Code of Practice

Upstream Polyethylene Gathering Networks – CSG Industry

Version 5

Companion Paper CP-04-001

Design factors: risk-based design

Rev 1

May 2020

Contents

Acknowledgements

This Companion Paper has been prepared by the Australian Pipelines and Gas Association (APGA) CSG Committee working group. The working group contributed significant time and resources at the working group level in developing and reviewing this companion paper and their support is acknowledged. The support of the APGA Board and the APGA Secretariat is also acknowledged.

Disclaimer

Feedback process

Feedback on this Companion Paper or recommendations for the preparation of other Companion Papers is encouraged.

In the first instance please direct feedback to:

Secretariat
Australian Pipelines and Gas Association
PO Box 5416
Kingston ACT 2604

Email: apga@apga.org.au

Preface

Companion Papers have been developed by the Working Group responsible for the *APGA Code of Practice for Upstream PE Gathering Networks – CSG Industry* (the Code) as a means to document technical information, procedures and guidelines for good industry practice in the Coal Seam Gas (CSG) industry.

Since 2008, the development of the LNG export industry based in Gladstone, Queensland, with its related requirement for a large upstream CSG supply network of pipelines and related facilities presented the impetus for significant improvements in design and best practice approach.

The principal motivation for the initial development of the APGA Code of Practice was safety and standardisation in design and procedures and to provide guidance to ensure that as low as reasonably practicable (ALARP) risk-based requirements were available to the whole CSG industry. Accordingly, the Code is focused solely on this industry and the gathering networks using locally-manufactured PE100 pipeline. The Code is a statutory document within Queensland.

Companion Papers were incorporated in Version 4 of the Code and are intended to provide information and best practice guidelines to the Industry, allowing the Code to be limited to mandating essential safety, design, construction and operation philosophies and practices.

These documents form part of a suite of documents together with the Code and are intended to:

a) be used in the design, construction and operation of Upstream PE Gathering Networks
b) provide an authoritative source of important principles and practical guidelines for use by responsible and competent persons or organisations.

These documents should be read in conjunction with the requirements of the Code to ensure sound principles and practices are followed.

These documents do not supersede or take precedence over any of the requirements of the Code.

A key role of the Companion Papers is to provide the flexibility to incorporate endorsed industry practices and emerging technologies expeditiously, as/when necessary.

A related benefit is that the Companion Papers can be referenced by the wider resources industry which uses similar PE gathering networks for gas or water handling, including coal bed methane (CBM) in underground coal mines; mine de-watering; or the emerging biogas industries (agricultural, landfill, etc.).

1 Scope

The scope of this Companion Paper is to detail the history of the application of the design factors up to Versions 5 of the Code and to define some important principles related to risk-based design.

2 Introduction

The Coal Seam Gas (CSG) industry began in Queensland in the late 1990s. Initially the design of gathering networks was based upon the philosophy from *AS 4645.3 Gas distribution networks - Plastics pipe systems*. This design led to conservative design factors in the range of 2.40 to 2.60 for open trench construction being used due in part to the higher operating temperatures experienced by the CSG industry.

Given that most of the CSG industry operated in remote rural locations, the use of the AS 4645.3 design philosophy which was intended for residential or industrial networks was seen as excessive for PE networks in remote rural locations.

The CSG industry formed a committee to investigate alternative design philosophies, which became sponsored by APGA and PIPA to become the *Code of Practice – Upstream PE Gathering Networks – CSG Industry.*

This Companion Paper outlines the changes in design factors made across the different versions of the Code of Practice, and the replacement of the risk factor with a risk-based design approach.

The principle of risk-based design is to implement risk mitigation on the basis of tolerable risk and as low as reasonably practicable (ALARP) being achieved through the safety management study (SMS) process.

The Companion Paper describes how to select the correct location classification as detailed in Section 4.8 of the Code based upon the 4.7 kW/m^2 full diameter rupture radiation contour for the gas pipeline section under consideration, such that the correct and adequate risk control measures (including both physical and procedural protective measures) can be applied in accordance with Section 4.5 of the Code. The methodology described in this Companion Paper for location classification and risk control measures is similar to that utilised under AS 2885.1 for high-pressure steel pipelines.

A number of worked examples of various location classification selection are included in Section 6 of this document for clarity.

3 Version history

This revision of the Companion Paper defines the progression in design factors up to Version 5 of the Code of Practice. Should future versions of the Code impact the design factors, then this Companion Paper will be updated by the APGA Code of Practice Committee, if there are no impacts to the Design Factors then this revision will remain applicable.

In respect of the design factors, V4 introduced the third significant change in how the design pressure for a particular pipe section is calculated. The design factors in Versions V1.1 to V3S changed little except that f1 was renamed from 'Operating Temperature Factor' in V1.1 to 'Temperature Design Factor' in V2 with no change in temperature reduction factors.

The Industry was confused as to the basis by which the Committee designated the 'fluid factor' to be 1.6 for CSG in Version 1 (it approximates 2.0 divided by the location class factor for Residential of 1.2 (rounded down) to adjust the factors in AS 4645 for the change to remote rural networks). Version 1.1 reconfigured the factors to be based upon the commonly understood factors used in the Industry.

The Design Factor C is calculated as the product of the following factors (f_0*f_1*f_2* f_3*f_4) as relevant:

Factor designation	Factor Description			
	Version 1.0	Version 1.1	Versions 2 to 3S	Version 4 / 5
f_0	Fluid Design	Material	Material	Material
f_1	Operating Temperature	Operating Temperature	Temperature Design	Temperature Design
f_2	Installation	Installation	Installation	Installation
f_3	Location Classification	Risk	Risk	Fluid
f_4		Fluid	Fluid	

3.1 f_0 – Fluid design / material

The fluid design factor has evolved as follows:

In Version 1, the fluid design factor – for CSG was the value of 1.6, and for all water types, the value of 1.25.

In subsequent versions the fluid design factor became split into the material and risk factors as follows:

The material factor became independent of the fluid and became 1.25 for all fluids.

The risk factor for Rural location classes became the fluid design factor divided by the material factor viz: for CSG, the value of 1.6 /1.25 =1.28, and for all water types, the value of 1.25 /1.25 = 1.00.

The overall risk factor f_3 became the product of the above times the Location Classification Factor as follows:

	Location Classification Factor		(New) Risk Factor f_3	
Location Class	CSG	Water	CSG	Water
Rural (R1)	1.0	1.0	1.0 *1.28 =1.28	1.0 * 1.0 = 1.0
Rural Residential (R2)	1.1		1.1*1.28 =1.4	
Residential (T1)	1.2		1.2*1.28 = 1.54	

The 'Residential' location class was dropped in Version 1.1 with its assessment for the assigned risk to be determined by the 'fit for purpose' design introduced in that Version.

3.2 f_1 – Temperature design factor

As previously mentioned, this factor has changed little except to rename the factor from 'Operating Temperature Factor' to 'Temperature Design Factor' to emphasise that the design pressure should be calculated from the design temperature (that is, the maximum average of the average pipe wall temperature for which the pipe is expected to withstand on an instantaneous basis at the design pressure).

It should be noted that the pipe wall temperature is the average of the inner wall (normally taken to be the fluid temperature) and the outer wall temperature. It is important to note that, based upon some Industry data, the outer wall temperature is not necessarily equivalent to the ground temperature, and may be some 10 degrees C above the ground temperature depending upon the type of CSG well completion and downhole pump selection (free-flow, progressive cavity pump (PCP), linear rod pump (LRP), electric submersible pump (ESP) or electric submersible progressive cavity pump (ESPCP)) and the fluid flow rate. This data may be the subject of a future and separate Companion Paper.

The design temperature as specified above is not necessarily the average wall temperature for design life, as life is based upon the long-term average of the average wall temperature.

The factor f1 is based upon PIPA's POP 013 document 'Temperature Rerating of PE Pipes' as follows:

Temperature ºC	Design Factor, f_1	Min. potential service life (years)
≤20	1.0	100
25	1.1	100
30	1.1	100
35	1.2	50
40	1.2	50
45	1.3	35
50	1.4	22
60	1.5	7

This factor may change in the future as the data from POP 013 is revised.

3.3 f_2 - Installation factor

This factor has not changed across the Code Versions, and is as follows:

Installation Method	Installation Factor f_2
Open Trench	1.0
Plough-in	1.1
Directional Drilling	1.2

The appropriate value for plough-in and directional drilling is to be determined by assessing the magnitude of surface damage and longitudinal strain caused by proprietary methods through a procedural qualification process. There are other possible factors to be considered when selecting the installation factor f_2 including tensile loads, critical buckling pressures, long term soil loads and the as-built hydraulic grade. For pipes designed and installed in accordance with 'Polyethylene Pipe for Horizontal Directional Drilling – PPI' a design factor of 1.0 may be used.

3.4 f_3 – Risk factor

The history of this factor is covered in the rationalisation of f_0 above, and has been removed from the calculation of the Design Factor C from Version 4. The use of risk-based design in lieu of the prescribed risk factor was made on the following basis:

- The industry requirement for higher design pressures was not achievable for PE networks within the SDR range of 7.4 to 13.6 using the prescribed factor approach;
- The industry's experience showed that increasing the wall thickness by 2 to 15 mm (reducing the SDR by one) as a result of f_3 (1.28 for CSG or 1.25 for saline water), does not mitigate penetration or integrity risk; and

- The use of risk-based design would provide a more effective and cost-efficient option to risk reduction.

Risk-Based Design is covered in the next section of this Companion Paper.

3.5 f_4 – Fluid factor

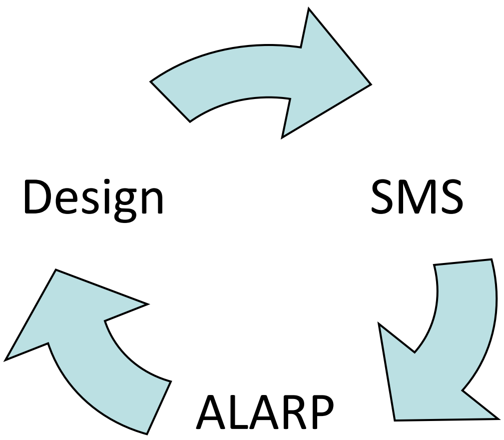
This factor is 1.0 for all fluid types. The inclusion of this factor in the Code is to allow the Code to be used for other Industry applications e.g. fuel gas containing heavier hydrocarbons where a factor of 1.2 or as determined by the design may be used. This factor has been redesignated f_3 in Version 4 as a result of removal of the risk factor.

4 Risk-Based Design

The principle of risk-based design is to implement risk mitigation on the basis of tolerable risk and driving residual risk to ALARP. This implies the use of the following steps:

1. Complete the preliminary design for the gas pipeline section under consideration in accordance with the 4.7 kW/m^2 full diameter rupture radiation contour for the section;
2. Subject the preliminary design to the safety management study (SMS) process;
3. Complete an ALARP assessment for any unacceptable risks;
4. Where the risk is not ALARP, modify the preliminary design by repeating Steps 1 to 4, until ALARP is achieved.

This is shown schematically below.

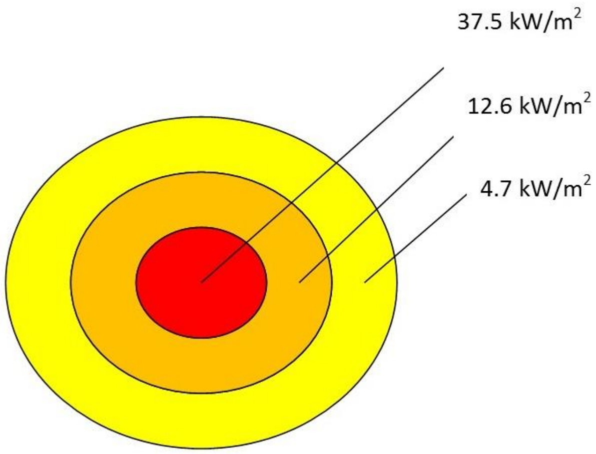


The basis of the risk assessment under the SMS is the consideration of the consequence and likelihood of exposure to an incident.

Risk-based design for gas pipelines in accordance with the Code is based around the consequence of the activity being considered against the radiation contour exposure limits (kW/m^2) for a full diameter pipe rupture with an ignited release.

Another potential scenario is an unconfined vapour cloud explosion (VCE), where the release cloud of flammable gas becomes sufficiently large prior to ignition, and the flame speeds accelerate to sufficiently high velocities, to cause explosive overpressure.

Although theoretically possible, within the CSG gathering system, VCE is unlikely to be a credible event for gas where the fluid factor f_3 is 1.00. VCE should be considered in the risk-based design if the fluid factor f_3 is greater than 1.00, the gas having significant C2 + hydrocarbons components (Reference GRI 00/0189 – Fire Hazard for Gas Pipelines).



Exposure Limit (kW/m^2)	Consequence
37.5	Chance of fatality for instant exposure. Pain threshold in less than 2s.
12.6	Typical fatality threshold, for normally clothed people, resulting in third degree burns after 30 seconds exposure. Significant chance of fatality for extended exposure. Pain threshold reached in 3-4s.
4.7	Injury may occur, especially after 30 seconds. Second degree burns. Pain threshold reached in 16s.

(Reference HIPAP 4 Table 6 Consequence of Heat Radiation).

4.1 Risk control requirements

Risk shall be controlled by selecting a combination of both physical and procedural controls for both integrity and external interference threats as detailed in Sections 4.5 of the Code of Practice, as per the following table.

Location Classification	Integrity	External Interference
Rural Residential, High Use (for Gas) or Sensitive (for Saline Water).	2x Procedural; or 1 x Physical and 1 x Procedural	1 x Physical and 1 x Procedural

The allowed physical and procedural measures are detailed in the Code of Practice. Note that it is intended that the 'High Use' sub location class is used for Gas, and the 'Sensitive' sub location class is used for saline water. There is no 'Sensitive' sub location class for gas nor 'High Use' sub location class for Saline Water.

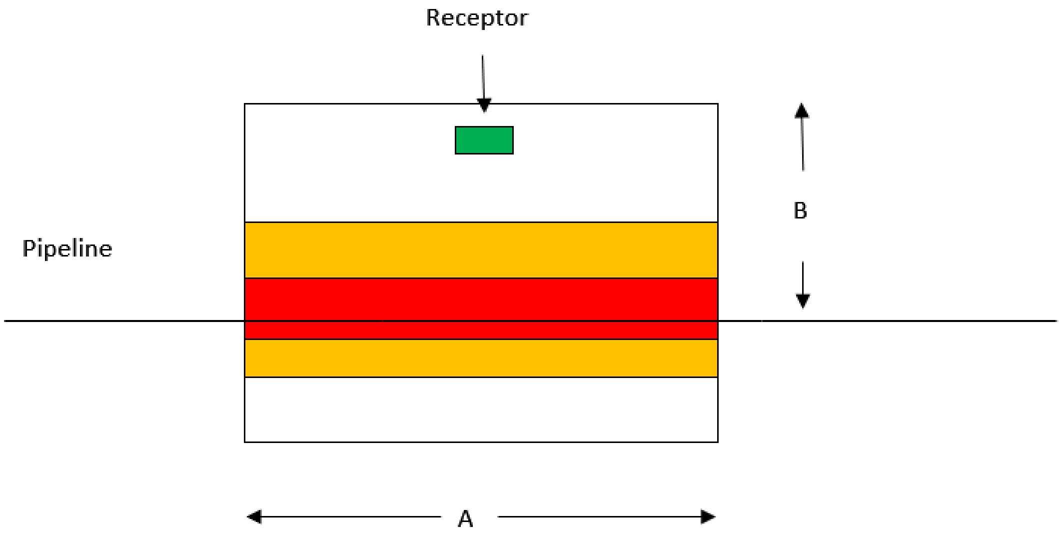
4.2 Gas requirements

The physical and procedural control measures shall be applied to, or installed over, the pipeline for the full length of the location class. The dimensions of the location class are defined by the 4.7kW/m^2 full diameter rupture radiation distance based upon the proposed design pressure (initial design) or MAOP (SMS review). Where there are multiple gas lines in the location class, the highest 4.7kW/m^2 radiation distance shall be used.

Note a full diameter rupture in PE is credible but low risk due to (a) failure of joints (based on world wide experience), (b) long term cracking and (c) impact damage severing pipe.

With reference to COP V5 Appendix A6, the risk within 4.7kW/m^2 full diameter rupture radiation contour would be Minor x Occasional = Low. Also, the 4.7kW/m^2 full diameter rupture radiation contour is an industry accepted basis for risk assessment.

Graphically this can be shown as:



Where:

- Each rectangle represents the area under consideration for the 4.7kW/m^2, 12.6kW/m^2 and the 37.5kW/m^2 radiation distances;
- Dimension A represents the full length of the class location and equals the 2 x 4.7kW/m^2 radiation distance plus the length of the Receptor parallel to the axis of the pipeline;
- Dimension B equals the 4.7kW/m^2 radiation distance;

The Receptor is the plant, camp, road or rail under consideration. The design of the pipeline should be such that the receptor is preferably outside the 4.7kW/m^2 radiation area but under no circumstances should the receptor be placed in the 37.5kW/m^2 radiation area (marked in red in the diagram).

Where the receptor is within the 4.7 kW/m2 radiation area and the route of the pipeline cannot be shifted to relocate the receptor outside the 4.7 kW/m2 radiation area, the SMS should review the threat associated with the receptor and determine whether the "High Use" Sub-location class should be applied. The outcome of the review should be documented in the SMS and approved by the licensee.

The accepted industry practice is that a single residence can be situated in the 4.7 kW/m2 radiation area but preferably outside the 12.6 kW/m2 radiation area. The SMS should review isolated houses inside the measurement length and identify if additional controls or change in locations class is required. The outcome of the review should be documented in the SMS and approved by the licensee.

4.3 Occupancy rate

One way of determining which location classification is correct for the Receptor(s) under consideration is through determining the occupancy rate.

Occupancy rate is defined as the number of people occupying the Receptor multiplied by the proportion of occupation time (hours per day).

The table below is a guide for Occupancy Rate that could be applied for the determination of locations class.

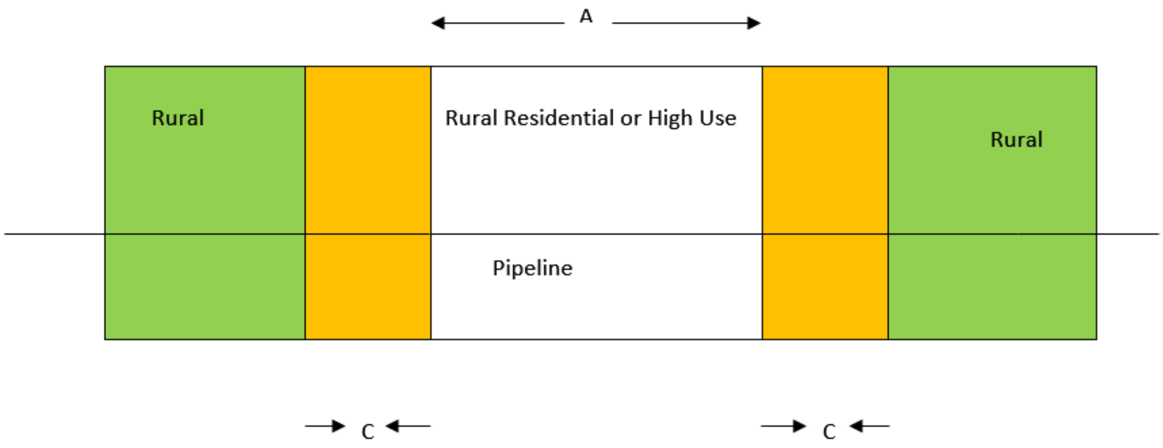
Location Classification	Occupancy Rate			
	D < 400 or P*D < 300	D < 560 or P*D < 450	D ≤ 800 or P*D ≤ 640	D > 800 or P*D > 640
Rural	< 2	< 2	< 2	< 2
Rural – High Use	> 2	> 2	> 2	> 2
Rural Residential	≤ 2	≤ 4	≤ 12	≤ 18
Rural Residential – High Use	> 2	> 4	> 12	> 18

Where P*D equals the product of the design pressure (kPag) and the pipeline diameter (metres).

4.3.1 Adjacent location classes

Where a higher location or sub location class (Rural Residential, or High Use) falls within the lesser location class, the requirements of the higher location or sub location class shall be applied to, or installed over the pipeline for the full length of the higher location or sub location class plus a distance either side of the higher location or sub location class equal to the 4.7kW/m2 full diameter rupture radiation contour distance for the pipeline(s) design pressure (or MAOP) and diameter.

Graphically this can be shown as follows:



Where C represents the distance either side of the higher location or sub location class equal to the 4.7kW/m2 full diameter rupture radiation distance for the pipeline(s) design pressure (or MAOP) and diameter. (Dimension A is as above).

4.3.2 Energy release rates

Another method of considering the consequence of a failure of a specific design is to consider energy release rates. With reference to AS 2885 and API RP 521; and considering the High Use sub location class equivalent to industrial or heavy industrial, the following is applicable:

Location Class	Maximum Energy Release Rate (GJ/s)
Rural	Unlimited
Rural High Use	10.0
Rural - Residential	Unlimited
Rural – Residential High Use	10.0
Residential	10.0
Residential – High Consequence	1.0

The location class Residential – High Consequence refers to schools, community halls or other public facilities where large numbers of the population may congregate.

With reference to Section 5.0, the maximum energy release rate is potentially a consideration for Rural, Rural Residential, High Use and Residential location classes for diameters above 710mm and design pressures above 600kPag.

4.4 Saline water requirements

The physical and procedural control measures shall be applied to, or installed over, the pipeline for the full length of the location class. The dimensions of the Sensitive location class are defined by the length of the pipeline (likely to be high point to high point on the pipeline's route) within the drainage area pertaining to the environmentally sensitive receptor (for example, waterway, river or dam).

The available release volume should be based on the maximum anticipated production flow rate plus the available stored volume within the drainage area.

The consequence of the available release volumes spilling into environmentally sensitive areas should be determined in accordance with the Production Operators environmental licence.

Where there are multiple saline water lines in the location class, the production rate and the stored volume of the largest diameter line shall be used.

4.5 Water requirements

The risk-based physical and procedural control measures described in accordance with Section 4.1 of this document are not required for PFW, treated or amended water lines unless as part of the risk-based design process these measures are necessary to provide ALARP risk.

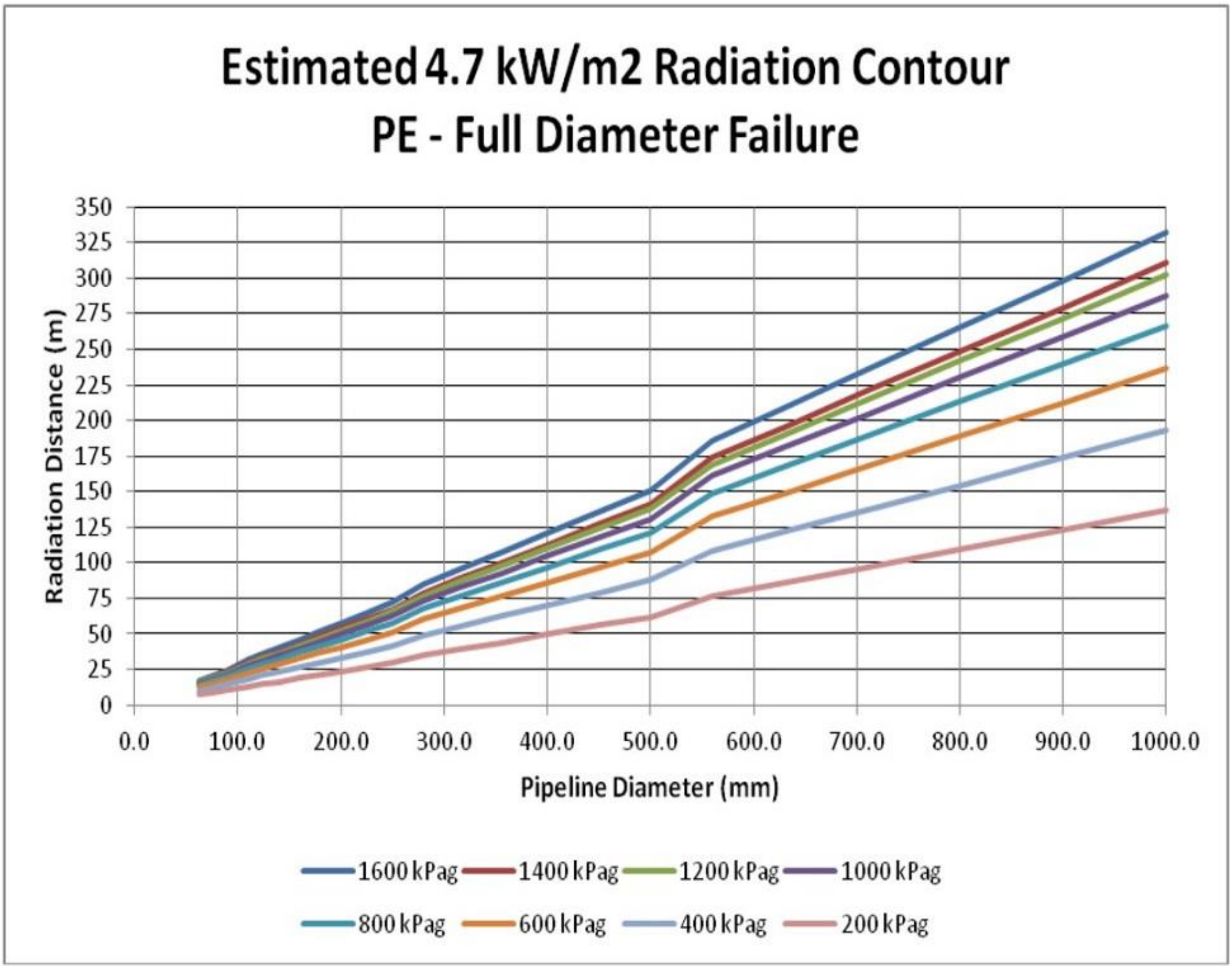
Where the gas content of PFW lines exceeds 2,000scm of gas per 100kl of water it is recommended that the line meets the gas requirements as per Sections 4.1 and 4.2 of this Paper.

5 Radiation Contours and Energy Release Rates

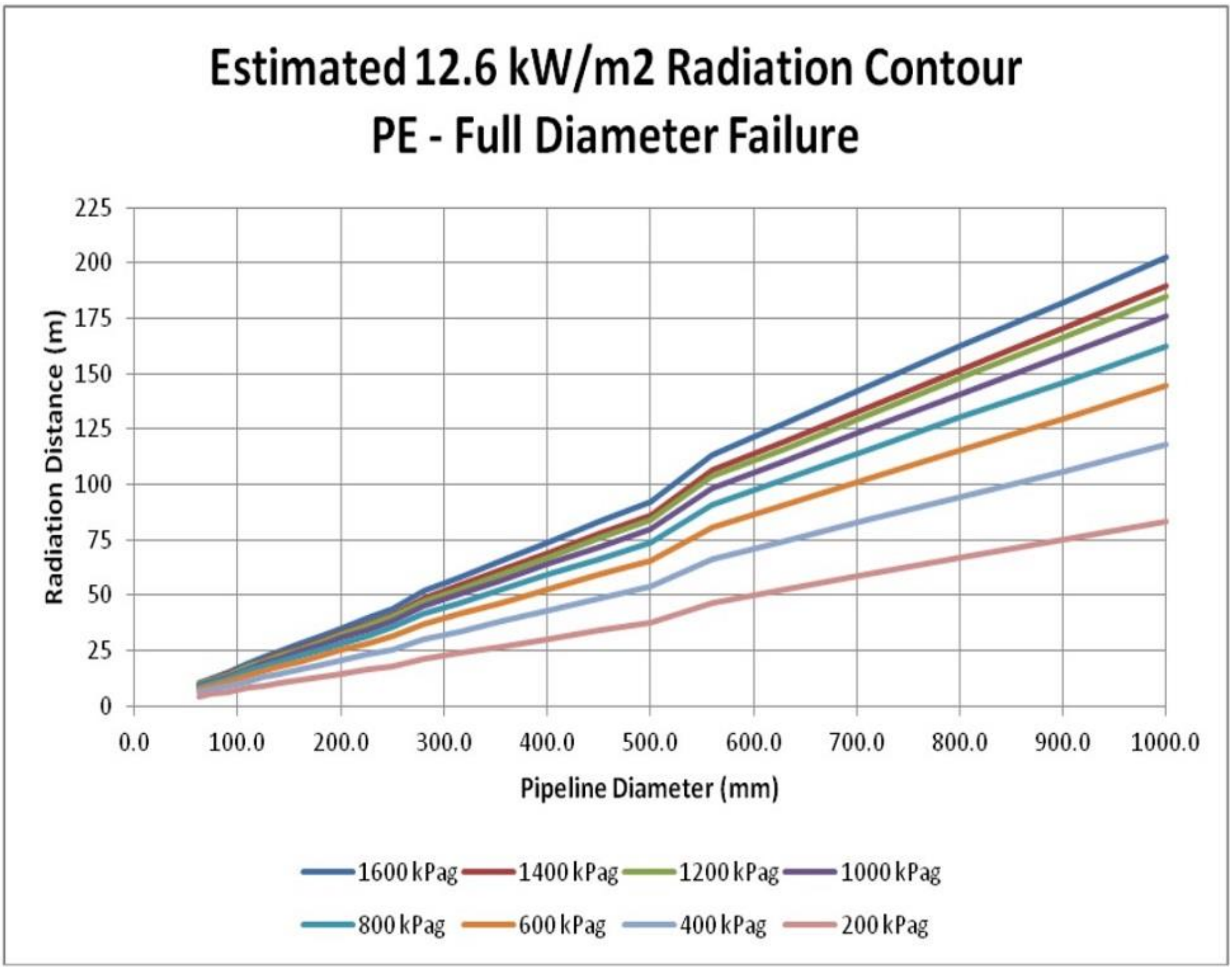
The full diameter rupture radiation contours for the 4.7kW/m2, 12.6kW/m2 and the 37.5kW/m2 radiation distances are shown below.

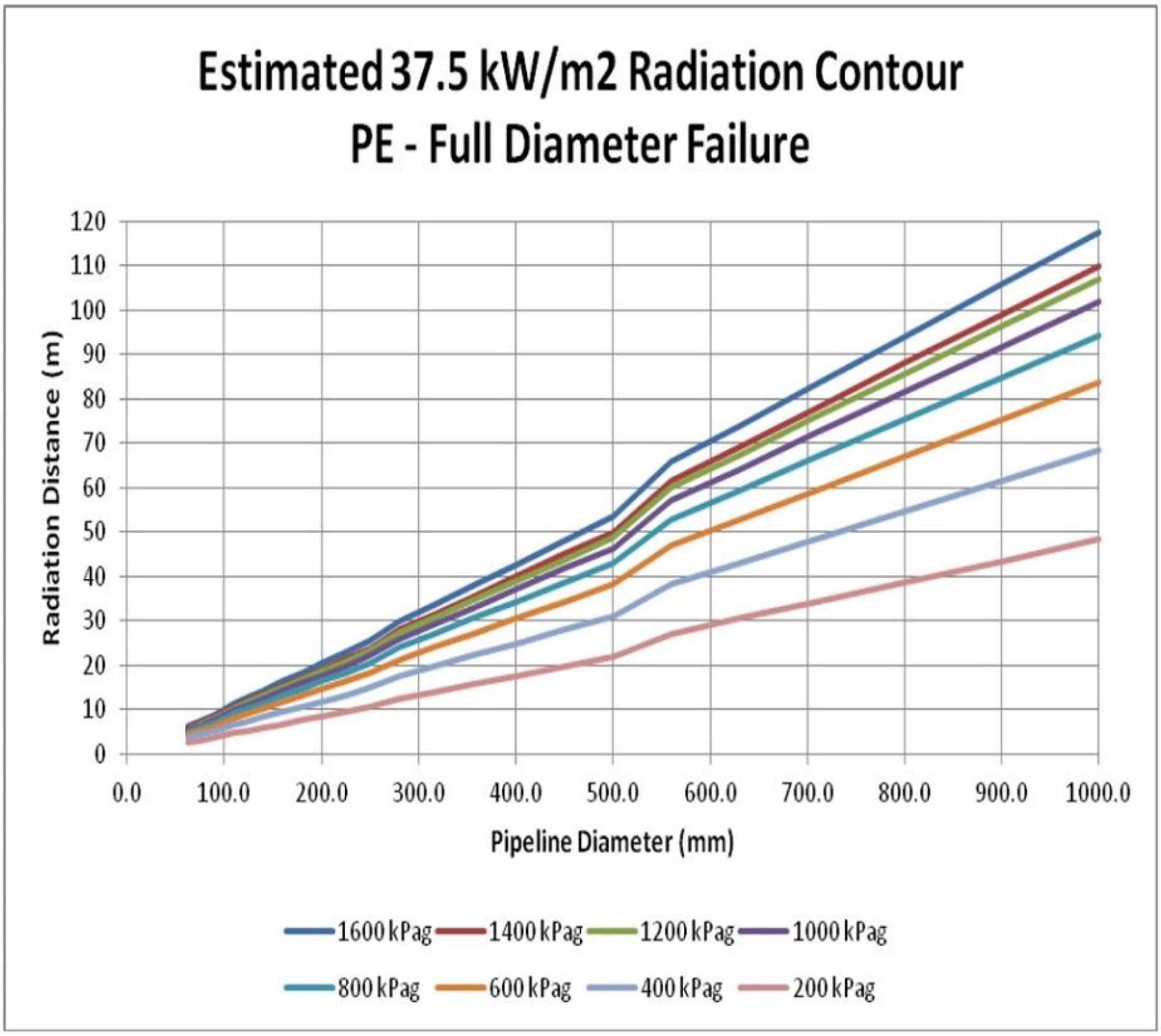
It is noted that the 4.7kW/m^2 radiation distances are slightly different to those presented in Appendix A of the Code. This reason for this is that the radiation contours shown in this paper are based upon the actual SDR (actual internal diameter of the pipe).

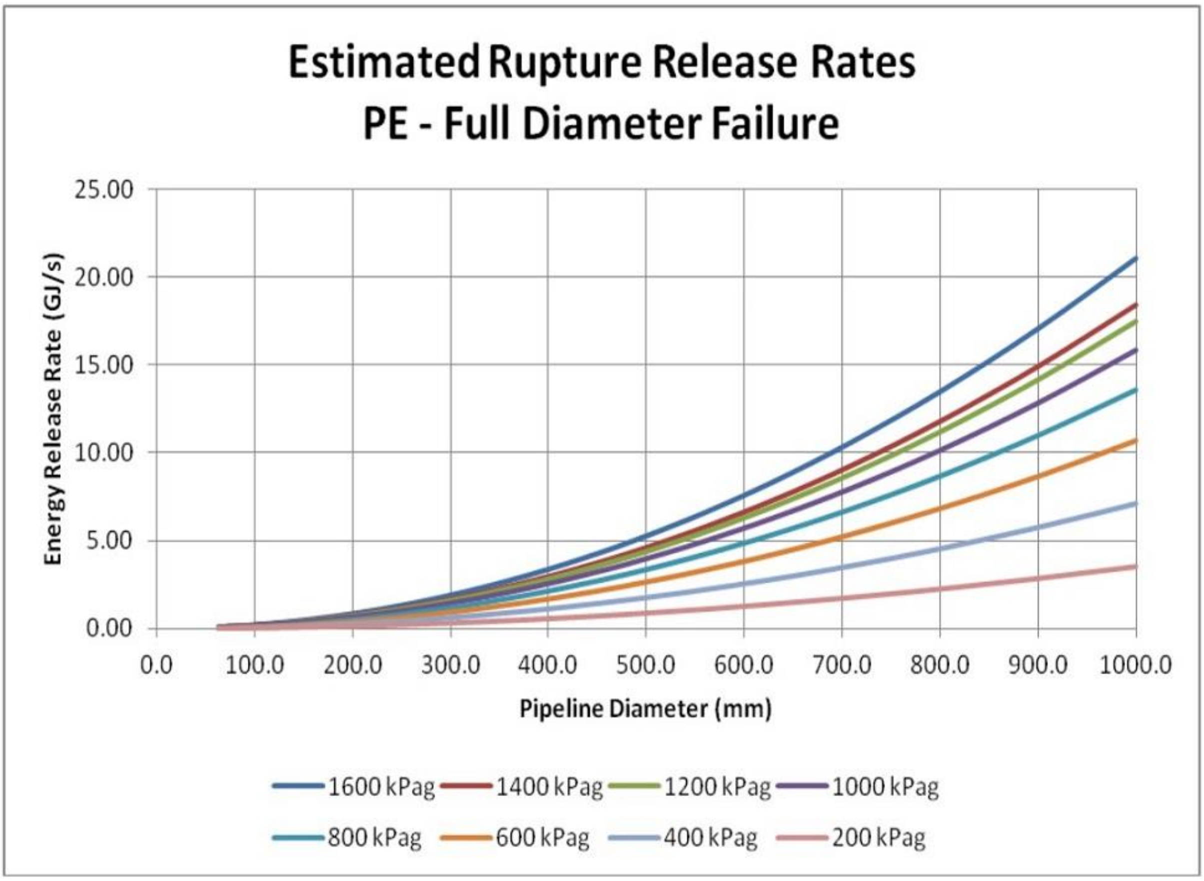
An energy release contour for full diameter ruptures is also shown for information.



Estimated 4.7 kW/m2 Radiation Contour
PE - Full Diameter Failure
Radiation Distance (m)
Pipeline Diameter (mm)
0
25
50
75
100
125
150
175
200
225
250
275
300
325
350
0.0
100.0
200.0
300.0
400.0
500.0
600.0
700.0
800.0
900.0
1000.0
1600 kPag
1400 kPag
1200 kPag
1000 kPag
800 kPag
600 kPag
400 kPag
200 kPag


Estimated 12.6 kW/m2 Radiation Contour
PE - Full Diameter Failure
Radiation Distance (m)
225
200
175
150
125
100
75
50
25
0
0.0
100.0
200.0
300.0
400.0
500.0
600.0
700.0
800.0
900.0
1000.0
Pipeline Diameter (mm)
1600 kPag
1400 kPag
1200 kPag
1000 kPag
800 kPag
600 kPag
400 kPag
200 kPag


Estimated 37.5 kW/m2 Radiation Contour
PE - Full Diameter Failure
Radiation Distance (m)
0
10
20
30
40
50
60
70
80
90
100
110
120
0.0
100.0
200.0
300.0
400.0
500.0
600.0
700.0
800.0
900.0
1000.0
Pipeline Diameter (mm)
1600 kPag
1400 kPag
1200 kPag
1000 kPag
800 kPag
600 kPag
400 kPag
200 kPag



6 Worked Examples

6.1 Example 1 – compressor station

A compressor station is designed to have a number of pipeline inlets, the largest being an 800 NB nodal transfer line with an MAOP of 1400kPag.

The station is operated by three personnel and manned for 12 hours per day.

The plant is inspected twice daily by two operators taking about 1.0 hour each. These two (2) operators also complete field inspection task for the rest of the day.

The Control room is 100 metres from the high-pressure inlet manifold.

An annual total plant outage (TPO) occurs, taking two weeks with 12 additional personnel envisaged. There is no night work during the TPO.

There is also an administration block near the compressor station having six staff working a 12-hour day. This administration block is 300 metres from the high-pressure inlet manifold.

The compressor station is considered to be remote from other infrastructure.

Determine the appropriate location class for the 800 NB line.

Workings

Radiation distances for the transfer line are approximately:

- 248 m for the 4.7kW/m^2 contour;
- 152 m for the 12.6kW/m^2 contour; and
- 88 m for the 37.5kW/m^2 contour.

Thus the control room is within the 12.6kW/m^2 contour, but the administration block is outside the 4.7kW/m^2 contour.

The occupancy rate for the plant is estimated as:

Occupancy rate contribution from three (3) operators

= ((2p x 2hr/day)/24hr day +(1p x 12hr/day)/24hr/day = 0.17 + 0.5 = 0.67.

Occupancy rate contribution from the TPO

= (14p*12hr/day*14days/yr)/(365*24 hr/yr) = 0.27

Total occupancy for the plant = 0.94.

The occupancy for the administration block is = (6p x12 hr/d) /24hr/day = 3.0

Answer

The location class is Rural (R1).

Reason

Even though the control room is within the 12.6kW/m^2 full diameter rupture radiation contour, the occupancy of the control room is less than 2, the SMS should validate the outcome. The administration block is outside the 4.7kW/m^2 contour so is not considered.

6.2 Example 2 – compressor station

As per Example 1 except that the control room is relocated to 200 metres from high-pressure inlet manifold, but in doing so the control room is then located within 100m of a low-pressure inlet manifold.

The largest inlet pipeline being a 1000 NB line with a MAOP of 200kPag.

All other data is identical.

Determine the appropriate location class of the pipelines.

Workings

Radiation distances for the 1000 NB line are; -

- 137m for the 4.7kW/m^2 contour;
- 83m for the 12.6kW/m^2 contour; and
- 48m for the 37.5kW/m^2 contour.

Thus the control room is within the 4.7kW/m^2 contour but the administration block is outside the 4.7kW/m^2 contour.

Answer

The location class is Rural for both pipelines.

Reason

The control room is outside the 12.6kW/m^2 full diameter rupture radiation contours but within the 4.7kW/m^2 full diameter rupture radiation contours for both lines.

The occupancy rate is 0.94 which is less than 2.0 as per table in Section 4.3. The administration block is outside the 4.7kW/m^2 contour so is not considered.

6.3 Example 3 – compressor station

As per Example 2 except that the compressor station is located in an area where the block size is typically less than 5ha, and there are three residences 200 metres from the high and low pressure inlet manifolds.

The manifolds are the closest point of the pipelines to the residences.

The residences are occupied by three families of four employed by the operator of the compressor station.

All other data is identical.

Determine the appropriate location class for the pipelines.

Workings

Residences are within the 4.7kW/m^2 full diameter rupture radiation contour but outside the 12.6kW/m^2 full diameter rupture radiation contour.

The occupancy rate is now a combination of the plant occupancy rate and the residential occupancy rate.

The plant occupancy rate = 0.94 (from Example 1)

The residential occupancy rate = (3 houses x 4p x 12hr/day)/24hr/day = 6.0.

Thus total occupancy rate = 0.94 +6.0 = 6.94.

Answer

The location class is Rural – Residential extending along the 800 NB pipeline for a distance of 248m upstream of the high-pressure inlet manifold, and extending along the 1000 NB pipeline a distance of 137m upstream of the low-pressure inlet manifold.

Reason

The residences and the control room are outside the 12.6kW/m^2 full diameter rupture radiation contours but within the 4.7kW/m^2 full diameter rupture radiation contours for both lines.

The occupancy rate is 6.94 which is less than 18.0 as per table in Section 4.3.

The administration block is outside the 4.7kW/m^2 contour so is not considered.

The fact that the residences are occupied by the Operators employees is not relevant.

6.4 Example 4 – well lease

Three well leases are located within 200 metres of an 800 NB nodal transfer line with an MAOP of 1400kPag and are located within 300 of each other (as measured axially to the pipeline).

The operator visits every two days and takes about 0.5 hours to complete tasks.

The leases typically shutdown once per month and take one operator about two hours to restart.

An annual total plant outage (TPO) taking four days and using five additional personnel is envisaged.

A workover is envisaged every five years. This is achieved by 12 personnel per 12-hour shift over two weeks.

The rig camp is 200 metres from the transfer line. The camp has five personnel.

The location is remote.

Determine the appropriate location class for the pipeline.

Workings

Radiation distances for the transfer line are:

- 248m for the 4.7kW/m^2 contour;
- 152m for the 12.6kW/m^2 contour; and
- 88m for the 37.5kW/m^2 contour'

Thus each lease and the rig camp are within the 4.7kW/m^2 contour.

The occupancy rate is a combination of the occupancy from the operators, the TPO personnel and the rig personnel.

Occupancy rate contribution from the operator's regular duties = (1p x 0.5hrs /48hrs) = 0.010

Occupancy rate contribution from the operator's start of one well = (1p x 2hrs/mth)/744 hrs/mth = 0.003

Occupancy rate contribution from the TPO = (6p x 4days x 12hrs/day)/(24 hrs/day x 365days/yr) = 0.033.

Occupancy rate contribution from the workover and rig camp = ((12p+12p+5p) x 24hrs/day x 14 days)/(24hrs/day x 365 days/yr x 5 yr) = 0.222.

Based on the information supplied, only two of the three leases are within the same 4.7kW/m^2 full diameter rupture radiation area of the same point source failure.

Hence occupancy rate = 2 x (0.010+0.003+0.033+0.222) = 0.536

Answer

The location class is Rural.

Reason

The lease and the rig camp are outside the 12.6kW/m^2 full diameter rupture radiation contour but within the 4.7kW/m^2 full diameter rupture radiation contour.

The occupancy rate is 0.536 which is less than 2.0 as per table in Section 4.3.

Only two of the three leases are within the same 4.7kW/m^2 full diameter rupture radiation area.

6.5 Example 5 – operations camp

A 100-bed operators camp is located in the vicinity of a number of lines running in parallel trenches, the nearest being an 800 NB nodal transfer line with an MAOP of 1400kPag at an average distance of 170 metres.

The camp has a staff of eight personnel. Twenty percent (20 beds) of the camp is within 150 metres of the line. The camp use is 90 per cent. The length of the camp parallel to the pipelines is 150m.

Determine the appropriate location class for the pipeline.

Workings

Radiation distances for the transfer line are:

- 248m for the 4.7kW/m^2 contour;
- 152m for the 12.6kW/m^2 contour; and
- 88m for the 37.5kW/m^2 contour.

Thus the camp is within the 12.6kW/m^2 contour.

It is assumed that the workers are in the camp for 12 hours, or 50 per cent of the day, and the camp staff are in the camp all the time.

The occupancy rate for the camp is = (0.9 x (100-8)p x12hrs/day)/24hours/day + 8 = 49.4.

Answer

The location class is Rural –Residential High Use, extending along the pipeline a distance of 248m either side of the Camp for a total distance of 646m.

Reason

Based on density the primary location class would be Rural-Residential. The occupancy rate is 49.4 which is more than 18.0 as per table in Section 4.3.

7 References

The following references are used:

1. AS 2885.1 –Pipelines –Gas and Liquid Petroleum – Design and Construction
2. API 521 – Pressure Relieving and Depressurising Systems - 2014
3. GRI-00/0189 Fire Hazard for Gas Pipelines
4. HIPAP 4 – Hazard Industry Planning Advisory Paper – No 4 - risk criteria for land use safety planning 2011.1