PDHonline Course M183 (2 PDH)

Basic Piping Design, Layout and Stress Analysis for the Construction of Piping Systems

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NORSOK STANDARD

PIPING DESIGN, LAYOUT AND STRESS ANALYSIS

L-002
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FOREWORD

NORSOK (The competitive standing of the Norwegian offshore sector) is the industry initiative to add value, reduce cost and lead time and remove unnecessary activities in offshore field developments and operations.

The NORSOK standards are developed by the Norwegian petroleum industry as a part of the NORSOK initiative and are jointly issued by OLF (The Norwegian Oil Industry Association) and TBL (Federation of Norwegian Engineering Industries). NORSOK standards are administered by NTS (Norwegian Technology Standards Institution).

The purpose of this industry standard is to replace the individual oil company specifications for use in existing and future petroleum industry developments, subject to the individual company's review and application.

The NORSOK standards make extensive references to international standards. Where relevant, the contents of this standard will be used to provide input to the international standardisation process. Subject to implementation into international standards, this NORSOK standard will be withdrawn.

1 SCOPE

This standard covers the basis for design and layout of process, drilling and utility piping for offshore oil and/or gas production facilities. Relevant parts of this standard may also be used for control room, laboratory, helideck and other facilities around the platform.

The standard does not cover the following:

1. All instrument control piping downstream of the last piping block valve.
2. Risers and sub-sea pipework.
3. Sanitary piping systems.
4. GRP piping. (See NORSOK standard M-621)

2 NORMATIVE REFERENCES

The following standards include provisions which, through reference in this text, constitute provisions of this NORSOK standard. Latest issue of the references shall be used unless otherwise agreed. Other recognized standards may be used provided it can be shown that they meet or exceed the requirements of the standards referenced below.

NORSOK L-001	Piping and valves
NORSOK L-003	Piping detail (presently L-CR-003)
NORSOK P-001	Process design
NORSOK R-001	Mechanical equipment
NORSOK S-001	Technical safety
NORSOK S-002	Working environment
NORSOK Z-002	Coding system (presently Z-DP-002)

National and international codes and standards:

ASME B31.3	Process Piping.
DNV	Guidelines for flexible pipes
ISO 5167	Measurement of fluid flow
ISO 10420	Flexible pipe systems for subsea and marine riser applications (based on API RP 17B)

3 DEFINITIONS AND ABBREVIATIONS

3.1 Definitions

Can	Can requirements are conditional and indicates a possibility open to the user of the standard.
Isolation Valve	An insulation valve is defined as a valve that is used to shut off a piece of equipment or system for maintenance purpose only.

May	May indicates a course of action that is permissible within the limits of the standard (a permission).
Normative references	Shall mean normative in the application of NORSOK standards
Shall	Shall is an absolute requirement which shall be followed strictly in order to conform with the standard.
Should	Should is a recommendation. Alternative solutions having the same functionality and quality are acceptable.

3.2 Abbreviations

The following abbreviations are given for terms used in this standard:

API	American Petroleum Institute
ASME	The American Society of Mechanical Engineers
D	Diameter
DNV	Det Norske Veritas
EDS	Element Data Sheet
ISO	International Organization for Standardization
NPS	Nominal Pipe Size
NPSH	Net Positive Suction Head

4 DESIGN AND LAYOUT

4.1 General

The design of all systems shall be in accordance with latest edition of the codes and standards listed in clause 2 Normative references.
Design conditions shall be in accordance with the ASME B31.3. except where the requirements of this standard are more stringent.

4.2 Numbering systems

Numbering systems for piping, piping items and valves shall be in accordance with Z-002.

4.3 Safety and work environment

Ergonomic consideration shall be taken in design regarding:

- Tools, valves and control devices, including emergency controls devices shall be accessible.
- Provision for cleaning, maintenance and repair shall be taken into consideration.

Requirements related to safety and working environment shall conform with S-002.

Potential source of hazard (release of hydrocarbons), e.g. flange joints, shall be located inside hazardous areas as defined in the Area Classification drawings or specification. However, a reevaluation of the area classification is still necessary, in order to check for any consequences. (Even if all sources are located inside hazardous area, there might still be a need for extentions).

Where applicable, provision shall be made to protect piping and equipment from falling objects.

4.4 Clearance and accessibility

All piping shall be arranged to provide specified headroom and clearances for technical safety, easy operation, inspection, maintenance and dismantling as stated in S-002.

Particular attention shall be addressed to clearances required for the removal of pump, compressor and turbine casings and shafts, pump and fan drivers, exchanger bundles, compressor and engine pistons. Piping shall be kept clear of manholes, access openings, inspection points, hatches, davits, overhead cranes, runway beams, clearance areas for instrument removal, tower dropout areas, access ways and emergency escape routes.

A vertical clearance of 40 mm is recommended between bottom of skid and deck/floor to facilitate cleaning/maintenance.

Pipe, fittings, valve controls, access panels or other equipment shall not extend into escape areas.

4.5 Pipe routing

4.5.1 Arrangement

All piping shall be routed so as to provide a simple, neat and economical layout, allowing for easy support and adequate flexibility.

Piping should be arranged on horizontal racks at specific elevations. When changing direction (from longitudinal to transverse or vice versa) the piping should change elevation, but care shall be taken to avoid pockets. No piping shall be located inside instrument, electrical or telecommunication control/switchgear rooms, except fire fighting piping serving these rooms. Bridge piping shall be designed with expansion loops capable of handling relative movement of platforms in design storm conditions.

4.5.2 Grouping

Cold and hot piping should be grouped separately with hot, non insulated, lines at a higher elevation than cold lines. Uninsulated lines with possibility for ice build-up, shall not be run above walk ways.

When expansion loops are required, lines should be grouped together and located on the outside of the rack.

Small pipes should be grouped together to simplify support design.

4.5.3 Location

Locating small pipes between large pipes shall be avoided especially when the large lines are hot. Heaviest lines should be located furthest from centre of the rack.

4.5.4 Sloping pipes

Sloping pipes, such as flare headers and drain lines, should be located together and the routing established at an early stage in the design period to prevent difficulties which may occur if other process and utility lines are routed first.

4.5.5 Utility headers

Utility headers for water, steam, air, etc. shall be arranged on the top of multi-tiered pipe racks.

4.6 Valves

4.6.1 Accessibility and installation

All valves requiring operation during normal or emergency conditions shall be accessible from a deck or platform.

Isolation valves shall preferably be accessible from deck or platform. However, if this is not possible, valves shall be positioned such that access from temporary facilities is obtained. Fire water ring main isolation valves shall always be accessible from deck or platform.

Pressure relief devices (relief valves, rupture discs) shall be accessible and installed for easy removal from deck or permanent platform. Relief valves shall be installed with the stem in the vertical position. Other valves may be tilted, as long as the stem is above horizontal position.

When ESD valves are installed as isolation valves, they shall be located as close as possible to the fire/blast partition.

4.6.2 Check valves

Check valves may be installed in vertical lines providing the flow is upwards, with the exception of some type of lift checks. Draining of the downstream side shall be provided.

4.6.3 Control valves

Control valves shall be located as near as possible to the relevant equipment to which they apply and where possible along stanchions, columns, bulk heads or tower skirts. Suitable areas where control valves may also be located are alongside walkways, working areas and other aisles providing no obstructions such as valve stems extended into the walkways occurs.

Control valves operated by a local controller shall be located within the visual range of the controller to enable the operation of the valve to be observed while adjustments are made on the controller.

When an increase in line size is required downstream, the control valve shall be located as close to the reducer as possible.

Where control valves are less than line size, the reducers shall be placed adjacent to the valve. Spools or reducers between flanged block and control valves shall be made long enough to permit bolt removal. In screwed lines with a screwed control valve, unions shall be installed on each side of the control valve.

Where high pressure drop conditions exists across control valves, sonic harmonics together with extreme noise levels can be expected. Piping subjected to these conditions must be carefully evaluated and designed to ensure that its size and configuration downstream of the valve prevents transmission of excessive vibration and noise.

4.6.4 Relief valves.

For relief valves, see clause 4.9.4.

4.7 Vents, drains and sample connections

4.7.1 General

Vents and drains exclusively used for hydrostatic pressure testing shall be provided if those showed on the P&ID's are not sufficient/suitable.

4.7.2 Vents and drains for operational use

Operational vents and drains shall be designed according to L-003.

Sloped drain lines shall be run to the nearest deck drain, avoiding walking areas. Open drains shall be valved and located such that discharge may be observed. Open pipe ends shall extend well into tundishes to avoid spillage.

Supports from any fixed structure components shall be avoided.

4.7.3 Vents and drains for hydrostatic pressure testing

High point vents and low point drains shall be designed according to L-003.

4.7.4 Sample points

All sample connections shall be designed in accordance with L-003 with capability to flush through test lines and containers before samples are taken.

Sample points for gas shall be connected to the flare system to ensure satisfactory flushing in advance of samples being taken. The sample connection shall be located as close as possible to the separator/scrubber outlet, and preferably directly after the first elbow on vertical line.

Points for oil samples shall be located on vertical part of pipe. Sample station to be designed to minimise oil spillage.

4.7.5 Combination valves

Use of "combination" valves shall be evaluated instead of a double block and single blinded bleed valve arrangement. Evaluation shall include space requirement, risks for vibration, leak risk and life cycle cost.

4.8 Equipment piping

4.8.1 General

Piping connected to equipment shall be designed so that any forces or moments caused by thermal expansion, dead and operating loads, do not exceed the limits specified by R-001 or the manufacturer.

Piping configurations at equipment shall be designed and supported so that equipment can be dismantled or removed without adding temporary supports or dismantling valves and piping other than removing spool pieces or reducers adjacent to equipment. Clearances shall permit installing

blind flanges or reversible spades on block valves on hazardous fluids or high pressure lines. Break out spools shall be as short as possible.

In the design of piping for rotating equipment provision shall be made for sufficient flexibility without the use of flexible couplings and expansion bellows. Cold springing of piping at rotating equipment shall not be used.

Where deck level pipe supports are required at pumps, compressors or turbines, they shall be supported on integral extensions of the equipment support structure, and not be anchored to equipment baseplate. This requirement shall apply to resilient as well as fixed supports, guides and anchors.

Provision shall be made for the isolation of equipment with blinds or the removal of spool pieces for pressure testing and maintenance.

Suitable supports and anchors shall be provided so that excessive weight and thermal stresses are not imposed on the casing of rotating equipment.

Piping shall be balanced through the use of spring supports and other supports to minimise the load exerted on the main compressor gas nozzles. The same is applicable for nozzles of large centrifugal pumps.

4.8.2 Pumps

Suction lines shall be as short as possible and designed without pockets where vapour or gas can collect. Where possible the piping shall be self-venting to the suction source. The suction line shall be checked to ensure that the NPSH (Net Positive Suction Head) fulfils relevant pump requirements.

Eccentric reducers shall be used in horizontal runs. If there is a possibility for air or gas pockets, the flat side shall be mounted up. If this is not the case, the flat side shall be mounted down, in order to avoid debris and to simplify drainage. Concentric reducers shall be used in vertical piping.

To minimise the unbalancing effect of liquid flow entering double suction centrifugal pumps, vertical elbows are preferred adjacent to suction flanges. If this requirement can not be met, the elbows in piping shall be at least 5 pipe diameters upstream of the pump suction flanges with the following qualifications:

- Where no reducer is employed between the pump flange and the elbow, a straight run at least 5 pipe diameters long shall be provided.
- Where a reducer is located between the pump flange and the elbow, a straight run of at least 2 pipe diameters long, based on the larger pipe diameter, shall be provided. A reducer next to the pump flange is considered to be equivalent to 3 large diameters.

Valves in pump discharge lines shall be located as close to the pump nozzles as possible.

All valves adjacent to pumps shall be accessible for hand operation without the use of chains or extension-stems. Hand-wheels and stems shall not interfere with the operational passageways or the removal of pumps.

Suction piping shall be designed to enable strainers to be easily installed or removed without springing the pipe.

4.8.3 Compressors

4.8.3.1 Gas compressors

In order to get a neat layout, top and bottom entry compressors should be evaluated.

All gas compressors suction piping between the knock-out vessel and the compressor shall be arranged to prevent the possibility of trapping or collecting liquid.

Piping shall slope continuously downwards from the suction cooler to the knock-out vessel connection. Piping shall be routed so that any condensate drains back from the compressor suction to the knock-out vessel.

All compressors shall be provided with a temporary strainer in the suction line unless a permanent strainer is called for on the P&ID's. The strainer shall be located as close to the compressor as possible, unless the P&ID's indicate otherwise.

Compressor discharge lines shall be equipped with check valves installed as close as possible to the compressor discharge nozzle.

4.8.3.2 Air compressors

For parallel compressor trains, with a parallel layout within the same area, utility pipe nozzles for two trains may be mirror imaged in order to get easy access to common maintenance areas.

Suction line silencers, where required, shall be located as close to the compressor suction connection as possible according to the compressor manufacturer’s instructions.

4.8.4 Turbines

In hazardous areas the fuel gas piping shall comply with L-001. In nonhazardous area all connections shall be buttweld except that valves and turbine connection may be flanged inside turbine enclosure. Turbine fuel control and fuel filters shall be easy accessible. All inlet and exhaust piping/ducting for turbines shall be adequately supported to the approval of the equipment manufacturer. Exhausts shall be routed into a non hazardous area and shall not prove hazardous to personnel or foul air inlet.

4.8.5 Diesel engine

Pipework shall not be run directly over diesel engines, exhaust piping or any position where leaking fuel oil can impinge onto hot parts. The pipework should not be supported by hanger type supports.

The fuel oil header shall not be “dead ended”, to simplify cleaning/purging.

Where a positive static head is required from the day tank, the minimum operating level shall be 300 mm above inlet of the fuel injection pump.

The drain line from the day tank shall be positioned so that the drain line outlet into the main drain is visible from the drain valve position.

4.8.6 Vessels and towers

Where possible, blinds, spacers and block valves shall be located directly on the vessel nozzles.

Check valves, shall be installed on the block valve at the vessel nozzle where not in conflict with clause 4.6.2.

4.8.7 Heat transfer equipment

Valves shall not be located directly on top of channel nozzles, to avoid obstructing the removal of channel ends. Spool pieces shall be provided to facilitate the tube pulling and maintenance.

Piping shall be arranged to permit cooling fluid to remain in all units on loss of cooling fluid supply.

Thermowells for inlet and outlet temperatures for each fluid service shall be provided and shall be located in adjacent piping when the exchanger nozzles will not permit a 90 mm immersion for the thermowell.

4.8.8 Launcher and receiver traps

Consideration shall be given to mechanical handling facilities for pigs and line logging devices. The facilities should have the following:

- Overhead hoists or access for fork lift truck.
- Winching points for logging device withdrawal.
- Storage and inflation facilities for pigs and logging devices.
- Cradle for inserting the pig.

The pig receiver opening closure shall face the sea. Vertical launchers shall be placed on the outside area on the platform and shall be open to air. Provision shall be made within the closure for hydraulic connections to allow the operation of a hydraulic equipment, such as maintenance pigs and hydroplugs.

Elevation of traps shall be kept to a minimum. Where a sight glas is specified on the drain line, sufficient space must be provided for observation of flow.

The traps shall have a pressure indicator positioned so that it will be visible to personnel operating the trap closures.

Piping between risers and launchers and/or receivers shall have a bend radius in accordance with specifications from intelligent pig supplier.

The junction between the production line and the inlet/outlet to the launcher/receiver shall be designed to prevent pigs from entering the production line.

The launcher/receiver shall be sloped towards the trap closure, and a spillage retention tray provided with drain, shall be installed. The retention tray for the receiver shall be sized according to the length and volume.

A minimum of 2 m straight run should be arranged between the sphere or bar tee and the pipeline ESD valve in order to accommodate for installation of an inflatable welding sphere. This is to provide double isolation against the pipeline if repair of the isolation valves to the pig trap or

isolation valves to the process area should be necessary. This is applicable to piping where non flexible risers are used.

4.8.9 Wellhead area piping & valves

In the design of piping manifolds, preference shall be given to the use of extruded branches.

On fabricated manifolds the terminus of the manifold runs shall be blind flanged or hubbed to simplify cleaning and inspection.

Production manifolds shall be designed for solid (scale) removal where this may be a problem.

Consideration shall be given to any changes of direction in the flowlines where the product contains particles at high velocities which will erode the fittings, e.g. target, tees, 3xD bends.

An erosion pipe spool approximately 2 m in length shall be considered for installation immediately downstream of each choke valve for corrosion/erosion monitoring. If the spool length between the choke valve and the shut off valve on the manifold is sufficiently short, it can be considered as an erosion spool.

4.9 Additional requirements related to piping systems

4.9.1 Air piping

Air piping shall have self draining provision at all low points for the collection of condensate. Air traps shall be provided with isolation valves, balance lines and drains to local collection points.

Instrument air headers and manifolds shall not be dead ended but supplied with blind flanges for cleaning and maintenance.

All branches and take-offs shall be from the top of the headers.

4.9.2 Steam piping

Steam piping shall be run to prevent pockets. Condensate shall be collected at low points by using a standard steam trapping system.

Drain points shall be from the bottom of the header and steam take-offs from the top.

4.9.3 Utility stations

Utility stations shall be provided as required for air, water, steam/hot water and nitrogen. Each station shall be numbered and located in the general working areas at deck level. Freshwater, seawater and plant air systems shall be equipped with hosereels. Nitrogen stations shall not be located inside enclosed areas. Nitrogen hoses shall be installed if required (for reference, see L-003). Different types of couplings shall be used for air and nitrogen.

4.9.4 Pressure relief piping

Piping to pressure relief valve inlet shall be as short as possible.

When relief valves discharge to atmosphere, the elevation at the top of the discharge line shall typically be 3000 mm above all adjacent equipment. This is to keep adjacent equipment outside plume area. Discharge tail pipes shall have a drain hole at the low point of the line.

Relief valves discharging to a flare system shall be installed so as to prevent liquid being trapped on the outlet side of the valve. All relief lines and headers shall be designed to eliminate pockets, but if a relief valve must be located at a lower elevation than the header, an automatically operated drain valve shall be installed at the valve outlet and piped to a collecting vessel or closed drain.

Relief valve headers shall slope towards the knock-out drum, taking into account anticipated deck deflection and platform tilt during operation. Pockets are to be avoided, but where a pocket is unavoidable, some approved means of continuous draining for the header shall be incorporated.

Unless specifically noted on the P&ID all branch connections on relief and blowdown systems shall be at 90° to the pipe run. Should there be a special requirement for a particular branch to enter a header 45°, this shall be highlighted by process engineers on the P&ID.

4.9.5 Open drain systems

Drains shall have slope as specified on the P&ID's. Open drain branch connections shall all be 45°. Rodding points shall preferably be through drain boxes and change of direction shall be evaluated against flushing requirements, where the total change of direction is greater than 135°.

4.9.6 Pneumatic conveying

Pneumatic conveying piping shall be designed according to and approved by the pneumatic conveying system manufacturer. Purge connections shall be easy accessible to avoid waste of time when plugs occur.

4.9.7 Fire/explosion protection

All project accidental load requirements shall be met (ref. S-001).

4.9.8 Firewater distribution system

The layout of the firewater distribution system shall be carefully designed with respect to hydraulic pressure drop.

Deluge nozzles branch off shall be located away from the bottom of the header to avoid plugging of nozzles.

Location of nozzles shall be as specified by the safety discipline. Necessary deviations to avoid obstructions etc. shall be approved by the safety discipline.

Dead end headers shall be avoided.

4.9.9 Lube, seal and hydraulic oil systems

Lube, seal and hydraulic oil systems shall have flanges and blind flanges on header ends for pickling and hot oil flushing.

4.10 Fittings

4.10.1 General

All piping fittings shall conform to the relevant code or standards listed in clause 2.

Branch connections shall conform to the applicable EDS given in L-001.

Short radius elbows and reducing elbows shall not be used.

Expansion bellows and flexible couplings shall not be used, without written approval.

Where entrained sand is expected within the fluid flow, target tees or long radius bends shall be considered in place of elbows for changes of direction to minimise the effect of erosion, provided the total pressure loss for the system is acceptable.

Where line clean out facilities are required on headers, a blind flange shall be provided to close the end. Where no clean out is required and no future extention is expected, the line shall be closed with a welding cap.

4.10.2 Line blinds

Location of line blinds are indicated on P&ID's.

The provision for blinding shall consist of a pair of flanges, one of which may be a flanged valve (except wafer type valves) or equipment nozzle.

Spectacle blinds, blinds and spacers shall be used in accordance with the L-001.

Provision shall be made for using mechanical means of lifting either by davits or block and tackle lifting points, where the weight exceeds tabulated. Wherever possible, blind/spacer shall be located in horizontal runs. Values are given in S-002.

Where line blinds are installed, the piping shall be designed to allow enough flexibility to spring the line by means of either jack screws or other jacking arrangements. On ring joint flanges the flexibility allowance shall be sufficient to allow for the removal of the ring without overstressing the piping.

If required, a break out spool shall be provided for dismantling.

4.10.3 Insulation spools/sets

Galvanic corrosion shall be prevented. Rubber or plastic lined insulation spools can be used.

4.10.4 Strainers

The P&ID's will indicate whether a permanent or a temporary strainer shall be used to protect equipment. The mesh size of the strainer shall have a free area of 250% of the cross-sectional flow area of the line in which it is installed. Easy removal and cleaning of filters shall be possible.

The strainer housing shall conform to the appropriate material classification for the service in which it is installed. The housing of permanent strainers shall have either flanged ends or butt-weld ends. Butt-weld ends are preferred due to weight saving, especially for the larger sizes.

The installation of permanent strainers shall permit cleaning without dismantling the strainer housing or piping.

Break out spool to be installed in conjunction with temporary strainers.

4.11 Hook-up piping

Offshore hook-up piping shall be kept to a minimum.

4.12 Hoses and flexible pipes

If hoses are used it shall be documented that they are suitable for the medium and the required pressure and temperature. Hoses with associated couplings shall be marked in accordance with applicable standards. Components should be designed so as to avoid them being wrongly connected. Hoses should be protected against damage from crushing/compression if their design will not withstand such loads.

Flexible pipes shall be designed in accordance with a recognised standard such as ISO 10420 Flexible pipe systems for subsea and marine riser applications (based on API RP 17B) or DNV Guidelines for flexible pipes.

4.13 Instrumentation

4.13.1 Materials and rating

Materials and rating for instrument connections shall conform to the relevant material rating classification of the parent line.

4.13.2 Accessibility, location and orientation

Special attention shall be given, with respect to accessibility, location and orientation of valves, vents and drains as well as block and by pass valves.

Control cabinets (accumulator packages) shall be located as close as practically possible to the respective valves.

Location of flow orifices shall be in accordance with ISO 5167 latest edition. For liquid services, flow orifices shall not be put on vertical pipe runs. Tapping points shall be in accordance with L-003.

For instrument items the following considerations shall be made during design for operator access requirements.

Table 1 Location and access for instrument items

Type of instrument	Access required for operations	Access via fixed ladder	Access via fixed platform
Thermocouples	No		
Test thermowells	Yes	Yes	Acc.
Local temperature indicator	No 1)	No	No
Pressure gauge	No 1)	No	No
Level gauges	Yes	Yes	Acc.
Temperature transmitter and switches (indicating)	Yes	Yes	Acc.
Temperature transmitter and switches (blind)	Yes	Yes	Acc.
Other transmitters and switches (blind)	Yes	Yes	Acc.
Other transmitters and switches (indicating)	Yes	Yes	Acc.
Recorders and controllers	Yes	No	Yes
Control valves and other final control elements, PSV's	Yes	No	Yes
All flow primary elements (orifice plates, ventures pitot tubes)	Yes	No	Yes

Note
1. Must be able to read from platform or fixed ladder.
   Yes Required minimum
   Acc. Acceptable but not mandatory

5 STRESS ANALYSIS

5.1 General

Stress analysis shall be performed according to ASME B31.3 para. 319.4.

5.2 Selection criteria for lines subject to comprehensive stress analysis

As a general guidance, a line shall be subject to comprehensive stress analysis if it falls into any of the following categories:

- All lines at design temperature above 180°C.
- 4" NPS and larger at design temperature above 130°C.
- 16" NPS and larger at design temperature above 105°C.
- All lines which have a design temperature below -30°C provided that the difference between the maximum and minimum design temperature is above:
  - -190°C for all piping
  - -140°C for piping 4" NPS and larger
  - -115°C for piping 16" NPS and larger
- Note: These temperatures above are based on a design temperature 30°C above maximum operating temperature. Where this is not the case, 30°C must be subtracted from values above.

- Lines 3" NPS and larger with wall thickness in excess of 10% of outside diameter. Thin walled piping of 20" NPS and larger with wall thickness less than 1% of the outside diameter.
- All lines 3" NPS and larger connected to sensitive equipment such as rotating equipment. However, lubrication oil lines, cooling medium lines etc. for such equipment shall not be selected due to this item.
- All piping subject to vibration due to internal forces such as flow pulsation and/or slugging or external mechanical forces.
- All relief lines connected to pressure relief valves and rupture discs.
- All blowdown lines 2" NPS and larger excluding drains.
- All piping along the derrick and the flare tower.
- All lines above 3" NPS likely to be affected by movement of connecting equipment or by structural deflection.
- GRE piping 3" NPS and larger.
- All lines 3" NPS and larger subject to steam out.
- Long vertical lines (typical 20 meter and higher).
- Other lines as requested by the stress engineer.
- All production and injection manifolds with connecting piping.
- Lines subject to external movements, such as abnormal platform deflections, bridge movements, platform settlements etc.

5.3 Design temperature

The design temperature for the selection of lines subject to stress analysis shall be as stated on the P&ID's/line lists.

Calculation of expansion stress shall be based on the algebraic difference between the minimum and maximum design temperature. The maximum design temperature shall not be lower than the maximum ambient temperature.

Reaction forces on supports and connected equipment may be based on the maximum algebraic difference between the installation temperature and the maximum or minimum design temperature.

For uninsulated lines subject to heat sun radiation, 60°C shall be used in the calculations, where this is higher than the relevant maximum design temperature.

5.4 Environmental temperature

The minimum/maximum environmental temperature shall be as specified by the project. Unless otherwise specified, the following environmental temperatures shall apply:

- Installation temperature: 4°C
- Min. ambient temperature: -7°C
- Max. ambient temperature: 22°C

5.5 Design pressure

The design pressure for the piping system shall be as stated on the P&ID's/line lists. Where internal pressure below atmospheric pressure can exist, full vacuum shall be assumed for stress calculations.

5.6 Vibration

The effects of vibration imposed on piping systems shall be evaluated and vibration sources which can be realistically determined shall be accounted for. This also includes acoustic induced vibration.

5.7 Loads

Environmental loads such as snow, ice and wind acting on exposed piping shall be evaluated. When affecting the integrity of the piping system, the imposed deflections or movements from the main structure shall be accounted for.

Process conditions which may result in impulse loadings, such as surge, slugging, water hammering, reaction forces from safety valves and two phase flow, shall be included in the calculations.

The effect of blast loads shall be evaluated, for piping which is required to maintain the integrity in an explosion event.

5.8 Bending moment on valves, flanges and mechanical joints

In order to minimise the risk of leakage at valves, flanges and mechanical joints, the bending moment on these shall be evaluated. Special attention shall be made to bolt tensioning values to ensure that sufficient gasket surface pressure is maintained at all conditions.

5.9 Flexible joints

Expansion bellows, sliding joints, ball joint and similar flexible joints will generally not be permitted.

5.10 Cold springing

Cold springing of piping will generally not be permitted. Where all other methods have been explored and found unacceptable, cold springing may be applied provided the location of application and the installation procedure gives a reasonable assurance that the cold springing requirements have been achieved during installation. Credit for cold springing to reduce reaction forces can only be given if it can be shown that stress relaxation or yielding do not occur in the piping system.

5.11 Spring supports

In general, the use of spring supports shall be kept to a minimum by careful consideration of support location and alternative pipe routing.

5.12 Loads from piping systems on equipment

When analysing piping connected to parallel located equipment, the relevant worst temperature combination case of the shall be used.

Calculation of thermal nozzle loads shall be based on the maximum or minimum design temperature.

Piping connected to compressor and pump suction and discharge nozzles shall be fully force balanced through its supports in the liquid filled condition and shall exert only minimal loads on the nozzles in order to minimise equipment misalignment caused by external loads.

Allowable loads on equipment shall be calculated in accordance with R-001.

When calculating loads on compressor nozzles, the point for resolvement of forces and moments shall be agreed with the compressor vendor.