

Australian/New Zealand Standard™

Pipelines—Gas and liquid petroleum

Part 6: Pipeline safety management



AS/NZS 2885.6:2018

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Australasian Corrosion Association
Australian Industry Group
Australian Institute of Petroleum
Australian Petroleum Production and Exploration Association
Australian Pipelines and Gas Association
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Australian/New Zealand Standard™

Pipelines—Gas and liquid petroleum

Part 6: Pipeline safety management

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PREFACE

This Standard was prepared by the Joint Standards Australia/Standards New Zealand Committee ME-038, Petroleum Pipelines.

The inclusion of roles and responsibilities in AS/NZS 2885.6:2018, was approved by the Standards Development and Accreditation Committee on 1 May 2015, as a one-off exemption to the directives of *Standardization Guide 009: Preparation of Standards for Legislative Adoption*.

The objective of this Standard is to provide requirements on PIPELINE SYSTEM safety management to prevent pipeline failure and resulting harm to people, disruption of supply to the community, and damage to the environment.

The AS(/NZS) 2885 series comprises the following:

AS 2885.0, *Pipelines—Gas and liquid petroleum*, Part 0: *General requirements*

AS/NZS 2885.1, *Pipelines—Gas and liquid petroleum*, Part 1: *Design and construction*

AS/NZS 2885.2, *Pipelines—Gas and liquid petroleum*, Part 2: *Welding*

AS 2885.3, *Pipelines—Gas and liquid petroleum*, Part 3: *Operation and maintenance*

AS 2885.4, *Pipelines—Gas and liquid petroleum*, Part 4: *Submarine pipeline systems*

AS/NZS 2885.5, *Pipelines—Gas and liquid petroleum*, Part 5: *Field pressure testing*

AS/NZS 2885.6, *Pipelines—Gas and liquid petroleum*, Part 6: *Pipeline safety management* (this Standard)

This Standard is a new part in the series. AS 2885.1—2012 included requirements on the SAFETY MANAGEMENT PROCESS that were removed in its latest revision and superseded by reference to this Part 6. This Standard applies to pipeline safety management for the whole AS(/NZS) series of standards for gas and liquid petroleum pipelines, except for submarine pipelines covered by Part 4.

Small caps have been used in this document to indicate terms which have been defined in AS 2885.0 (for example, “PIPELINE SYSTEM”).

The terms “may”, “should” and “shall” are not in small caps but are defined terms that are used in this Standard to indicate an option (may), a recommendation (should) or a mandatory statement (shall).

The term “informative” has been used in this Standard to define the application of the appendix to which it applies. An “informative” appendix is only for information and guidance.

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FOREWORD

Safety management is integral to the planning, design, construction, testing COMMISSIONING, operation, maintenance and abandonment of a PIPELINE SYSTEM.

AS 2885.0 identifies the LICENSEE as being accountable for the safety and integrity of the PIPELINE SYSTEM, so the LICENSEE is responsible for safety management.

PIPELINE SYSTEM safety management applies controls to identified THREATS and reduces residual risk to a level that is AS LOW AS REASONABLY PRACTICABLE (ALARP) through a SAFETY MANAGEMENT STUDY (SMS). THREATS that are not CONTROLLED are investigated by RISK ASSESSMENT.

Mandatory PHYSICAL and PROCEDURAL requirements are specified for control of external interference THREATS, which are known to be the events most likely to create a failure.

Mandatory requirements for “no RUPTURE” and maximum energy release rate are specified in AS/NZS 2885.1 for new PIPELINE SYSTEMS in HIGH CONSEQUENCE AREAS.

For existing pipelines in HIGH CONSEQUENCE AREAS, or where a change in land use will introduce a HIGH CONSEQUENCE AREA to an existing pipeline, an assessment against those requirements of AS/NZS 2885.1 is required and this Standard applies mandatory requirements for maintaining the risk at a level that is ALARP.

To help recognize the inherent risk of potential catastrophic outcomes in HIGH CONSEQUENCE AREAS, this Standard mandates that the LICENSEE be aware of the potential consequences and associated THREAT mitigation measures.

All controls require ongoing management so that they remain effective. The outcomes of the SAFETY MANAGEMENT PROCESS are incorporated in the PIPELINE MANAGEMENT SYSTEM.

STANDARDS AUSTRALIA/STANDARDS NEW ZEALAND

Australian/New Zealand Standard
Pipelines—Gas and liquid petroleum

Part 6: Pipeline safety management

SECTION 1 SCOPE AND GENERAL

1.1 SCOPE

This Standard specifies the SAFETY MANAGEMENT PROCESS for PIPELINE SYSTEMS and covers all elements of the system designed, constructed or operated under the AS/(NZS) 2885 series of Standards, including MAINLINE PIPE and PIPELINE ASSEMBLIES, STATIONS and control systems.

As safety management is a continuous process, this Standard applies throughout the life cycle of a PIPELINE SYSTEM from design to abandonment.

This Standard does not apply to workplace health and safety, construction safety, or environmental impacts other than resulting from a FAILURE EVENT, as other parts of the AS/(NZS) 2885 series contain specific requirements relevant to these areas.

NOTE: The APGA *Code of Environmental Practice* provides industry accepted guidance on environmental management through the planning and asset acquisition, construction, operational and decommissioning phases of a pipeline's lifecycle.

1.2 NORMATIVE REFERENCES

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document.

NOTE: Documents for informative purposes are listed in the Bibliography.

AS 2885.0, *Pipelines—Gas and liquid petroleum*, Part 0: *General requirements*

AS 2885.3, *Pipelines—Gas and liquid petroleum*, Part 3: *Operation and maintenance*

AS/NZS 2885.1, *Pipelines—Gas and liquid petroleum*, Part 1: *Design and construction*

AS/NZS 2885.5, *Pipelines—Gas and liquid petroleum*, Part 5: *Field pressure testing*

1.3 DEFINITIONS

For the purposes of this Standard the definitions in AS 2885.0 apply.

1.4 ABBREVIATIONS

ALARP	AS LOW AS REASONABLY PRACTICABLE
APGA	Australian Pipelines and Gas Association
CHAZOP	Control system HAZOP
FEED	Front-end engineering design
FMEA	Failure mode effects analysis
GIS	Geographic information system
HAZOP	Hazard and operability study

LOPA	Layer of protection analysis
MAOP	MAXIMUM ALLOWABLE OPERATING PRESSURE
PIMP	Pipeline integrity management plan
PMS	PIPELINE MANAGEMENT SYSTEM
SIL	Safety integrity level
SMS	SAFETY MANAGEMENT STUDY

1.5 GENERAL REQUIREMENTS

1.5.1 Safety management in the pipeline life-cycle

SAFETY MANAGEMENT STUDIES are the means of applying safety management principles. Section 5 contains specific objectives and requirements for SAFETY MANAGEMENT STUDIES conducted at the following life-cycle phases:

- (a) Design and construction phase:
 - (i) Preliminary design.
 - (ii) Front-end engineering design (FEED).
 - (iii) Detailed design.
 - (iv) Pressure test design.
 - (v) Pre-construction review.
 - (vi) Construction changes review.
 - (vii) Review prior to COMMISSIONING.
- (b) Operation and maintenance phase:
 - (i) Periodic review (maximum interval five years).
 - (ii) LAND USE CHANGE.
 - (iii) ENCROACHMENT or activity on easement.
 - (iv) Change of operating conditions, including abandonment.
 - (v) FAILURE EVENT review.

1.5.2 Safety management studies

The SAFETY MANAGEMENT STUDY shall address the complete PIPELINE SYSTEM, including STATIONS and control systems.

All THREATS to the integrity of the PIPELINE SYSTEM shall be identified, and multiple independent controls shall be applied to each credible identified THREAT. THREATS that are not CONTROLLED shall be subject to RISK ASSESSMENT and residual risk shall be shown to be AS LOW AS REASONABLY PRACTICABLE (ALARP).

The SMS shall be undertaken and revised at intervals during the design, construction, COMMISSIONING and operational phases to facilitate periodic re-assessment of THREATS and the implementation of controls as knowledge of THREATS and control effectiveness is changed or improved over the pipeline lifecycle.

The facilities and control systems shall be reviewed by appropriate safety study methods including as a minimum—

- (a) the process safety of the PIPELINE SYSTEM shall be assessed through a hazard and operability study (HAZOP); and

- (b) non-process THREATS shall be subject to the SAFETY MANAGEMENT PROCESS in accordance with this Standard.

NOTE: Other methods that should be considered include CHAZOP, Bowtie, SIL, LOPA, FMEA. IEC/ISO 31010 or SA/SNZ HB 89 provides guidance.

SAFETY MANAGEMENT STUDIES shall be carried out by the LICENSEE or the LICENSEE'S representative. Other stakeholders should be involved where necessary.

Pipeline safety management shall be carried out by COMPETENT PERSONNEL.

SAFETY MANAGEMENT STUDIES and their outcomes shall be documented and APPROVED.

1.5.3 Documentation

1.5.3.1 General

The SAFETY MANAGEMENT PROCESS shall be documented with sufficient detail so that independent reviewers or future users can make an informed assessment of the integrity of the process and its outcomes, including the basis for the identification of THREATS and the reasoning behind the assessment of the effectiveness of the controls applied.

1.5.3.2 New pipelines

For new pipelines, safety management documentation shall be transferred from the design and construct phase of the project to the operating phase of the project in a form that enables safety management to be undertaken from the time that operation commences and throughout the lifecycle of the asset.

Where THREAT controls require ongoing activities, those activities shall be documented in the PIPELINE MANAGEMENT SYSTEM.

1.5.3.3 Existing pipelines

For existing pipelines, the existing PIPELINE MANAGEMENT SYSTEM (see AS 2885.3) shall be updated with the actions from the SAFETY MANAGEMENT PROCESS. The PIPELINE MANAGEMENT SYSTEM shall identify these actions as arising from the SMS.

1.5.4 Implementation

All actions arising from the SAFETY MANAGEMENT PROCESS shall be implemented unless further review after the SMS, including consultation with relevant workshop participants, justifies and documents cancellation of the action.

Implementation of SMS actions shall be documented.

Where ongoing action is required, a reporting mechanism shall be implemented and audited to demonstrate effectiveness.

For new PIPELINE SYSTEMS, all SMS actions that are necessary for safe pressurization and operation shall be completed prior to the commencement of COMMISSIONING.

The period allowed for the implementation of each action shall be identified as part of the SMS.

1.5.5 Safety management study validation

Where required by this Standard, each SMS shall be validated in a properly constituted workshop that shall review each aspect of the SMS. A workshop is properly constituted when it includes, as a minimum, participants who—

- (a) are collectively COMPETENT in the subject area to be addressed by the workshop;
- (b) have detailed field-based knowledge of the pipeline route and its surroundings; and
- (c) have authority to make decisions in the field which they represent.

Workshops for the design phase of a new pipeline shall include representatives of the LICENSEE who are collectively COMPETENT in all relevant design disciplines. Also, a representative from the operations and maintenance team should be included.

Workshops during the operational phase shall include representatives with the COMPETENCE and authority to make decisions on engineering, operational and maintenance matters.

NOTE: Participation of the regulatory authority in any workshop may be beneficial.

The workshop should be facilitated by someone who is sufficiently independent of the pipeline to ensure that the SMS is subject to challenge.

NOTE: The facilitator does not need to be external to the LICENSEE'S organization. Appendix J contains further brief guidance on facilitators.

Prior to a validation workshop, THREAT identification should be completed and mitigation measures recommended, and this information should be provided to workshop participants. Exceptions to this recommendation are noted in Section 5.

NOTES:

- 1 The workshop is typically the last stage in the process apart from implementation of actions and final documentation. Validation is the main objective but a workshop often fulfils other important functions including engagement with stakeholders and providing an opportunity for a wide range of views on threats and controls.
- 2 Guidance on assessment of the integrity of the SAFETY MANAGEMENT PROCESS is provided in Appendix J.

1.5.6 High consequence recognition

The LICENSEE shall be aware of the potential consequences of pipeline failures in HIGH CONSEQUENCE AREAS, the controls in place to mitigate these consequences and the limitations of the controls.

NOTE: Appendix H contains guidance on this requirement.

SECTION 2 CLASSIFICATION OF LOCATIONS

2.1 BASIS OF SECTION

The pipeline route shall be sectioned according to land use, and each section allocated LOCATION CLASSES that reflect threats to PIPELINE SYSTEM integrity, and risks to people, property and the environment. The primary LOCATION CLASS shall reflect the population density. Where appropriate, one or more secondary LOCATION CLASSES reflecting special land uses shall be allocated to locations along the route.

NOTE: Consideration of population density includes both residents and others who spend prolonged periods in the vicinity of the pipeline as a result of their employment, recreation or any other reason.

For a new PIPELINE SYSTEM, the LOCATION CLASS analysis shall be based on the land use permitted in the legislation, regulations, planning scheme or equivalent applicable to the land in question. A detailed investigation shall also be undertaken to identify all reasonably anticipated changes in land use along the route over the design life of the pipeline. Where the extent of the anticipated LAND USE CHANGE can reasonably be determined, the pipeline LOCATION CLASSES shall be based on the most demanding of the current and anticipated land uses.

NOTE: The APGA “*Guideline for investigations of land use around pipelines to guide initial location classification under AS 2885*” should be consulted to determine the requirements for detailed investigations into land use planning and the impacts on LOCATION CLASSIFICATION.

For existing PIPELINE SYSTEMS, the allocated LOCATION CLASSES shall be reviewed to take full account of current land use and authorized developments along the pipeline route, but need not take full account of land use which is planned but not implemented.

2.2 LOCATION CLASSIFICATION

It is the intent of this Standard that the LOCATION CLASS is selected from an analysis of the predominant land use in the broad area traversed by the pipeline.

NOTE: Sectioning the pipeline by LOCATION CLASSIFICATION allows the analysis of threats that apply over sections of the route (e.g. farming, forestry, urban development).

The following requirements shall be followed in determining the LOCATION CLASS:

- (a) The LOCATION CLASS at any point on the pipeline shall be determined by assessing the land use within a radius of one MEASUREMENT LENGTH from that point.
- (b) Where land within the MEASUREMENT LENGTH is consistent with a more demanding LOCATION CLASS than the predominant land use, the more demanding LOCATION CLASS shall be applied.

NOTE: The MEASUREMENT LENGTH is used to determine LOCATION CLASS regardless of whether RUPTURE is a credible failure mode.

- (c) At the point where the LOCATION CLASS changes, the more severe LOCATION CLASS shall extend into the less severe LOCATION CLASS by at least the MEASUREMENT LENGTH.

2.3 PRIMARY LOCATION CLASS

The pipeline route shall be classified into one of the primary LOCATION CLASSES R1, R2, T1 and T2 as defined below.

In the event of any doubt of which LOCATION CLASS applies, the more demanding LOCATION CLASS should be adopted.

Land through which the pipeline passes shall be classified as follows:

- (a) *Rural (R1)* Land that is unused, undeveloped or is used for rural activities such as grazing, agriculture and horticulture. Rural applies where the population is distributed in isolated dwellings. Rural includes areas of land with public infrastructure serving the rural use (e.g. roads, railways, canals, utility easements).
- (b) *Rural Residential (R2)* Land that meets any of the following criteria:
 - (i) Defined in a local land planning instrument as rural residential or its equivalent.
 - (ii) Occupied by single residence blocks typically in the range 1 ha to 5 ha.
 - (iii) Rural or semi-rural areas for which the number of dwellings within the MEASUREMENT LENGTH radius from any point on the pipeline does not exceed approximately 50.

Land used for other purposes but with similar population density shall be assigned rural residential LOCATION CLASS. Rural Residential includes areas of land with public infrastructure serving the rural residential use (e.g. roads, railways, canals, utility easements).

- (c) *Residential (T1)* Land that is developed for community living or is defined in a local planning instrument as residential or its equivalent. Residential applies where multiple dwellings exist in proximity to each other and dwellings are served by common public utilities. Residential includes areas of land with public infrastructure serving the residential use, e.g. roads, railways, recreational areas, camping grounds/caravan parks, suburban parks, small strip shopping centres. Residential land use may include isolated higher density areas provided they are not more than 10% of the land use within a radius of one MEASUREMENT LENGTH at any point on the pipeline. Land used for other purposes but with similar population density shall be assigned Residential LOCATION CLASS.
- (d) *High Density (T2)* Land that is developed for high density community use or is defined in a local planning instrument as high density or its equivalent. High Density applies where multi-storey development predominates or where large numbers of people congregate in the normal use of the area. High Density includes major sporting and cultural facilities, major retail and business centres (e.g. town centres, shopping malls, hotels and motels) and areas of public infrastructure serving the high-density use (e.g. roads, railways). To assist in determining the LOCATION CLASS boundary between T1 and T2, the T2 LOCATION CLASS contains more than approximately 50 dwellings per hectare.

NOTE: In Residential and High Density areas, the societal risk associated with loss of containment is a dominant consideration.

2.4 SECONDARY LOCATION CLASS

Secondary LOCATION CLASSES S, E, I, HI, CIC, and C are subclasses that may occur within any primary LOCATION CLASS.

Where the land use through which the pipeline route passes is identified as S, E, I, HI, CIC, or C, the requirements of the primary LOCATION CLASS (R1, R2, T1, T2) shall be applied with the additional requirements established for the secondary class.

Small and medium pipeline facilities may take the same primary LOCATION CLASS as the pipeline and do not require a secondary LOCATION CLASS, provided they are closely associated with the pipeline and under the same management, and have low staffing levels (e.g. pipeline compressor STATION, field compressor STATION). Large and/or heavily staffed facilities indirectly associated with the PIPELINE SYSTEM (e.g. gas processing plant or oil terminal) may require HI LOCATION CLASS, particularly if managed independently of the PIPELINE SYSTEM.

Secondary LOCATION CLASSES are defined as follows:

- (a) *Sensitive use (S)* The sensitive use LOCATION CLASS identifies land where the consequences of a FAILURE EVENT may be increased because it is developed for use by sectors of the community who may be unable to protect themselves from the consequences of a pipeline FAILURE EVENT. Sensitive uses are specifically defined in some jurisdictions, but include schools, hospitals, aged care facilities and prisons. Sensitive use LOCATION CLASS shall be assigned to any section of the PIPELINE SYSTEM where there is a sensitive development within a MEASUREMENT LENGTH.

The design requirements for High Density (T2) shall apply.

NOTE: In sensitive use areas, the societal risk associated with loss of containment is a dominant consideration.

- (b) *Environmental (E)* The Environmental LOCATION CLASS identifies locations of high environmental sensitivity to pipeline failure, including particularly areas where pipeline failure may impact on threatened ecological communities or species or where rectification of environmental damage may be difficult. Areas of high environmental sensitivity may be identified by analysis of government environmental mapping within the pipeline MEASUREMENT LENGTH and, where required, may be validated by field surveys conducted by COMPETENT persons. A consequence assessment shall be undertaken, and depending on the assessed environmental severity the requirements of R2, T1 or T2 shall be applied.
- (c) *Industrial (I)* The Industrial LOCATION CLASS identifies land that poses a different range of THREATS because it is developed for manufacturing, processing, maintenance, storage or similar activities or is defined in a local land planning instrument as intended for light or general industrial use. Industrial applies where development for factories, warehouses, retail sales of vehicles and plant predominates. Industrial includes areas of land with public infrastructure serving the industrial use

The design requirements for Residential (T1) shall apply.

NOTE: In industrial use areas, the dominant consideration may be the THREATS associated with the land use or the societal risk associated with the loss of containment.

- (d) *Heavy Industrial (HI)* Sites developed or zoned for use by heavy industry or for toxic industrial use shall be classified as Heavy Industrial. They shall be assessed individually to assess whether the industry or the surroundings include features that—
- (i) contain unusual THREATS to the PIPELINE SYSTEM; or
 - (ii) contain features that may cause a pipeline FAILURE EVENT to escalate either in terms of fire, or for the potential release of toxic or flammable materials.

A consequence assessment shall be undertaken, and depending on the assessed severity, the requirements of R2, T1 or T2 shall be applied.

NOTE: In heavy industrial use areas, the dominant consideration may be the THREATS associated with the land use or a range of location specific risks associated with the loss of containment.

- (e) *Common Infrastructure Corridor (CIC)* Land which, because of its function, results in multiple (more than one) parallel infrastructure development within a common easement or reserve, or in easements which partially or fully overlay the pipeline easement.

CIC classification includes pipelines within reserves or easements for roads, railways, powerlines, buried cables, or other pipelines. It does not include crossings, roads or tracks which are not gazetted, or where the pipeline is adjacent to but outside a road reserve.

AS/NZS 2885.1 addresses PROCEDURAL CONTROLS for CIC LOCATION CLASS.

NOTE: In CIC areas, the dominant consideration may be the THREATS associated with the land use by other infrastructure operators or the higher consequences of loss of containment associated with increased transient population (e.g. roads) or other parallel infrastructure.

- (f) *Crowd (C)* The crowd LOCATION CLASS shall be applied to locations where there may be crowds or congestion leading to concentrations of population that are both intermittent and much higher than typical for the prevailing primary LOCATION CLASS. Examples include sports fields, roads subject to serious traffic congestion, and rural community halls.

Where C LOCATION CLASS is assigned, the SMS shall examine risk to the concentration of people with consideration of the number of people, the frequency and duration of assembly, the time of day or week that people are present, and the likelihood that THREATS and the population concentration will occur at the same time. Controls appropriate to the level of risk shall be applied.

NOTE: In crowd areas, the societal risk associated with loss of containment is a dominant consideration. The risk level may vary considerably. For example, the SMS may conclude that a country playing field, which is only used on occasional Sundays, presents a much lower risk than a motorway that becomes highly congested twice every weekday, because of both the frequency of congestion and the likelihood (or otherwise) of concurrent THREATS.

SECTION 3 SAFETY MANAGEMENT PROCESS

3.1 BASIS OF SECTION

The SAFETY MANAGEMENT PROCESS consists of the following:

- (a) Location analysis and classification (see Section 2).
- (b) THREAT identification.
- (c) THREAT control.
- (d) Failure analysis of THREATS where failure is still possible.
- (e) Qualitative RISK ASSESSMENT and treatment of residual risk:
 - (i) High or extreme risks are not acceptable.
 - (ii) Intermediate risks require a formal ALARP assessment including application of additional controls as necessary.
 - (iii) Low or negligible risks are deemed to be ALARP.

Figure A1 of Appendix A illustrates the SAFETY MANAGEMENT PROCESS. This Section describes its detail and application.

3.2 THREAT IDENTIFICATION

The intent of THREAT identification is to identify all THREATS with the potential to damage the PIPELINE SYSTEM, cause interruption to service, cause release of fluid from the pipeline, or cause harm to pipeline operators, the public or the environment.

A key principle of threat identification is that a THREAT is associated with a location.

THREAT identification shall be undertaken for the whole PIPELINE SYSTEM, including the full length of the pipeline and its facilities. The THREAT categories shall include, at least—

- (a) external interference;
- (b) corrosion;
- (c) natural events;
- (d) faults in design, materials or construction;
- (e) faults in operations, maintenance and management systems;
- (f) intentional damage; and
- (g) any other relevant THREATS

The THREAT identification process shall generate sufficient information about each threat to allow effective controls to be identified and applied.

NOTE: Extensive guidance on THREATS and the THREAT identification process is given in Appendix C.

When a THREAT has been identified, but is later assessed as non-credible, the reason for it being declared non-credible shall be documented. The validity of this decision shall be re-assessed at each revision of the SMS.

NON-CREDIBLE THREATS do not require controls.

3.3 THREAT CONTROL

3.3.1 General

Control is achieved by the application of multiple independent protective measures in accordance with the AS(NZS) 2885 series.

Controls shall be applied until either it can be demonstrated that the pipeline is protected from the specified THREAT or no further practicable controls are available. If the controls applied are not sufficient for the THREAT to be CONTROLLED the THREAT shall be subject to failure analysis in accordance with Clause 3.4.

NOTES:

- 1 Design measures which eliminate a THREAT are to be preferred over those which reduce it, and design measures in general are to be preferred over measures implemented through operation and maintenance procedures.
- 2 In this Standard, the concepts of PHYSICAL and PROCEDURAL CONTROLS are applicable only to external interference THREATS and are not relevant to other types of THREATS. Guidance on PROCEDURAL CONTROLS is provided in Appendix E.

3.3.2 External interference threats

External interference protection for new pipelines shall be designed in accordance with, and for existing pipelines shall be assessed against, AS/NZS 2885.1.

NOTE: Guidance on external interference protection is provided in Appendix D.

3.3.3 Other threats

THREATS other than external interference shall be CONTROLLED by design in accordance with AS/NZS 2885.1 and/or procedures in accordance with AS 2885.3.

3.4 FAILURE ANALYSIS

3.4.1 General

Where a THREAT is not a CONTROLLED THREAT, the THREAT shall be further analysed to determine the extent of the damage that it may cause to the PIPELINE SYSTEM, for input into the consequence analysis.

Where the outcome is a potential FAILURE EVENT, the analysis shall determine the mode of failure. Failure may be immediate or delayed, or there may be no failure. Where applicable, the analysis shall also determine relevant inputs to the consequence analysis such as the energy release rate or spill volume at the point of failure and/or supply disruption magnitude and duration.

NOTE: Modes of pipe failure include propagating fracture, RUPTURE, holes, pinholes, cracks, dents, GOUGES, and loss of wall thickness.

Where a FAILURE EVENT is identified, additional controls to prevent failure shall be investigated. Where additional controls are identified as a result of the investigation, they should be applied, where practicable.

Any remaining FAILURE EVENTS shall be subject to RISK ASSESSMENT in accordance with this Standard.

For RISK ASSESSMENT of FAILURE EVENTS sufficient FAILURE SCENARIOS shall be assessed to identify the highest resulting risk rank in accordance with Clause 3.5.

NOTES:

- 1 Consideration of more than one scenario may be necessary because, for example, an excavator impact may result in coating damage (with possible subsequent corrosion), a GOUGE (with possible delayed failure, or possible supply impact due to MAOP reduction pending repair), penetration or RUPTURE.
- 2 Analysis of FAILURE SCENARIOS is discussed and illustrated in Appendix F and Appendix G.

3.4.2 Documentation

The failure analysis for each FAILURE SCENARIO should document the following (as applicable):

- (a) The PIPELINE SYSTEM design features.
- (b) The THREAT.
- (c) Details of the failure, including the following:
 - (i) The mode of failure.
 - (ii) The physical dimensions of the failure.
 - (iii) The location of the failure.
- (d) Details of the FAILURE SCENARIO, including the following:
 - (i) The nature of the escaping fluid.
 - (ii) The energy release rate or spill volume.
 - (iii) The contour radius for a radiation intensity of 12.6 kW/m² and 4.7 kW/m².
 - (iv) The impact of the release on people (injuries or fatalities).
 - (v) The impact of the failure on supply (magnitude and duration).
 - (vi) The impact of the failure on the environment (particularly liquids impact).

NOTE: Some of the information in this list may be addressed in a generic manner for a given set of pipeline parameters, and does not necessarily have to be documented against every THREAT analysed.

3.5 QUALITATIVE RISK ASSESSMENT

3.5.1 General

RISK ASSESSMENT of FAILURE SCENARIOS shall be undertaken in accordance with the qualitative method described in this Clause 3.5.

NOTE: This qualitative risk evaluation method is consistent with the process defined within AS/NZS ISO 31000.

There are circumstances where risk estimation using quantitative (numerical) methods may be useful to enable comparison of alternative mitigation measures as a basis for demonstration of ALARP, and in some jurisdictions, to satisfy planning criteria. Purely quantitative methods are not permitted as a substitute for the qualitative assessment required by this Standard, although quantitative estimates may be used to assist with estimating frequency and consequences as part of the qualitative method required by this Standard.

NOTE: Quantitative RISK ASSESSMENT methods need to be used with great care. Classical quantitative RISK ASSESSMENT using historical failure rates is not valid for determining the absolute risk level of Australian and New Zealand pipelines due to the lack of relevant statistical data. The failure rate of Australian pipelines has been assessed to be at least an order of magnitude lower than pipelines in other parts of the world so use of historical failure rates from overseas will generate unrealistically conservative results. Reliability-based analysis such as permitted by Canadian Standard CSA Z662 may have more validity.

3.5.2 Severity analysis

The consequences of each FAILURE SCENARIO shall be described, assessed and documented.

A severity class shall be assigned to each FAILURE SCENARIO based on the consequences at the location of the failure. The severity class shall be selected from Table 3.1.

NOTE: Appendix G provides guidance on estimating consequences.

TABLE 3.1
SEVERITY CLASSES

Dimension	Severity class				
	Catastrophic	Major	Severe	Minor	Trivial
	Measures of severity				
People	Multiple fatalities result	One or two fatalities; or several people with life-threatening injuries	Injury or illness requiring hospital treatment	Injuries requiring first aid treatment	Minimal impact on health and safety
Supply (see Note)	Widespread or significant societal impact, such as complete loss of supply to a major city for an extended time (more than a few days)	Widespread societal impact such as loss of supply to a major city for a short time (hours to days) or to a localized area for a longer time	Localized societal impact or short-term supply interruption (hours)	Interruption or restriction of supply but shortfall met from other sources	No loss or restriction of pipeline supply
Environment	Impact widespread; viability of ecosystems or species affected; or permanent major changes	Major impact well outside PIPELINE CORRIDOR or site; or long-term severe effects; or rectification difficult	Localized impact, substantially rectified within a year or so	Impact very localized and very short-term (weeks), minimal rectification	No effect; or minor impact rectified rapidly (days) with negligible residual effect

NOTE: Appendix G provides guidance on assessment of consequence severities.

3.5.3 Frequency analysis

A frequency class shall be assigned to each FAILURE SCENARIO. The frequency class shall be selected from Table 3.2.

The contribution of existing controls to the prevention of failure shall be considered in assigning the frequency class.

NOTE: Appendix F provides guidance on estimating frequencies.

TABLE 3.2
FREQUENCY CLASSES

Frequency class	Frequency description
Frequent	Expected to occur once per year or more
Occasional	May occur occasionally in the life of the pipeline
Unlikely	Unlikely to occur within the life of the pipeline, but possible
Remote	Not anticipated for this pipeline at this location
Hypothetical	Theoretically possible but would only occur under extraordinary circumstances

3.5.4 Risk ranking

Table 3.3 shall be used to combine the results of the consequence analysis and the frequency analysis to determine the risk rank.

Use of the risk matrix in Table 3.3 is mandatory for SAFETY MANAGEMENT STUDIES in accordance with this Standard. Other methods such as a corporate risk matrix may be used only in parallel with Table 3.3 or as part of a separate corporate RISK ASSESSMENT.

TABLE 3.3
RISK MATRIX

	Catastrophic	Major	Severe	Minor	Trivial
Frequent	Extreme	Extreme	High	Intermediate	Low
Occasional	Extreme	High	Intermediate	Low	Low
Unlikely	High	High	Intermediate	Low	Negligible
Remote	High	Intermediate	Low	Negligible	Negligible
Hypothetical	Intermediate	Low	Negligible	Negligible	Negligible

NOTE: Comparative studies sponsored by the Energy Pipelines Cooperative Research Centre have shown that for risks ranked as Intermediate, Table 3.3 produces results consistent with both reliability-based analysis (in accordance with Annex O of CSA Z662-07) and quantitative risk assessment. Use of a different risk matrix or method that has not been similarly calibrated may produce invalid results.

3.6 RISK TREATMENT

3.6.1 General

Action to reduce risk shall be taken in accordance with Table 3.4, based on the risk rank determined from Table 3.3.

The action(s) taken and the planned effect on risk shall be documented.

3.6.2 Risk treatment during design

Risk treatment actions at design stage may include the following:

- (a) Relocation of the pipeline route.
- (b) Modification of the design for any one or more of the following:
 - (i) PIPELINE SYSTEM isolation.
 - (ii) PHYSICAL CONTROLS for prevention of external interference.
 - (iii) PROCEDURAL CONTROLS for prevention of external interference.
 - (iv) Corrosion prevention.
 - (v) Operational controls.

TABLE 3.4
RISK TREATMENT ACTIONS

Risk rank	Required action
Extreme	Modify the THREAT, the frequency or the consequences so that the risk rank is reduced to Intermediate or lower. For an in-service pipeline, the risk shall be reduced immediately.
High	Modify the THREAT, the frequency or the consequences so that the risk rank is reduced to Intermediate or lower. For an in-service pipeline, the risk shall be reduced as soon as possible. Risk reduction should be completed within a timescale of not more than a few weeks.
Intermediate	Repeat THREAT identification and risk evaluation processes to verify the risk estimation; determine the accuracy and uncertainty of the estimation. Where the risk rank is confirmed to be “intermediate”, where reasonably practicable modify the THREAT, the frequency or the consequence to reduce the risk rank to “low” or “negligible”. Where it is not reasonably practicable to reduce the risk rank to “low” or “negligible”, action shall be taken to— (a) remove THREATS, reduce frequencies and/or reduce severity of consequences to the extent practicable; and (b) formally demonstrate ALARP (see Section 4). For an in-service pipeline, the reduction to “low” or “negligible” or demonstration of ALARP shall be completed as soon as possible. Risk reduction or demonstration of ALARP should be completed within a few months.
Low	Determine the management plan for the THREAT to prevent occurrence and to monitor changes that could affect the classification.
Negligible	Review at the next relevant SMS (for periodic operational review, LAND USE CHANGE, ENCROACHMENT, or change of operating conditions).

3.6.3 Risk treatment during operation and maintenance

Risk treatment actions at operating pipeline stage may include one or more of the following:

- (a) Installation of additional or modified PHYSICAL CONTROLS.
- (b) Additional or modified PROCEDURAL CONTROLS.
- (c) Specific actions in relation to identified activities (e.g. presence of operating personnel during activities on the easement).
- (d) Modification to pipeline marking.
- (e) Changes to the isolation plan.
- (f) Changes to the PIPELINE SYSTEM design or operation to satisfy the requirements of this Standard when there is a change to the LOCATION CLASS of the pipeline.
- (g) Specific operational or maintenance procedures.
- (h) Repair, remediation or removal of a condition or DEFECT that presents a THREAT.

THREAT treatment for operating PIPELINE SYSTEMS should consider interim control measures (e.g. reduction in operating pressure, access restrictions) to allow time for the implementation of permanent control measures (e.g. repair).

3.7 CONTROL FAILURE CHECK

If the SMS process has not encountered any THREATS that require risk evaluation, further analysis is recommended. To test the rigour of the study, a situation where failure of THREAT control measures leads to a FAILURE EVENT should be treated as a THREAT. The residual risk of such THREATS should be assessed and treated in accordance with this Standard.

NOTES:

- 1 Almost all pipeline incidents occur because of failure of control measures. Hence, failure of THREAT controls is itself an important THREAT. The worst-case control failure THREAT(S) should be at a location where the consequences are most severe. It may be appropriate to address failures of different THREAT controls (e.g. external interference, corrosion) or different locations.
- 2 It is recommended that THREATS involving failure of controls are identified towards the end of the SAFETY MANAGEMENT PROCESS by which time sufficient knowledge of the THREATS and controls will have been developed to identify locations where fault tolerance is an essential part of the design.
- 3 For some PIPELINE SYSTEMS that have a low level of THREATS and/or a high level of protection, it may be difficult or impossible to identify a plausible situation where failure of THREAT control measures leads to loss of containment and serious consequences. The attempt to identify a worst-case failure should still be documented.

S E C T I O N 4 A L A R P

4.1 BASIS OF SECTION

Risk shall be reduced to AS LOW AS REASONABLY PRACTICABLE (ALARP).

For the purpose of this Standard, the risk associated with a THREAT is deemed ALARP if—

- (a) the THREAT is CONTROLLED;
- (b) the residual risk is assessed to be Low or Negligible; or
- (c) the residual risk is formally demonstrated to be ALARP.

NOTE: Guidance on formal ALARP assessment is provided in Appendix I.

4.2 DEMONSTRATION OF ALARP

Risks found to be Negligible are deemed ALARP.

Risks found to be Low may be deemed ALARP, provided these risks are managed to prevent any rise in risk.

NOTE: Notwithstanding that a risk has been determined to be low or negligible, if there are simple measures that could be taken to reduce risk further, then those measures should be adopted.

Risks found to be Intermediate shall be subject to a formal ALARP assessment that considers—

- (a) the current level of risk (including the effectiveness of current and planned controls) and any additional justification for further risk reduction;
- (b) additional or improved controls available for further reducing the risk;
- (c) the reduction in risk resulting from each available control;
- (d) the cost of each available control;
- (e) the uncertainty in the analysis including uncertainty in the effectiveness of controls and the consequences and likelihood of failure; and
- (f) the reasons why any options for additional or improved controls have not been adopted.

The formal ALARP assessment shall be documented.

Formal ALARP assessment is required when—

- (i) the risk level is Intermediate; or
- (ii) an existing pipeline is in a HIGH CONSEQUENCE AREA and does not conform with current requirements for NO-RUPTURE and energy release rates; or
- (iii) an existing pipeline was designed without a fracture control plan and does not conform with current fracture control requirements.

For in-service pipelines where formal ALARP assessment is required by (i), (ii) or (iii) above, the risk controls listed below shall be considered as part of formal ALARP assessment:

- (A) Imposition of RESTRICTED OPERATING PRESSURE or reduction of MAOP (to a level where RUPTURE is non-credible).
- (B) Pipe replacement (with NO-RUPTURE pipe).
- (C) Pipeline relocation (to a location where the consequence is eliminated).

- (D) Modification of land use (to separate the people from the pipeline).
- (E) Implementing controls that are effective in controlling THREATS capable of causing RUPTURE of the pipeline.

For new pipelines, the above risk controls for in-service pipelines may also be applicable together with any other controls that are appropriate to the nature of the THREAT and the consequences of failure.

SECTION 5 APPLICATION OF SAFETY MANAGEMENT

5.1 BASIS OF SECTION

Every PIPELINE SYSTEM shall have a SMS which is revised and updated as the pipeline progresses through its lifecycle and as external circumstances change. This Section defines the design phases and operational events which can trigger a SMS revision or a new SMS.

NOTE: In practice most PIPELINE SYSTEMS will have a single regularly updated SMS covering the whole system, APPROVED at each stage as required by this Standard, and supplemented when necessary by temporary SMSs for short-term activities such as pressure testing and ENCROACHMENTS.

The fundamental requirements of the SAFETY MANAGEMENT PROCESS apply to every new or revised SMS. This Section defines the application of the SAFETY MANAGEMENT PROCESS through the different stages of the pipeline lifecycle where differing circumstances mean that the details of the process will vary in order to achieve effective safety management.

Figure A2 of Appendix A illustrates the SAFETY MANAGEMENT PROCESS in the context of the pipeline lifecycle and other safety review methods.

5.2 SMS INPUTS AND OUTPUTS

5.2.1 SMS inputs

The SMS inputs shall include the following as a minimum, except where noted otherwise:

- (a) Any previous SMS documentation, and the associated SMS database or equivalent.
- (b) Aerial or satellite imagery of the pipeline route, most recent readily available (noting the recency of the data).
- (c) Land use information at a level of detail appropriate to the objective of the SMS.
- (d) Design or as-built documentation recording the pipeline as it is intended to be built or as it currently exists, including particularly details of wall thickness, material grade, depth of cover and other PHYSICAL protection measures and also the type and location of other infrastructure and features crossed by or in close proximity to the pipeline.
- (e) Operating procedures defining procedural protection measures (or, for an SMS early in the design phase when procedures may not be available, information on the proposed procedural measures).
- (f) Pipeline integrity management plan defining integrity management activities, procedural measures, asset condition and corrosion mitigation (or, for an SMS early in the design phase when the pipeline integrity management plan may not be available, information on the proposed integrity management and corrosion mitigation measures).
- (g) Damage resistance calculations (penetration resistance and RUPTURE resistance), including assessment of conformance with the “NO-RUPTURE” requirement for high consequence areas (see AS/NZS 2885.1:2018, Clause 4.10.2); ideally these will be documented in the fracture control plan (or fracture resistance assessment where no fracture control plan was prepared at time of design).
- (h) Effects of ignited fluid release including the 4.7 kW/m^2 radiation distance (MEASUREMENT LENGTH) and 12.6 kW/m^2 radiation distances for both RUPTURE and credible leaks and, for high-consequence areas, assessment of conformance with maximum energy release.

- (i) Pipeline isolation plan.
- (j) Site layouts and other relevant details for any facilities within the SMS scope.

5.2.2 SMS outputs

Each SMS shall generate the following outputs:

- (a) Summary report of the SMS, or revision of an existing report, defining the scope, purpose, inputs, participants in the validation workshop, and key outcomes.
- (b) List of actions to be implemented, including due dates.
- (c) Record of each identified THREAT including its location, mitigation measures applied and whether or not it is considered CONTROLLED.
- (d) Record of risk evaluation for each THREAT to which it was applied, including reasons for the adopted failure mode, FAILURE SCENARIOS and consequences, severity rating and frequency rating.
- (e) Records of formal ALARP assessments.
- (f) Record, or revision, of pipeline LOCATION CLASS.

Implementation of actions arising from the SMS shall be recorded.

5.3 MULTI-PIPELINE SYSTEMS

Where a PIPELINE SYSTEM comprises a number of broadly similar pipelines, such as a production field gathering system, the SAFETY MANAGEMENT PROCESS may be applied to groups of pipelines that share common characteristics.

For the purposes of this Clause, common characteristics include the same land use and LOCATION CLASSIFICATION and similar but not necessarily identical MAOP, diameter and wall thickness. Pipelines that have substantially different MEASUREMENT LENGTHS, penetration resistance or RUPTURE resistance should not be included in the same group.

For non-location-specific and repetitive THREATS, the SAFETY MANAGEMENT PROCESS may be applied to all pipelines in a group with common characteristics. In addition, each individual pipeline shall be reviewed to identify location-specific THREATS.

5.4 DESIGN AND CONSTRUCTION

5.4.1 SMS plan

A SMS plan shall be prepared at the commencement of each pipeline project, including multi-PIPELINE SYSTEMS.

Provided the requirements of the SMS plan are included in a project document, such as the design basis or a project plan, it is not necessary to prepare a stand-alone SMS plan.

The SMS plan shall define the following:

- (a) Any optional SMS phases or workshops that will be omitted and the reasons for omission.
- (b) Whether pressure test design is required to be subject to SMS.
- (c) The inputs required for each SMS phase.
- (d) Criteria for construction changes that require SMS review.

The requirements for design and construction SMS apply both to new projects and to modifications of existing pipelines. The SMS for a modification project should be appropriate to the extent and complexity of the proposed changes.

5.4.2 Preliminary design SMS

At the conceptual design phase, a preliminary design SMS may be necessary for regulatory approvals. It may not be essential for all projects. Where a preliminary design SMS is done, the requirements below shall apply.

NOTE: For any project, and particularly those in HIGH CONSEQUENCE AREAS, it is good practice to carry out a preliminary design SMS as soon as the project concept is reasonably well defined, to identify significant safety issues at an early stage when changes required to minimize risk, such as route selection, can be achieved with the least cost and disruption.

Sufficient design information shall be developed to allow the preliminary design SMS to be carried out effectively. The preliminary design SMS shall—

- (a) identify high consequence events that impose significant risks to community and environment, and their proposed controls; and
- (b) deliver sufficient information to allow stakeholders involved in the regulatory approvals process to make informed decisions about the risks associated with the project.

NOTE: It is recognized that this is the preliminary design stage, and that the detailed design stage will identify more detailed threats and develop further specific controls for them.

The preliminary design SMS should also consider the following:

- (i) LOCATION CLASS and environmental sensitivity assessments leading to definition of HIGH CONSEQUENCE AREAS.

NOTE: For the preliminary design SMS, liaison with land owners and land users is not usually required.

- (ii) Typical THREATS in typical locations.
- (iii) Location-specific THREATS, particularly in HIGH CONSEQUENCE AREAS.
- (iv) Basic pipeline design parameters.
- (v) The energy release rate and the contour radius for a radiation intensity of 4.7 kW/m² and 12.6 kW/m² in the event of a full-bore RUPTURE.

The preliminary design SMS shall be prepared by the design team and shall be validated by a workshop (see Clause 1.5.5). In addition to participants listed in Clause 1.5.5 the workshop should include people COMPETENT in environmental matters, land liaison, and route selection.

5.4.3 Front end engineering design SMS

An SMS during the front-end engineering design (FEED) phase is not mandatory but recommended, to provide a basis for decisions that need to be made early in the project.

NOTE: Decisions made during FEED phase can have a fundamental influence on the overall safety of the completed pipeline and can be difficult or impossible to modify at a later stage of the project, especially once orders for pipe and other long-lead items have been placed. The FEED SMS should give serious consideration to matters such as the operational safety aspects of route selection, fracture toughness requirements and the quantity of increased wall thickness pipe.

Where a FEED SMS is done, it shall be prepared by the design team and shall be validated in a workshop. If significant changes to the pipeline route are still possible, the workshop should include, in addition to participants listed in Clause 1.5.5, people COMPETENT in environmental matters, land liaison, and route selection.

NOTE: Operating procedures are unlikely to be developed at this stage but operations and maintenance personnel will have knowledge about the proposed operation and should be involved in the SMS to provide input and to make decisions on operational matters.

5.4.4 Detailed design SMS

The detailed design SMS addresses all aspects of pipeline design and shall be completed as part of the detailed design phase. The detailed design SMS shall demonstrate that the requirements of AS/NZS 2885.1 have been achieved, or that they will be achieved subject to effective implementation of all actions recommended by the SMS.

Detailed preparatory information and analysis is required to provide consistency of approach across the pipeline and to provide all the tools necessary to correctly identify all THREATS and facilitate their assessment and control.

The SMS shall be undertaken by personnel with expertise in the design, construction and operation of the pipeline, including, or with the support of, personnel closely familiar with the land uses and environments along the entire route.

The detailed design SMS shall be validated in a workshop constituted in accordance with Clause 1.5.5.

The input information listed below are additional to the requirements of Clause 5.2.1. If any of these items are not applicable, the reason for exclusion shall be documented in the SMS plan.

- (a) Design basis and description including—
 - (i) basic pipeline parameters; and
 - (ii) engineering design guidelines for non-standard construction (crossings, facilities).
- (b) Design calculations (e.g. thickness).
- (c) Typical design drawings (crossings, facilities).
- (d) The initial and/or FEED SAFETY MANAGEMENT STUDIES (where available).
- (e) The corrosion mitigation strategy.
- (f) Pipeline alignment.
- (g) LOCATION CLASS including HIGH CONSEQUENCE AREAS.
- (h) An assessment of current land uses, and plans for future land use (based on a land use planning study).
- (i) Land user survey, comprising documented investigations of external interference THREATS including information from land owner/holder, public/planning authority, construction contractor.
- (j) Documented investigations of external interference THREATS from existing and planned buried and above-ground infrastructure crossing and parallel to the pipeline.
- (k) Construction and landowner constraints.
- (l) Environmental constraints.
- (m) Isolation plan.
- (n) HAZOP and other design review studies applied to STATIONS, pipeline facilities and pipeline control systems.
- (o) Fracture control plan.
- (p) Environmental studies and information developed specifically for the pipeline project or as otherwise may be available for the route traversed by the pipeline.

5.4.5 Pressure test design SMS

If a pipeline pressure test section is in a location where a leak or burst during testing could impact the public or harm the environment, then the risks shall be assessed through the SMS process. The assessment of pressure test risks may be incorporated in the detailed design SMS.

NOTES:

- 1 Locations where the public could be affected include roads and houses that are within range of debris ejected by the burst.
- 2 Where pipe has passed the pre-test in accordance with AS/NZS 2885.5, this Standard considers that leak or burst is not a credible outcome and the pressure test design at that location need not be subject to SMS.

The pressure test design SMS shall assess the consequences for the public or environment if a leak or burst were to occur and shall identify control measures.

All THREATS shall be CONTROLLED

NOTE: As all THREATS will be CONTROLLED, risk evaluation will not be required as part of a pressure test design SMS.

The SMS for pressure testing shall be prepared by the design team and shall be validated in a workshop. In addition to the participants listed in Clause 1.5.5, the workshop should include a TEST SIGNATORY as defined in AS 2885.0.

5.4.6 Pre-construction review SMS

At the completion of design and prior to commencement of construction, a pre-construction review of the detailed design SMS should be undertaken.

The objectives of the review are to—

- (a) confirm that any corrective actions required to be completed prior to construction have been either implemented effectively or have a documented plan for implementation prior to construction;
- (b) confirm that systems and procedures nominated as controls in the detailed design SMS for THREATS involving materials or construction faults have been either implemented effectively or have a documented plan for implementation prior to construction; and
- (c) update the SMS to address any changes (e.g. design changes, route changes) or new information (e.g. landowner, environmental or geotechnical information) that have occurred since the detailed design SMS, and confirm that the requirements of AS/NZS 2885.1 continue to be met.

The pre-construction review SMS should be validated by a workshop if there has been significant change or new information since the most recent previous SMS.

5.4.7 Construction changes revision SMS

The SMS plan shall nominate the types of changes during construction that are significant for the purpose of this Clause 5.4.7 (e.g. route changes that are more than a defined offset from the design centre-line, adjustments to facility locations, change in distribution of heavy wall pipe).

Where significant changes to the pipeline design are required because of unforeseen issues identified during construction, the changes shall be addressed via a formal management of change process which includes assessment against the SMS requirements, and update of the SMS documentation.

A construction changes revision should be validated by a workshop if there has been significant change since the previous SMS.