

ABOVE GROUND PIPING

Standards Followed for Material and Construction:

ASTM: American Society for Testing & Materials.

ASNT: American Society for Non Destructive Testing.

ASME: American Society for Mechanical Engineering.

AWS: American Welding Society.

API: American Petroleum Institute.

AWWA: American Water Works Association.

ANSI: American National Standard Institute.

AISI: American Iron & Steel Institute.

NACE: National Association of Corrosion Engineers

Standard for Construction of Piping System.

1. **ASME B31.1** - Power piping.
2. **ASME B31.2** - Fuel Gas Piping.
3. **ASME B31.3** - Process piping.
4. **ASME B31.4** - Pipeline Transportation system for liquid hydrocarbon & other liquid.
5. **ASME B31.5** - Refrigeration Piping.
6. **ASME B31.8** - Gas transmission & distribution piping system.
7. **ASME B31.9** - Building services piping.
8. **ASME B31.11** - Slurry transportation piping system.

Construction of Equipments.

1. **ASME section I:** - Rules for construction of power boiler.
2. **ASME Section II:** - Materials.
 - Part A** – Ferrous materials.
 - Part B** – Non-Ferrous materials.
 - Part C** – Specification for electrodes & filler wire.
 - Part D** – Properties.
3. **ASME Section IV:** - Rules for construction of Heating Boiler.
4. **ASME Section V:** - Non-destructive Examination.
5. **ASME Section VI:** - Recommended rules for care & operation of heating boiler.
6. **ASME Section VII:** - Recommended guidelines for care of power boiler.
7. **ASME Section VIII:** - Rules for construction of pressure vessels. (Division I & II)
8. **ASME Section IX:** - Welding & brazing qualification.

- ❖ **SATIP** - Saudi Aramco Typical Inspection Plan
- ❖ **SAIC** - Saudi Aramco Inspection Check List
- ❖ **SATR** - Saudi Aramco Test Report
- ❖ **SAES** - Saudi Aramco Engineering Standard.
- ❖ **SAEP** - Saudi Aramco Engineering Procedure.
- ❖ **SAMSS** - Saudi Aramco Materials System Specification.
- ❖ **RFI** - Request for Inspection.
- ❖ **PQP** - Project Quality Plan
- ❖ **SMYS** - Specified Minimum Yield Strength.
- ❖ **MQMR** - Monthly Quality Management Report.
- ❖ **QMIS** - Quality Management Information System.

- ❖ **PMCC** - Partial Mechanical Completion Certificate.
- ❖ **NCR** - Non-Conformance Report.
- ❖ **P&ID** - Piping and Instrumentation Diagram.
- ❖ **ISO** - Isometric Drawings.
- ❖ **UT** - Ultrasonic Testing is used for (Flaw detection/Evaluation, Dimensional check, Material Characterization **ASTM E164-13 welding, E2375 Wrought products, E213 Pipe**).
- ❖ **RT** - Radiographic Testing (Used to find the defects in the welding rays).
- ❖ **PT or DPT or LPT** - Dye/ Liquide/Penetrant Test method used to locate surface-breaking defects.
- ❖ **MPT** - Magnetic Particle Test used for detecting surface and slightly subsurface Discontinuities in ferromagnetic materials.
- ❖ **PWHT** - Post Weld Heat Treatment **SAES-W-011**.
- ❖ **PMI** - Positive Material Identification.
- ❖ **HT** - Hardness Test. (Tensile Test, Brinell Test, Impact Test).
 - Tensile Test:** Sample is subjected to control tension until it breaks **ASTM E8**.
 - Brinell Test:** Sample is penetrated with loaded indenter **ASTM E10, HB = Test Force F / Surface area indentation A.**
 - Impact or Charpy V-notch test:** The amount of energy absorbed by a material during fracture **ASTM E23**.
 - Rockwell Test:** **ASTM E18-07** same as Brinell test.
- ❖ **PQR** - Procedure Qualification Record.
- ❖ **WPS** - Welding procedure specification.

- SAES-A-004:** General Requirements for Hydro testing.
- SAES-A-007:** Hydro Testing Fluids & Lay-Up procedures.
- SAES-L-105:** Selection of Pipes.
- SAES-L-108:** Selection of Valves. **API-598:** Testing & Leakage Test of Valve.
- SAES-L-109:** Selection of Flanges, Bolts & Gaskets.
- SAES-L-110:** Threaded Joints & Branch Connections.
- SAES-L-150:** Pressure Testing for Plant Piping / Pipe Lines.
- SAES-L-310:** Design of Plant Piping.
- SAES-L-350:** Construction of Plant Piping.
- SAES-L-410:** Design of pipe lines.
- SAES-L-450:** Construction of On-land & Near-shore pipe lines.
- SAES-H-200:** Handling & Storage of Pipes.
- SAEP-351:** Bolt Torqueing Procedure.
- SAEP-379:** Quality Issues Notification.
- SAEP-380:** Equipment Deficiency Report.
- SAEP-381:** Escalation Process for NCR.
- SAEP-388:** Cleaning of Piping.
- SAPE-1151:** Inspection Requirements for Procurement materials & Equipment.
- SAEP-1160:** Hydro Test Package preparation procedure.

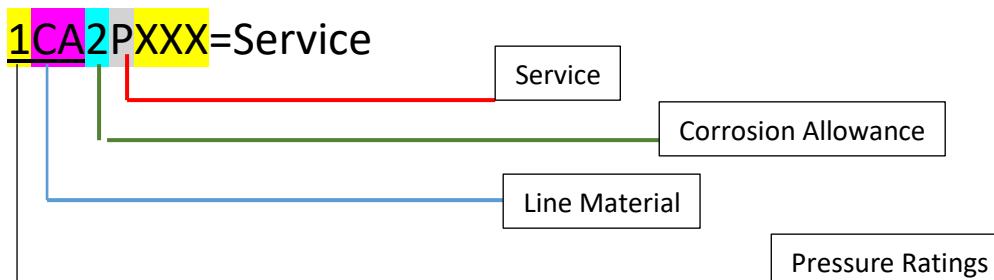
P&ID: Piping & Instrumentation Drawings used for

1) Line Number 2) Flow Direction 3) Line Limits 4) Equipment's & Valves 5) Instrumentation.

Isometric Drawings: Isometric drawings will be at 30° degree & detailed drawings for piping which says.

1) Line Number 2) Material details 3) Material Grade 4) Bolts & Gasket Details 5) Joint Number
 6) Support Details 7) Component Details 8) Design Pressure 9) Design Temperature
 10) IFC Stamp.

How to read Line class numbers: As per SAES-L-105 Para 7-9.



Pressure Ratings: #150, #300, #600, #900, #1500, #2500.

Corrosion Allowance: 0 = 0mm, 1 = 1.6mm, 2 = 3.2mm, 3 = 4.8mm, 4 = 6.4mm, 9 = SAES-L-033.

Service: A=Acid, C=Caustic, D=Drain/Swerve, H=Hydrogen, P=Process, U=Utility, W=Water, A=Air
C=Chemical, CA=Caustic, CWR=Cooling Water Return, CWS=Cooling Water Supply

For more refer to **SAES-L-105 para 9**

Material Selection		Material			
Pipe		Pipe			
ASME:B36.10	= CS Pipes Selection	CS	ASTM : A53 Grade A/B, A106 Gr.A/B/C; A333 Gr A/B		
ASME:B36.19	= SS Pipe Selection	SS	ASTM : A312 TP 304/304L; A312 TP 316/316L		
		Alloy	ASTM : A335 Gr.P1/P2/P5/P7/P9/P11		
		LTCS	ASTM : A333 Gr 6 / API 5L Gr X65 & above / ASTM A671 CC 65		
			Wrought Fittings (Elbows) : Make by bending the Pipe		
Butt welded fittings		CS	ASTM A234Gr.WP B/C		
ASME B16.9	= Steel butt welding fittings	SS	ASTM A403 WP304/WP304L; A403 WP 316/316L		
ASME B16.28	= Short radius elbows	Alloy	ASTM A234 WP1/WP5/WP7/WP9/P11		
		LTCS	ASTM 420 WPL6		
			Cast Fittings : Pouring of Molten metal & making shape		
Socket & Threaded fittings		CS	ASTM A216 B/C, A352 LCB/C.		
ASME B16.11	= Forged steel socket Welding & threaded fittings	SS	ASTM A217 CA15; A296 CA15		
		Alloy	ASTM A217 WC1/WC5/WC6/WC9		
			Forged Fittings : Make by Hammering & Other process		
Flanges		CS	ASTM A105: ASTM A181.		
ASME B16.1	= Cast iron pipes flanges & flanged fittings	SS	ASTM A182F6 F304/F304L / F316/F316L		
ASME B16.5	= Flanged fittings. (Up to 24")	Alloy	ASTM A182F1/F2/F5/F7/F9		
ASME B16.47	= Flanged fittings (Up to 24")	LTCS	ASTM A350 LF2		
			Gasket		
Valves			ASME B16.20	= Metallic Gasket	
ASME B16.10	= Dimension of valves				
ASME B16.34	= Connection Valves		ASME B16.21	= Nonmetallic gasket	

Pipe = Hallow shape use for transmission of fluids/liquids/gases/ from one end to other end.

Gr. = Grade

TP = Tubular Product

WP = Weld able Cast.

N = Normalization (Type of Heat Treatment).

CS = Carbon Steel

SS = Stainless Steel

Pipe = 3 Types

1. ERW Pipe (Electric Resistance Weld) (Above 85% Efficiency).
2. Seamless Pipe (Above 90 % Efficiency).
3. Spiral Pipe (Above 70 % Efficiency).

Carbon content in: CS

- ASTM Gr. A– 0.25 %
- ASTM Gr. B– 0.30 %
- ASTM Gr. C – 0.35 %.

Carbon content in: SS

1. ASTM 304 - 0.08 %
2. ASTM 304L- 0.035%
3. ASTM 316 - 0.08 %
4. ASTM 316L- 0.035%

SAES-A-004: General Requirements for Pressure Testing.

Testing: 1) Pneumatic Test 2) Hydro Test 3) Service Test & Others.

- 1) **Pneumatic Test:** Using Air or other approved gas testing is done.
- 2) **Hydro Test:** Using Water or Other approved fluids.
- 3) **Service Test:** Done using same service used in the pipe system.

Pressure Relief valve set for Hydro Test

- 1) Pressure Relief valve 5% below 85% SMYS (Specified Minimum Yield Strength) of material.

Example: 100 Psi is the test pressure PSV should be at 105 Psi.

- 2) Pressure Relief valve 10% above 85% SMYS (Specified Minimum Yield Strength) of material.

Example: 100 Psi is the test pressure PSV should be at 110 Psi.

- 3) 7 Days Calibration.

Manifold Design Pressure Rating/Details as per G.I.-0002.102 Para 5

- 1) Manifold Calibration 6 Months.
- 2) 1.2 times the test pressure.
- 3) 100% NDT has to be done.
- 4) Bleed Valve has be provided form over pressuring of system.
- 5) Check Valve has to be provided.

Pressure gauges SAES-A-004

- 1) The calibration one (1) month with next calibration date.
- 2) All gauges shall have 30 to 80% of the full range. (Pressure B/W 30-80 %).
- 3) Min 2 Gauges in system 1 in system 2nd at Manifold. 5% variation in 2 gauges.
- 4) Additional gauges can be installed for big systems

CALCULATIONS.**Vents and Drains**

- 1) Vent at high point & Drain at low point.
- 2) Vents and drains used only for the pressure test shall be Plugged & seal welded and penetrant tested.

Temporary Connections and Supports.**TEST BLIND CALCULATION**

- 1) Temporary supports shall be installed prior to hydrostatic testing.
- 2) All temporary items installed for testing (e.g., manifolds, valves, Blinds, spacers, supports) as per **SAES-A-004 Para 10.**

SAES-A-007: Hydrostatic Testing Fluids and Lay-Up Procedures.**Water Quality for Hydro Test.**

- 1) To maintain water quality oxygen scavengers are used, to calculate follow SAES-A-007 Appendix-1 Page 19.
- 2) Carbon steel / Alloy Steel 14 days water in system, residual concentration greater than 20ppm and oxygen concentration less than 10 ppb (Hydro Test)
- 3) Stainless Steel Equipment for 300/400 Series of chloride content is 50ppm to avoid pitting & stress corrosion cracking.
- 4) Contact of water with SS is not more than 4 days.

Lay-Up or Preservation of System:

- 1) Wet Lay-Up 2) Dry Lay-Up 3) Inert Gas Lay-Up 4) Ambient Lay-Up 5) Other Lay-Up.
All piping and equipment shall comply with the lay-up procedures per SAES-A-007.

Wet-Lay Up: Can be achieved by using

- Water of 10 ppb to 20 ppm shall be maintained with scavengers.
- Close the system with air tight and check pp values for every 6 months till the system used.

Dry Lay-Up: Can be achieved by using 1) Hot Air 2) Inert Gas (dew Point) 3) Drying Chemicals.

- Drain the water completely
- Used the scrappers to remove the water from pipelines
- Blow the Dry-Air using Oil free compressor not more than 12 Hr.
- Check the Dew Point at -1 Degree, if using Sweet gas (Inert Gas or Nitrogen) pressure
- The system at 30 Psi. (Para 5.2.3.7) if pressure is less than adjust.

Inert Gas Lay-Up: Using Argon or Nitrogen gas

- Drain water from hydro-test using scrappers.
- Remove the water from system using inert gas or Nitrogen till no water comes out & shut
- Down the system till start-up at 30 Psi.

Ambient Lay-Up: System shall meet following requirements.

- Drains at low points
- Corrosion allowance
- Pitting can be tolerate
- Particulate rust can be tolerate.

Other Lay-Up:

- Shall be approved from CSD (Consultant Service Department) and Owners representatives.

SAES-L-105: Piping Material Specifications.

Material Specification for Pipes / Fittings / Valve for more details refer SAES-L-105		
01-SAMSS-035 = API Pipes	02-SAMSS-001 = low Tem. Service Fittings	04-SAMSS-001 = Gate Valve
01-SAMSS-332 = Grade B Pipes	02-SAMSS-005 = Butt Weld Fittings	04-SAMSS-003 = Low Temp Valve
01-SAMSS-333 = Grade C Pipes	02-SAMSS-011 = Flanges	04-SAMSS-005 = Check Valve

SAES-L-108: Selection of Valves.

- i.) Service ii) O&M requirments iii)

04-SAMSS-048: Valve Inspection & Testing Requirements.

SATIP: Valve Inspection, Testing

SAIC-L-2024: Inspection of valves

Field Testing as per para 4.7:

- Testing location shall be specified.
- Valves shall be subjected to a high pressure hydrostatic seat test prior to installation in the line.
- Pressure/Duration/Leakage and acceptance criteria as per manufacturer.
- No leakage in Isolation valves.

Same Valve Body Parts:

- i) Body 2) Bonnet 3) Seat 4) Spindle 5) Stem 6) Packing 7) Wheel Handle 8) Actuators 9) O-rings ETC.,

Valves: Valves are used to control the flow in the process whenever is required and selection of valve Depends on Services, Pressure & Ratings.

Valve Ratings & Class: 150#, 300#, 600#, 900#, 1500#.

Valve Connections: 1) Bolted 2) Welded 3) Threaded (Rare).

Valve Material: 1) Cast Iron 2) Steel 3) Stain less Steel 4) Alloy.

(A & M): Automatic & Manual.

(MOV): Motorized operated Valve.

Manual: It's done Manual

Automatic: It's controlled with actuators (Actuator will have motor in it).

Actuators: This is an instrument which will be connected to SCADA and valve will be controlled From DCS room. It's mainly used to control the flow and pressure in the system

Types of Valves & Functions.

Butterfly Valve: 

1. Disc or Plate is used to regulate or prevent the flow.
2. Disc or Plate present in the flow. Consider the pressure drop.
3. This Valve is Manual or Motorized.

Control Valve: 

1. Rotatory Motion & Linear motion to control the flow.
2. This Valve is motorized. (Actuators & Motors are used)(MOV).
3. Used to Control the flow as a result control in liquid level, pressure & temp.

Gate Valve: 

1. Seat (Plate) is moved up & down to control the flow.
2. It seals the surface between Gate and Seat. (A & M).
3. it's often used in liquid services.

Ball Valve: 

1. Ball with hole is used to control the flow.
2. When hole is lined the flow is passed and it rotates at 90 Degree

Plug Valve:

1. Plug rotate in the body of Valve to control the flow.
2. **Plug valves** have one or more hollow passageways going sideways through The **plug**, so that fluid can flow through the **plug** when the **valve** is open.

Globe Valve:

1. Disc is used to control the flow.
2. **Valve** used for regulating flow in a pipeline, consisting of a movable Disk-type element and a stationary ring seat in a generally spherical body.

Check Valve:

1. Swing, Disc & Ball are used to control the flow.
2. It allows to flow fluid in one direction.
3. The pressure of forward fluid flow opens the valve (Swing, disc or ball) and the pressure from backflow closes it, forcing the (Swing, Disc or Ball) against seat.

API-598: Testing of Valves

Testing depends upon Ratings of Valve (150#, 300#, 600#, 900#, and 1200#).

Types of Testing

1) **Seat Test** (30Sec - 2Min) Max can be done by

i) Pneumatic Test ii) Hydro Test

Seat Test will be carried out by two methods and done as per Data Sheet & Vendor.

During testing we have to check the leakage from Packing & Seat.

2) **Shell Test** (30Sec – 2 Min) Max

1. Hydro Test

Seat test shall be carried out for (30Sec – 2 Mint).

During testing we have to check the leakage.

During testing we have to check Bubble & Count the bubble.

SAES-L-109: Selection of Flanges, Stud Bolts and Gaskets:**Type of Flanges as per para 6**

i) Weld Neck (WN) ii) Threaded iii) Socket Weld iv) Slip On v) Lap-Joint vi) Blind vii) Orifice viii) Isolating.

Face of Flanges as per para 6

i) Raised Face (RF) ii) Ring Joint (RJ) iii) Flat Face (FF).

Blinds:

1) All blinds hydro test shall meet the requirements of ASME B31.3, paragraph 304.5.3.

2) Standard Drawings for blinds SAES-L-109 para 10.

Note: Selection of flanges depends on

- i. End connection (Bolted, Weld Neck and Slip-On)
- ii. Ratings
- iii. Operation & maintenance of system.
- iv. Service & temperature.

Gaskets:

i) Spiral Wound Metallic ii) Metallic iii) Non-Metallic

❖ PIKOTEC gasket is used in dis-similar materials or other approved gaskets.

Note: Selection of gasket depends on

1. Flange face. (Raised Face, Flat Face)
2. Ratings.
3. Temperature.
4. Services.

❖ Bolts & Nuts as per SAES-L-109 para 12 and ASME.

1. **ASTM A193 Grade 7:** Bolts
2. **ASTM A320 Grade 3:** Bolts
3. **ASTM A194 Grade 2H:** Nuts
4. **ASTM A194 Grade 4 or 7:** Nuts

SAES-L-110: Threaded Joints, Branch Connections.

Socket Weld requirements: SAES-L-110

- 1) For hazardous services 1 ½" to 2" Max
- 2) For Sour services 1"
- 3) 1.5mm to 3 mm gap has to maintain before welding.

Threaded Joints: SAES-L-110

- 1) For hazardous services 1 ½" to 2" Max.
- 2) For non-hazardous services 3" Max for 4" required special permission.
- 3) PTFE Teflon tape shall not use above 204°C
- 4) Engagement of Threads as below as per **SAES-L-110 para 7.**

ND/ Size	Threads
1/2" - 3/4"	6
1" – 1 ½"	7
2" - 3"	8
4"	10

Branch Connection as per SAES-L-110 para 12 shall be made.

And as per ASME B31.3 304.

SAES-L-150: Pressure Testing for Plant Piping and Pipe Lines. As per para 7 & 8

- Test shall be conducted 1.5 times the design pressure.
- All Joints shall be exposed for visual leakage.
- No painting shall be done on weld joints.
- System shall be pressurized for 30 minutes at 100% & pressure has been increased as 30%, 60% and 100%.
- All punch A items shall be cleared.

Test Preparation

- New piping systems shall be cleaned in accordance with **SAES-L-350.**
- Soft Seated Valves & Control Valves shall be removed.

Flushing.

- Flushing of piping as per **SAES-L-150.**
- Remove temporary supports after flushing & Draining of system.

Water Flushing.

- All CS piping systems shall be flushed using high pressure [60.8 mPa (8.8 ksi) minimum] As per SAES-L-350.
- Stainless steel lines chloride content shall be less than 50 mg/L with dew point -1°C.

SAES-L-350: Construction of Plant Piping.

- All material shall have clear marking.
- All material shall be procured from approved Vendor.
- Fit-Up & Tolerance as per **SAES-L-350 para 9.**
- Shop fabrication of piping shall be in accordance with **01-SAMSS-010.**

Erection and Installation refer SAES-L-350 Para 15

1. Internal Cleaning of Pipe. 2. Visual Inspection for Damage. 3. Using Nylon Ropes. 4. Tag/Spool as per drawing/Elevation. 4. Spool shall not directly placed on Ground.

Flange Alignment as per SAES-L-350 Para 9

- Vertical bolt hole offset: ± 2.4 mm
- Horizontal bolt hole offset: ± 2.4 mm
- Rotational offset: ± 2.4 mm.
- Flange face tilt across diameter: 0.025mm per 25 mm (0.001 inch per inch)
- Maximum of 0.672 mm (0.030 inch).
- Flange face separation, gasket thickness: ± 1.6 mm.
- Combination of vertical, horizontal and rotational offset: ± 3.2 mm.

SAES-H-200: Handling & Storage of Coated Pipes.

Handling of Material:

- All painted & Non Painted materials shall not be placed directly on ground. (150 mm above ground).
- Pipes shall place on mounts or sleepers (**SAES-L-350**)
- Bevel End, Bends, Pipe wall & Coating shall be protected.
- Slings or Nylon ropes shall be used from loading & Off-Loading.
- No steel metal shall be used.
- Coated pipes shall not be dragged or pulled.
- Fittings and valves shall be stored in shipping crates or on racks.

Stacking & Storage of Materials:

- 150 mm above the ground all material shall be placed.
- Material shall be placed level to avoid dropping or Slipping using pads or skids.
- Cover all the material from foreign material using polyethylene or equivalent.
- Stacking height shall not exceed 1.5 Meters.
- ❖ Repair of Coated Material as per SAES-H-200 para 6 and Holiday test has to be conducted.

SAEP-351: Bolted Flange Joints Assembly or Bolt Torqueing.

- Types of Bolt Torqueing 1) Manual. 2) Hydraulic. (Refer Method Statement).
- Tools shall be calibrated with 6 months validity.
- Bolts tightened in accordance with **SAEP-351**.
- Bolt Torqueing Valves as per SAEP-351-02 table for all gaskets except insulating gasket
- Bolt Torqueing Valves as per SAEP-351-03 table for isolating gasket.
- Bolt Torqueing sequence as per SAEP-351 Table 1 for 4 to 32 bolts.
- Bolt Torqueing sequence as per SAEP-351 Table 2 for 36 to 68 bolts.
- Bolt Torqueing as 30%, 60% and 100% with star pattern.
- Bolt Torqueing at 100% circumferential.
- Thread shall be visual as per SAEP-351 after bolt torqueing.

Tightening Procedure where Leaks Occur During Pressure Testing.

- Inspect stud bolts and nuts for defects or damage to threads or improper cleaning of threads.
- Inspect flange faces for damage, misalignment.
- Inspect gasket for damage or defects.
- All completing the inspection torque again.

SAEP-379: Quality Issues Notification. Says refer to SAEP-381.

SAEP-380: Equipment Deficiency Report (EDR).

- Inspectable Material by VID (Vendor Inspection Department) categories defined below.
- 1) Category A 2) Category B 3) Category C 4) Category B.
- 1) Category A: Material procured under this category required visual inspection & released for shipment by VID.
- 2) Category B: Material procured under this category required review of certificates & released for shipment by VID.
- 3) Category C: Material procured under this category required no inspection & released for shipment by VID.
- 4) Category S: Material procured under this category required visual inspection & Inspection & released for shipment by VID

SAEP-381: Escalation Process.

- It says about changing of log-Book to NCR from NCR to Worksheet and from Worksheet to Delinquent Worksheet.

Types of Violation. Any violation against Standards/Codes/Procedures/Drawings then **(By Client)**

1) Minor 2) Moderate 3) Major

1) Minor = log-Book 2) Moderate = NCR (Non Conformance report) 3) Major = Work sheet.

- Reply to LBE/NCR/WS = i) Root Cause ii) Corrective Action iii) Preventive Action
iv) ACD (Agreed Closing Date).

- Response to LBE/NCR within 48 hr.
- Repeated violation with 6 months LBE = NCR / NCR = DWS1 / DWS1 = DWS2 / DW2 = DWS3
- ACD can be extend once, ACD (Change) to = ACD 1.
- If ADC1 is not closed then escalate from LBE=NCR / NCR=DWS1 / DWS1=DWS2 / DWS2=DWS3.

Escalation Stages.

- LBE 5 Stages = LBE = NCR = DWS1 = DWS2 = DWS3.
- NCR 4 Stages = NCR = DWS1 = DWS2 = DWS3.
- WS 3 Stages = DWS1 = DWS2 = DWS3.

INCR (Internal Non-Conformance Report). Raised by Contractor or Sub-Contractor.

- INCR is raised within 48 Hr. client has to be notified.
- ACD can be extend once, ACD (Change) to = ACD 1.
- If ADC1 is not closed then escalate from ACD1 (Changes to) = NCR (Client)
- INCR escalate to NCR of client after ACD1.

SAEP-1150: Inspection Coverage on Projects.

- Inspection Coverage is covered by,
- PQP = Project Quality Plan (That describes the activities, standards, responsibilities, processes (Engineering, Procurement & Construction) necessary to achieve **quality** in the delivery of a **project**).
- QA = Quality Assurance (Assurance of work from Standards/Code/Specification that will be Implemented at different stages of project execution).
- QC = Quality Control (Execution of work as per Standards/Codes/Specification & quality will be Maintained by Inspection & Testing).
- Organization Chart = which says about the Quality personal & communication process.
- PQAM/PQCM = Project Quality Assurance Manager/Project Quality Control Manager will be assigned.
- QCL/QCS = Quality Control Lead's/Quality Control Supervisors as assigned.
- PID = Project Inspection Department (Will be assign to witness/monitor the project execution With level of Insp at different phases).
- QA/QC Inspectors = To assure the quality of work at every activities by testing & inspecting the work And recorded with RFI (Request for Inspection).
- VID (Vendor Inspection Department): Assigned for Material & Procurement.
- Inspection Coverage is done by:
 - 1) ITP (Inspection Test Plan)
 - 2) RFI (Request for Inspection)
 - 3) Level of Inspection.

ITP (Inspection Test Plan):

- 1) Which says about the activity for which inspection is required.
- 2) Client/Contractor/Subcontractor involvement during inspection (H/W/S/A/R).
- 3) Procedure/Specifications/Codes required for the activity.
- 4) Inspection Checklist & Inspection Report required for activity.

RFI (Request for inspection):

- 1) Has to be raised as per activity in the ITP.
- 2) Numbering /Assigned QC as per the area/activity.

Level of Inspection (During Construction).

- 1) Hold = Inspection activity has to be witnessed by Client Inspector (PID). (Mandatory)
- 2) Witness = PID witness is required/not required, can be done by Contractor/Sub-Con.
- 3) Surveillance = PID/Contractor QC witness is not required. (Optional)
- 4) Review = Review of documents by PID work cannot be proceed.
- 5) Approval = Documents required for approval form PID work cannot be proceed.

QA/QC Coverage: Quality department provides inspection services in various phases of the project
By direct inspection, monitoring and quality assessments.

Weekly Project Progress & QC Meetings: Discusses the look-ahead plan, quality issues & solve the issues.

Weekly Look-ahead plan schedule: Look-ahead plane is a planning to cover the work activity and special Importance to any new activity.

SAEP-1151: Inspection requirements for contractor procured materials & equipment.

- Level of inspection for VID, PID, SAID.
- Level 0/1/2/3/4 = applicable for material & equipments at manufacturer.
- Level A/R/S/W/H/ITP = applicable inspections for construction.

AS per SAEP 1151 level of inspection for Material & Equipment		AS per ITP level of Inspection for Construction	
Level 0	Documents required, No Vendor inspection	A	Approve (Documents will be submitted for Approval)
Level 1	Final Inspection prior to Shipment.	R	Review (Documents will be submitted for Approval)
Level 2	All Inspections, Hold/Witness/Surveillance before Shipment.	S	Surveillance (Work can be proceed)
Level 3	Inspection Daily/Weekly/Bi-Weekly basis.	W	Witness (Work can be proceed with permission)
Level 4	Resident Inspector continuously monitoring the work.	H	Hold (Work cannot be proceed without presence of PID/Inspector)

SAEP-1160: Tracking & Reporting of Welding, NDT & Test Package preparation.**Contents of Package.**

- Test Flow Diagram.
- P & ID Marked.
- Isometric Marked.
- Test Limits.
- Water Analysis Report.
- Weld Joint Summary.
- NDT reports.
- Calibration Certificates of all components.
- Manifold Diagram and Calibration report.
- Pre-pressure test Check List (Punch List).
- Reinstatement report.
- Temporary blinds & Components & supports Identification.
- Bolt Torqueing Report.
- Safety Sheet.
- Lay-Up method (If required).

SCHEDULE Q

1. General
2. Quality Management System Requirements (QMSR).
3. Documents Requirements.
4. Management Responsibility
5. Resource Management
6. Project Realization/Execution.
7. Measurements/Analysis/improvement.

Attachment i: Contractor & Sub-Con personal Qualification.

Attachment ii: Company Standards & Procedures containing quality requirements.

Attachment iii: Quality requirements for material.

Attachment IV: Quality requirements for construction phase.

Attachment v: Quality system deliverables.

1. General: Minimum quality requirements for Contractor – Sub-Con.

PQP/ITP/Personal Qualification = **30 Calendar days** for review & approval.

2. QMSR: Implementation of ISO: 9001 latest version **21 days** for approval.
3. **Documents Requirements:** Documents req. for construction, QP/ITP/SATR **7 days** for approval for a revision.
4. **Management Responsibilities:** Internal Audit **every 6 months and within 2 weeks** recommended action.
5. **Resources Managements:**
 1. All quality personnel for project.
 2. Mobilization & De-mobilization date of Quality personnel.
 3. Assign – Re placement – Change – Leave – Vocation of Quality personnel.
6. **Project Realization/execution:** 1. Design 2. Procurement 3. Construction 4. Pre-Commissioning.
7. **Measurements/Analysis/Improvement:**
 1. NCR and LBE shall be reply within **48Hr raised by Owner**.
 2. Summary of Open/Close NCR/LBE with dates shall be maintained.
 3. Contractor Internal (INCR) shall be reported **within 48Hr**.
 4. Investigate Root-Cause and initiate corrective action **within 7 day**.
 5. Internal Audit shall be carried out 6 Months.
 6. Full Audit shall be done (Stages) 15% & 60% (or as per Quality plan).
 7. Audit reports shall be submitted within **14 days** with corrective action.

Attachment i: Contractor & Sub-Con personnel qualification.

1. QCS = shall have Degree & 8 years Exp. Or Diploma & 10 Years Exp.
2. QC = shall have Degree & 5 years Exp. Or Diploma & 7 years Exp.
3. Quality personnel requirements.

Attachment iv: Quality requirements for construction phase.

1. **RFI = 24Hr** at site & **RFI = 48Hr** for week end & remote areas. **1 week = Holiday**.
2. SATIP/SAIC/SAIR = shall be used as per the activity.
3. 2 week look-ahead schedule of all planned quality activities shall be submitted.
4. Implementation of special process. (Qualification of Technicians).

All procedures & Qualification shall be submitted for Review/Approval **21 day's prior to start of work**.

Special Process for Mechanical	Work Procedure Qualification A = Approval Req R = Review Req	Personnel Procedure Qualification Approval Req = Yes/No	Personnel Qualification Approval Req = Yes/No
Welding/Brazing	A	Yes	Yes
NDT	A	Yes	Yes
PMI	A	No	Yes
HT	A	No	No
Pressure testing	A	No	No
Valve Test	A	No	No
Coating & Lining	A	No	Yes
Gasket & Bolt torquing	A	No	No
Hot taps & Tie inns	A	No	No
HVAC testing	A	No	No
RTR pipe works	A	No	Yes

5. Maintain calibration certificate log status with expiry dates.

6. Quality personnel requirements for Project.

Position	Contractor	Sub-Contractor
QA Manager	One (1) Full Time	N/A
QC Manager	One (1) Full Time	One (1) Full Time
QCS (Supervisor)	One (1) full time per discipline for each eight (8) inspectors	One (1) full time per discipline for each eight (8) inspectors
Piping Inspector	One (1) Full Time for (5) Sub-Con Inspector	One (1) Full Time for (15) workers
Valves Testing	One (1) Full Time	One (1) Full Time

Quality System Deliverables:

Title	First Submittal to COMPANY	Subsequent submittals to COMPANY
Quality Plan: Paragraph 3.2 of Schedule "Q"	Twenty one (21) calendar days after the effective date of Contract and for any significant changes	Within 7 calendar days of each revision requirement
Organization Chart(s) Paragraph 5.12 of Schedule "Q"	With Quality Plan submittal	When changes occur
Personnel Qualifications: Paragraph 5.6 of Schedule "Q"	Prior to assignment of personnel on the project	Prior to bringing new Quality personnel on the project
Quality Audit Schedule: Paragraph 7.3.2 of Schedule "Q"	Within twenty one (21) calendar days of the effective date of the Contract	Within 7 calendar days of revisions
Audit Report: Paragraph 7.3.5 of Schedule "Q"	Within fourteen (14) calendar days of completion of the audit and re-audit.	
CONTRACTOR, Vendor and Subcontractor non-conformities: Paragraph 7.5.3 of Schedule "Q"	Within forty eight (48) hours of reporting each nonconformance	Notification of clearance required
Non-conformance Summary: Paragraph 7.5.5 of Schedule "Q"	After the first nonconformance is issued	Weekly for the Project Progress Meeting
Two-week look-ahead schedule; Paragraph 3.3 of Attachment II! Paragraph -1.6 of Attachment IV-	Fourteen (14) calendar days before the start of any inspection activity of first purchase order or start of construction activities	Weekly
Special Process Procedures and Personnel Qualification Procedures: Paragraph 3.11 and 3.13 of Attachment III; Paragraph 2.1 of Attachment IV	Twenty one (21) calendar days prior to operation or test	Prior to execution
Construction Inspection and Test Plans: Paragraph 1.1 of Attachment IV	One month prior to start of construction WORK	Revision -Approval prior to execution
Hydrostatic Test Package: Paragraph 2.1, Attachment IV.	Prior to each hydrostatic test.	Prior to each hydrostatic test.

General Points:

- Types of Joint 1) Butt Joint 2) Threaded Joint 3) Bolted Joint 4) Socket Joint.
- Type of Gasket 1) Metallic 2) Non-Metallic 3) Pilkotek Gasket used between dissimilar material (CS-SS)
- Types of reducers 1) Concentric 2) Eccentric reducers.
- Types of Elbow 1) 90° 2) 45°
- Spectacle Blind = Have two blinds one open & one close, the purpose of this blinds is for maintenance of Line without closing full line. Or used as Isolation of line.

Supports:

- Shoe Support.
- Saddle Support.
- Leg Support.
- Dummy Support (Trunnion Supports).
- Anchor Support
- Cantilever Support.
- Guide Support.
- Spring Support.
- Hanger Support.
- Special Support.

Long Radius Elbow: 90

LRE 90° Elbow	$= 1.5 \times \text{Dia of Elbow in Inches} \times 25.4$ $= 1.5 \times 10" \times 25.4$ $= 381 \text{ MM.}$	45° Elbow	$= 15.7 \times \text{Dia of Elbow}$ $= 15.7 \times 10$ $= 157$
SRE 90° Elbow	$= 1 \times \text{Dia of Elbow} \times 25.4$ $= 1 \times 10 \times 25.4$ $= 254$	SRE 45° Elbow	$= 10.5 \times \text{Dia of Elbow}$ $= 10.5 \times 10$ $= 157$

Note: Take the Length of the elbow and subtract from the total length of the pipe to get actual length of pipe

Example: Actual Length of Pipe = Elbow - Total Length of Pipe.

$$\begin{aligned} \text{Actual Length of Pipe} &= 10" \text{ } 90^\circ \text{ Elbow} - 2000 \text{ MM Pipe.} \\ &= 381 - 2000. \\ &= 1619 \text{ mm.} \end{aligned}$$

Ovality: Non-Circularity of a Pipe/Fittings is called Ovality.

ASME B31.1 - 2001

104.2 Curved Segments of Pipe (B) for ferrous material, when the radius of a bend is 5 nominal pipe diameters or greater, and the nominal wall thickness of the pipe is schedule 40 or thicker, the difference between maximum and minimum diameters shall not exceed 8% of average measured outside diameter of the pipe before bending.

QA/QC

Difference between QA & QC.

QA = Quality Assurance.

QA = Will assure that the work will be

Executed as per which Standards, Codes & Specification.

To maintain the level of Quality in a Service or Product at different stages.

QC = Quality Control.

QC = Work should be executed as per Standards, Codes & Specification by testing & Inspection.

What is Schedule Q?

1. Minimum Quality has to be maintained by Contractor or Sub-Contractor during execution of work at different Stages.
1. Quality Management System Requirements.
2. Documents Requirements.
3. Management Responsibilities.
4. Resource Management.
5. Project Execution.

Responsibilities of QC Inspector.

1. Surveillance & Monitor the activities at Site.
2. Work shall be executed as per Standards, Codes & Specification.
3. Work shall be done as Approved ITP / Drawings / IFC drawings (Issued for Construction).
4. Updated drawings shall be used at Site.
5. Raising RFI & Closing RFI.
6. Maintain the documents & reports on daily basis and update the data for tracing.
7. Perform internal inspections before raising RFI.
8. Assure availability of tools & Equipments during inspection.
9. Familiar with Codes & Standards.
10. Inspection of work done by Construction.
11. Witnessing & Monitoring during execution of work.
12. Work shall be carried out with Safety.
13. Tool box meeting & explaining the work to construction to maintain quality.
14. Guide the construction as per the priority of work.
15. Issue NCR to construction whenever required.

Responsibilities of Piping QC Inspector:

1. Approved Documents/ITP's/Procedure used.
2. Material Receiving Inspection.
 - P.O: Purchase Order
 - Delivery Note
 - IRN: Inspection Release Note (3rd Party)
 - IRC: Inspection Release Check List (3rd Party).
 - Color Coding
 - MTC: Mill Test Certificate 1)Heat Number 2)Material Specification
4) Mechanical Properties (Tensile Test, Tough/Impact Test for LTCS only).
5) Chemical Properties (ASEM SEC-II part A/B).
3. Material Handling and storage. (Refer Above)
4. Fabrication & Fit-Up.
 - Drawing.
 - Material & Color Coding.
 - Fit-Up inspection as per WPS
 - Root Gap: 3-4 mm.
 - Root Face: 0.2 mm.
 - High-Low: 1.5 mm.
 - Bevel Angle: 37.5 Degree.
 - Heat Tractability on fabricated pipes.
 - Orientation of fittings as per drawings.
 - Rollings & Size.

Material Receiving AS PER

SATIP-L-350-01: Material Receiving
SAIC-L-2005: Pipes, **SAIC-L-2006:** Fittings
SAIC-L-2007: Gasket, **SAIC-L-2008:** Bolts
SAIC-L-2009: Flanges.

SHOP FABRICATION AS PER

SATIP-L-350-08: Shop Fabrication
SAIC-L-2035: Cutting & Fit-Up

5. Releasing for Painting/Site.

- Once welding is finished mark the joint details on template & release for paint.
- All the weld joints shall be protected from painting.
- Bevels/End of pipes & Fittings shall be protected from paint.

Pipe Installation AS PER

6. Installation & Erection.

- Internal Pipe should be clean.
- Elevation of pipe as per drawing to know the location.
- Templates for the joint details.

**SATIP-L-350-01: On-plot Piping Installation
SAIC-L-2011 & L-2012: Installation & Erection**

7. Line Check/Pre-Pressure Test/Punch List.

Punch A: Testing cannot be procced without clearing Punch A.

- Welding has to be completed.
- Installation of Vents & Drains.
- Installation of Supports.
- Close all the Log Books & NCR related to package.
- Removal of Paint & Masking tape from weld joints.
- Calibration Certificates (Gauges/Manifold/PSV).
- Temporary Blind Installation details.
- Temporary Welding DWR.
- Water Analysis report.
- As Build Drawings shall be approved.
- Bolt Torquing.
- Temporary supports installation where ever is required.
- Orientation of valves.

Punch List AS PER**SATIP-A-004-02: Hydro test of On-plot Piping
SAIC-A-2010: Pre-Test Punch List
SATR-A-2007: Punch List****Punch B:**

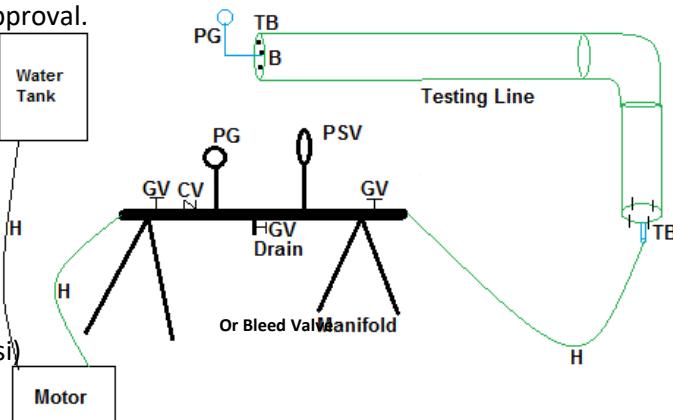
- Paint Touchup.
- Removal of Temporary Items.
- Seal Weld on Vents & Drains.
- Draining of Line.
- Flushing of Line.

Punch C:

- Paint Touch Up.
- House Keeping.

8. Hydro Test. (Its type of method used to check the leak in the System using water).

- Package Submission/Review/Approval.
- Test Limits identification.
- NDT & reports. (Clearance)
- Weld Summary. (Clearance)
- SIS (Safety Instruction Sheet).
- Clearing Punch A.
- Hydro Test preparation.
- Fill the water in the line.
- Calculation for Hydro Test.

Design Pressure of Line 100 PSI. (1 Bar = 14.5 Psi)**PG = Pressure Gauge.****PSV = Pressure Safety Valve.****CV = Check Valve.****TB = Test Blind / Temporary Blind.****B = Bolts.****H = Hose/Pipe.****Hydro Test Pressure.**

1.5 X Times Design pressure.

100 X 1.5

150 Psi.

Manifold Pressure. (Calibration 6 Months)

1.2 X Times the test Pressure.

150 X 1.2

180 Psi.

Pressure safety Valve. (Calibration 7 Days)

0.5 Times the test pressure (or) 10 % of test pressure which one is less?

150 X 0.05 = 7.5 Psi

157.5 Psi.

Pressure Gauge. (Calibration 6 Months).

Pressure should be between 30 to 80 % in the dial range.

- Pressure the line by 30%, 60% & 100%

Hydro Test pressure 150 Psi (Pressure shall be increased gradually).

30% = 45 Psi hold 10Min 60% = 90 Psi hold 10Min

100% = 150 Psi hold 30 Min.

- Hydro Test complete (No leak)
- Drain the line.
- Flush the line.
- Close the line and protect the line.

Hydro Test as per SATIP-A-004-02

SAIC-A-2001: Hydro Test Procedure

SAIC-A-2003: Review of Test Package

SAIC-A-2011: Test Preparation

SAIC-A-2015: Test Pressure Inspection

SATR-A-2001: Pressure Test Report

SAIC-L-2017: Flushing of Line

SATR-A-2008: Flushing of Line Report

Bolt Torquing: As per SAEP-351 (Torque wrench 6 Months calibration)

- Bolt Torquing is done by two type Manual & Hydraulic.
- Manual & Hydraulic follow the same method.

1. Star Pattern

30% Value

60% Value

100% Value

2. Circumferential /Circular

100% Value.

SAIC-L-2014: Bolted Flange Inspection

Lay-Up: SAES-A-007 Refer the above documents.

SAIC-A-2007: Lay-Up Procedure

SATR-A-2009 & SATR-A-2014: Lay-Up Inspection

Reinstatement:

- Drain, Flushing & Hydro test completes & documents are accepted.
- All Vents & Drains are seal Welded.
- All temporary components shall be removed.
- Clear Puch B & Punch C.
- Jacking Screw, Process blind, Spectacle blind, Spade etc., correctly installed.
- Spring hangers & Components as per Mfg.
- Reinforcement pad Air Test 5 Psi.
- Close weep hole with heavy grease.
- Chain wheel operator installed.
- All instruments & Valves are installed in correct flow.
- Orifice flow elements installed.
- Pressure relief valve installed with calibration tag.
- Gasket / Bolt torquing as to be done.
- All start-up items shall installed (Strainers, Filters Other items restricted from test)
- Lay Up as per Owners approval.
- Chemical Cleaning completed (If required).
- Final line Check as per specification.

SAIC-A-2006: Reinstatement Procedure

SATR-A-2007 & 2011: Reinstatement (Post-Test) check list

PMCC: Partial Mechanical Completion Certificate will be issued to Construction of completion of above activities.

Note: Punch B & C or other minor works will be changed to **Master Punch** that will be given by

Pre-Comm & Commissioning team. And will be cleared by them.

Log Book Entry: It's given when there is any violation in work. (Work Executed against Codes & Standards)

NCR: For more refer SAEP-381 Escalation Process.

NCR: Non Conformance report is given for the repeated violation within 6 months.

NCR: Contents.

- 1) Root Cause 2) Corrective Action 3) Preventive Action. 4) ACD (Agreed Closing Date)
(Has to be replied within 7 working days).
- 2) ACD (Agreed Closing Date) when we are going to close NCR there is no time limit.
If NCR is not closed in ACD we can change the date 1 Time.

Pre-Commissioning:

Commissioning:

Non Metallic Piping & Utility Piping

- SAES-L-070:** Installation of Utility Piping.
SAES-L-610: Non-Metallic Piping.
SAES-L-650: Construction of Non-Metallic Piping.

6. **RTR:** Reinforced Thermosetting Resin.
7. **FRP:** Fiber Reinforced Plastic.
8. **GRE:** Glass Reinforced Epoxy.
9. **GRP:** Glass Reinforced Pipe.
10. **GRV:** Glass Reinforced Vinyl ester.
11. **PVC:** Polyvinyl Chloride.
12. **CPVC:** Chlorinated Polyvinyl Chloride.
13. **HDPE:** High Density Poly Ethylene.

14. Material Handling & Storage same as Metallic Piping. SAES-S-070 & SAES-H-200.

- All material should shall be protected for direct sun light.
- All Material should keep in building or shade.
- Solvents, Chemicals, bounding agents & Cements shall be kept at 26.7°C Max.

15. Test Preparation as per Metallic piping. SAEP-1106

16. General Requirements for Hydro Testing as per SAES-A-004.

17. Pressure Testing for Plant Piping & Pipe Lines SAES-L-150.

- ***Hydro Test is conducted for 2 Hr. for the joints exposed for visual leakage.***
- ***Hydro Test is conducted for 24 Hr. for the joints backfilled and recorded on Pressure Recorder.***
- ❖ ***All the activities as same as Metallic Piping.***

Construction Activities as per SAES-S-070 Para 8

- Qualification of installer. 1) Shall be trained 2) Trail Joint. 3) Approval from Manufacture.

Excavation of Trenches SAES-S-070 Para 9 & SAES-L-650

- O.D + 300 (300 + 300 =600) trench size Minimum.
- Shall have work space for jointing & other activities.
- Trenches shall be protected from land escape.
- 150 mm ground bed shall be done below the pipe.
- Slop of trench less than 15 Degree.
- 2 or more pipes in one trench distance B/W them is 1 M (**SAES-L-650 para 7.2.**)

Backfilling of Pipes SAES-S-070

- Clean sand shall be used for backfilling.
- Backfilling shall be conducted layer by layer as 300mm.
- Compaction has to be done (Manually) with water.
- Back filling on top of the pipe is from (300-900mm).

Assembly of Pipes SAES-S-070 & SAES-L-610

- Pipes shall not move after joint is completed till it cures.
- Cure time of joints is depends on weather from (10-150 Minutes).
- If required external heating shall be given for (120 Min – at 90 – 120°C).
- All material used for lamination shall be from manufacturer.
- Follow the manufacturer instructions for lamination.
- All the solvents shall be mixed as per manufacturer.
- Pipe joints shall be made in trenches.

- Flat Face flanges shall be used in piping system.
- Pipes can be backfilled partially with joints exposed.
- Handle the pipes with care during assembly & Installation.

Inspection of Joints SAES-S-070 & SAES-L-610

- As per ASTM D2563.
- Visual inspection of joints for any defects.
- Heating Time & Socking Time.
- Barcol Hardness Test (Min- 30 value).
- Repair of Joints & Damages (As per Manufacturer).
- Distance B/W 2 joints not less than 0.6 Mtr (2ft).
- **Visual Inspection Acceptance Criteria refer SAES-L-650 Appendix A**
 - **Crack, Void, Crazing, Dry Spot, Burn, Chip, Pin Hole, Impact Mark**

Hydro Testing SAES-L-610

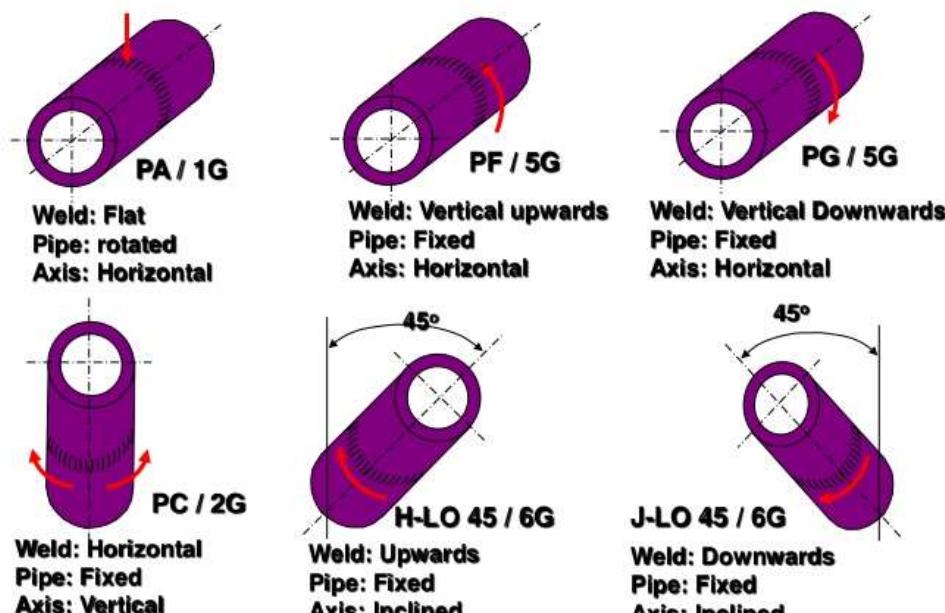
- Gauges, Manifold, Test Package, Check list, Re-instatement as same as Metallic Piping.
- Water: Potable water, Drinking Water or Sea water can be used for hydro test.
- Hydro test for 4 Hr. when joints are exposed for visual leakage.
- Hydro test for 24 Hr. when joints are backfilled and recorded on thermal recorder.

Bolt tightening procedures and maximum torque for bolting on nonmetallic flanges shall be in accordance with ASTM D4024.

NOTE: All the activities will be same as above ground piping except few.

Welding General Notes:

Pipe Welding Positions 2.17



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Notes 1: Welder Qualify for 2G + 5G is qualified for all positions.

2: Welder Qualify for 6G is qualified for all positions.

3: Position & Process of welder for which he is qualified.

4: Welder qualify for $\frac{1}{2}$ " thickness is qualified for 2times the thickness Eg: 12.7mm thickness = 25.4mm thickness.

5: Welder qualify for 1" thickness is qualified for unlimited thickness Eg: 25.4mm thickness = Unlimited thickness.

6: JCC card: Job Clearance Card (Have to Check).

i) P numbers ii) F numbers iii) Thickness iv) Process v) Position vi) Uphill/Downhill vii) Backing.

i) P-numbers = Refer to Base material.

ii) F-numbers = Refer to Filler material.

iii) Thickness = Refer to thickness of pipe.

iv) Process = GTAW (Gas Tungsten Arc Weld) / SMAW (Submerged Arc Weld)

v) Position = 1G/2G/5G/6G.

vi) = Uphill / Downhill.

vii) Backing = Using any shield during welding from back side of the weldment.