



Exploration & Production

GENERAL SPECIFICATION

PIPING VALVES VESSELS

GS PVV 111

Piping design specification

03	10/04	General review
02	10/03	General review – Change of Group name and logo
01	10/02	General review
00	03/01	First issue
Rev.	Date	Notes

Contents

1. Scope	4
2. Reference documents	4
3. Materials.....	6
3.1 Tubes.....	6
3.2 Fittings	7
3.3 Connections.....	8
3.4 Flanges	8
3.5 Gaskets and bolts	9
3.6 Valves	10
3.7 Change of piping material class.....	10
4. General design rules.....	10
4.1 Layout of piping	10
4.2 Flexibility of piping	11
4.3 Clearances and access	12
4.4 Installation of valves	14
4.5 Installation of instruments	15
4.6 Vents and drains.....	16
4.7 Isolation (GS ECP 103)	16
4.8 Utility stations.....	17
4.9 Sample taps.....	17
4.10 Thermal insulation and heat tracing.....	17
5. Special design rules.....	17
5.1 Vessels and columns.....	17
5.2 Storage tanks.....	18
5.3 Reactors	18
5.4 Exchangers.....	18
5.5 Air coolers.....	18
5.6 Heaters	19
5.7 Pumps.....	20
5.8 Compressors	20



6. Supports	21
6.1 General.....	21
6.2 Identification of supports.....	21
6.3 Temporary supports.....	21
7. Principle for the preparation of the main piping drawings, documents and models.....	21
7.1 General appearance of documents	21
7.2 Piping and Instrument Diagrams (P&ID's)	22
7.3 Line list.....	24
7.4 General drawings.....	24
7.5 Piping drawings	26
7.6 Isometric drawings.....	26
7.7 Piping supports	27
7.8 Models	28
8. List of equipment	28
8.1 Characteristics of equipment	28
8.2 Identification of equipment.....	28



1. Scope

This document sets rules for the design of piping systems (process and utilities) of onshore and offshore petroleum installations.

Its scope is essentially the same as that of [ASME B31.3](#). The following are specifically excluded: onshore and offshore pipelines, furnaces and boilers tubes, building heating and ventilation piping.

For high pressure piping class 10 000 API, piping shall be designed according to chapter IX "High Pressure Piping" of [ASME B31.3](#).

2. Reference documents

The reference documents listed below form an integral part of this General Specification. Unless otherwise stipulated, the applicable version of these documents, including relevant appendices and supplements, is the latest revision published at the EFFECTIVE DATE of the CONTRACT.

Any divergence between any of the Contractual Reference Documents, or between this specification and any other Contractual Reference Document, shall be reported to the COMPANY for decision. In such a case, and unless otherwise agreed or decided by the COMPANY, it is understood that the more stringent requirement shall apply.

Exceptions to, or deviations from this specification are not permitted unless previously accepted in writing by the COMPANY. For this purpose, requests for substitutions or changes of any kind shall be complete with all pertinent information required for the COMPANY assessment.

Regulations

If the country of installation has its own regulation, it must be applied wherever more stringent than the Basic Code.

Any Construction Code or Government Regulations, which may be listed in the Project Specifications or in the contract, shall have precedence except where this Specification is more stringent.

Standards

Reference	Title
API RP 14E	Recommended Practice for Design and Installation of Offshore Production Platform Piping Systems
NACE MR-01-75/ISO 15156	Materials for Use in H ₂ S-containing Environments in Oil and Gas Production
ASME B1.20.1	Pipe Treads (Except Dryseal)
ASME B16.5	Steel Pipe Flanges and Flanged Fittings
ASME B16.10	Face to Face and End to End Dimensions of Valves
ASME B16.47 Serie "A"	Large diameter steel flanges NPS 26 through NPS 60
MSS SP 6	Standard Finishes for Contact Faces of Pipes Flanges and Connecting-ends Flange of valves and fittings

Professional Documents

Reference	Title
API 6D	Specification for pipeline valves

Regulations

Reference	Title
Not applicable	

Codes

Process and utilities piping shall comply with the requirements of ASME B31.3.

The ASME code, Section 1, shall be applied for certain sections of piping connected to steam generators. The portions of piping to which this code is applied shall be clearly identified on the flow diagrams.

Reference	Title
ASME B31.3	Code for Pressure Piping. Chemical Plant and Petroleum Refinery Piping
ASME Section 1	Boiler and Pressure Vessel

Other documents

Reference	Title
Not applicable	

Total General Specifications

Reference	Title
GS COR 170	Materials for sour service (upstream applications) Specification for design
GS COR 350	External protection of off-shore and coastal structures and equipment by painting
GS ECP 103	Process sizing criteria
GS EXP 501	Equipment and piping numbering
GS PVV 107	Flexibility analysis
GS PVV 109	Allowable nozzle loads on static equipment
GS PVV 112	Piping materials classes
GS PVV 113	Block models
GS PVV 114	Design models

Reference	Title
GS PVV 115	3D Electronic models
GS PVV 116	Model review check list
GS PVV 142	Valves
GS PVV 143	Metallic pipes
GS PVV 144	Fittings
GS PVV 145	Flanges
GS PVV 146	Bolting for piping
GS PVV 147	Gaskets for piping and vessels
GS PVV 148	Glass-reinforced plastic piping materials (tubes and accessories)
GS PVV 149	Spring hangers and supports
GS PVV 150	Valves in cryogenic service
GS PVV 171	Steel piping fabrication
GS PVV 172	Hot tapping
GS PVV 173	Pneumatic testing of aboveground piping systems
GS PVV 175	Internal cleaning of piping and vessels
GS PVV 178	Design and erection of glass-reinforced plastic (GRP) piping system
GS PVV 771	Thermal insulation (hot service)
GS PVV 772	Thermal insulation (cold service)
GS PVV 773	Thermal insulation (cyclic service)

3. Materials

3.1 Tubes

3.1.1 Minimum diameter

The minimum diameter used shall be 1/2". This restriction on diameter does not apply to utilities connections, to orifice flanges, drains and vents, tracing, etc.

3.1.2 Standardised diameters

Diameters shall be chosen from the customary series:

1/2", 3/4", 1", 1 1/2", 2", 3", 4", 6", 8", 10", 12", 14", 16", 18", 20", 22", 24", etc.

In particular, tubes having nominal diameters of 1/4", 3/8", 1"1/4", 2"1/2", 5", 7", 9" and 22" shall not be used. If vessels have connections at these diameters, the piping from the vessels shall be increased to the next largest diameter.

For diameters above 24", sizes 30", 36", 42", 48", 56" and 60" are preferred dimensions.

3.1.3 Threaded piping

Threaded carbon-steel piping used for process services shall be at least schedule 80 and 2" maximum diameter.

3.2 Fittings

3.2.1 Fittings up to 1"1/2 in diameter

a) Ends

As a general rule, the fittings used for piping up to 1"1/2 in diameter shall be made of forged steel, of the "socket welding" Type.

This requirement is not applicable to 10 000 API rating classes where "butt welding" type shall apply.

Welding fittings made of malleable cast iron are prohibited.

Threaded fittings made of forged steel may be allowed on water and compressed-air piping, drains, vents, temperature taps, etc., up to 1"1/2 in diameter. The threading shall be NPT, as per [ASME B1.20.1](#).

b) Elbows

Up to 1"1/2 in diameter, bending shall be preferred to elbows; the bending radius shall be equal to five times the nominal diameter of the tube.

c) Tees

Equal and unequal tees shall be used.

3.2.2 Fittings 2" or more in diameter

a) Ends

As a general rule, the fittings used for piping 2" or more in diameter shall be made of the "butt-welding" Type.

b) Elbows

Elbows shall have a large radius ($R = 1.5 d$)

If bends must be used for these diameters, they shall be cold-fabricated for the diameters 2" and 3" and hot-fabricated for diameters 4" or more. The bending radius shall be equal to five times the nominal diameter of the tube.

c) Tees

Equal tees may be used for all connections to piping of the same diameter. The limits within which they may be used shall be specified in the piping material classes specification.

Reduced tees shall be used as indicated in the piping materials classes.

For piping classes 10 000 API ratings, Sockolet, Thredolet and Weldolet branch connection types are not allowed. Only Sweepolet for branch diameter less than 2" is acceptable and reduced tees, equal tees or equal tee plus reducer for larger diameters are acceptable.

d) Reducers

The use of concentric reducers shall be the general rule. The use of eccentric reducers shall be restricted in principle to piping in layers on pipe racks and to pump intakes.

3.3 Connections

Connection shall be made at 90°; oblique connections shall be avoided except as detailed below.

Oblique connections at 45° may be accepted only for flare, vent and drain piping systems with header above 4". Weld fabricated oblique connections are only acceptable for pressure rating up to 150#. They shall be designed and fabricated to a pressure rating of 300#.

Above this pressure rating limit of 150# oblique connections shall be shaped by hot extrusion or forging.

Connections shall be reinforced if service conditions require it (pressure, expansion, vibration). Reinforcements shall be designed in compliance with [ASME B31.3](#).

The types of connections which may be used in each case are shown in [GS PVV 112](#).

3.4 Flanges

3.4.1 Dimensions

Except as otherwise indicated, the dimensions of flanges shall comply with [ASME B16.5](#) for diameters up to 24" inclusive and with standard [ASME B16.47 Serie "A"](#) for diameters over 24".

Instrument connections in 150# piping material class shall be 300#.

3.4.2 Ends

For diameters of 2" or more, "welding neck" flanges shall be used exclusively. However, "slip-on" flanges may be used in accordance with the piping material classes for ratings 150 and 300.

3.4.3 Flange facing

Flange facing shall be one of the three main types:

- Flat face (F.F.) for connection to materials made of cast iron (in ratings 125) or to materials made of GRP (glass-fibre reinforced plastic)
- Raised face (R.F.)
- Grooved, for ring joint (R.J.).

The type of flange facing and its finish are specified in the piping materials classes ([GS PVV 112](#)).

For piping lines with rating 1500# and higher, the use of Hub connector may be considered as an alternative to ASME flanges.

This shall not apply to equipment connections where ASME flanges shall be used.

The flange facing finishes shall be in conformity with the table below, based on the recommendations of standard [MSS SP 6](#):

Flange facing designation	Flange facing finish (contact face)	Average roughness ("Ra" maximum value)
RF	1/16" raised face Concentric or spiral serrated, or "stock finish"	150 microns 50 microns
RF "smooth finish"	1/4" raised face "smooth finish"	125 AARH (3.2 microns)
RTJ	Groove for ring joint	63 AARH (1.6 microns)

3.4.4 Connection between dissimilar material

Connection between carbon steel piping and corrosion resistant alloy (CRA) piping shall be done by flange or hub connector.

The connection shall be located as far as possible on a vertical pipe.

On chloride containing fluids connection shall be as follows:

- On carbon steel side, the flange or hub shall be weld overlaid with CRA including seal joint contact surface.
- CRA layer shall be 3 mm thick and shall be of the same chemical analysis as the CRA piping class material.
- The bolting and gasket shall be as per CRA piping class.

3.5 Gaskets and bolts

The types to be used shall be specified in the piping material classes specification.

CAF gaskets are prohibited.

Graphite impregnated flat gaskets shall not be used with stainless steel flanges in case of chloride containing fluid.

Bolt tensioners:

Hydraulic bolt tensioners shall be used on flange stud bolts 50 mm in diameter and larger.

Stud bolt for use with bolt tensioners shall have the normal length increased by one bolt diameter each side. Bolt extensions beyond the nut shall be protected from corrosion by caps.

3.6 Valves

3.6.1 Ends

As a general rule, valves up to a diameter of 1"1/2 inclusive shall have "socket welding" or NPT-tapped ends, except for 10 000 API piping classes where valves shall be "Butt Welding" end. Valves 2" or more in diameter shall be flanged whatever the rating.

3.6.2 Dimensions

Except as otherwise stated in the valve data sheets, the dimensions between the flanges or the welding ends of valves shall comply with [API 6D](#). However, [ASME B 16.10](#) is applicable for all valves or sizes not listed in the [API 6D](#).

3.6.3 Hand wheels

Hand-wheels made of aluminium alloy are not allowed.

3.6.4 Drains

Check valves shall have a boss on the downstream side to allow for the drilling of a drain, as follows:

- 1/2" NPT for 2" to 4"
- 3/4" NPT for 6" to 8"
- 1" NPT for 10" to 24"

3.7 Change of piping material class

When a pipe of a given class is connected to a pipe of a higher class, the portion of line extending from the connection up to and including the first valve installed shall be made in the higher class.

When a control valve is installed with a bypass, the upstream isolating valve and the bypass valve must be in the higher class if there is a change of class.

4. General design rules

Design of piping systems shall be designed in compliance with requirements set forth in specification [GS ECP 103](#).

In addition offshore piping systems shall comply with [API RP14E](#).

4.1 Layout of piping

4.1.1 General

The layout and routing of piping and the layout of equipment must:

- Comply with the codes, standards, specifications and local regulations (if any) referred to in Chapter 2
- Allow for economical connections both to minimise the length of piping and to facilitate its supporting
- Allow for ease of operation, access to the equipment, and maintenance.

The routings shall take into account the movement of the piping and the possible movement of the equipment and/or structures to which the piping is connected or by which it is supported.

The piping shall not touch other piping, structures, electrical cables or conduits, or instruments.

4.1.2 Above-ground piping

Above-ground piping shall be arranged in layers. It shall be run on pipe racks or pipe ways.

Except in special cases (insulated piping, for example), all changes in piping direction shall necessarily be accompanied by a change in level, so as not to interfere with the installation of additional piping. Superimposed parallel layers of piping must be sufficiently far apart to allow for these changes of direction.

Low or high points inducing gas or liquid pockets shall be avoided as far as possible. They shall be fitted with drains or vents. Expansion loops shall be positioned horizontally.

The use of pipe ways shall be restricted essentially to process and utilities connecting lines outside the production units. In this case, roads shall cross the lines on bridges. Loops over roads are prohibited.

4.1.3 Underground piping

In on-shore facilities, the piping of utilities such as cooling water, fire water, etc., and certain process piping may be run underground.

4.2 Flexibility of piping

4.2.1 Routing of piping

The flexibility of the piping shall be assured by adequate routing (loops or changes of direction). Expansion bellows, expansion joints or flexible hoses shall in no circumstances become the general rule for solving problems of thermal expansion, vibrations, or relative movements: their use is strictly limited to specific prior approval by the COMPANY.

4.2.2 Flexibility analysis

Flexibility analysis shall be done by the Engineering Company on all lines, according to the [GS PVV 107](#). In particular, the selection of the analysis method (level 1, 2, or 3) must be in compliance with this document.

4.2.3 Allowable forces and moments

The allowable forces and moments resulting from the calculations, applied to a static equipment connection (fabricated vessels, exchangers, etc.) must be within the limits recommended by the Basic Code or by the Vendor of the equipment. In any case, they shall not exceed the values shown in Appendix 1 of [GS PVV 211](#) or [GS PVV 212](#).

In the case of rotating machines, these forces and moments must be submitted by the Engineering Company to the Manufacturer of the rotating machine for approval.

4.2.4 Floating facilities

Hull movements shall be taken into account for piping on floating facilities (accelerations and hull distortion).

4.3 Clearances and access

4.3.1 Minimum vertical clearances for unhindered travel

- By mobile cranes: 6 m
- On main roads: 5.5 m
- On roads inside the unit: 3.75 m
- On rail lines (not electrified): 5 m
- Above walkways: 2.1 m
- Below piping: 2.1 m
- To ceiling inside buildings: 2.1 m
- Mobile lifting equipment in operating areas: 2.4 m

4.3.2 Clearances under piping on pipeways

When piping is installed on pipeways, the bottom of the piping must be at least 0.3 m above the ground.

4.3.3 Horizontal clearances for unhindered travel

- For mobile maintenance equipment: 3 m
- Between horizontal drums: 0.75 m
- Between tubular exchangers, not twinned: 0.75 m
- Between twinned tubular exchangers: 0.45 m
- Between the shoulder of a road and the vertical projection of an item of equipment, or the end of a platform, structure, or pipe: 0.5 m
- Between two pipes, or between a pipe and a structure (including insulated flanges and/or any fireproofing on the structure): 0.025m
- To allow a man to pass freely: 0.75 m
- Open space in front of a manhole: 0.9 m
- Minimum width of maintenance platforms: 0.9 m
- Minimum width of platforms for the operation of a valve or instrument: 0.75 m

4.3.4 Width of roads

- Minimum width of main roads (exclusive of shoulders and sidewalks): 6 m
- Minimum width of secondary roads (exclusive of shoulders and sidewalks):
 - Roads in unit areas: 4 m
 - Roads in storage areas: 3 m

4.3.5 Platforms

The layout and arrangement of platforms, walkways and means of access thereto must be such that the supervisory rounds can be made at various levels without requiring excessive climbing up or down.

Platforms over 8 m long shall be served by two separate accesses (stairs or ladders). These means of access shall be placed in such a way that no point between two accesses is more than 20 m from at least one of them and there shall be no blind lengths of platform exceeding 8 m.

There shall be a platform in front of each manhole. This requirement may be waived in the case of manholes on horizontal drums of which the centreline is at a height of less than 3.75 m.

4.3.6 Stairs

Access to the various levels of the structures and buildings shall be by stairways. Stairways shall also be provided for certain platforms when they must be used every day for maintenance, operation or supervision.

4.3.7 Ladders

As general rule, access to platforms shall be by fixed ladders and the upper landing shall be to the side of the ladder. However, in the case of platforms on the top of equipment, the top landing may be in front of the ladder.

The ladders shall have a maximum height of 9 m.

The ladders shall be provided with safety cages beginning at a height of 2.5 m from the bottom of the ladder.

4.3.8 Access around heaters and boilers

Accesses and clearances around heaters, boilers and the like shall be sufficient to allow for easy maintenance and operation of burners, soot blowers, air filters, fans, etc.

4.3.9 Clearance for exchanger maintenance

The clearance to be left in front of exchangers for tube removal shall be at least the length of the tube bundle of the exchanger plus 1.5 m.

Roads or accesses may be used as the tube-removal area with the approval of the COMPANY.

4.3.10 Fixed handling equipment

When access to equipment, structures or piping by mobile equipment for maintenance, loading or unloading operations is impossible, fixed handling equipment shall be provided (points of attachment, monorails, jib, etc.).

This equipment shall allow for direct handling, i.e. without support from the ground.

4.4 Installation of valves

4.4.1 Valves operated frequently

Valves which will be operated frequently to meet operating requirements shall be easily accessible from the floor, from a platform or from a fixed ladder.

4.4.2 Valves operated infrequently

Valves which will be operated infrequently and of which the hand wheel is above 2.1 m shall be equipped with a chain wheel. The chains must hang down about 1 m above the operating level, and must not obstruct a passage.

However, threaded valves shall never be equipped with chain wheels.

Valves which will be operated only for shutting down and of which the centerline of the hand wheel is at a height not exceeding 5 m above the operating level shall be accessible by means of a mobile ladder. Above 5 m, permanent access (platforms, ladders, etc.) shall be provided.

4.4.3 Orientation of hand wheels

The order of preference in the orientation of hand wheels is as follows:

- Vertical, valve stem up
- Horizontal
- At 45°, stem up.

Valves operated manually by a lever and fitted with a locking device shall be installed horizontally with the stem in the vertical position to avoid gravity movement of the handle bar. Except for special cases, valves must not be installed with the stem below the horizontal plan (for gate valves located on flare lines, if any, the stem orientation must be vertical down). The horizontal centrelines of the hand wheels of valves operated from a platform must not be above a height of 1.80 meter.

4.4.4 Adjustment valves (globe valves)

Valves providing a flow adjustment (globe valves) shall be used only on piping not exceeding 6" in diameter.

4.4.5 Operation by stem extension

Valves which cannot be reached from a given floor level may be operated from a higher floor level using a stem extension.

4.5 Installation of instruments

4.5.1 Accessibility and orientation

Instruments shall be located and oriented in such a way that they are directly accessible and readable from the existing fixed ladders and platforms or from the floor.

4.5.2 Safety valves

Safety valves shall be installed vertically and as close as possible to the equipment or piping to be protected. If for installation reasons (e.g. accessibility) the inlet connection length of safety valves has to be bigger than usual, the pressure drop in the related section of pipe must be checked.

The atmospheric exhaust pipe shall be designed with a view to the safety of the personnel, according to the nature and temperature of the substance discharged. However, the atmospheric exhaust shall never be located at a height of less than 3 m above existing platforms within a radius of 7.5 m (a hole 6 mm in diameter will be drilled in the bottom of the low point of the atmospheric exhaust pipe to avoid corrosion).

If a safety valve exhaust is connected to a flare network, the safety valve should be installed at a higher elevation than the flare header, and shall have no pockets. If the safety valve has to be installed below the flare header, the exhaust pipe must be traced and equipped with a drain valve, and must always be dealt with in a special study by the process department of the Engineering Company.

Special care shall be devoted to the attachments of the safety valves to avoid any risks of abnormal effects and vibrations on the valve body. The supporting arrangement must not interfere either with the maintenance or with the dismantling of the safety valve.

4.5.3 Other in-line instruments

The installation of other instruments in lines (control valves, temperature and pressure taps, orifice flanges, etc.) must comply with the instrument specifications.

4.5.4 Instrumentation on equipment or piping

Unless noted otherwise, the instrument nozzles on vessels and exchangers shall be 300 Lbs rating minimum and connection shall have a diameter not less than 2".

Instrument connections on either equipment or piping requiring either single or double block and bleed facilities shall be made of an integrated manifold.

Manifold shall be ball type two or three pieces bolted.

The bleed valve shall be needle type with a bolted bonnet.

The side of this integrated manifold, which connects to the equipment or piping must be flanged, whilst the instrument connection side may be threaded as required.

The bleed connection shall be 1/2" NPT F protected by a plastic plug (to be removed once the valve is installed on site). For non toxic fluids, the bleed shall be open (in no case should a plug been installed). For lethal or toxic fluids, the bleed shall be connected to vent or drain network as applicable.

4.6 Vents and drains

4.6.1 Drains and vents for normal operation

The vents and drains necessary for operation shall be shown and dimensioned on the P&IDS.

They shall include valves terminated by threaded plugs (without sealing welds) or blind flanges, according to the piping material classes specification.

4.6.2 Drains and vents for hydrostatic tests

The vents and drains necessary for hydrostatic tests shall be provided at the high and low points of the piping. The drains and vents shall be shown only on isometric piping drawings.

These vents and drains shall consist only of 3/4" diameter couplings and threaded plugs (with sealing weld after testing).

4.7 Isolation (GS ECP 103)

For isolation of equipment, control valves, PSV's, etc., or section of piping removable or open in operation, double block and bleed isolation is required on all fluids having one of the following conditions:

- Operating pressure above 70 bar g.
- Operating pressure above 35 bar g. only for LNG
- H₂S partial pressure > 1 bar
- Fluid very corrosive and abrasive

De-pressurising, drainage or sample manual globe valves which may induced freezing during operation shall be located at least 600 mm downstream of a block valve.

All equipment will be generally isolated by spectacle blinds, or spacer and ring blinds (when isolation for maintenance) installed at a minimum distance of equipment and easily accessible except for PSV's for which a spool piece is required.

Plain or reversible blinders shall be installed as shown on the P&ID's. Sufficient clearance shall be left for operation of the reversible blinders.

Permanent spectacle blind and spacer and rings will be installed depending on diameter and rating as follows:

Rating ANSI	No positive isolation device	Permanent spectacle blinds	Spacer or ring blinds
150 RF	$\varnothing < 8"$	$8" < \varnothing < 14"$	$14" < \varnothing$
300 RF	$\varnothing < 6"$	$6" < \varnothing < 10"$	$10" < \varnothing$
600 RF and RJ	$\varnothing < 4"$	$4" < \varnothing < 8"$	$8" < \varnothing$
900 RJ and above	$\varnothing < 2"$	$2" < \varnothing < 6"$	$6" < \varnothing$

4.8 Utility stations

Utilities stations grouping the water, steam and air service piping shall be installed in the areas of the compressors, exchangers, pumps, heaters, on certain tanks platforms, columns and reactors and throughout the unit for cleaning and washing using ordinary hoses 15 m long.

4.9 Sample taps

4.9.1 Accessibility

Sample taps shall be installed as indicated on the P&ID's. They shall be accessible from the floor or from a platform.

4.9.2 Location

Sample taps on horizontal piping shall be on the side of the pipes. A sample tap must not be located on a dead end. In the case of sampling on the discharge of pumps, in particular, it shall be installed on the length common to the pump in service and the standby pump.

4.10 Thermal insulation and heat tracing

4.10.1 General

Thermal insulation must be provided whenever necessary to assure the operation of the installation at the temperature required by the process studies or for protection of the personnel (although protection by metal mesh shall be preferred whenever possible). Any required tracing and thermal insulation shall comply with the following COMPANY specifications, as appropriate: **GS PVV 771**, **GS PVV 772**, **GS PVV 773**. Surfaces shall be appropriately protected in accordance with **GS COR 350** before installation of thermal insulation.

4.10.2 Insulation of piping

All insulated pipes 2" or more in diameter shall rest, at their points of support, on shoes at least 100 mm high. For piping not more than 1"1/2 in diameter, these shoes shall be 50 mm high minimum.

4.10.3 Protection of personnel

Protection of the personnel by metal mesh must be provided on uninsulated piping and equipment when the service temperature thereof is over 70°C. This protection shall also apply to cold lines, which might be a danger to the operators.

5. Special design rules

5.1 Vessels and columns

5.1.1 Arrangement of piping

Piping on columns shall be installed radially along the column and oriented towards the pipe rack side; manholes and platforms shall be opposite the pipes (in other words, on the access side).

5.1.2 Platforms for access to manholes

The centres of the manholes shall be located approximately 0.9 meter above the platforms.

5.1.3 Fixed handling equipment

There shall be jibs on the top of all columns more than 15 m high. They must be able to bear a load of at least 500 kg and shall be oriented in such a way as to allow for direct handling from the floor to the various platforms.

5.2 Storage tanks

The layout of piping inside the retention walls or basins of storage tanks shall be designed with allowance for possible subsidence of the tank and on the assumption that the pipes are "anchored" at the retention embankments and walls through which they pass.

5.3 Reactors

5.3.1 Access and maintenance of agitators mechanisms

Platforms shall be installed on reactors equipped with agitators, for access to the mechanisms. It should be possible to remove the agitators mechanisms by crane or by using a monorail.

5.3.2 Loading and unloading

Reactors having catalytic beds or cloths requiring frequent replacement shall have manholes allowing for their loading and unloading.

A jib shall be provided to serve the various manholes. A service area on the ground and on the adjacent floor shall be provided near the vessel.

5.4 Exchangers

5.4.1 Grouping

Exchangers must be grouped whenever possible.

5.4.2 Superposition

When the shells are superposed, the centreline of the top shell must not be at an elevation of more than 6 meters. The number of shells, which may be superposed, is limited to 4.

5.4.3 Positioning of reboilers

Reboilers shall be positioned as close as possible to the equipment they serve.

5.4.4 Piping

The piping equipping the exchangers must in no case interfere with the dismantling of the exchangers and the withdrawal of the tube bundles.

5.5 Air coolers

5.5.1 Positioning

Air coolers may have their own supporting structures or may be installed above pipe racks.

They shall be positioned so as to assure correct functioning. They shall not be installed above gas compressors, tanks or exchangers containing petroleum products at a temperature of 300°C or more, hot pumps, or pumps conveying volatile substances.

5.5.2 Inspection and maintenance

The mechanisms and drive motors of blowers shall be accessible by walkways for inspection and maintenance operations. A jib shall be provided at each end of air coolers.

5.5.3 Handling of tube bundles

Tube bundles to be removed shall be handled by crane. Equipment, structures and piping must not interfere with access by this crane.

5.5.4 Positioning of pumps under the air coolers

Pumps not belonging to the category specified in § 5.7.1 may be installed under the air coolers. However, their drive motors must be located outside the vertical projections of the tube bundles of atmospheric coolers.

5.6 Heaters

5.6.1 Piping installation

If possible, the process piping equipping a heater shall be laid out symmetrically so that the pressure drops of the various passes are equivalent. The layout shall take into account the various operating cases (decocking operation, reduced production, starting up, etc.), the problems related to the flexibility of the piping and movements, and the allowable forces and moments on the nozzles of the heaters as recommended by the Manufacturer.

The piping must not obstruct the disassembly hatches, nor interfere with the withdrawal or dismantling of the soot sweepers and blowers and other apparatus with which the heaters are equipped.

5.6.2 Adjustment of burners

The adjustment valves on the fluids fed to the burners shall be placed close to the observation windows so that they can be operated while observing the setting of the flame.

5.6.3 Steam snuffing

When heaters are equipped with a steam snuffing system, the valves controlling the system shall be grouped behind a fire wall and preferably installed on the control-room side.

5.6.4 Tube pulling

Space and access shall be allowed for the pulling of the tubes of the heaters, which will be performed by a mobile machine.

5.6.5 Operation and maintenance

There shall be accesses and walkways for access to the burners, observation windows, soot blowers, and instrument connections of the heater and of the stack.

5.7 Pumps

5.7.1 Positioning

Pumps shall be positioned in accordance with process requirements, and as close as possible to the equipment concerned, so as to give the shortest possible suction circuit. However, suction and discharge lines shall be designed with sufficient changes of direction so as to allow for flexibility during erection and operation (tightening of flanges, expansion of lines, etc.).

5.7.2 Suction

Suction lines shall be designed in such a way as to avoid any low point or air pocket between the equipment and the suction flange of the pump.

A temporary or permanent filter shall be provided on the suction, between the block valve and the nozzle of the pump.

5.7.3 Discharge

The valves and check valve placed on the discharge line shall be, in general, of the same diameter as the discharge diameter of the pump.

However, when the difference in diameter between the discharge line and the pump discharge nozzle is equal to or greater than two diameters, the valve and check valve shall be of an intermediate diameter.

Examples:

Discharge line	Discharge nozzle	Valve and check valve
dia. 6"	dia. 4"	dia. 4"
dia. 8"	dia. 4"	dia. 6"

5.7.4 Orientation of valves

Suction and discharge valves shall be installed as close as possible to the pump nozzles.

The hand wheels of these valves shall be oriented, whenever possible, inside the perimeter of the pump, so as to leave the maximum clearance around the pump and allow the hand wheels to be operated with a minimum of movement.

5.7.5 Piping

Piping shall be arranged so as not to interfere with the removal of the pump, when the suction and discharge valves are left in place.

5.8 Compressors

On compressors, the layout and supports of piping shall be designed so as not to interfere with operating and maintenance operations.

Suction and discharge lines shall be designed with sufficient changes of direction so as to allow for flexibility during erection and operation (tightening of flanges, expansion of lines, etc.).

A temporary filter shall be installed on the suction of each compression section. It shall be designed and supplied by the Manufacturer of the compressor.

On reciprocating compressors, piping must be designed with allowance for vibration and pulsation problems. Supports shall be irregularly spaced to avoid any resonance effect. In general, reciprocating compressors shall be equipped with pulsation dampers.

6. Supports

6.1 General

All piping shall be supported, guided and anchored taking into account their deflection as well as the differential movements generated by the equipment and the stresses, forces and moments on the equipment. Supports shall be installed so as to prevent the effects of vibration.

All piping shall be considered as being filled with water, except when pneumatic tests are specifically required.

6.2 Identification of supports

Each support shall be identified by reference to a standard supports schedule or to a special supports schedule, as applicable.

6.3 Temporary supports

Temporary supports shall be provided to secure the piping on the modules during transport and handling.

7. Principle for the preparation of the main piping drawings, documents and models

7.1 General appearance of documents

7.1.1 Formats

The following standardised formats shall be used on the preparation of the various documents:

- A0 (1189 x 841 mm)
- A1 (841 x 594 mm)
- A2 (594 x 420 mm)
- A3 (420 x 297 mm)
- A4 (297 x 210 mm)

The use of other formats must be submitted to the COMPANY for approval.

7.1.2 Reduction of documents - Digitisation - Microfilming

The density of information in a given format must allow for easy reading; documents must remain legible after possible digitisation, reduction or microfilming. In particular, the height and shape of letters and figures must be chosen with this possibility in mind.

7.1.3 Title blocks

Each document shall have a title block giving at least the following information:

- The document serial number, including the contract reference number
- The date and revision number of the document
- The purpose of issue of the document
- The title of the document, including the contract name
- The signatures or initials of the persons who drafted, checked and approved the document.

A standard title block shall be submitted to the COMPANY for approval at the start of each contract.

7.1.4 Revisions

Revisions shall be clearly identified on all documents and modified portions of documents shall be outlined.

7.1.5 List of drawings

All documents shall be logged in a list of drawings. This list of drawings shall make it possible to keep track of the various issues and revisions of these documents. A new revision of this list shall be issued monthly.

7.1.6 Scales

The following scales shall be used:

- For overall layout drawings: 1/1000 - 1/500
- For unit layout drawings: 1/100 - 1/200 - 1/250
- For Piping and Instrument Diagram (P&ID's): none
- For drawings of off-site piping: 1/100 - 1/200 - 1/500 and 1/50 for details
- For drawings of on-site piping: 1/33 1/3 - 1/50
- For isometric drawings of piping: none.

The metric system shall be used for all drawings. However, the diameters of pipes shall be stated in inches (").

7.2 Piping and Instrument Diagrams (P&ID's)

7.2.1 General

Piping and Instrument Diagrams must give all information needed for understanding the process and construction of an unit. The P&ID's shall constitute the basic document of the operating manual for the units.

In the design and construction stages, the P&ID's must specify what will be built as regards the equipment, instrumentation, piping and their accessories.

7.2.2 Main types of Piping and Instrument Diagrams (P&ID's)

a) Process or utilities production P&ID's

These documents show the equipment, piping and instrumentation directly related to the process or to the production of utilities.

The equipment shall be arranged according to the logical progress of the process.

b) Utilities distribution P&ID's

These documents show the headers, sub-headers and distribution branches for the various fluids (water, steam, fuels, etc.) fed to the various users at their various locations.

Control functions in connection with this utilities supply shall be shown on the process or utilities production P&ID's.

c) Machine P&ID's

These documents show the equipment piping and instrumentation of machine ancillaries or major items of equipment (compressor, turbine, feed pumps, etc.).

7.2.3 Matching up of P&ID's

When process or utilities production P&ID's are divided into several sheets, the departures and arrivals of piping common to two sheets must be located at the same height above the bottom of the drawing. In-flows and out-flows of fluids at the perimeter of the site shall be shown at the bottom of the drawing if possible.

7.2.4 Equipment

All equipment shall be identified in accordance with the method specified in § 8.2, and named. The main characteristics of equipment to be shown on the P&ID's shall be specified by the COMPANY. The main items of equipment concerned are:

- Pumps
- Exchangers
- Vessels and columns
- Compressors
- Turbines
- Air coolers
- Heaters
- Storage tanks.

Connections to equipment shall be specified by diameter. The rating of any flange shall be indicated when it differs from the class of the line.

Space must be left for equipment which is to be added in the future.

Pumps shall be grouped in the bottom half of the P&ID's and aligned on the same horizontal line.

7.2.5 Piping

Primary piping shall be shown by heavy lines and secondary piping by medium lines.

All valves and all pipe fittings shall be shown, including reducers on lines. Except as otherwise indicated, valves shall be assumed to be of the same size as the line. However, ball valves shall always be "reduced bore" except if specifically indicated as "full bore" on the P&ID's.

All piping shown on the P&ID's shall be identified by numbers which shall be listed in the list of lines.

The piping shall be numbered in accordance with the method specified in § 7.3.2.

7.2.6 Insulation and tracing

The tracing and insulation of equipment, piping and instruments shall be indicated by symbols.

7.3 Line list

7.3.1 Characteristics of piping

The piping shall be numbered and listed in a document known as "line list", which must be prepared at the same time as the P&ID's.

For each line, the following characteristics must be indicated in this list:

- Origin and destination (from..... to.....)
- State of fluid conveyed (liquid, gaseous, etc.)
- Service and design pressure
- Service and design temperature
- Test type and pressure (water, air, etc.)
- Thickness and type of insulation
- Any tracing
- Numbers of corresponding isometric drawings.

7.3.2 Numbering of piping

Numbering of lines shall be as per **GS EXP 501**

7.4 General drawings

7.4.1 General arrangement

These drawings shall show, as seen in plan, the whole of the complex or plant, bounded by the property limits, and connections with the various external lines of communication (roads, rail lines, canals, etc.).

A location drawing shall show the position of this entire complex or plant with respect to the nearest inhabited area and public facilities (cities, motorways, airports, stations, ports, etc.).

All roads, fences, unit boundaries, main pipe-rack and pipe-way traverses, and equipment (outside the unit) shall be identified and their locations indicated by a system of coordinates.

All buildings (watchmen, administration, laboratory, fire, etc.), the various areas (stores of material, washing, maintenance, etc.), the main items of equipment inside the units, embankments and changes of level, etc., shall be shown.

A table shall give the names and drawing numbers of the units, main buildings, and items of equipment whenever it is impossible to mark these names and numbers near the building, unit or equipment in question.

The prevailing winds, true "North" and "Drawing North" shall be marked on these drawings and shall serve as the basic reference for all other documents.

The drawings shall be updated as the design work progresses and updated "as-built".

7.4.2 Layout of units

These drawings shall show the whole of the unit, bounded by the perimeter of this unit and connections to the various roads and means of access provided around this unit.

A location drawing shall show the location of this unit within the complex or plant.

The "Drawing North" and prevailing winds shall be shown.

All equipment, structures, removal and washing areas, etc., shall be shown as seen in plan. They shall be identified and their positions defined by a system of coordinates.

A layout drawing of the unit as seen in elevation shall be drafted from characteristic cross-sections or cut-away referred to the layout drawing in plan. Only the identifications of equipment and structures shall be given on this drawing.

These drawings shall be updated as the design work progresses and updated "as-built".

These drawings shall be the basic reference for the layout of foundations, equipment, structures, etc., on the site.

7.4.3 Classification of zones

These drawings shall be prepared from transparencies of the general arrangement drawings and shall show the various type I, II and hydrogen zones serving to determine the type of electrical equipment and instrumentation to be used and the road traffic system within a complex or a plant.

7.4.4 Connection of piping at unit boundaries

These drawings shall specify the identifications, positions, characteristics, supports and the scope of supply and work of the various contracting parties for piping entering or leaving the unit, plant or complex.

7.4.5 Sub-division of drawings

On a transparency of the general arrangement drawings, the sub-division of piping drawings shall be determined on the basis of the following main criteria:

- Use format A0 as much as possible
- Use the rows of pipe-rack or structures, the bottoms of retention walls, the centrelines of roads, unit or module boundaries, etc., as drawing boundaries
- Treat pipe-racks as separate drawings and, in the case of two-level piperacks, show these levels on the same drawing

- Plan to show on a single drawing equipment which is interconnected and closely spaced, such as column/reboiler, groups of exchangers, etc.
- Group the various levels of platforms (columns, structures, etc.) on the same drawing insofar as possible.

7.5 Piping drawings

7.5.1 Layout drawings

These drawings shall show the piping on plan view and give all information required for the preparation of isometric drawings and for erection of the piping. Cross-sections and details shall be drafted on these drawings to facilitate the drafting of the isometric drawings.

The orientation of the drawing shall be indicated on all drawings. If possible, it should be the same in all cases.

The numbers of the drawings adjacent to the boundaries of a given drawing shall be indicated.

7.5.2 Dimensioning

Unit boundaries, rows of pipe-racks and structures and equipment shall be laid out with reference to a system of coordinates. The elevations of horizontal equipment and platforms and the bottom levels of grouped or individual piping, etc., shall be indicated.

7.5.3 Equipment nozzles

Tables shall specify the characteristics of equipment nozzles (diameters, rating and flange face finish, elevations, orientations and centre distances).

7.5.4 Depiction of piping

In the case of piping drawings to a scale of 1/33 1/3 or 1/50, piping up to 12" in diameter shall be shown by single lines, and piping 14" or more in diameter shall be shown by double lines.

All piping lines shall be identified by their number. Alongside this number, the direction of flow and any insulation and tracing shall be indicated.

Tracing manifolds (departure and return) shall be shown and identified like other piping.

7.5.5 Supports

The supports of piping 2" or more in diameter shall be shown and their positions identified.

7.5.6 Instrumentation

All instruments in lines or on equipment shall be shown and marked with the identifications appearing on the P&ID's.

7.6 Isometric drawings

7.6.1 General

These drawings, drafted in isometric perspective with NORTH to the left and towards the top of the drawing, shall be prepared for each line serial number. Several isometric drawings may be prepared for a single line serial number.

Except as otherwise indicated, piping on pipe-racks or pipe-ways shall not be shown by isometric drawings. However, lines less than 12 meters in length must be included in an isometric drawing.

The continuations of the lines and the orientation of valves and instruments, etc., shall be indicated on each drawing.

All pipe supports shall be shown and located on isometric drawings by reference to both their identification number and the coordinates system of the isometric drawing.

7.6.2 "Construction" isometric drawings

"Construction" isometric drawings shall be prepared for lines 2" or more in diameter. The dimensions marked on these drawings must be exact and allow for the fabrication of the piping.

7.6.3 "Erection" and "equipment" isometric drawings

"Erection" and "equipment" isometric drawings shall be prepared for lines up to 1"1/2 in diameter. In the case of isolated lines on an item of equipment, there is no limitation of diameter. The dimensions marked on the drawings may be approximate, and in this case, must be adjusted during erection.

7.6.4 Bill of materials

A list of materials summarising the quantities and references of the material necessary to build a given line and specifying the weight according to the destination of these materials (prefabrication or erection) shall be prepared for each isometric drawing (including the materials required for tracing). This bill of material shall be printed on each relevant isometric drawing.

7.7 Piping supports

7.7.1 General

All piping supports (either standard or special supports) shall be shown by drawings with all their dimensions indicated on them.

7.7.2 Standard supports

As a general rule, the standard supports drawings of the Engineering Company shall be used wherever possible. These standard supports drawings shall be submitted to the COMPANY for approval at the early stage of the project and, in any case, before issuing the isometric drawings.

7.7.3 Non-standard supports

Supports which cannot be included in the "standard" categories must be shown by special drawings which shall be identified and logged in lists of "special" supports.

Drawings of special supports must be issued at the same time as the corresponding isometric drawings.

7.7.4 Spring supports

Variable and/or constant spring supports must be identified (together with the corresponding standard and/or specially-drafted support) and logged in lists.

7.8 Models

7.8.1 Block models

Block models, if required on the project, shall be built and used in compliance with **GS PVV 113**.

7.8.2 Design models

Design models, if required on the project, may take the place of the piping general arrangement drawings; they shall be built and approved in compliance with **GS PVV 114**.

8. List of equipment

8.1 Characteristics of equipment

The characteristics of itemised equipment shall be listed in a document known as the "List of equipment".

This document shall be submitted to the COMPANY for approval and shall specify the following characteristics for each item of equipment concerned as applicable:

- Identification (item number and name)
- Service
- Service temperature and pressure
- Design temperature and pressure
- Name of Manufacturer and requisition and order numbers
- Overall dimensions (height, length, width or diameter)
- Weight to be taken into account for lifting
- Level of plan of installation (for off-shore platforms)
- Main materials in the case of fabricated equipment such as vessels, columns, tanks, etc.
- Main material and heating power in the case of heating equipment
- Speed, installed capacity, flow rate and type of fluid in the case of rotating machines such as pumps, compressors, etc.
- Protection: paint, insulation (including thickness of insulation), fireproofing.

The list of equipment shall be completed by a "remarks" column and must include an in-set giving at least the information listed in § 7.1.3.

8.2 Identification of equipment

Identification of equipment shall be as per **GS EXP 501**