1. Standards Followed for Material and Construction:

a. ASTM : American Society for Testing & Materials.
b. ASNT : American Society for Non-Destructive Testing.
c. ASME : American Society for Mechanical Engineering.
d. AWS : American Welding Society.
e. API : American Petroleum Institute.
f. AWWA : American Water Works Association.
g. ANSI : American National Standard Institute.
h. AISI : American Iron & Steel Institute.
i. NACE : National Association of Corrosion Engineers

2. American Society of Mechanical Engineers (ASME)

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 Systems for Liquid Hydrocarbons and other Liquids
5. ASME B31.5 - Refrigeration Piping
6. ASME B31.8 - Gas Transmission and Distribution Piping System
7. ASME B31.9 - Building services piping.
8. ASME B31.11 - Slurry Transportation Piping System

- ASME B16.1 - Cast Iron Pipe Flanges and Flanged Fittings
- ASME B16.5 - Pipe Flanges and Flanged Fittings up to 24”
- ASME B16.47- Large Diameter Steel Flanges (Above 24”)
- ASME B16.36 - Orifice Flanges
- ASME B16.48- Spectacle plate, Blank & Spacer

- ASME B16.9 - Steel Butt welding Fittings
- ASME B16.28 - Steel Butt welded Short Radius Elbows and Returns Bends
- ASME B16.25 – Butt welding Ends

- ASME B16.11 - Forged Steel Socket-Welding and Threaded Fittings

- ASME B16.20 - Metallic Gaskets for Pipe Flanges
- ASME B16.21 - Nonmetallic Gaskets for Pipe Flanges

- ASME B16.10 – Face to Face & End to End Dimension of valves.
- ASME B16.34 - Steel Valves (Flanged, Threaded and Butt Welding End)

- ASME B16.39- Malleable Iron Threaded Pipe Unions

- ASME B36.10 - Welded and Seamless wrought iron pipes
- ASME B36.19 – Stainless Steel pipes

3. ASME SEC

- ASME SEC I – Rules for Construction of Power Boiler
- ASME SEC II – Materials

a) Ferrous Materials
b) Non Ferrous Materials
c) Specifications of electrodes and filler wires
d) Properties

- ASME SEC V – NDE
- ASME SEC VIII – Rules for Construction of Pressure Vessels
- ASME SEC IX – Welding and Brazing Qualifications

4. American Petroleum Institute (API)

- API SPEC 5L- Specification for Line Pipe
- API SPEC 6D - Specification for Pipeline Valves
- API STD 599- Metal Plug Valves-Flanged, Threaded and Welding Ends
- API STD 600- Steel Gate Valves-Flanged and Butt-Welding Ends
- API STD 602 -Steel Gate, Globe, and Check Valves for Sizes NPS 4 and Smaller for the Petroleum and Natural Gas Industries
- API STD 607 -Fire Test for Quarter-Turn Valves and Valves Equipped with Nonmetallic Seats
- API RP 941- Steels for Hydrogen Service at Elevated Temperatures and Pressures in Petroleum Refineries and Petrochemical Plants
- API-570 – Piping Inspection Code
- API-598 – Valve Inspection and Testing
- API-601 – Metallic Gasket
- API 609 - Butterfly Valves, Lug-Type and Wafer-Type

- 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.

SATIP

SATIP-A-004-01 – Pneumatic Testing
SATIP-A-004-02 – Hydro Testing of On plot piping
SATIP-A-004-03 – Hydro Testing of Pipelines
SATIP-A-004-05 – Leak Testing
SATIP-L-108-01 – Valve Inspection , Testing and Installation
SATIP-L-350-01-- On-Plot Metallic Piping Installation
SATIP-L-350-02-- Piping Tie-In Installation For Plant Piping

SATIP-L-350-05-- Fire Water Distribution Piping Installation
SATIP-L-350-06 - PLANT PIPING - Steam & Steam Condensate Piping
SATIP-L-350-07 - Cement Lined Pipe Installation
SATIP-L-350-08 - Shop Fabrication - Piping & Miscellaneous Steel Structures
SATIP-L-350-09- Utility Piping Installation - Plant Air & Nitrogen Gas
SATIP-W-011-01- Welding of On-Plot Piping
SATIP-J-600-01 - Safety Relief Valve Installation

SAES

- SAES-A-004 - General Requirements of Pressure Testing
- SAES-A-007- Hydrostatic Fluids and Lay-up Procedures
- SAES-A-206 - Positive Material Identification
- SAES-B-017- Fire Water System Design
- SAES-L-100 - Applicable Codes and Standards for Pressure Piping
- SAES-L-101- Regulated Vendor List for Pipes, Fittings and Gaskets
- SAES-L-102 - Regulated Vendor List for Valves
- SAES-L-105 – Piping Line Classes
- SAES-L-108 - Selection of Valves
- SAES-L-109 - Selection of Pipe Flanges, Stud Bolts and Gaskets
- SAES-L-110- Limitations on Piping Joints and Components
- SAES-L-120- Piping Flexibility Analysis
- SAES-L-125- Safety Instruction Sheet for Piping and Pipelines
- SAES-L-130 - Material for Low Temperature Service
- SAES-L-131- Fracture Control of Line Pipe
- SAES-L-132- Material Selection for Piping & Pipeline
- SAES-L-133 - Corrosion Protection Requirements for Pipelines/Piping
- SAES-L-136- Pipe, Flange, and Fitting Material Requirements
- SAES-L-140 - Thermal Expansion Relief in Piping
- SAES-L-150 - Pressure Testing of Plant Piping & Pipe Line
- SAES-L-310 - Design of Plant Piping
- SAES-L-350 - Construction of Plant Piping
- SAES-L-410 - Design of Pipelines
- SAES-L-450: Construction of On-land & Near-shore pipelines.
- SAES-L-610 - Nonmetallic Piping
- SAES-W-011- Welding Requirements for On-Plot Piping
- SAES-W-012 - Welding Requirements for Pipeline
- SAES-H-002- Internal and External Coatings for Steel Pipelines and Piping
- SAES-H-200 - Storage, Handling and Installation of Externally Coated Pipe

- SAES-J-100 – Process flow metering
- SAES-J-600 - Pressure Relief Devices
- SAES-J-700 - Control Valves
- SAES-S-010 - Sanitary Sewers
- SAES-S-020 - Oily Water Drainage Systems
- SAES-S-030- Storm Water Drainage Systems

SAEP

SAEP-35- Valves Handling, Hauling, Receipt Tests, and Storage
SAEP-302- Instructions for Obtaining a Waiver of a Mandatory Saudi Aramco Engineering Requirement
SAEP 319 – Pressure Relief Device Testing Inspection.
SAEP-1150 - Inspection Coverage on Projects
SAEP-1151 - Inspection Requirements for Contractor Procured Materials and Equipment
SAEP-1154 - Guidelines for Contractor's Quality Plan
SAEP-1160 - Tracking and Reporting of Welding, NDT and Pressure Testing for Capital Projects
SAEP-327 - Disposal of Wastewater from Cleaning, Flushing and Dewatering Pipelines and Vessels
SAEP-351 - Bolted Flange Joints Assembly
SAEP 385- Preservation of Project Material And Equipment.
SAEP-388: Cleaning of Piping.

SAIC & SATR

Pre-Welding & Weld Joint Fit-Up Inspection – SAIC-W-2005 & SATR-W-2006
Branch Connection
a) Integrally Reinforced welding
Outlets, I.e. : Weld-o-Lets, Weld Boss
b) Reinforced Stub-ins
Threaded connections inspection - SAIC-L-2015

Venturi, Flow Orifice Plate & Restriction orifice installation - SAIC-L-2016
Thermowell Installation - SAIC-L-2020
Chemical Injection & Sample Connections - SAIC-L-2021
Relief valve installation - SAIC-J-2009
Bolt Torquing – SAIC-L-2014 & SATR-L-2001
Valve Installation – SAIC-L-2043
Pre-Test Punch List – SAIC-A-2010 & SATR-A-2007

Internal Cleaning – SAIC-L-2017 & SATR-A-2008
Pressure Gauge Calibration Report – SATR-A-2002
Relief Valve Calibration Report – SATR-A-2006
Water Analysis Report – SATR-A-2014

Hydro Test Checklist & Report

Verification of Testing Equipment – SAIC-A-2009
Inspection of Pressure Test Preparation - SAIC-A-2011
Inspection of Filling and Pressurization - SAIC-A-2013
Visual Inspection at Pressure Test - SAIC-A-2015
Depressurization and Disposal of Waste Water - SAIC-A-2017
Pressure Test Report – SATR-A-2001
Lay-up Inspection – SAIC-A-2018 & SATR-A-2009
Reinstatement – SAIC-L-2022 & SATR-A-2011

Pneumatic Test

Pressurization of Pneumatic Test (Strength & Service) - SAIC-A-2020
Inspection of Pneumatic Test (Strength & Service) - SAIC-A-2021
Depressurization of Pneumatic Test (Perform Leak Test) - SAIC-A-2022
Pressurization for Bubble Leak Test (Using Air, Inert Gas) - SAIC-A-2023
Inspection of Leaks for Tightness Testing - SAIC-A-2024

Duties & Responsibilities

To Control all the Quality Related activities as per approved standard and procedures

Material Receiving
Fabrication and Erection as per standards
Valve installation and Bolt torquing flange joint assembly
Pre-Test punch listing
Internal Cleaning
Testing (Hydro, Pneumatic, Service)
Lay-up
Re-instatement

Schedule Q

It is the minimum Quality Requirement for Contractor and Sub contractor quality System.

Quality Plan

It is a document, that specify quality standards, specifications and the sequence of activities to a particular project or contract.

SATIP

Saudi Aramco Typical Inspection Plan. It Includes Sequence of various activities perform and inspections and these sequence of activities are (1) Documentation Review (2) Material Receiving (3) Installation (4) Pre-Commissioning

Pre-Commissioning

To check the ability to withstand the operating pressure prior to the introduction of final product

Inspection Action Points

Hold :- QA/QC organization shall be notified of the timing of inspection or test in advance. Inspection or test shall not be carried out without the QA/QC organization representative in attendance.

Witness :- QA/QC organization shall be notified of the timing of Inspection or test in advance. However, the inspection or test shall be performed as scheduled if the QA/QC organization representative is not present

Review :- Activity can proceed with approved Documents

Surveillance :- QA/QC organization to monitor work in progress without notice from Construction Organization.

prevent their frequent opening.

- Pressure Test: A test conducted to piping or equipment by subjecting it to an internal pressure using liquid or gas to ensure strength or tightness of the system at the test pressure.
- Hydrostatic Test: A pressure test conducted using water or other approved liquid in test medium.
- Pneumatic Test: A pressure test conducted using air or other approved gases in the test medium.
- Leak Test: A pressure test to ensure tightness of flanged and threaded joints at the test pressure.
- Service Test: A pressure test conducted at maximum operating pressure Using service fluids.
- Strength Test: A pressure test to verify the integrity of the piping systems or equipment for service at the design pressure.

Material Receiving

- PO (Purchase Order)
- DN (Delivery Note)
- MTC (Material Test Certificate)
- MTO (Material Take Off)
- Inspection Release Certificates (IRC)
- Vendor Approval

Material Identification

All pipe and fittings shall have the material specification and grade stamped, stenciled, or otherwise clearly marked with permanent marking method

9COM : - Commodity Classification Code number used in the SAP system to procure material

CCC :- "Commodity Classification Code"

Minimum Inspection Levels of Material Receiving

- Level 0- only document required no need to vendor inspection.
- Level 1-only final inspection is required prior to shipping.
- Level 2- Pre inspection is required one or more surveillance.
- Level 3- same as level 2.
- Level 4- Resident inspector continuously monitoring the work.

PRESERVATION (Storage and Handling)

- Pipe shall not be stored directly on the ground. Pipe shall be placed on mounds or sleepers
- Stacking of pipes shall be made in a manner to avoid damage to pipes or coatings.
- Fittings and valves shall be stored in shipping crates or on racks
- End protectors on pipes, flanges, weld bevels, threads, and socket ends shall be firmly attached
- Stainless steel material shall be protected against exposure to seawater splash during shipment and storage
- Lined and coated pipes and fittings shall be lifted with wide fabric or rubber covered slings and padding shall be used to prevent damage to lining or coating
- All materials shall be handled with care during fabrication and installation to prevent damage

Pipe Fit-Up and Tolerances

- The maximum tolerance for axial dimensions, face-to-face, center-to-face and location of attachments shall be ± 3 mm.
- Flattening of bends, measured as the difference between the largest and the smallest outside diameter at any cross section, shall not exceed 5% of the nominal diameter of the pipe. Flattening of bends at weld ends shall not exceed 3% of the nominal pipe diameter.
- Lateral transition of branches and connections from the centerline of the run shall not exceed ± 1.5 mm.
- Rotation of flanges, measured as the offset between elevations of bolt holes on opposite sides of a flange centerline, shall not exceed ± 2.4 mm.
- The tilt of a flange measured at the periphery across any diameter shall not exceed 1.6 mm from the square position.
- For piping over 3-inch NPS and connected to machinery/equipment, flange alignment shall be within the following
  a) Vertical bolt hole offset : ± 2.4 mm
  b) Horizontal bolt hole offset : ± 2.4 mm
  c) Rotational offset : ± 2.4 mm
  d) Flange face tilt across diameter: 0.025 mm per 25 mm (0.001 inch per inch) of flange outside diameter up to a maximum of 0.672 mm (0.030 inch), and 0.254mm (0.010 inch) for all flanges with an outside diameter less than 10 inches.
  e) Flange face separation, gasket thickness : ± 1.6 mm
  f) Combination of vertical, horizontal and rotational offset : ± 3.2 mm

  In the case where a spectacle plate is installed between two flanges, these tolerances can be increased by 30% except for tolerances for flange face tilt across diameter and flange face separation.
- Internal misalignment (High-Low) of butt joints shall not exceed 1.5 mm.
- If post-weld heat treatment (PWHT) of pipe spools is required , non-pressure containing welded attachments such as shoe support for insulated lines, dummy extensions and legs, and wear pads shall be welded to the pipe spools before stress relieving. PWHT of piping spools with flanged joints shall be done before flange assembly

Dummy Supports

A 6 mm weep hole shall be drilled for all dummy supports. The weep hole shall be located near the base plate for all vertical dummy supports, and near the run pipe at 6 o'clock position for all horizontal dummy supports.

Low Friction Support

Teflon sheets or similar low friction materials are used to function as low friction supports

Sliding surfaces shall be protected from paint and sand blasting.

Provision shall be made to allow angular adjustment of the bearing surface during installation, so that an even distribution of the load can be assured.

Low friction supports shall be constructed such that sand or other debris cannot accumulate on sliding surfaces (by making the top surface larger than the bottom surface).

Spring Supports

The spring setting shall be verified that they are matching the design requirements.

The spring support shall be in full engagement with pipe.

All springs shall be in compression, so that failure will not result in the complete release of load.

Springs shall be factory set to the calculated cold settings by means of travel stops. Upper stops for load preset and lower stops for hydro-test shall be provided. These stops shall be banded or locked in place so they cannot be easily dislodged during erection or hydro-test. The travel stops shall be painted red and shall have a bright color tag indicating "Remove after Hydro-test."

Each spring hanger assembly must be capable of sustaining the load during hydro testing, which is equal to 2 times the operating load.

Hanger Rods

Rod hangers shall not be used for lines 12" NPS and larger in liquid service or multi-phase flow.

All hangers shall be provided with means for vertical adjustment

Suitable locking devices shall be used at all threaded connections of the hanger assembly (double nuts).

Bolt Torquing Procedure

Bolts, nuts and washers shall be visually checked for proper size, grade, and dimension and for any physical damage Also, the suitability of the stud bolts and nuts material for the service temperature and the compatibility with the flange material shall be checked.

The bolts/nuts combinations for which the nuts will not turn freely by hand shall be verified

The gasket rating and dimension for piping system shall be verified as required by ASME B16.20 and ASME B16.21.

The gasket seating Area shall be examined for compliance with the recommended surface finish and for damage to surface finish such as scratches, nicks, gouges and burrs

The nuts shall be turned freely by hand before applying the lubricant

Lubricant shall be applied to both the nut bearing surface and the male threads.

Align the Flange and Gasket

Torque wrench should be calibrated. accuracy should not exceed ±5%.

Torquing crew shall be proper trained people

Mark the studs as per tightening Sequence

Tightening shall have a minimum of four passes (33%-66%-100%-100%) to achieve the required torque load

The nuts shall have full thread engagement after the flange assembly.

Note:- Torque values shall be determined according to flange rating, bolt size, type of gasket, and the lubricant's friction factor

Spiral Wound gasket:

Outer rings are required for all pipe sizes.

Inner rings are required for the following flanges:

1. Flanges size 24" and larger;
2. Flange class 900# and above;
3. Spiral wound gaskets with graphite or PTFE filler materials.
4. Flanges in vacuum services.

When raised face flanges are to be used, the flange finish shall be 3.2 to 6.4 micrometers Ra

For hydrogen service, flange facing surface finish for raised face shall not exceed Ra 3.2 micrometers (125 microinch).

For general hydrocarbons and process hydrocarbon services including steam, ASME B16.20 spiral wound gaskets with 316 stainless steel winding and high purity flexible graphite filler shall be used for raised face flanges

Spiral wound gaskets with graphite filler material is limited to 425°C

Ring joint Gasket

The dimension of the ring-joint gasket indicated by letter designation (R, RX, or BX) stamped on the ring gasket was verified to conform with the flange size and flange standard where it will be used.

Rubber coated ring joint gaskets may be used for severely corroded services.

Soft iron or low carbon steel may be used for the ring type joint material.

Ring joint flanges for use with ring joint gaskets per ASME B16.20 shall be used for:

Flanges in Class 900 and higher ratings
Underwater pipelines in Class 300 and higher ratings,
Design temperatures in excess of 480°C,
API SPEC 6A Type 6B flanges,
Hydrogen service in Class 300 and higher ratings.

Material Selection for Bolts and Nuts

Process and general services :- (- 40 to 450) - A193 Grade B7 & A194 Grade 2H

Low temperature services :- (- 73 to 450) - A320 Grade L7M & A194 Grade 7M
(-101 to 343) - A320 Grade L7 & A194 Grade 4 or 7

High temperature services :- (450 to 645)- ASTM A193 Grade B16 & A194 Grade 4

Wet sour services :- (-48 to 450) - A193 Grade B7M & A194 Grade 2HM
(- 73 to 450) - A320 Grade L7M & A194 Grade 7M

PIKOTEK Gaskets

Pikotek Gaskets are used to dissimilar metal flanged joints with high potential galvanic corrosion and Insulting joints for cathodic protection.
PIKOTEK gaskets shall not be used in services operating at 280°F and higher.

Parts of Pikotek Gasket

Insulation G
asket
Insulating sleeve
Insulating washer
Plate washer

Pikotek Gasket for water corrosive services where flange face corrosion is a concern,

Gaskets with Teflon sealed, glass reinforced epoxy laminated to 316 stainless steel core.

Flange Standards

24 inch size and smaller flanges shall be as per ASME B16.5.
Ab ove 24 size inch flanges shall be as per ASME B16.47 series A.

ASME B16.47 Series A flanges are identical to MSS SP-44 flanges.
API SPEC 6A , 6B Flanges shall be rating 3000 and above, from 1½-inch to 10-inch NPS

Blind Flanges

A105N, from - 20°C to 425°C
A350 LF2 Cl 1, from - 45°C to 425°C
A516 Gr 70 N, from - 45°C to 425°C.

Maximum Size for the Allowed Bore in the Blind Flanges

Size of NPS Flanges	Maximum NPS for Tapped Pipe
4”	1½”
6”	2”
8”-14“	3”
16” and larger	4”

Types of Flanges

Weld neck flanges
Slip on flanges
Lap joint flanges
Socket welded flanges
Screwed flanges
Threaded flanges
Orifice flanges
Blind flanges
Integral flanges
Swivel ring flanges

Weld neck flanges –used for but welding where Radiography is required.it is commonly used for 2” and above and also used for high pressure services.
Slip on flanges – it is a double welded joint flange. one joint with hub and other joint with bore Slip-on flanges are used only for category D services.
Lap joint flanges – it is used to avoid welding dissimilar metals where the pipe stub-end is made from high alloy material and the flange body is made from carbon steel.it is also used for Easy alignment of bolt holes.
Swivel ring flanges - swivel ring flanges used for underwater pipe tie in connection
Threaded flanges – used for threaded connection
Blind flanges – used for where flange to be re-open

Orifice flanges – used for process flow metering
Socket welded flanges - used for socket welding

Jackscrews shall be used to facilitate flange separation for maintenance
For orifice flanges, jackscrews shall be installed at 3 and 9 o'clock positions.

Bolt Tensioning Procedure (HYDRATIGHT - 50% Tensioning Method)

Bolts, nuts and washers shall be visually checked for proper size, grade, and dimension and for any physical damage Also, the suitability of the stud bolts and nuts material for the service temperature and the compatibility with the flange material shall be checked.
The bolts/nuts combinations for which the nuts will not turn freely by hand shall be verified
The gasket rating and dimension for piping system shall be verified as required by ASME B16.20 and ASME B16.21.
The gasket seating Area shall be examined for compliance with the recommended surface finish and for damage to surface finish such as scratches, nicks, gouges and burrs
The nuts shall be turned freely by hand before applying the lubricant
Lubricant shall be applied to both the nut bearing surface and the male threads.
Align the Flange and Gasket
Mark the studs as per tightening Sequence
Mark bolts in 2 Sets, Set 'A' & Set 'B', alternatively.
Tensioners are fitted to every other bolt of Set 'A'.
Pressurize the tensioners to pre-determined "Pressure A" per the approved procedure. (This is repeated 2 more times.)
Transfer tensioners to Set 'B' bolts and pressurize to pre-determined "Pressure B" and tighten nuts. This is repeated 2 more times. (NOTE: Pressure B is lower in value than Pressure 'A')
After tensioning, Break Loose Pressure (BLP) is verified to be greater than or equal to Pressure B by the following steps:

a) Fit tensioner to one of the tensioned bolts in Set 'A'.
b) Pressurize slowly until the nut is loosened using a Tommy Bar and socket.
c) Once the nut moves, stop pressurizing and record the achieved pressure. This is the Break Loose Pressure(NOTE: If BLP < Pressure B, Tensioning is a Fail.)

Bolt Tensioning Procedure (HYDRATIGHT - 100% Tensioning Method)

Bolts, nuts and washers shall be visually checked for proper size, grade, and dimension and for any physical damage Also, the suitability of the stud bolts and nuts material for the service temperature and the compatibility with the flange material shall be checked.
The bolts/nuts combinations for which the nuts will not turn freely by hand shall be verified
The gasket rating and dimension for piping system shall be verified as required by ASME B16.20 and ASME B16.21.
The gasket seating Area shall be examined for compliance with the recommended surface finish and for damage to surface finish such as scratches, nicks, gouges and burrs
The nuts shall be turned freely by hand before applying the lubricant
Lubricant shall be applied to both the nut bearing surface and the male threads.
Align the Flange and Gasket
Mark the studs as per tightening Sequence
Mark bolts in 2 Sets, Set 'A' & Set 'B', alternatively
Tensioners are fitted to ALL bolts.
Pressurize the tensioners to pre-determined "Pressure A" per the approved procedure. (This is repeated 2 more times.)
After tensioning, Break Loose Pressure (BLP) is verified to be greater than or equal to Pressure A by the following steps:

a) Fit tensioner to one of the tensioned bolts in Set 'A'.
b) Pressurize slowly until the nut is loosened using a Tommy Bar and socket.
c) Once the nut moves, stop pressurizing and record the achieved pressure. This is the Break Loose Pressure.
(NOTE: If BLP < Pressure A, Tensioning is a Fail.)

Notes - Manual torque wrenches shall not be used for 1” bolts size and larger.

SAES-L-108 – SELECTION OF VALVES

all new valves designated for isolation service (as specified by the Proponent) shall be subjected to a high pressure hydrostatic seat test prior to installation in the line. A low pressure pneumatic seat test at (5 psig) shall be substituted for the high pressure hydrostatic seat test for flare system valves
Butt weld and socket weld end valves in nominal pipe size (NPS) 2 inches and smaller are Exempted from field testing requirements for flare system valves
All resilient (soft) seated isolation valves shall have zero leakage.

Trim material :- includes the stem, the body and closure, seating surfaces, bushings, pins, springs, guides, and any other small parts in contact with the service fluid

The use of welded bonnet valves in hydrocarbon services shall be limited to NPS 4 inch and smaller

Screwed bonnet and screwed body valves shall not be used in any hydrocarbon or hazardous material services unless the bonnets and body end connections are tack welded to the body or provided with locking pin

Union bonnet valves shall not be used in any hydrocarbon or hazardous material services

In hydrocarbon services, the minimum body rating of threaded and socket weld end NPS 2 inch and smaller valves shall be equivalent to API STD 602 Class 800

Chain wheel operation shall not be provided for emergency isolation valves or valves having a threaded body connection.

Gate valves with back-seats shall not be installed with their stems below the horizontal except in the following cases: (a) clean services, (b) when they function as isolation valves in pressure relief and flare system piping, and (c) when in utility or other similar non-critical services (firewater is considered to be critical service).

All threaded connections on valve bodies and associated piping shall be seal welded.

Lever operated ball valves shall be equipped with a hand wheel or self-locking handle to prevent accidental operation

Concentric butterfly valves, such as the API STD 609 Category A type (typically with internal rubber linings), are permitted only in non hydro carbon applications

Butterfly valve Minimum requirements in hydrocarbon service are

Butterfly valves in hydrocarbon service shall be limited to a maximum rating of Class 900

Design according to API STD 609 Category B valves with offset-seat type construction.

Valve body shall be of the lug-type with tapped bolt holes or (double) flanged type has been specified. (Use of the wafer-type body is not permitted)

Valves shall be full-rated. In systems where the normal operating pressure is 103 kPa (15 psig) or less, the valve may be specified with half-rated trim (approximately 50% of the full-rated pressure).

Valves shall be bi-directional, although they may have a "preferred" direction. Valves shall be installed in the "preferred" direction indicated on the valve

Check Valves

Dual and single plate wafer check and swing check valves shall not be used in reciprocating pump and compressor suction and discharge services or similar pulsating services.

A non-slam internal-spring-assisted type check valve shall be installed at the discharge of pumps and compressors.

For all sizes NPS 4 inch and above, a turbulence-free minimum distance of 5 pipe diameters upstream and 2 pipe diameters downstream of every check valve shall be maintained. pipe fittings such as elbows, reducers, tees, etc., or flow restricting devices such as orifices, control valves, etc., shall not be installed in these zones

Check valves in sizes NPS 3 inch and above shall not be installed in vertical lines,

Check valves in hydrocarbon service up to Class 600 shall either have a lug-type body with tapped bolt holes or a flanged body. In higher ratings, a flanged body is mandatory.

Wafer-type bodies are not permitted in any hydrocarbon service

Spring-assisted non-slam piston check valves (also referred to as nozzle check valves) shall be long-pattern with face-to-face dimensions in accordance with API SPEC 6D

Plug Valves

Used only for Hydrocarbon service

Flanged plug valves in hydrocarbon service shall be of the inverted lubricated pressure balanced design, except that Class 150 valves NPS 6 inch and smaller may have a standard plug with springs for balancing the plug

Note;- All valves in services below -45°C shall be full austenitic stainless steel
All valves in service below -100°C shall have an extended bonnet.

For LPG or high pressure gases which auto refrigerate, an upstream gate valve shall be installed in addition to the throttling valve in any line that discharges to the atmosphere or to a low pressure system.

Under water Isolation valves shall be ball type with a minimum rating of Class 300. The flange face shall be the ring joint type

Isolation valves in stand-alone pressure relief valve inlet and discharge piping shall be gate, ball, high performance butterfly (flanged) or plug valves that can be car-sealed open. A gate valve in this service shall be installed with the stem

in or below the horizontal position. For clean gas service, the valves shall be soft seated with double block and bleed capability if temperature permits.
Isolation valves in flare system piping shall be gate, ball, high performance butterfly or plug valves .A gate valve in this service shall be installed with the stem in or below the horizontal position
Emergency isolation valves (EIVs) shall be gate, ball, high performance butterfly (flanged) or plug valves
Atmospheric drain and vent valves shall be provided with a plug or blind on the discharge side
Flangeless valves shall not be used as the first block valve against storage tanks or vessels containing hazardous materials
Scraper trap mainline isolation valves shall be full bore thru-conduit gate or ball valves.
Scraper trap Drain valves shall be inverted pressure balanced lubricated plug valves with Stellite hardfacing on the plug and body seating surfaces.
Scraper trap Kicker valves and vent valves shall be inverted pressure balanced lubricated plug valves
Instrumentation root isolation valves shall be API STD 602 gate valves.
Steam service Isolation valves, NPS 2 inch and larger, in Class 600 and higher rated systems shall be parallel slide gate valves equipped with a cavity pressure relief system
Blowdown valves in gas pipelines shall be plug valves
Mainline bypass/equalization valves in gas service shall be inverted pressure balanced lubricated plug valves
Monel K-500 may be substituted for Monel 400 where additional hardness or strength is required
Do not use diaphragm valves in dry chlorine service
For water services, use PVC up to 50°C. Use CPVC in range between 50°C and 72°C.

Punch list;- List of unfinished or un matched item as per IFC Drawing

"A" punch items

Any direct welding and NDT balance
All in line BT
Valve test Report
Orifice flange flush grinding and seal welding
Arc strikes and Gouges
All weld joint, flanged, and threaded joint should be visually exposed prior to hydro test

Straightness, plumb out
Dead leg, Dog Leg
A 6 mm Weep hole should be provided all vertical and horizontal dummy support
Internal flapper of welded check valves should be remove

"B" punch items

All Guide supports
Orifice plate and jack screw installation
All Test limit should be final BT with permanent gasket and bolts
All instrument connection
FG and Strainer should be installed
All check valves and control valves as per process flow direction
Internal flapper of welded check valves should be re-installed
All spectacle blind and paddles should be installed as per P&ID
Pipes are in full contact with the supports.
All vents and drains are provided with bar stock plugs or blinds
All nuts and bolts of flange connections are fully engaged
Relief valve installation
Painting
Insulation

Contents of Test Package

1. Table of content
2. Flow chart
3. Index
4. Safety instruction sheet
5. Mark-up P&ID
6. Isometric drawings
7. Support drawings
8. GA drawings
9. Weld summary
10. NDE Summary
11. Blind list
12. Valve test report
13. Bolt Torquing flange joint assembly SAIC & SATR
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15. Internal cleaning SAIC & SATR
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17. Calibration Report of PG, RV and Manifold
18. Water analysis Report

19. Lay-up SAIC & SATR
20. Re-instatement SAIC & SATR

Pressure Rating or Class (ASME B16.5/B16.47 Flange Class)

1- 150, 3 - 300 , 6 - 600 , 9 - 900 , 15- 1500, 25 - 2500
80 - Non-pressure , 90 - Class 3000 API 6A , 95 - Class 10000 API 6A, 99 - Design pressure

Line Material

BC - Copper Tubing
LP - Polypropylene-lined Carbon Steel
BD - 90-10 Cu-Ni
LT - PTFE Lined Carbon Steel
CA - Impact Tested Carbon Steel
NC - Hastelloy C276
CS - Carbon Steel
NM - Monel 400
CG - Galvanized Carbon Steel
NR - Incoloy 800
CH - Carbon Steel, PWHT for Process
NT - Carpenter 20 (Alloy 20)
CT - HIC Tested Carbon Steel
PU - CPVC(Chlorinated PVC)
CJ - 1-1/4 Cr-1/2 Mo Alloy Steel
PV - PVC(PolyVinyl Chloride)
CK - 2-1/4 Cr-1 Mo Alloy Steel
SA - 304/304L Stainless Steel
CL - 5 Cr-1/2 Mo Alloy Steel
SC - 304H Stainless Steel
CM - 9 Cr-1 Mo Alloy Steel
SD - Type 316/316L Stainless Steel
CX -Carbon Steel, Jacketed
SL - 347 Stainless Steel
DC - Cast Iron, Grey
SP - Duplex Stainless Steel UNS S32205/S31803
FE - Glass Fiber Reinforced Epoxy
SJ - 321 Stainless Steel
LC - Cement-lined Carbon Steel

SY - Super Duplex Stainless Steel UNS S32750
LE - Epoxy-lined Carbon Steel
SV - 254 SMO UNS S31254
LH - HDPE-lined Carbon Steel
WA - Reinforced Thermoplastic Pipe
LL - Cladded Carbon Steel

Corrosion Allowance

Symbol	Corrosion Allowance
0	Zero
1	1.6 mm (1/16”)
2	3.2 mm (1/8”)
3	4.8 mm (3/16”)
4	6.4 mm (1/4”)
9	Corrosion allowance as noted.

Service

Symbol	Service
A	Acid
C	Caustic
D	Drain/Sewer
H	Hydrogen
P	Process (General Hydrocarbon)
T	Wellhead Piping (Owner designator)
U	Utility
W	Water (Owner designator)
Y	Chlorine Gas (Owner designator)

Saudi Aramco Service Codes

Code	Service	Code	Service
A	Air	NG	Natural Gas
MO	Mist Oil	BBD	Boiler Blowdown
AH	Acid Hydrocarbon	OS	Oily Sludge
N	Nitrogen	BD	Blowdown

AS Acid Sewer
BFW Boiler Feed Water
BS Bio-Sludge
C Chemical
CA Caustic
CAS Caustic Sewer
CAT Catalyst
CS Chemical Sewer
CW Chilled Water
CWR Cooling Water Return
CWS Cooling Water Supply
DGA Diglycolamine
DFW Deaerator Feed Water
DMW Demineralized Water
DSW Distilled Water
DT Duct Trims
DW Drinking Water
E Exhaust Steam
EIA Emergency Instrument Air
FG Fuel Gas
FGH High Pressure Fuel Gas
OW Oily Water
OWS Oily Water Sewer
P Oil & Oil Products
PA Process Air
PE Pond Effluent
PG Purge Gas
PO Pump Out
PT Pump Trims
PW Process Water
R Refrigerants
RL Relief Line
RLC Cold Relief Line
RLW Warm Relief Line
RW Raw Water
S Steam
SA Sulfuric Acid
SC Steam Condensate
SCA Spent Caustic
SF Sulfur
SO Seal Oil
SOW Sour Water

FGL Low Pressure Fuel Gas SPO Slop Oil
FLO Flushing Oil SR Sewer (Storm)
FO Fuel Oil SW Salt Water
FW Fire Water SWS Sanitary Sewer
GG Gart Gas TPW Tempered Water
H Hydrogen TW Treated Water
HCL Hydrochloric Acid UA Utility Air
HO Hydraulic Oil UW Utility Water
HSG Hydrogen Sulfide Gas VG Vent Gas
IA Instrument Air VT Vessel Trim
LO Lube Oil W Water
ME Methanol WW Waste Water
600C 600 psig H.P. Condensate 150C 150 psig M.P. Condensate
60C 60 psig L.P. Condensate 15C 15 psig L.P. Condensate
600S 600 psig H.P. Steam 150S 150 psig M.P Steam
60S 60 psig L.P. Steam 15S 15 psig L.P. Steam

Chemical or Vapor Phase or Foam Cleaning

The interior of the piping for the following specific services shall be cleaned after hydrostatic pressure testing to remove oil, grease, preservatives, rust

a) Boiler feed water and steam condensate.
b) Lube oil and seal oil.
c) Seal gas supply piping.
d) Steam supply line to turbines.

e) DGA, TEG, and Refrigerant systems.

f) If necessary to meet service fluid quality.

NOTES:- Test pressures less than 85% of SMYS can have relief valves set at 10% above test pressure.

Pressure Testing manifold shall be separately pressure tested to at least 1.2 times the system test pressure but not less than the discharge pressure of the pump used for the pressure testing.

Pressure rating or design of test manifold components (isolation valves, pipe nipples, fittings) exceed system test pressure by 20%

Test Manifold pressure tested to at least 20 percent above test pressure of the system under test.

The following items shall be excluded from the in-situ pressure testing

Rotating machinery, such as pumps, turbines and compressors;

Strainers and filter elements

Pressure relieving devices, such as rupture disks and pressure relief valves;

Locally mounted indicating pressure gauges, where the test pressure will exceed their scale range;

Equipment that cannot be drained (This includes valve cavities. See Valve Care

Instrument Devices).

Other unlisted sensitive equipment (propose exclusion in test package)

Internal Cleaning Methods

Water Flushing - Equipment which is sensitive to damage during water flushing shall be removed, blocked off or isolated. systems shall be flushed using high pressure jet of rotating hose or rotating nozzle with a minimum Water velocity of 3 m/s. The general flushing medium shall be plant/ process water or raw water.

When flushing stainless steel lines, the chloride ion content shall be less than 50 mg/L. After flushing, the piping systems shall be completely drained, dried to a dew point below -1°C and protected against corrosion

Pneumatic Flushing

Pneumatic flushing with dry air (dew point -1°C or less) or steam with a minimum exit velocity of 15 m/s. Repeat flushing until cleanliness is verified

by observing the absence of any solids impact on a polished metal target at the exit

Pressurized Air Shock Blowing (PASB)

PASB is used to removing trapped liquid in the piping, or to verify cleanliness of small bore pipe where video inspection is impossible or inadequate due to pipe dimension or configuration and PASB used for initial cleaning for instrument air, plant air and nitial cleaning of small bore pipe (less than 2 inch). The air shocking pressure shall never exceed the working pressure of the system or (115 psi). Repeat PASB until cleanliness is verified by observing the absence of any solids impact on a polished metal target at the exit

Mechanical Scrapers

Mechanical scrapers can be used under the condition that damage to the pipe interior surface shall not occur.

Notes :- Equipment must be laid-up after hydro testing unless it can be ensured that it will be returned to service within 30 days from the first introduction of hydro test water to the system.

Lay up Methods

Wet Lay up

After Remove the hydro test water from the system. Maintain the system under a positive pressure between 30 to 50 psig using nitrogen, sweet hydrocarbon gas or hydraulic pressure of the treated water. Use gauges to monitor the positive pressure in the system during lay-up with a scale range not exceeding three times the target pressure. Minimum residual oxygen scavenger concetration in water shall be 20 ppm & maximum O2 concentration of 10 ppb

Dry Lay up

After Remove the hydro test water from the system. Immediately start drying the system using hot dry air or dew point controlled air to a dew point of -1°C or less reached at all exit points. Shut in the system, maintain and monitor the pressure during the lay-up period. When the required dew point is reached, pressurize the system with nitrogen or sweet gas to the final lay-up pressure of 30 psig .

Ambient Lay up

Remove the hydrostatic test water using a positive pressure of nitrogen or sweet gas until no water drains out of the system. Shut in the system under positive pressure until commissioning and start-up.

Inert Gas Lay-Up

Remove the hydrostatic test water using nitrogen or sweet gas until no water drains out of the system. Shut in the system at 2-10% of operating pressure or 50 psig or less with nitrogen or hydrocarbon gas

Other approved gas lay up

Eg:- Vapor-Phase Corrosion Inhibitor (VCI)

When the bulk of the water has been removed, blow vapor phase corrosion inhibitor Cortec VpCI 309 or equivalent with nitrogen until it is visibly discharged at the bottom of the valve

SAES-L-110 - Limitations on Pipe Joints and Components

The maximum size of socket-welded joints in hazardous services shall be 1½-inch for new construction.

The maximum size of socket-welded joints in hazardous services shall be 2-inch for maintenance, minor field modifications of existing piping systems, and when necessary to match existing equipment connections.

For sour service, the maximum size of socket-welded joints shall be 1-inch.

The axial gap between male and female component shall be maximum of 3 mm and minimum of 1.5 mm. This gap is required prior to welding

The use of sleeve couplings shall be limited to cement lined pipe in water services such as firefighting piping systems and oily water service

The following piping components are not allowed to use in pressure piping systems

Caulked joints

b) Soldered, brazed, and braze-welded joints

c) Expanded joints: (They are slip on type of joints using O-ring to seal the pressure.)

d) Bell-type and packed joints

The thread joints shall be taper pipe thread (NPT) conforming to ASME B1.20.1

In hazardous services, the maximum size of threaded connections shall be 1½-inch for standard fittings and valves,

In hazardous services, the maximum size of threaded connections shall be 2-inch maximum when required for maintenance, or minor field modifications of

existing piping systems, or to match threaded specialty devices such as scraper signals and access fittings for corrosion monitoring.
Threaded connection shall not be used in hydrogen service.
In non-hazardous services, the maximum size of threaded connections shall be 3-inch for standard fittings and valves,
In non-hazardous services, the maximum size of threaded connections shall be 4-inch maximum on special items such as fire hydrants

Thread Engagement Requirements for Taper Pipe Threads

Nom. Pipe Size	Number of Threads Engaged
1/2" & 3/4"	6
1" through 1-1/2"	7
2" through 3"	8
4"	10

PTFE (Teflon) tape shall not be used for service temperature greater than 204°C on threaded connections

Seal welding of all threaded joints up to the first block valve is required in the following services and applications:

a) All hydrocarbons.
b) Boiler feed water, condensate, and steam systems utilizing ASME Class 300 and higher flange ratings.
c) Toxic materials such as chlorine, phenol, hydrogen sulphide, etc.
d) Corrosive materials such as acid, caustic, etc.
e) Oilfield chemicals (e.g., corrosion inhibitors, emulsifiers, electrolytes, etc.)
f) Piping which is subject to vibration, whether continuous or intermittent

Seal welding is not required for the following services and applications:

a) Thermowells
b) Bar stock plugs downstream of a seal-welded block valve.
c) Special devices such as access fittings and scraper signals.
d) Joints which require frequent disassembly and are located downstream of a seal welded block valve, e.g., sample connections.
e) Instrument piping downstream of the primary instrument isolation valve.
f) Pipe union ring threads and joints with elastomer o-rings.
g) Threaded joints, downstream of a seal welded root valve, which discharge directly to an open drainage system or to the atmosphere.
h) Extended body valves with integrally reinforced welding end per API STD 602.

PTFE (Teflon) tape or joint compounds shall not be used in threaded connections requiring seal welding

For steel piping in hazardous services, threaded and socket welding fittings shall conform to ASME B16.11 Class 3000, Class 6000 or higher.

Pipe unions in hazardous services shall be limited to Class 3000 threaded socket welding forged steel unions in accordance with MSS SP-83. The material shall be carbon steel per ASTM A105, ASTM A350 or alloy steel per ASTM A182.

Pipe unions shall not be installed in the pipe section between the main pipe run and root valve.

Threaded bushings with one size reduction shall not be used. When bushings are allowed, only hex head steel bushings shall be used. Flush steel bushings are not permitted.

Welding bosses shall be forged steel ASTM A105, ASTM A350 or ASTM A182,.

Integrally reinforced welding outlets (such as Weldolets, Threadolets, Sockolets, etc.) in Class 3000, 6000 or higher.

Malleable iron screwed fittings shall conform to ASME B16.3 Class 150 and shall be galvanized and limited to non-hazardous services, except that pipe unions shall be Class 300.

Pipe plugs for use in metallic piping shall be solid body, bar-stock, or forged steel plugs in accordance with ASME B16.11

The material requirements of carbon steel butt weld fittings to: ASTM A234 Grade WPB and MSS SP-75

Crosses are not permitted

Laterals shall be used for low pressure system (less than 150 psig) such as flare lines.

Branch connections, such as those for drain and vent connections, on tees, elbows and reducers are not permitted

SAES-310 :- DESIGN OF PLANT PIPING

Dead Leg : Dead legs leading to internal corrosion shall be avoided at the design stage Piping sections that are potential for internal corrosion due to flow stagnation

A section of a piping system meeting the following criteria is considered as a dead leg:

1) When a pipe section is connected to a flowing stream where it is not self-draining and is not normally flowing.

b) The piping material has the potential for corrosion in service.

c) When the length is longer than three times its pipe diameter, or 1.22 m (4 ft) whichever is less. The length of the dead leg is the distance measured from the outside diameter of the header (or run) to the near end of the branch valve

For branch connections of 1-½ inch NPS and smaller, the length of the dead leg is the distance measured from the end of the boss to the near end of the valve.

Commentary

Dog Leg : Due to distortion during welding

Drip Leg : used to Remove condensate from steam lines

Intermediate sizes and the sizes: ⅛, ¼, ⅜, 1¼, 2½, 3½, and 5 inches shall not be used except when necessary to match equipment connections.

Pipe (excluding stainless steel tubing) smaller than ¾-inch nominal size shall not be used for hazardous services (including vents and drains) except for instrument connections

Threaded pipe is allowed up to NPS 2" for existing facilities in hydrocarbon services and up to NPS 3" for utility piping

Exemptions to Dead Legs

A section of a piping system meeting the following criteria is not considered as a dead leg even if it meets the dimensional criteria above:

a) Piping system that is corrosion resistant by its nature.

b) The service is not corrosive and experience has demonstrated such claim.

c) The service is not wet

All piping shall be routed and supported to allow access to machinery for operation, inspection and maintenance. Inlet and outlet isolation block valves around machinery shall be accessible from grade near machinery.

Isolation block valves are required in the inlet and outlet process piping to and from all machinery. A check valve shall be installed in the discharge line of all pumps. The check valve shall be located between the machine discharge flange and the discharge block valve.

Pressure connections including isolation valves shall be provided on the inlet and outlet piping to and from all machinery. The inlet pressure connection shall be located between the permanent or temporary strainer and the machinery inlet piping flange.

Inlet and discharge piping and isolation block valves shall be the same size or larger than the machinery inlet and outlet nozzle size respectively.

Temporary strainers shall be used during the commissioning and initial operating period of new plants to prevent foreign objects from entering the machinery.

Strainer shall be located between the inlet isolation block valve and the machinery inlet connection not closer than five pipe diameters to the machinery inlet nozzle.

Piping vents and drains shall be located in break-out-spools on the inlet and outlet piping to the machine. These connections shall not be placed in angle sections of reducers

Centrifugal equipment suction line shall have a straight run minimum of five pipe diameters between the suction flange and first valve, fitting or strainer to ensure stable and uniform flow at the machinery suction nozzle. The minimum length shall be calculated using the diameter of the pump inlet nozzle. Vertically suspended double casing pumps and horizontal self-priming pumps are exempted from this requirement

Piping Connected to Pump

Suction piping shall be designed to prevent the formation of gas or air pockets. Sufficient venting provisions shall be included.

The suction piping shall be sloped a minimum of 10 millimeters per meter (⅛ inch per foot) toward the pump

Reducers used on horizontal suction line shall be eccentric with the flat side on top. Eccentric reducer with the flat side on top shall be utilized for overhead piping into a top suction pump. Concentric reducer shall be used on the vertical suction line as required.

Suction and discharge piping for vertical in-line pumps shall have adjustable supports

If strainers are required beyond commissioning and initial operating period, they shall be “T” or “Y” type with minimum ¼ inch openings and at least 150% flow area

Piping Connected to Compressor

Horizontal reducers installed in the inlet piping to compressors or blowers shall be eccentric with the flat side on the bottom of the pipe to prevent the accumulation of any liquids.

Suction piping layout for wet gas compressors shall be free of sections where standing liquid may accumulate and shall slope back toward the suction vessel.

Adequate drains on the piping shall be provided to remove any standing liquids

Suction piping to wet gas compressors shall be heat traced and insulated.

The suction line to each compressor or blower shall be provided with permanent or temporary strainer of an adequate strength.

Routing of compressor recycle lines shall be designed to be self-draining preventing liquid from accumulating in piping low points.

The anti-surge recycle line shall join the compressor discharge on a piping tee branch, located as close as possible to the compressor discharge. The anti-surge recycle line should join the compressor suction line at the suction knock-out drum or suction piping upstream of knock-out drum in a 45° angled connection directing the recycle flow towards the compressor.

The type of check valve shall be non-slam internal-spring assisted type.

Reciprocating compressors suction piping downstream of the suction drums and pulsation suppression devices of compressors operating at or within 5°C of the gas saturation temperature shall be heat traced and insulated to ensure that condensation of liquids does not occur.

Positive displacement machinery shall be equipped with a pressure relief device. This pressure relief device shall be located between the machinery discharge connection and the first isolation block valve or blind. Pressure relief device discharge piping shall be routed to a designated system.

All pressure piping appurtenances shall be isolated to atmosphere by double isolation (e.g., double block valves or one block valve with plug or one block valve with blind flange).

Notes:-

Above-grade piping shall be supported to provide a minimum of 300 mm clearance between bottom of the pipe and the finished grade.

A minimum clearance of 50 mm shall be provided for inspection and freedom of pipe movement between above ground piping crossing with any structure (including pipe support structure). This clearance is also required for above ground piping crossing with another pipe.

Branch connections, 4 inch and smaller, including drain and vent valves and drip legs of all sizes, shall be located at a minimum horizontal distance of 610 mm (24 inches) from any fixed obstruction. This requirement does not apply to that part of the support which is attached directly to the piping, such as horizontal and vertical dummy extensions.

The minimum cover over underground pressure piping shall be 450 mm in unpaved or paved areas and 750 mm under paved roads

Rod hangers shall not be used for lines 12” NPS and larger in liquid service or multi-phase flow

Saddle-type supports with pads shall be provided for piping 30-inch NPS and larger

Connectors and Color Coding for Plant Utility Stations

Utility	Hose Connection	Color Code
Demineralized Water	1-inch brass Aeroquip 5101	
Blue-White stripe	Raw Water	1-inch brass Aeroquip 5101
Blue	Air	¾-inch iron Dixon Air King AM-8
Green/Gray stripe	Steam	1-inch steel Dixon Boss Wf-36
White	Nitrogen	1-inch steel wing nut union
Green/Orange stripe		

Hose connections positioned at elevation shall be 600 mm to 1200 mm. They shall be pointing 45 degrees downward. The piping shall be securely bolted to a supporting structure and have adequate access.

Utility connections shall be installed with minimum 150 mm clearance between each other.

Each utility take-off connection shall be located at the top of the horizontal main header or auxiliary header.

Root valves shall be provided for each utility take-off connection from a main header or auxiliary header

Instrument air take-off connections to the plant utility station shall always be provided with root valves.

Each utility line shall be provided with an isolation valve just upstream of the specified hose connector and Ball or globe valves shall be used for air, water,

In nitrogen service, globe or angle valves shall be used for steam service,

Each line shall have a service name plate in Arabic and English indicating the service.

The utility pipe and the ends of hoses provided with the station shall be color coded.

The steam line shall have a steam trap and shall be insulated for personnel protection except for utility steam take-off lines.

Utility steam take-off lines shall be insulated but shall not be provided with steam traps. Utility steam stations located above the utility steam header shall be self-draining

The utility side shall have a block (root) valve, pressure gauge, check valve and a drain valve to depressurize the hose or the break-away spool.

The process side shall also have a check valve, block valve and pressure gauge near the hose connection. When disconnected, both open piping ends shall be capped, or plugged, or fitted with blind flange

SAES-A-004 :- GENERAL REQIUREMENTS OF PRESSURE TESTING

Category D Fluids : fluids which are nonflammable, nontoxic and fluids which are not damaging to human tissue on contact.
Category M Fluids :- fluids which are flammable, toxic and fluids which are damaging to human tissue on contact.
Pressure Test : A test conducted by using liquid or gas to build up an internal pressure to ensure strength or tightness of the system at the test pressure.
Hydrostatic Test: A pressure test conducted using water or other approved liquid as the test medium.
Pneumatic Test: A pressure test conducted using air or other approved gas as the test medium or in conjunction with liquid
Service Test : A pressure test conducted at operating pressure using the service fluid
Leak Test: A pressure test to ensure tightness of flanged and threaded joints at the test pressure.
Strength Test: A pressure test at an internal pressure determined in accordance with standard and the applicable Code to verify the integrity of the piping systems for service at the design pressure
Revalidation Test: A pressure test performed to prove the integrity of existing pipelines or plant piping
Tightness Test: A pressure test to ensure tightness of the piping system (i.e., no leaks in the system) at the test pressure

Pressure Test procedure

An approved test procedure shall be available at the site prior to pressure test
A minimum of two pressure gauges are required for the test system. One pressure gage shall be on the test manifold and the others on the test system. Their accuracy shall be within 5% of one another. When the system is larger two more gauges are required. The calibration interval shall not exceed one (1) month prior to the test date and calibration certificates shall be available at site. Stickers shall be applied indicating the latest calibration date. All gauges shall have a range such that the test pressure is within 30 to 80% of the full range.
Relief valve is located in the system under test and near the test pump with Isolation valves on the inlet and outlet of the relief valve sealed open during the test. Relief valve(s) of adequate capacity are set to relieve at 5%* above the hydro test pressure. . The calibration interval shall not exceed one (1) week prior to the test date and calibration certificates shall be available at site. Stickers or TAG shall be applied indicating the latest calibration date.
A bleed valve shall be provided to protect the piping and equipment from overpressure. The bleed valve shall be readily accessible in case immediate depressurization is required.

Blind flanges, paddle blinds or spectacle blinds shall be used to isolate the test sections. They shall be the same class rating or higher of the system

All in-line valves if not used as test isolation valves shall be in a partially open position

When a block valve is used for isolating test sections, the differential pressure across the valve seat shall not exceed the seat test pressure during pressure testing

check valve has a by-pass valve, the disc of the check valve shall be removed, and securely attached to the outside of the check valve prior to the pressure test.

All vents shall be open during filling

Filling and pressurizing shall be done on the upstream side of check valves in the system. The test fluid shall be injected at the lowest point in the system

After reached the Test pressure, The isolation valve between the test manifold and pump shall be closed and the test pump disconnected. The isolation valve downstream of the manifold shall be opened after the pump is disconnected

Note :-

The maximum CS equipment contact time with hydro test water shall be 14 days from the first introduction of water

Equipment must be laid-up after hydro testing unless it can be ensured that it will be returned to service within 30 days from the first introduction of hydro test water to the system.

The maximum SS equipment contact time with hydro test water shall be 4 days from the first introduction of water

At end of lay-up, commission & start up heat exchangers shall be within 14 days, & other equipment within 60 days

Type 300-series stainless steel systems shall be tested only with water having maximum allowable chloride concentration of 50 ppm

Sulfate Reducing Bacteria (SRB) count of 10^3 per ml or less as determined by the Rapid Chek II Method

Treatment of Hydrostatic Test Water

When CS equipment contact time with hydro test water exceed 14 days and SS equipment contact time with hydro test water exceed 4 days an approved oxygen scavenger shall be added to the hydrostatic test water. Treat water before it enters the system. Use batching scrapers and or a slug of nitrogen to separate the air in the system from coming in contact with treated water, then fill systems with water injecting sufficient oxygen scavenger to maintain its residual concentration at greater than 20 ppm & an oxygen concentration of less than 10 ppb

Lube and seal oil piping shall be pressure tested with its own fluid. The test pressure shall be 1.5 times the design pressure or 690 kPa (ga) (100 psig) whichever is the greater

Underground process piping shall be tested prior to backfilling. The test pressure shall be maintained for a minimum of 2 hours

If the must be back-filled, then the joints shall remain exposed during testing, otherwise the test shall be a 24 hour recorded test.

Flare lines 24-inch NPS and larger with a design pressure of (75 psig) or lower may be pneumatically strength tested

Piping in vacuum service shall be pressure tested to 1.5 times the differential external pressure not less than 100 kPa (ga) (15 psig)

Service test is acceptable for the following services:

a) Plant utility piping in air and inert gases services with a designed pressure and equal to less than 035 kPa (ga) (150 psig).

b) Low pressure steam piping designed for 60 psig or less

Low pressure steel piping in water, instrument air, plant air, inert gas (Nitrogen, Argon, etc.), and steam systems operating at 1035 kPa (ga) (150 psig) or lower, may be strength tested with its own product at its operating pressure (service test).

Weld-Plus-Ends shall be subjected to a pneumatic pressure test of 35 to 70 kPa (ga) (5 to 10 psig) in the annulus between the gasket and the seal weld. It shall be examined for leaks using a soap solution

Air Gap: An air gap is the unobstructed vertical distance through the free atmosphere from the lowest opening from any pipe, equipment, Air gap shall be a minimum of 25 mm (1 inch) and shall not exceed 100 mm (4 inch).

Orifice flanges up to 24 inches shall be in accordance with ASME B16.36 and ANSI 2530/API 14.3/AGA-3.

Orifice flanges larger than 24" can be based on ASME B16.47

In process piping , Orifice flanges shall be rated at a minimum of ASME/ANSI Class 150.

For liquid and steam services, pressure taps shall be located on the horizontal side of the piping or up to 45 degrees down from horizontal. The impulse lines shall be sloped downward approximately 1:12 toward the transmitter

For gas and vapor services pressure taps shall be located on the vertical from the top of the piping, or up to 45 degrees from top. The impulse lines shall be sloped downward approximately 1:12 toward the process connections

All parallel pipe lines with adjacent orifice flanges or orifice fittings shall have a minimum spacing of 300 mm (12 in) between flanges outside diameters if horizontal taps are required. In addition, they shall be staggered so that no two pairs of orifice flanges (centerline to centerline) are less than 1 m (3 ft) apart
Interconnecting impulse tubing between a differential flow element and a transmitter shall be limited to a maximum length of 6 m (20 ft) for flow meters used in control loops.
Flow measurements requiring temperature compensation thermos wells shall be located between 5 to 20 nominal pipe diameters downstream of the meter

Orifice plate installation

Flange taps shall be used for all orifice meter installations
Paddle type orifice plates shall be used where raised face orifice flanges are used.
Orifice plate shall be stamped with the Instrument Tag Number of the element, the element location in the pipe, the pipe internal diameter and the direction of flow
Drain or Vent hole for Vertical Meter Run – No hole
Horizontal Meter Run, Wet Gas or Saturated Steam – One drain hole, bottom location.
Horizontal Meter Run, Gas Entrained Liquid service - One vent hole, top location.