



Exploration & Production

GENERAL SPECIFICATION

PIPING VALVES VESSELS

GS PVV 107

Flexibility analysis

02	10/04	General review
01	12/03	Change of Group name and logo
00	03/01	First issue
Rev.	Date	Notes



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1. Scope

This document sets the rules for the piping stress analysis of the process and utilities piping systems of onshore and offshore petroleum installations.

Its scope is essentially the same as that of **ASME Code B31.3**. The following are specifically excluded: onshore and offshore pipelines, furnaces and boilers piping, building heating and ventilation piping, etc.

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.

Process and utilities piping shall comply with the requirements of **ASME Code B31.3** "Petroleum Refinery Piping".

Piping systems covered by this specification shall be designed and analysed in accordance with this Code and with the documents listed hereafter at their latest revisions at the date of the contract.

Any divergence between any of the Reference Documents, or between this specification and any 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.

Standards

Reference	Title
Not applicable	

Professional Documents

Reference	Title
WRC 107 and 297	Welding Research Council Bulletins 107 and 297

Regulations

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

Reference	Title
Not applicable	

Codes

Reference	Title
ASME B31-3	Process Piping

Other documents

Reference	Title
Not applicable	

Total General Specifications

Reference	Title
GS PVV 211	Design and fabrication of pressure vessels according to ASME VIII div. 1 or div. 2
GS PVV 212	Design and fabrication of pressure vessels according to PD 5500

3. Design basis

3.1 General

The design of piping systems shall take into account the different conditions during operation and maintenance (start-up, shutdown, steam-out, etc.).

3.2 Piping system

Piping flexibility shall be provided by sufficient changes of direction using bends, loops, etc.

The use of expansion joints shall be avoided and shall be subject to prior approval by the COMPANY.

All piping shall be adequately supported (anchors, guides, limit stop, etc.) to prevent excessive stresses from expansion, weight, wind, friction effects and other mechanical loading.

3.3 Design data

The main design data of each line shall be taken from the following documents:

- Line list
 - Operating and design pressures
 - Operating and design temperatures
 - Type and thickness of insulation
 - Type of heat tracing, if any
- Piping material classes
 - Material

- Diameter, wall thickness
- Type of fittings, flanges, valves.

The site data shall be taken from the relevant Project Specification which shall give the following information:

- Minimum ambient temperature
- Maximum ambient temperature
- Maximum solar temperature
- Wind data such as wind speed for each grade level
- Earthquake data

4. Methods of analysis

Piping systems shall be stress analysed using one of the following methods corresponding to three accuracy levels:

- **Level 1: Visual inspection (or by analogy)**

This method shall be restricted to lines that are similar to others, or lines having a clear and adequate flexibility.

- **Level 2: Approximate analysis**

This method includes the use of charts, nomographs and simplified formulae which may only be accepted if they are used in the range of configuration for which their accuracy is acceptable.

- **Level 3: Comprehensive analysis**

This method requires computer calculations exclusively.

The accuracy level selection shall be indicated in a document called "Critical Line List". This document shall include all the lines to be reviewed by the stress analyst and shall be submitted to the COMPANY for approval.

These lines must be selected in accordance with the criteria shown on Appendix 1.

5. Results of the stress analysis

The results of the analysis shall be indicated on the stress sketch, or on the isometric drawing.

The lines which are subject to approximate or comprehensive analysis methods (Levels 2 and 3) shall be registered on a document which shall include the following information:

- Line number, including revision and date
- Calculation number
- Type of analysis
- Revision and date of issue
- Results of analysis, according to the following:



Level 1 analysis:

No actual values of forces and moments acting on supports are requested for an analysis at Level 1.

Level 2 Analysis:

The result of a Level 2 Analysis may be only shown on the utilised charts or tables.

Level 3 Analysis:

A Level 3 analysis of piping systems requires a full computer calculation.

The computer program with sufficient documentation has to be submitted to the COMPANY for approval prior to its use as a calculation tool. This computer program shall be able to handle static load cases, and also dynamic load cases if required for the work to be done.

5.1 Calculation note

The results of the analysis shall be shown on a calculation note which shall include as a minimum:

- Mechanical characteristic of the piping system
- Design conditions
- Load cases taken into account (according to the [ASME B31-3 Code](#))
- Displacements, forces, moments and stresses at all supports, nozzles and particular points of the piping system
- Isometric view of the piping system showing all supports and nodes necessary for the calculation

5.2 Computer outputs

The computer outputs shall be submitted to the COMPANY for review.

5.3 Nozzle loads

Results of calculations at rotating machine nozzles shall be submitted for approval to the related Manufacturer except if they are within the allowable limits given by this Manufacturer.

Piping loads to pressure vessel nozzles shall be calculated using a rigid method, or using nozzle flexibility derived from [WRC 107](#) and [WRC 297](#). The resulting loads shall meet the criteria of Appendix 1 of COMPANY specification [GS PVV 211](#) or [GS PVV 212](#).

5.4 Stress Intensification Factor (SIF) for Tees

5.4.1 Tees at 90°

For tee connections at 90°, the standard Stress Intensification Factor (SIF) as per ASME B31.3 is applicable.

5.4.2 Oblique connections at 45°

In case of oriented tees, Stress Intensification Factor (SIF) is higher due to the angle of connection between branch and header.

a) For Forged connection, this SIF shall be calculated as per equation below (header and branch element):

$$h = 4.4 (T / r_2)$$

$$i_0 = 0.9 / [h^{2/3} (\sin \alpha)^{3/2}]$$

$$i_l = (3 i_0 / 4) + 0.25$$

b) For Unreinforced Fabricated Tee, this SIF shall be calculated as per equation below (Pipe to Pipe for header and branch element):

$$h = T / r_2$$

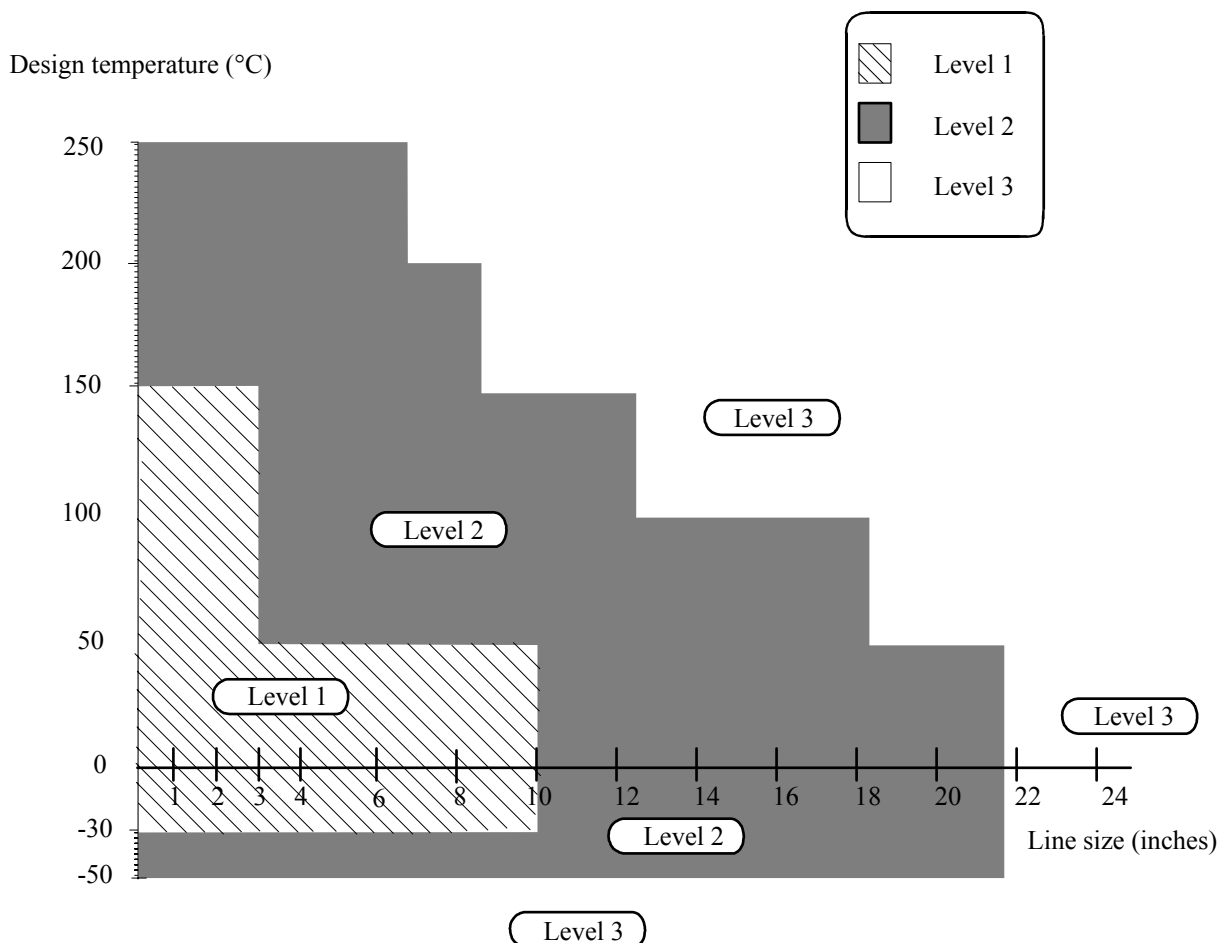
$$i_0 = 0.9 / [h^{2/3} (\sin \alpha)^{3/2}]$$

$$i_l = (3 i_0 / 4) + 0.25$$

Where:

- h is for Flexibility Characteristic.
- i_0 is for Stress Intensification Factor Out-of-Plane.
- i_l is for Stress Intensification Factor In-Plane.
- T is for Thickness of pipe header.
- r_2 is for Radius of pipe header.
- $\sin \alpha$ is for Sinus of small Angle between header and branch

Appendix 1 Stress analysis level requirements



Level 1: Visual or analogy

Level 2: Approximate (by means of charts)

Level 3: Comprehensive (computer calculation)

Note: A level 3 stress analysis is also required in the following cases:

- Lines above 100°C, if made of non-metallic materials
- Lines above 50°C, if made of non-ferrous materials
- Lines related to "sensitive" equipment such as rotating machines (large pumps, turbines, compressors, etc.), or to any particular equipment for which the related Manufacturer specifies low nozzle loading levels (if the diameter of these lines does not exceed 2 inches, a level 2 analysis only is acceptable).
- Any other lines which could operate under particularly severe condition.