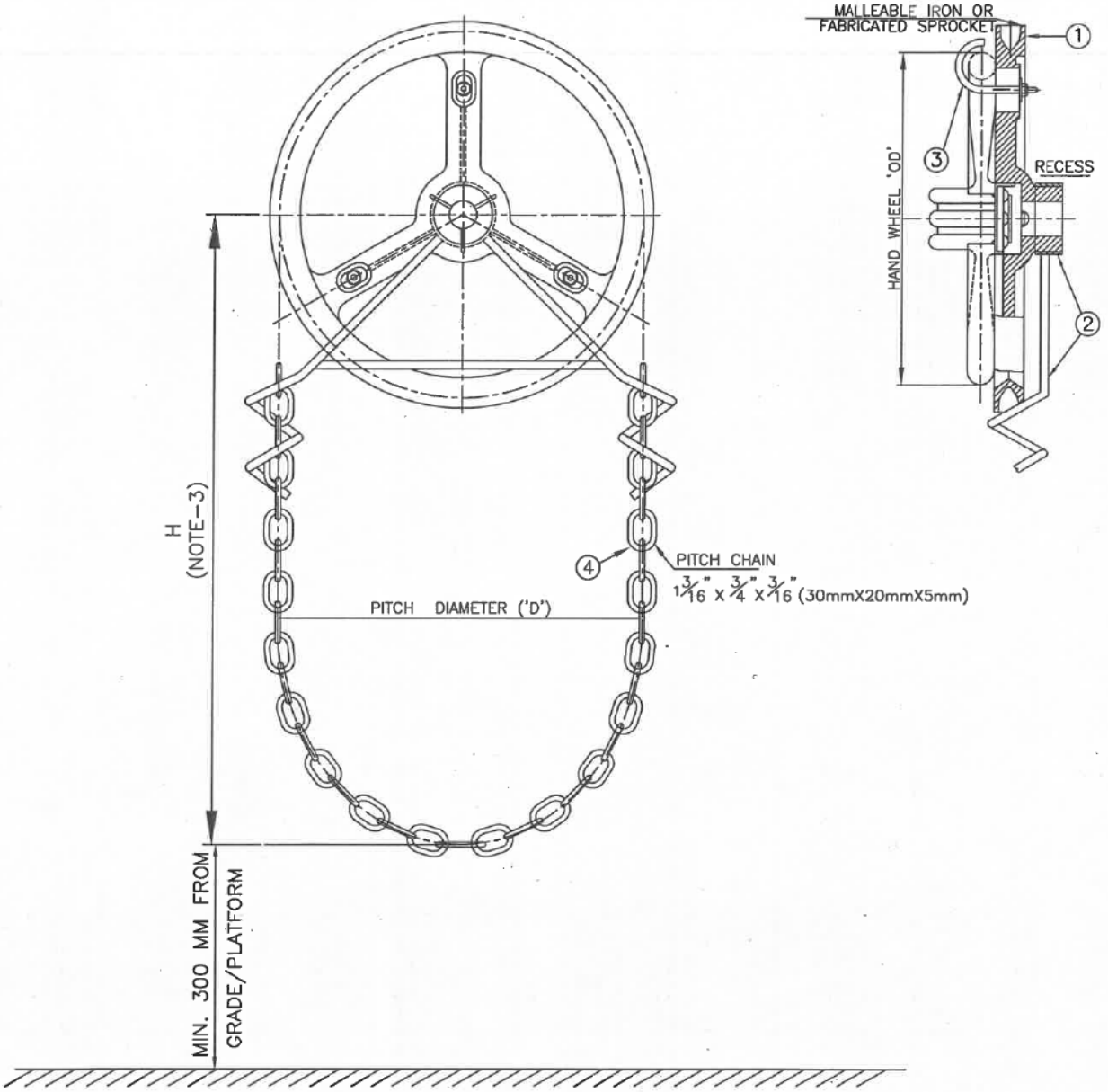

VENDORS SCOPE OF SUPPLY :

1. SPROCKET
2. CHAIN GUIDE LEVER WITH FIXING ITEMS.
3. INSTALLATION KIT INCLUDING J-BOLTS, NUTS & WASHERS.
4. CHAIN

NOTES:

1. THIS IS A SCHEMATIC ARRANGEMENT FOR QUOTATIONS ONLY.
2. VENDOR DESIGN TO BE BASED ON THE SCHEMATIC ARRANGEMENT SHOWN.
3. 'H' IS THE DIMENSION FROM THE CENTERLINE OF VALVE STEM OR GEAR INPUT SHAFT TO THE BOTTOM OF THE CHAIN LOOP, WHICH WILL BE PROVIDED IN THE REQUISITION.
4. VENDOR TO SUBMIT DETAIL DRAWING INCLUDING CHAIN LENGTH.

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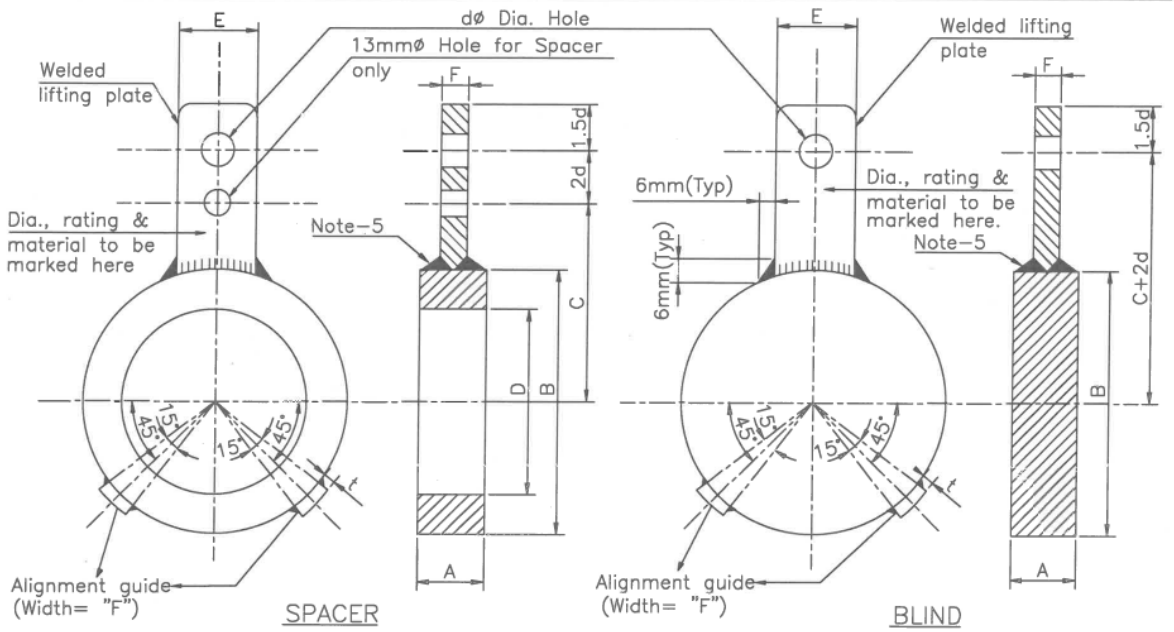

NOTES:

1. Both surfaces shall have a resultant surface finish of 125µin to 250µin average roughness with either a concentric or spiral serrated finish.
2. Dimensions are for flanges to ASME B 16.47B (erstwhile API 605) for sizes 26" to 60".
3. Diameter, rating & material specification shall be marked on welded fixed plate. Material as per line class.
4. Thickness 'A' is based on ASTM A285 Gr.C for 150# and ASTM A516 Gr.70 for 300# & 600# with corrosion allowance of 1.5mm on each face.
5. Welding and heat treatment requirements shall be in accordance with ASME B31.3
6. Alignment Guide shall be welded in the middle of thickness of Spacer & Blind.
7. All dimensions are in mm unless otherwise specified.

DIA. NB	150#								WEIGHT KG(APPROX)	
	A	B	C	D	E	F	d	t	BLIND	SPACER
26	40	711	473	648	35	15	20	5	120	22
28	42	762	498	698	33	15	20	5	140	25
30	45	813	524	749	31	15	20	5	175	30
32	48	864	551	800	29	15	20	6	210	35
34	50	921	583	851	42	15	20	5	250	40
36	53	972	609	902	39	15	20	6	295	45
38	54	1022	642	925	48	15	20	9	345	50
40	59	1080	668	1003	44	15	20	6	400	65
42	61	1130	693	1054	41	18	20	6	460	70
44	64	1181	718	1105	38	18	20	6	520	80
46	67	1235	751	1156	62	18	20	8	595	90
48	70	1289	776	1205	56	18	20	7	680	100
50	72	1340	803	1255	51	18	26	7	770	110
52	75	1391	827	1306	45	18	26	6	865	120
54	77	1441	855	1356	44	27	26	9	950	125
56	80	1492	880	1406	42	27	26	9	1060	140
58	83	1543	918	1455	63	27	26	16	1180	160
60	86	1600	943	1505	59	27	26	13	1315	175
TOL.	±0.3	±0.5		±0.5	±0.5					

Rev. No.	Date	Purpose	Prepared by	Checked by	Stds. Committee Convenor	Stds. Bureau Chairman
6	17.12.25	REVISED & ISSUED AS STANDARD	SRG	PK	SH	MN
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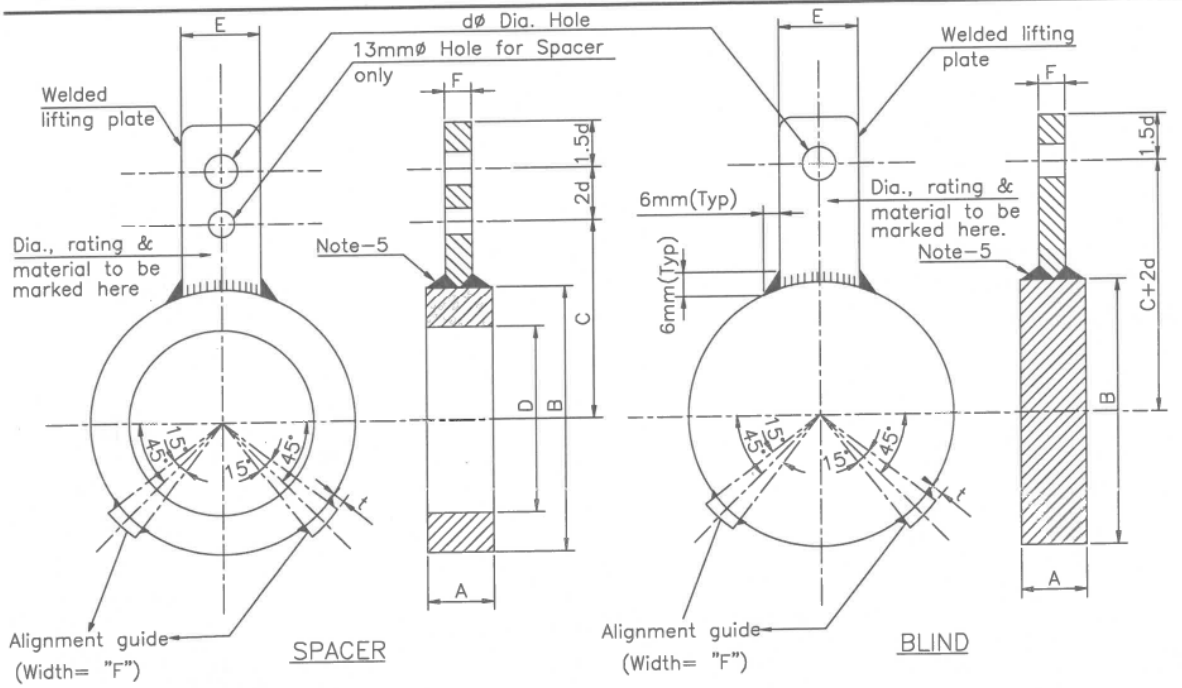

NOTES:

REFER PAGE 1 OF 3 FOR NOTES.

DIA. NB	300#								WEIGHT KG(APPROX)	
	A	B	C	D	E	F	d	t	BLIND	SPACER
26	60	737	513	641	36	15	20	15	195	55
28	65	787	540	689	32	15	20	17	240	60
30	69	845	575	738	35	15	20	18	295	70
32	73	902	608	787	47	15	20	17	355	85
34	77	953	635	835	41	15	20	18	420	95
36	82	1010	665	886	55	18	20	17	495	115
38	86	1060	690	941	47	18	20	17	595	130
40	91	1114	718	992	41	18	20	16	685	150
42	95	1168	748	1038	53	18	26	14	785	165
44	100	1219	773	1092	47	27	26	14	895	185
46	104	1270	810	1140	61	27	26	22	1010	200
48	107	1327	835	1183	53	27	26	19	1145	225
50	112	1378	860	1234	46	35	26	19	1285	250
52	116	1429	888	1286	41	35	26	18	1430	270
54	119	1480	918	1333	45	35	26	23	1575	290
56	125	1537	963	1381	76	40	32	26	1785	330
58	130	1594	993	1429	67	40	32	29	2000	380
60	133	1651	1020	1478	71	40	36	26	2210	420
TOL.	±0.3	±0.5		±0.5						

Rev. No.	Date	Purpose	Prepared by	Checked by	Stds. Committee Convenor	Stds. Bureau Chairman
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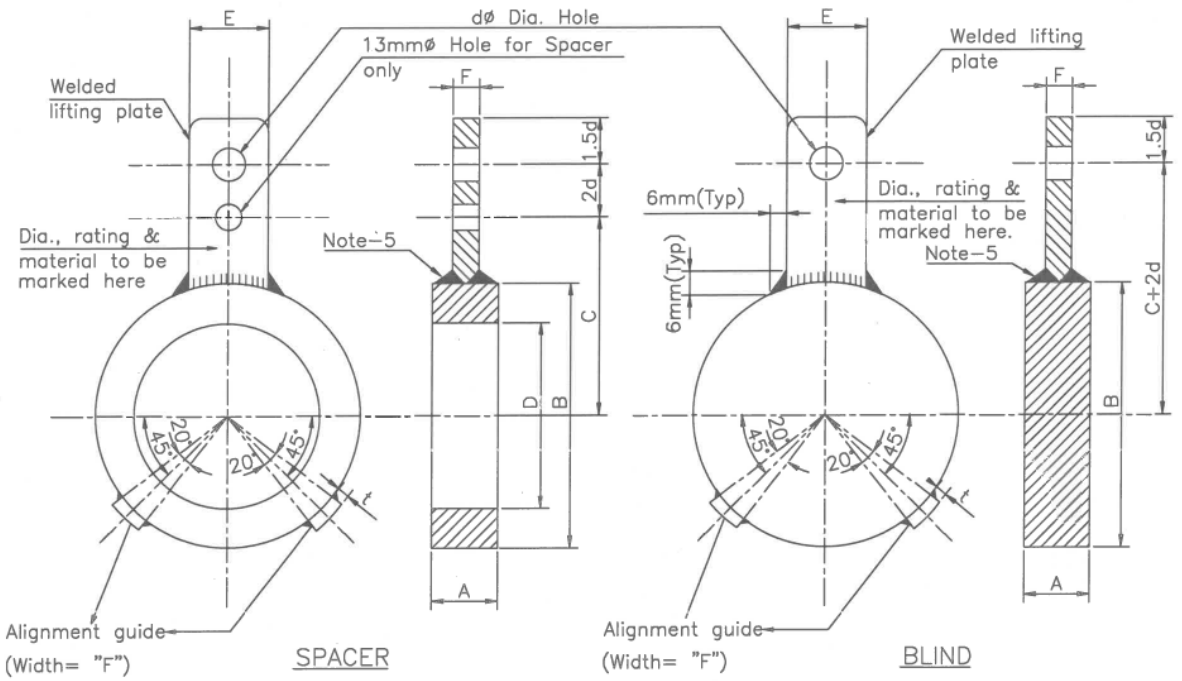

NOTES:

REFER PAGE 1 OF 3 FOR NOTES.

DIA. NB	600#								WEIGHT KG(APPROX)	
	A	B	C	D	E	F	d	t	BLIND	SPACER
26	82	727	525	632	38	15	20	17	260	65
28	88	784	555	681	42	15	20	15	320	80
30	95	841	590	732	46	15	20	17	405	100
32	100	895	623	779	49	18	20	17	490	115
34	107	953	660	829	70	18	20	20	595	140
36	113	1010	688	879	56	18	20	17	705	165
38	119	1054	715	930	62	18	26	23	800	170
40	125	1111	740	975	51	27	26	20	940	205
42	130	1168	783	1022	69	27	26	24	1090	240
44	137	1226	808	1073	57	27	26	20	1265	275
46	143	1276	835	1122	62	35	32	23	1435	300
48	149	1334	878	1172	63	35	32	26	1635	345
50	155	1384	915	1219	84	35	32	30	1830	380
52	161	1435	940	1267	67	40	32	30	2040	410
54	167	1492	970	1316	73	40	32	30	2290	460
56	172	1543	1008	1364	73	40	36	33	2535	495
58	178	1600	1033	1413	78	40	36	30	2820	565
60	185	1657	1078	1462	104	40	36	36	3150	635
TOL.	±0.3	±0.5		±0.5	±0.5					

Rev. No.	Date	Purpose	Prepared by	Checked by	Stds. Committee Convenor	Stds. Bureau Chairman
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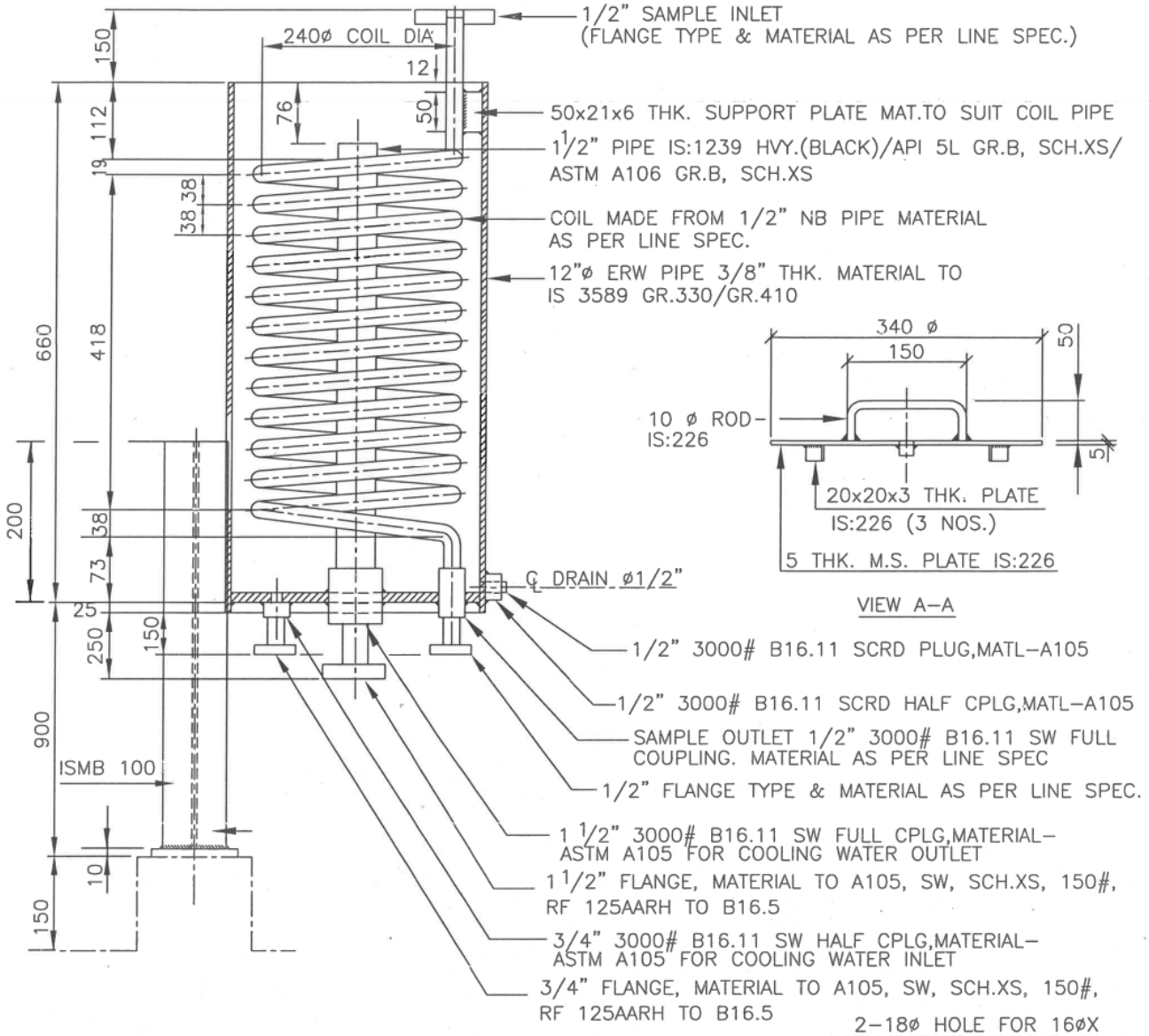
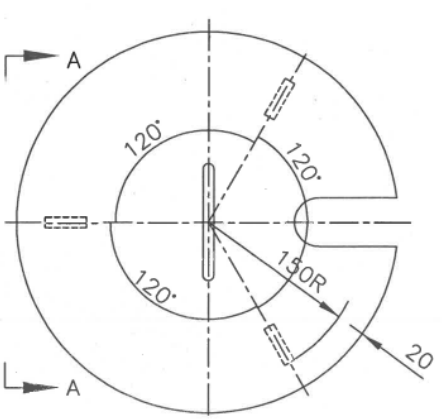
SAMPLE COOLER - TYPE 1 (NON-CONGEALING SERVICES)

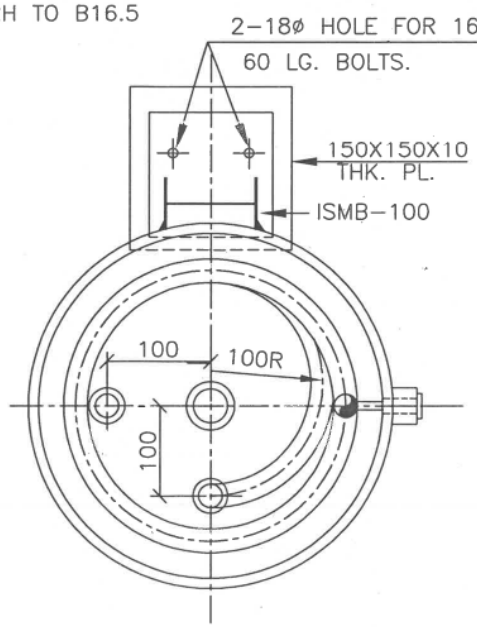


NOTE:

1. INSTEAD OF FIXING COOLER TO ISMB-100 AS INDICATED, IT CAN BE FIXED TO ANY CONVENIENT STEEL SUITABLY



COVER DETAIL



PLAN VIEW

Rev. No.	Date	Purpose	Prepared by	Checked by	Stds. Committee Convenor	Stds. Bureau Chairman
6	04.03.25	REVISED & ISSUED AS STANDARD	PK	SH	GB	MN
5	06.12.19	REVISED & ISSUED AS STANDARD	SG	SH	MI	RKT

Approved by

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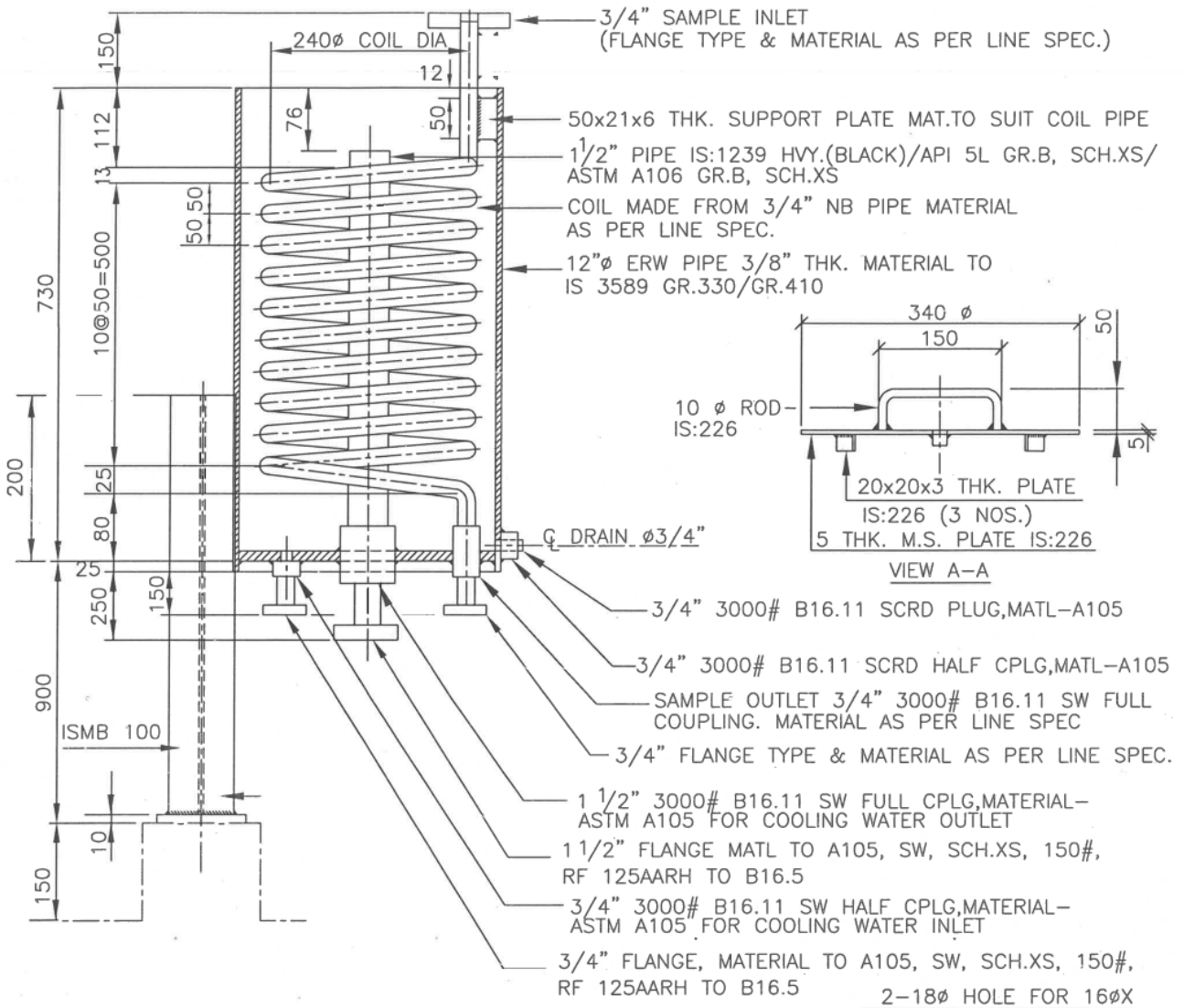
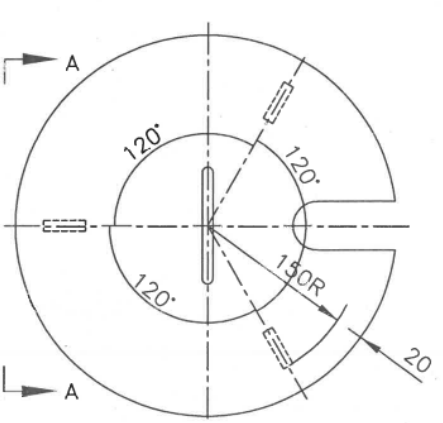
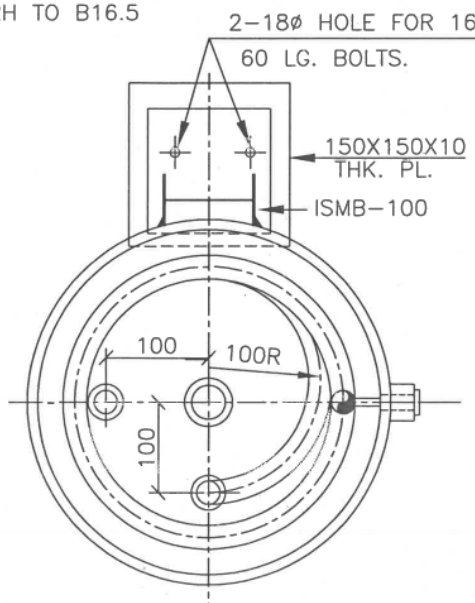


NOTE:

1. INSTEAD OF FIXING COOLER TO ISMB–100 AS INDICATED, IT CAN BE FIXED TO ANY CONVENIENT STEEL SUITABLY



COVER DETAIL



PLAN VIEW

Rev. No.	Date	Purpose	Prepared by	Checked by	Stds. Committee Convenor	Stds. Bureau Chairman
4	04.03.25	REVISED & ISSUED AS STANDARD	PK	SH	GB	MN
3	06.12.19	REVISED & ISSUED AS STANDARD	SG	SH	MI	RKT

Approved by

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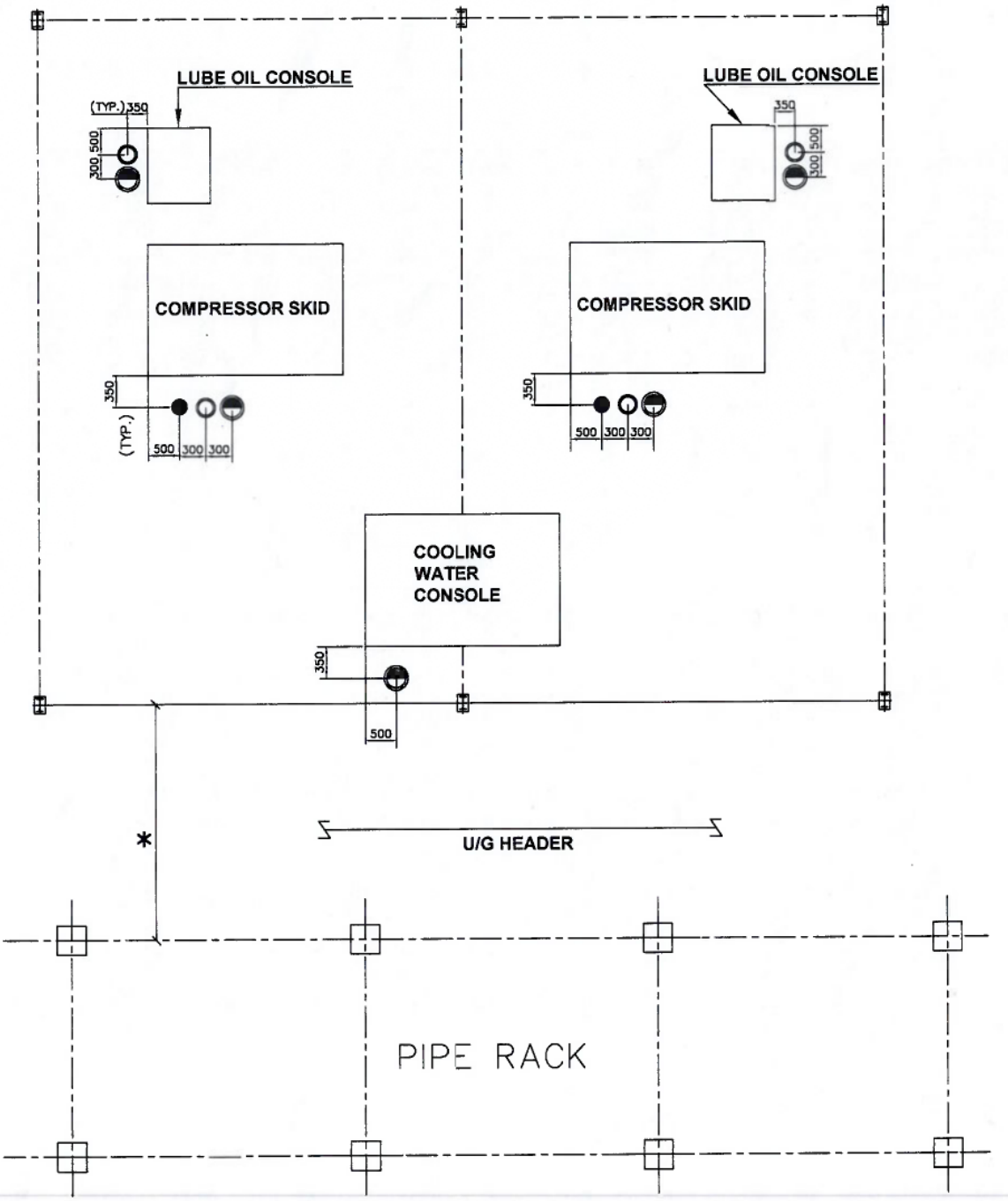

LEGENDS

- ● CBD (CLOSED BLOW DOWN)
- ○ OWS (OIL WATER SEWER)
- ◒ CR / SS (CONDENSATE RECOVERY / STORM SEWER)
- * AS PER EQUIPMENT LAYOUT / 3D-MODEL.

NOTES:

1. THIS STANDARD SHALL BE READ IN CONJUNCTION WITH COMPRESSOR LAYOUT DRAWING ATTACHED IN THE ENQUIRY DOCUMENTS. THE PLACING / ARRANGEMENT OF VARIOUS AUXILIARY SKIDS AS SHOWN IN THIS STANDARD SHALL BE FINALIZED CASE TO CASE BASIS. THIS STANDARD SHALL BE REFERRED FOR THE LOCATION / ORIENTATION OF THE DRAIN POINTS W.R.T. VARIOUS AUXILIARY SKIDS.
2. THE STANDARD DRAWINGS FOR DRAIN POINTS SHALL BE ATTACHED WITH THE MR FOR COMPRESSORS. VENDOR WHILE SUBMITTING THE PLOT PLAN IN KICK OFF MEETING SHALL INCORPORATE THE DRAIN POINTS AS PER STANDARD DRAWING ALONGWITH THE DIMENSIONAL DETAILS OF THE AUXILIARY SKIDS.
3. THE VENDOR SHALL MANIFOLD ALL THE DRAIN POINTS HAVING COMMON DESTINATION. VENDOR SHALL TERMINATE SINGLE POINT DRAIN AT GRADE FOR EACH DESTINATION (i.e. CBD, OWS or CR/SS) FOR EACH SKID AT LOCATIONS SHOWN IN THE STANDARD.
4. IN CASE VENDOR DURING DETAIL ENGINEERING INDICATES TECHNICAL LIMITATION FOR MANIFOLDING SOME OF THE DRAIN POINTS, THE SAME SHALL BE RESOLVED CASE TO CASE BASIS. HOWEVER IN SUCH CASE VENDOR SHALL BE ASKED TO ROUTE INDIVIDUAL DRAIN LINES FROM ONE SKID TO COMMON LOCATION AT GRADE.

Rev. No.	Date	Purpose	Prepared by	Checked by	Stds. Committee Convenor	Stds. Bureau Chairman
					Approved by	
2	09.10.25	REAFFIRMED & ISSUED AS STANDARD	SRG	PK	SH	MN
1	04.05.20	REAFFIRMED & ISSUED AS STANDARD	SG	SH	GB	SKS

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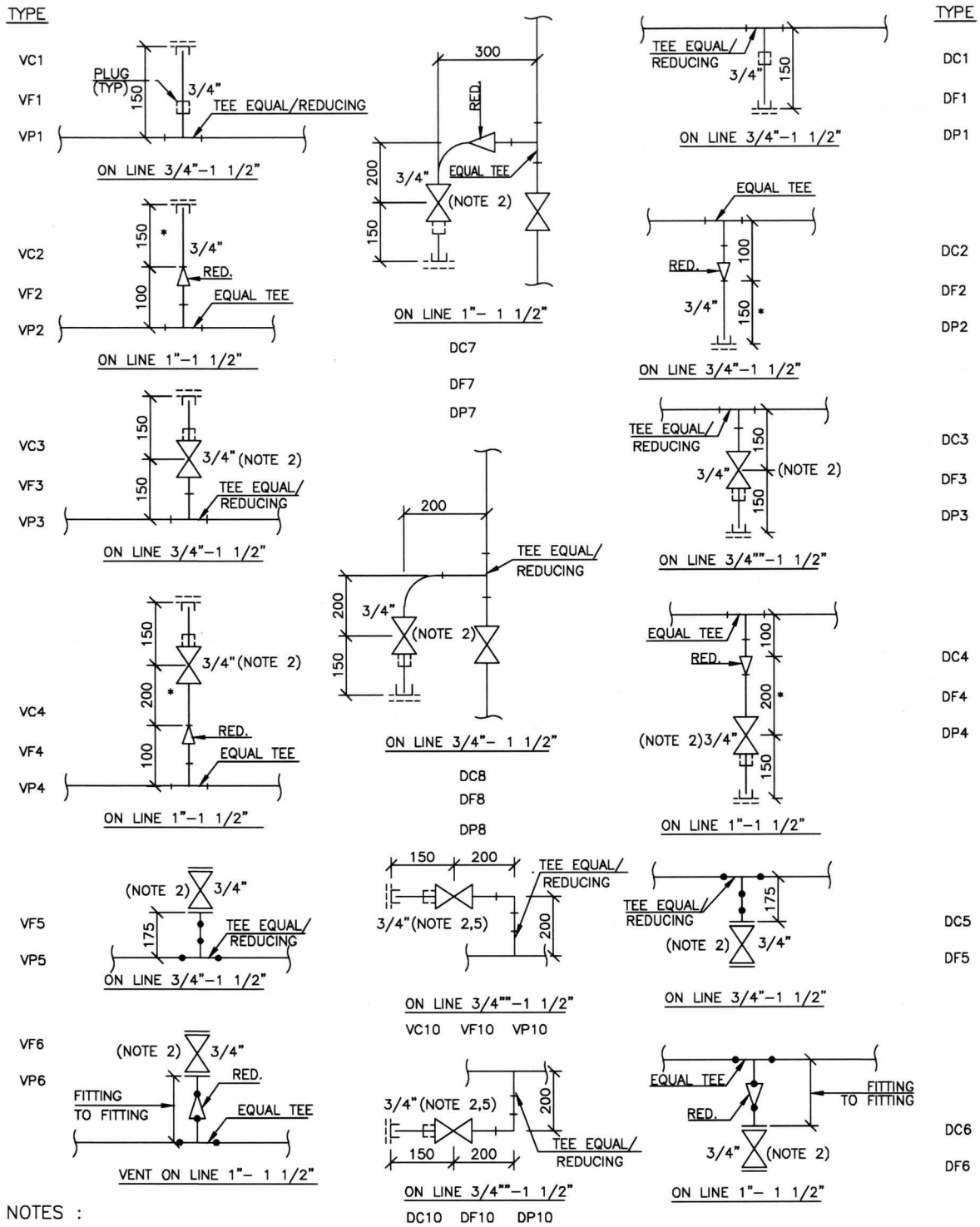

NOTES :

1. DIMENSIONS INDICATED ARE VALID FOR 50mm(MAX) INSULATION. FOR HIGHER INSULATION THICKNESS, INCREASE DIMENSIONS AS REQUIRED. DIMENSIONS MARKED '*' ARE MAXIMUM AND MAY BE REDUCED TO SUIT.
2. VALVES TO BE PROVIDED SHALL BE SIMILAR TO LINE ISOLATION VALVE (GATE, BALL OR PLUG VALVE ETC., WITH FLGD, S.W. OR SCR'D ENDS) UNLESS OTHERWISE SPECIFIED IN PMS, BRANCH–OFFS LIKE TEES(EQUAL OR REDUCING)/HALF COUPLINGS S.W. OR SCR'D)/SOCKOLETS/WELDOLETS AND END CONNECTIONS LIKE CAP/PLUG/FLANGE & BLIND FLANGE SHALL BE AS PER PIPING MATERIAL SPECIFICATION.
3. LEGEND : V = VENT; D = DRAIN; C = CAP; F = FLANGE; RED. = REDUCER, COUPLING OR SWAGE; P = PLUG.
4. PLUGGED END OF VALVE OR FITTING SHALL BE THREADED.
5. VALVE STEM ORIENTATION TO BE AT OR ABOVE 45° ABOVE THE HORIZONTAL POSITION IN LIQUID CRYOGENIC SERVICE.

Rev. No.	Date	Purpose	Prepared by	Checked by	Stds. Committee Convenor	Stds. Bureau Chairman
					Approved by	
6	20.06.22	REVISED & ISSUED AS STANDARD	PK	SH	GB	SM
5	06.12.19	REAFFIRMED & ISSUED AS STANDARD	SG	SH	MI	RKT

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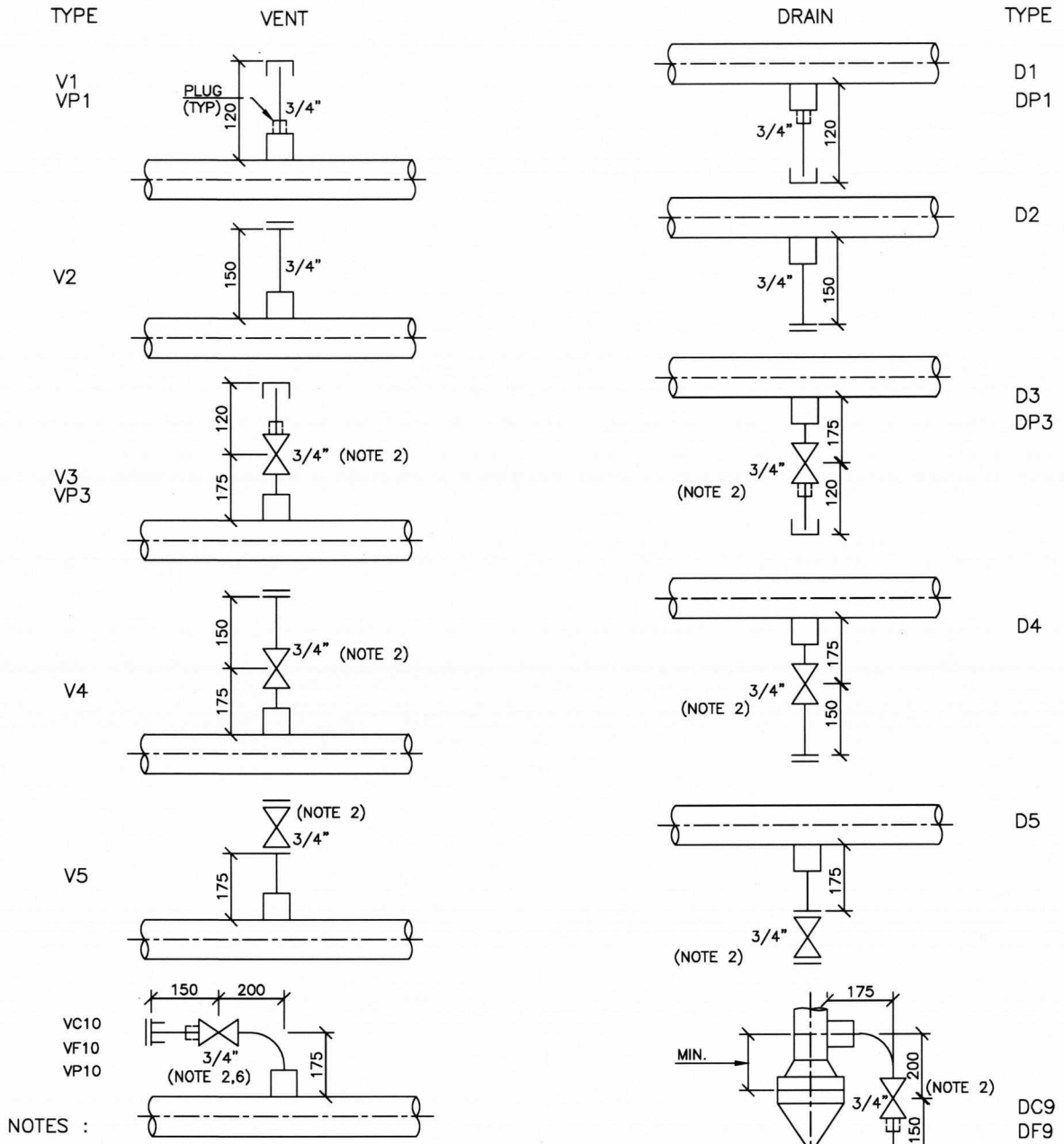

NOTES :

1. DIMENSIONS INDICATED ARE VALID FOR 75mm (MAX) INSULN. THICKNESS. FOR HIGHER INSULATION THICKNESS INCREASE DIMENSION AS REQUIRED
2. VALVES TO BE PROVIDED SHALL BE SIMILAR TO LINE ISOLATION VALVE (GATE, BALL OR PLUG VALVE ETC., WITH FLGD, SW OR SCR'D ENDS) UNLESS OTHERWISE SPECIFIED IN PMS.
   BRANCH-OFFS LIKE HALF CPLG(SW OR SCR'D)/SOCKOLET/WELDOLET & END CONNECTIONS LIKE CAP/PLUG/FLANGE & BLIND FLANGE SHALL BE AS PER PIPING MATERIAL SPECIFICATIONS.
3. VENTS/DRAINS CAN BE PROVIDED ON FLAT SIDE OF ECCENTRIC REDUCER ON SIZES 4" & ABOVE
4. LEGEND V=VENT, D=DRAIN, C=CAP, F=FLANGE, P=PLUG
5. PLUGGED END OF VALVE OR FITTING SHALL BE THREADED
6. FOR LIQUID CRYOGENIC SERVICE VALVE STEM ORIENTATION TO BE AT OR ABOVE 45° ABOVE HORIZONTAL POSITION.

Rev. No.	Date	Purpose	Prepared by	Checked by	Stds. Committee Convenor	Stds. Bureau Chairman
6	20.06.22	REVISED & ISSUED AS STANDARD	PK	SH	GB	SM
5	06.12.19	REAFFIRMED & ISSUED AS STANDARD	SG	SH	MI	RKT

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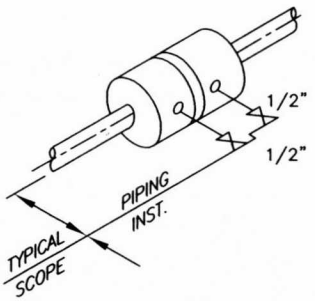
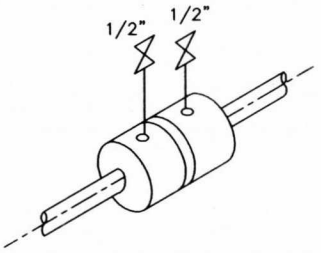
FOR LIQUID

DETAIL– ①



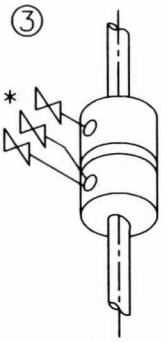
FOR GAS LINES & STEAM LINES (NOTE–10)

DETAIL– ②



FOR VERTICAL LINES

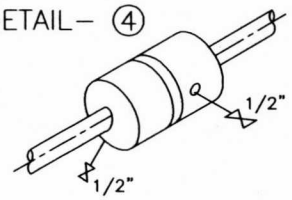
DETAIL– ③



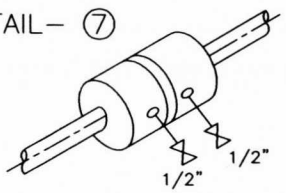
* FOR STEAM & CONDENSIBLES, LOWER BLOCK VALVE SHALL BE RAISED TO THE LEVEL OF THE UPPER BLOCK VALVE

FOR LIQUID LINES ON PIPE RACK WITH OPERATING TEMP > = 0°C

DETAIL– ④ NOTE–5

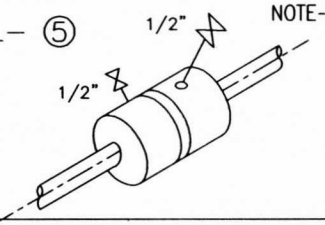


DETAIL– ⑦

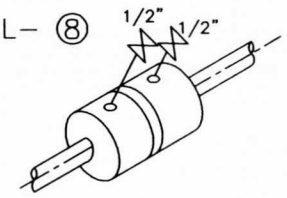


FOR STEAM & GAS LINES ON PIPE RACK & LIQUID LINES WITH TEMP BELOW 0°C

DETAIL– ⑤ NOTE–5

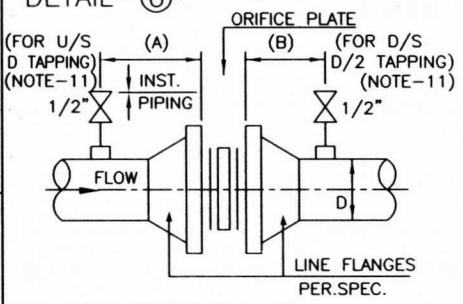


DETAIL– ⑧



FOR TAPS ON PIPE RACK (150# & 300#)

DETAIL– ⑥ (NOTE–3)



ORIENTATON OF TAPS SHALL BE
LIQUID LINES WITH OPERATING TEMP. >= 0°C : 45° FROM VERTICAL DOWNWARDS
STEAM, GAS & LIQUID LINES WITH OP.TEMP < 0°C : 45° FROM VERTICAL UPWARDS

INSTRUMENT SCOPE

A. ORIFICE FLANGES ASSEMBLY WITH BOLTS/NUTS AND GASKETS
B. IMPULSE LINE STARTING AFTER THE TAPPING VALVE

PIPING SCOPE

A. TAPPING NIPPLE, COUPLINGS AND VALVES

NOTES :

1. ORIFICE FLANGES IN HORIZONTAL LINES SHALL BE PREFERED.
2. TAPS SHALL BE ORIENTED TO SUIT LOCATION OF INSTRUMENT.
3. TAPPING ON PIPE AS PER DETAIL–6 SHALL BE CONSIDERED IN ACCORDANCE WITH THE COUPLING POSITIONS FROM UPSTREAM AND DOWNSTREAM SIDE FLANGE FACES FOR LINE OF :–
   A. RATING 150# AND SIZE >=16"
   B. RATING 300# AND SIZE >=20"
   FOR ALL OTHER LINE SIZES AND RATINGS. TAP SHALL BE CONSIDERED ON ORIFICE FLANGE FOR ORIFICE ASSEMBLIES BY INSTRUMENTATION.
4. IN CASE OF VERTICAL LINES FLOW SHALL BE UPWARDS FOR LIQUIDS CONTAINING VAPOUR & DOWNWARDS FOR WET GASES & STEAM.
5. THE ORIENTATION OF TAPPING IN CASE OF DETAILS 4 & 5 SHALL BE AS FOLLOWS:
   FOR LIQUID LINES WITH OPERATING TEMPERATURE >= 0°C :
   4,8 &16 BOLT FLANGE – AT 45° TO VERTICAL POINTING DOWNWARDS
   12 BOLT FLANGE – AT 60° TO VERTICAL POINTING DOWNWARDS
   20 BOLT FLANGE – AT 54° TO VERTICAL POINTING DOWNWARDS.
   FOR LIQUID LINES WITH OPER. TEMP. < 0°C AND STEAM AND GAS LINES :
   4,8 & 16 BOLT FLANGE – AT 45° TO VERTICAL POINTING UPWARDS,
   12 BOLT FLANGE – AT 60° TO VERTICAL POINTING UPWARDS
   20 BOLT FLANGE – AT 54° TO VERTICAL POINTING UPWARDS.
6. DETAILS 4 & 5 SHALL NOT BE USED FOR PRE–FABRICATED HOOK–UPS.
7. FOR CLEARANCE REQUIREMENT AROUND ORIFICE FLANGE REFER EIL STD. 7–44–0504
8. FOR DETAILS OF ORIFICE TAPPINGS AND ORIENTATION, REFER EIL STD. 7–52–0005.
9. IN CASE OF PRE–FABRICATED HOOKUP, NIPPLE & ISOLATION VALVE SHALL BE SUPPLIED BY PREFABRICATION VENDOR.
10. FOR STEAM LINES, DETAIL–1 CAN BE CONSIDERED IN CASE OF SPACE CONSTRAINTS OR AS PER LICENSOR REQUIREMENT.
11. FOR DIMENSIONS A & B REFER STD. 7–52–0022.
12. FOR LIQUID CRYOGENIC SERVICE VALVE STEM ORIENTATION TO BE AT OR ABOVE 45° ABOVE HORIZONTAL POSITION.

Rev. No.	Date	Purpose	Prepared by	Checked by	Stds. Committee Convenor	Stds. Bureau Chairman
6	20.06.22	REVISED & ISSUED AS STANDARD	PK	SH	GB	SM
5	24.01.20	REVISED & ISSUED AS STANDARD	SG	SH	MI	RKT

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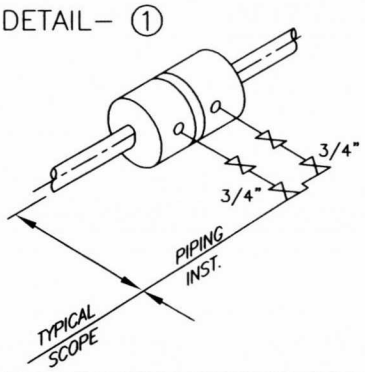
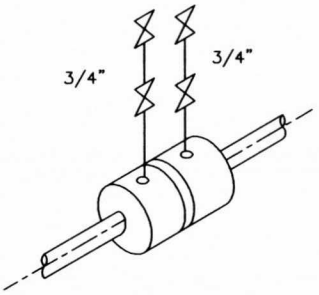
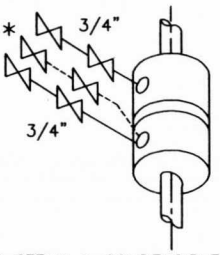
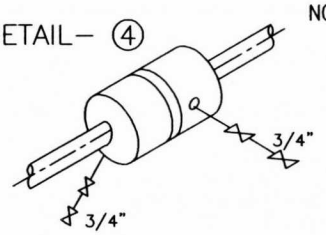
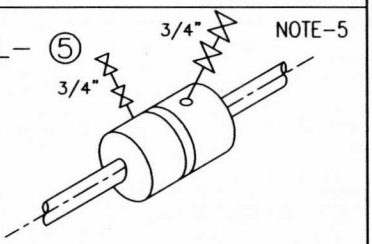
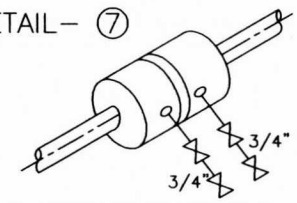
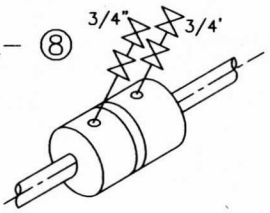
FOR LIQUID	FOR GAS LINES & STEAM LINES (NOTE-10)	FOR VERTICAL LINES
DETAIL– ① 	DETAIL– ② 	DETAIL– ③  * FOR STEAM & CONDENSIBLES, LOWER BLOCK VALVE SHALL BE RAISED TO THE LEVEL OF THE UPPER BLOCK VALVE
FOR LIQUID LINES ON PIPE RACK WITH OPERATING TEMP > = 0°C	FOR STEAM & GAS LINES ON PIPE RACK & LIQUID LINES WITH TEMP BELOW 0°C	
DETAIL– ④ NOTE-5 	DETAIL– ⑤ NOTE-5 	
DETAIL– ⑦ 	DETAIL– ⑧ 	

INSTRUMENT SCOPE

A. ORIFICE FLANGES ASSEMBLY WITH BOLTS/NUTS AND GASKETS
B. IMPULSE LINE STARTING AFTER THE TAPPING VALVE

PIPING SCOPE

A TAPPING NIPPLE, COUPLINGS AND VALVES

NOTES :

1. ORIFICE FLANGES IN HORIZONTAL LINES SHALL BE PREFERED.
2. TAPS SHALL BE ORIENTED TO SUIT LOCATION OF INSTRUMENT.
3. DELETED.
4. IN CASE OF VERTICAL LINES FLOW SHALL BE UPWARDS FOR LIQUIDS CONTAINING VAPOUR & DOWNWARDS FOR WET GASES & STEAM.
5. THE ORIENTATION OF TAPPING IN CASE OF DETAILS 4 & 5 SHALL BE AS FOLLOWS:
   FOR LIQUID LINES WITH OPERATING TEMPERATURE >= 0°C :
   4,8 &16 BOLT FLANGE – AT 45° TO VERTICAL POINTING DOWNWARDS
   12 BOLT FLANGE – AT 60° TO VERTICAL POINTING DOWNWARDS
   20 BOLT FLANGE – AT 54° TO VERTICAL POINTING DOWNWARDS.
   FOR LIQUID LINES WITH OPER. TEMP. < 0°C AND STEAM AND GAS LINES :
   4,8 & 16 BOLT FLANGE – AT 45° TO VERTICAL POINTING UPWARDS,
   12 BOLT FLANGE – AT 60° TO VERTICAL POINTING UPWARDS
   20 BOLT FLANGE – AT 54° TO VERTICAL POINTING UPWARDS.
6. DETAILS 4 & 5 SHALL NOT BE USED FOR PRE-FABRICATED HOOK-UPS.
7. FOR CLEARANCE REQUIREMENT AROUND ORIFICE FLANGE REFER EIL STD. 7-44-0504
8. FOR DETAILS OF ORIFICE TAPPINGS AND ORIENTATION. REFER EIL STD. 7-52-0005.
9. IN CASE OF PRE-FABRICATED HOOKUP, NIPPLE & ISOLATION VALVE SHALL BE SUPPLIED BY PREFABRICATION VENDOR.
10. FOR STEAM LINES, DETAIL-1 CAN BE CONSIDERED IN CASE OF SPACE CONSTRAINTS OR AS PER LICENSOR REQUIREMENT.
11. FOR LIQUID CRYOGENIC SERVICE VALVE STEM ORIENTATION TO BE AT OR ABOVE 45° ABOVE HORIZONTAL POSITION.

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6	20.06.22	REVISED & ISSUED AS STANDARD	PK	SG	SM	
5	24.01.20	REVISED & ISSUED AS STANDARD	SG	SM	RKT	

Approved by

Signature Not Verified
Digitally signed by ARITRA DE
Date: 2026.05.18 17:57:09 IST
Location: eProcure-EPROC

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