

Australian/New Zealand Standard™

Gas distribution networks

Part 1: Network management



AS/NZS 4645.1:2018

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Australian/New Zealand Standard™

Gas distribution networks

Part 1: Network management

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PREFACE

This Standard was prepared by the Joint Standards Australia/Standards New Zealand Committee AG-008, Gas Distribution, to supersede AS/NZS 4645.1:2008.

The objective of this Standard is to provide for the protection of the general public, gas distribution network operating personnel and the environment. It also ensures the operation of a safe, reliable and sustainable gas distribution network that reticulates gas to consumers.

The AS/NZS 4645 series of Standards comprises the following parts:

AS/NZS

4645.1 Part 1: Network management (this Standard)

4645.2 Part 2: Steel pipe systems

4645.3 Part 3: Plastics pipe systems

These Standards adopt a performance-based approach for gas distribution network management. A performance-based (rather than prescriptive) approach recognizes that one particular standard or way of doing things may not be the best fit for all situations in all gas distribution networks. A performance-based approach allows innovation and development in the way gas distribution networks are managed, operated and maintained. A performance-based standard aims to specify safety outcomes while allowing some flexibility on how these outcomes are delivered.

The AS/NZS 4645 series of Standards—

- (a) provides performance-based requirements for gas distribution network safety, defining important principles during the lifecycle of gas distribution networks;
- (b) provides prescriptive (deemed to conform) means of conformance in support of some of those performance-based requirements; and
- (c) allows for alternative means of conformance that may be also acceptable provided the required safety outcomes can be demonstrated.

This Standard covers the design, construction, commissioning, operation, maintenance and decommissioning of gas distribution networks and provides a performance-based framework for their management. This Standard identifies the high-level safety requirements for all stages in the life-cycle of a gas distribution network.

In this Standard, the terms ‘means of conformance’ and ‘a means of conformance’ have been used to indicate an appropriate mechanism or mechanisms that can be used for achieving an acceptable level of risk. These terms are equivalent to the terms ‘means of compliance’ and ‘a means of compliance’ as used in the 2008 edition of the Standard. Where the Standard is referenced in legislation in all Australian and New Zealand jurisdictions, conformance with this Standard may imply compliance with the regulations.

AS/NZS 4645.2 and AS/NZS 4645.3 set out means of conformance for elements of design, materials, construction, testing, commissioning and decommissioning of steel and plastics mains and services within a gas distribution network. The means of conformance for other elements of a gas distribution network are documented in this Standard. Conformance to the requirements of this Standard, other than that outlined in the means of conformance can be achieved through the processes described in this Standard.

This Standard can be used as a stand-alone document whereas AS/NZS 4645.2 and AS/NZS 4645.3 are to be used in conjunction with this Standard.

This Standard takes a risk management approach in accordance with AS/NZS ISO 31000, *Risk management—Principles and guidelines*. Risks associated with the gas distribution network are required to be at acceptable levels with respect to any loss of supply of gas and any threats from escaping gas, throughout the life of the gas distribution network. Safety and Operating Plans are used to ensure that all risks associated with the design operation and maintenance of a gas distribution network are identified and appropriately managed.

This Standard is not a design handbook, nor a manual on distribution practices. It does not remove the need for qualified and experienced engineering design, installation and operation or for competent engineering judgment, and does require interpretation and implementation by competent engineers.

The Australian and New Zealand Technical Regulators have advised that this Standard will apply to the lifecycle of new gas distribution networks and modifications or augmentations to existing assets within gas distribution networks. However, the Sections on operations, maintenance, repair, decommissioning, gas quality and risk assessment may be suitable for application to existing assets in existing gas distribution networks.

Statements expressed in mandatory terms in notes to figures are deemed to be requirements of this Standard.

The terms ‘normative’ and ‘informative’ have been used in this Standard to define the application of the appendix to which they apply. A ‘normative’ appendix is an integral part of a Standard, whereas an ‘informative’ appendix is only for information and guidance.

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FOREWORD

This Standard achieves its purpose through six fundamental principles as follows:

- (a) A gas distribution network is designed and constructed to have sufficient controls to withstand the threats to which it may be subjected during its lifecycle.
- (b) Before a gas distribution network is placed into operation it is inspected and tested to prove its integrity.
- (c) Important matters relating to safety, engineering design, materials, testing and inspection are reviewed, documented, recorded and approved in accordance with the Safety and Operating Plan (SAOP) framework.
- (d) Operations and maintenance provide for continued monitoring and safe operation of the gas distribution network.
- (e) Where changes occur in or to a gas distribution network, which alter the design assumptions or affect the original integrity, appropriate steps are taken to assess the changes, to ensure continued safe, reliable and sustainable operation of the gas distribution network.
- (f) Where a means of conformance alternative to that provided in this Standard is to be adopted, a review is undertaken to determine that the alternative is within an acceptable level of risk.

Where this Standard does not provide detailed requirements appropriate to a specific item, the fundamental principles set out above and the principles and guidelines set out in this Standard are the basis on which an engineering assessment is to be made.

STANDARDS AUSTRALIA/STANDARDS NEW ZEALAND

Australian/New Zealand Standard
Gas distribution networks

Part 1: Network management

SECTION 1 SCOPE AND GENERAL**1.1 SCOPE**

This Standard specifies the requirements for safe, reliable and sustainable management of gas distribution networks operating at less than or equal to 1050 kPa that reticulate gas to consumers.

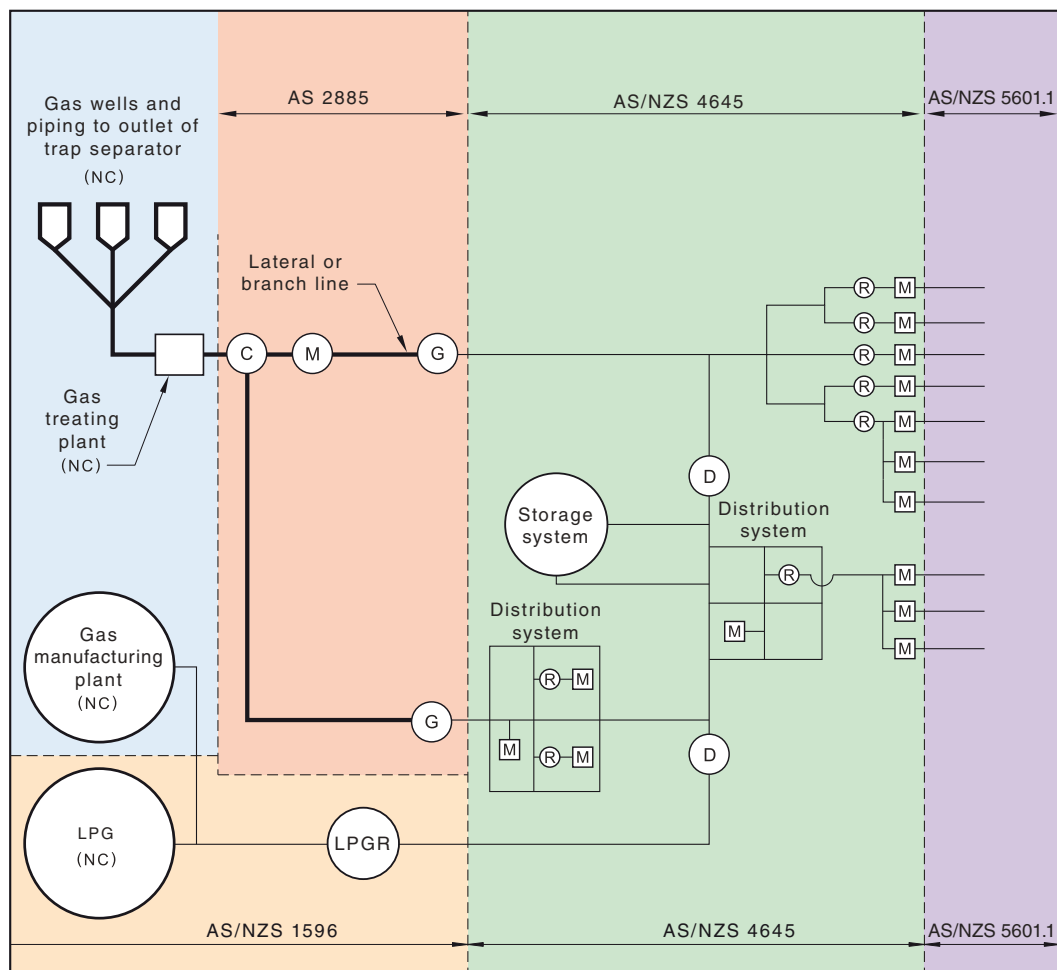
Appendix A lists the additional requirements for elements of a gas distribution network with a MAOP greater than 1050 kPa as allowed in New Zealand and by legislation in some states of Australia.

The requirements apply to the lifecycle of new gas distribution networks or new assets introduced where existing gas distribution networks are modified or augmented. The Sections on operations, maintenance, repair, decommissioning, gas quality and risk assessment may be suitable for application to existing assets in existing gas distribution networks.

Gas distribution networks within the Scope of this Standard comprise all facilities between—

- (a) the outlets of all city gates, supply points or their equivalent or for an LP Gas distribution network, the point of exit of the LP Gas feeder plant; and
- (b) the outlet of the consumer's meter assemblies,

as detailed in Figure 1.1.



LEGEND:

— = Pipeline (Transmission)

— = Pipeline (Distribution)

—(R)—(M) = Gas service with regulator and meter

—(M) = Gas service with meter

(C) = Compressor station

(M) = Meter station

May include pressure regulators

(G) = Distribution receiving station or gate station

May include pressure regulators

(D) = Distribution regulator station

(LPGR) = Gas regulator covered by AS/NZS 1596

(NC) = Not covered by AS/NZS 4645

FIGURE 1.1 ROLE OF STANDARDS IN GAS SUPPLY CHAIN

1.2 EXCLUSIONS

This Standard does not apply to the following:

- Piping from the outlet of the consumer meter assembly or equivalent point of supply, and any other piping in accordance with AS/NZS 5601.1.
- Gas distribution networks that utilize steel pipe with a hoop stress of more than 20% of the Specified Minimum Yield Stress (SMYS).

NOTE: Where an element of the gas distribution network includes steel pipe with a hoop stress greater than 20% of SMYS, AS 2885.1 provides appropriate requirements for design and construction and AS 2885.3 provides appropriate requirements for operation and maintenance relevant to that higher hoop stress.

- (c) Piping associated with the distribution and reticulation of LP Gas in the liquid phase (refer to AS/NZS 1596).
- (d) Transport of mixture of gas with a hydrogen content in excess of 15% by volume.
- (e) Piping associated with gas manufacturing plants, petroleum processing plants, industrial plants or mines.
- (f) Pressure vessels (refer to AS 1210).
- (g) Pipework from onsite LP Gas storage either in cylinders or tanks which is solely on a single private land holding. However, in some jurisdictions this Standard may be adopted for these circumstances.

NOTE: The relevant statutory authority may regard this Standard as appropriate for other than fuel gas.

1.3 REFERENCED DOCUMENTS

AS

1074	Steel tubes and tubulars for ordinary service
1432	Copper tubes for plumbing, gasfitting and drainage applications
2129	Flanges for pipes, valves and fittings
2885	Pipelines—Gas and liquid petroleum
2885.1	Part 1: Design and construction
2885.2	Part 2: Welding
2885.3	Part 3: Operation and maintenance
2944	Plastics pipes and fittings for gas reticulation
2944.1	Part 1: Polyamide pipes
2944.2	Part 2: Polyamide fittings
3688	Water supply and gas systems—Metallic fittings and end connectors
4041	Pressure piping
4176	Multilayer pipes for pressure applications
4176.8	Part 8: Multilayer pipe systems for consumer gas installations with a maximum operating pressure up to and including 5 bar (500 kPa)—Specifications for systems
4564	Specification for general purpose natural gas
4670	Commercial propane and commercial butane for heating purposes
4809	Copper pipe and fittings—Installation and commissioning
5200.053	Plumbing and drainage products—Stainless steel pipes and tubes for pressure applications

AS/NZS

1020	The control of undesirable static electricity
1477	PVC pipes and fittings for pressure applications
1518	External extruded high-density-polyethylene coating system for pipes
1596	The storage and handling of LP Gas
1867	Aluminium and aluminium alloys—Drawn tubes
2492	Cross-linked polyethylene (PE-X) pipes for pressure applications
2537	Mechanical jointing fittings for use with crosslinked polyethylene (PE-X) for pressure applications
2537.5	Part 5: Plastics pipes and fittings—Crosslinked polyethylene (PE-X) pipe systems for the conveyance of gaseous fuels—Metric series—Specifications—Fitting

AS/NZS

2885	Pipelines—Gas and liquid petroleum
2885.5	Part 5: Field pressure testing
4129	Fittings for polyethylene (PE) pipes for pressure applications
4130	Polyethylene (PE) pipes for pressure applications
4645	Gas distribution networks
4645.2	Part 2: Steel pipe systems
4645.3	Part 3: Plastics pipe systems
5601	Gas installations
5601.1	Part 1: General installations
60079	Explosive atmospheres
60079.10.1	Part 10 Classification of areas—Explosive gas atmospheres
	.1:
60079.14	Part 14 Electrical installations design, selection and erection
	:

AS/ISO

7	Pipe threads where pressure-tight joints are made on the threads
7.1	Part 1: Dimensions, tolerances and designation
6993	Buried, high-impact poly (vinyl chloride) (PVC-HI) piping systems for the supply of gaseous fuels
6993.1	Part 1: Pipes for a maximum operating pressure of 1 bar (100 kPa) (ISO 6993-1:2006, MOD)
6993.3	Part 3: Fittings and saddles for a maximum operating pressure of 1 bar (100 kPa)

AS/NZS ISO

9001	Quality management systems—Requirements
31000	Risk management—Principles and guidelines

NZS

5263	Gas detection and odorization
5435	Specification for liquid petroleum gas (LPG)
5442	Specification for reticulated natural gas

ISO

ISO 49	Malleable cast iron fittings threaded to ISO 7-1
--------	--

ASME

B1.20.1	Pipe Threads, General Purpose (Inch)
B16.5	Pipe Flanges And Flanged Fittings: NPS 1/2 Through NPS 24 Metric/Inch Standard
B16.9	Factory-Made Wrought Buttwelding Fittings
B16.11	Forged Fittings, Socket-Welding And Threaded
B36.19 M	Stainless Steel Pipe

ASTM

D2467	Poly (Vinyl Chloride) (PVC) plastic pipe fitting Schedule 80
A53/A53M Grade B	Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
A106/A106M	Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service

BS	
1640	Specification for steel butt-welding pipe fittings for the petroleum industry
1640-1	Part 1: Wrought carbon and ferritic alloy steel fittings
1640-3	Part 3: Wrought carbon and ferritic alloy steel fittings. Metric units
3799	Specification for steel pipe fittings, screwed and socket-welding for the petroleum industry
7838	Specification for corrugated stainless steel semi-rigid pipe and associated fittings for low-pressure gas pipework of up to DN 50
EN	
1759	Flanges and their joints—Circular flanges for pipes, valves, fittings and accessories, Class designated
1759-1	Part 1: Steel flanges, NPS 1/2 to 24
10241	Steel threaded pipe fittings
BS EN ISO	
1452.3	Plastics piping systems for water supply and for buried and above-ground drainage and sewerage under pressure. Unplasticized poly(vinyl chloride) (PVC-U). Fittings

1.4 NOTATION

Symbols used in equations in this Standard are defined in relation to the particular equations in which they occur.

1.5 DEFINITIONS

1.5.1 Acceptable level of risk

Where risk is reduced to negligible or low, or for intermediate risks, the risk has been demonstrated to be as low as reasonably practicable (ALARP).

See Appendix B for further information and requirements on determination.

1.5.2 Active monitor regulator system

A pressure regulating system with two pressure regulators installed in series for the purpose of automatically taking over the control of the downstream pressure should the active pressure regulator fail.

1.5.3 Approved

Approval is a conscious act formally documented by a person or persons, with the authority to bring resources to bear on a particular issue, as identified in the Safety and Operating Plan (see Clause 2.4.2) or, where legally required, by the relevant statutory authority, see Clause 1.5.41.

1.5.4 Authority

For statutory authority, see Clause 1.5.41.

1.5.5 Breather port

A breather port is an orifice or opening exposing the diaphragm in a regulator to atmosphere which allows it to move up and down as required. Breather ports are not designed to discharge gas under normal operations.

1.5.6 Casing

A pipe, through which a gas main or service passes, that is intended to protect the gas main or service from excessive external loads or to facilitate the installation or removal of a section of the gas main or service.

1.5.7 Competent person

A person who has acquired, through education, training, qualification or experience or a combination of these, the knowledge and skill enabling that person to perform the task required.

1.5.8 Consumer billing meter

The measurement device that is used to measure the quantity of gas transported through the gas distribution network to a consumer (including other gas distribution network operator connections).

1.5.9 Consumer meter assembly

The consumer billing meter and/or pressure control/protection devices or components that automatically regulates downstream pressure to the consumer piping.

NOTES:

- 1 Devices or components in the consumer meter assembly can include regulators, overpressure protection, filters, associated piping, test points and valves.
- 2 The consumer meter assembly is equivalent to the term 'consumer billing meter installation' in AS/NZS 5601.1. In New Zealand, it is known as the 'gas measurement system'.
- 3 Additional regulators can be installed separate from the consumer meter assembly. These are generally known as 'boundary regulators'.

1.5.10 Consumer piping

Any piping downstream of a consumer meter assembly or equivalent point of supply.

1.5.11 Equipment

The set of necessary tools, plant, or other devices required to construct, operate, maintain, renew or decommission a gas distribution network.

1.5.12 Fuel gas

Any hydrocarbon gas or mixture of gases, possibly in combination with liquid petroleum condensates, and intended primarily as a fuel for residential or industrial use.

1.5.13 Full bore relief

A device/regulator that vents gas to atmosphere to protect the downstream supply from over pressurization.

1.5.14 Gate station

The point of interface (injection point) between the upstream supply system and the gas distribution network.

NOTES:

- 1 Gate stations are also known as city gates.
- 2 This may include the following:
 - (a) Terminus of a gas transmission system being the infrastructure upstream of the gas distribution system, operating at a MAOP of greater than 1050 kPa (except as allowed under Appendix A). Gas transmission systems are generally designed and operated in accordance with the suite of AS (and AS/NZS) 2885 Standards.
 - (b) The transfer of custody from one gas distribution network to another gas distribution network.
 - (c) Interface with a gas storage manufacturer or delivery system governed by a different Standard.

1.5.15 High density community use

High density community use areas include areas where buildings of four or more storeys are prevalent, major shopping centres, schools, hospitals, aged care facilities, major sporting and cultural facilities. Public infrastructure (e.g. roads and railways, trafficable tunnels) in direct proximity of the high density community use area is also deemed to be part of the high density community use area.

1.5.16 Insertion

Operation of placing a gas pipe into an existing pipe or conduit.

1.5.17 Internal service

A service or upstand that is installed inside a building.

1.5.18 Lifecycle

The period between creation and termination of gas distribution network assets.

NOTE: The activities in this period include the design, construction, commissioning, maintenance, operation, renewal and decommissioning of assets.

1.5.19 Liquefied petroleum gas (LP Gas)

A mixture composed predominantly of any of the following hydrocarbons, or any combination of them in the vapour phase: propane, propene (propylene), butane, butene (butylene).

1.5.20 Main

A pipe installed to convey gas to other distribution facilities or a service.

1.5.21 Materials

Includes all materials, components, fittings, parts or other elements that are used in the lifecycle of the gas distribution network.

1.5.22 Network operator

The entity identified in legislation, or in the Safety and Operating Plan that manages the lifecycle of the gas distribution network.

1.5.23 Network pressure control stations

An installation that automatically regulates network pressure in a downstream piping system.

NOTES:

- 1 Network pressure control stations are also known as distribution gas pressure control equipment in other Standards.
- 2 Devices or components in the station typically include regulators, overpressure protection elements, filters, associated piping, test points and valves.

1.5.24 Odorant masking

The concealing of the distinctive odour of the odorant.

1.5.25 Odorization

The addition of a chemical substance (odorant) to the gas to enable the gas to be identified by smell.

1.5.26 Odour fade

The reduction in level of odorant in the gas distribution network due to the process of physical and/or chemical reaction and/or absorption.

1.5.27 Ovality

Difference between the measured maximum outside diameter and the measured minimum outside diameter at the same cross-section of the pipe.

1.5.28 Padding

Material directly surrounding the main or service, which aligns the main or service into position. The padding comprises the following three zones:

- (a) Main or service underlay/bedding.
- (b) Main or service overlay.
- (c) Main or service side support.

1.5.29 Permanent joint

Any joint that is intended to, and cannot readily, be disassembled.

NOTE: Examples are brazed, welded, glued, solvent cement, crimped and hydraulically or mechanically compressed joints.

1.5.30 Pressure

NOTE: Pressure is expressed as gauge pressure in kilopascals, unless otherwise stated.

1.5.30.1 *Maximum allowable operating pressure (MAOP)*

The maximum pressure at which a gas distribution network or any element of the gas distribution network may be operated in accordance with the provisions of this Standard.

NOTE: Plastics material standards may use a different definition.

1.5.30.2 *Test pressure*

The maximum pressure permitted by this Standard or nominated by the statutory authority, for testing purposes only.

1.5.31 Purging

1.5.31.1 *Commissioning purging*

Replacing the air or inert gas in a gas distribution network or elements of a gas distribution network with fuel gas before putting the gas distribution network into an operational state.

1.5.31.2 *Decommissioning purging*

Removing the fuel gas from the distribution network or elements of a gas distribution network by its replacement with either air or an inert gas.

1.5.32 Regulator

The active component that automatically regulates the downstream pressure.

1.5.33 Series 2

Refers to nominal outside diameter series PE pipes as described in AS/NZS 4130.

1.5.34 Service

A pipe that carries gas from a main to one or more consumer meter assemblies or equivalent points of supply.

1.5.35 Shall

Indicates a requirement.

1.5.36 Should

Indicates a recommendation.

1.5.37 Significant incident

A significant hazardous event that may include personal injury, significant property damage, major gas escapes, loss of gas supply to a large area or critical consumer, or significant environmental damage.

1.5.38 Significant near miss

An event that occurred with the potential to cause a significant incident.

1.5.39 Specified minimum yield stress (SMYS)

The specified minimum yield stress to which the pipe is purchased.

1.5.40 Standard dimension ratio (SDR)

The nominal ratio of the pipe outside diameter to the wall thickness.

1.5.41 Statutory authority

An authority with legislative powers relating to matters within the scope of this Standard.

1.5.42 Thickness**1.5.42.1 Nominal thickness**

The thickness of material nominated in the material order, ignoring the manufacturing tolerance provided in the specification under which the pipe was manufactured.

NOTE: The quantity symbol is t_N .

1.5.42.2 Pressure design thickness

The thickness of material required for the material to be capable of withstanding internal pressure, as calculated according to the equations in the design section of this Standard.

NOTE: The quantity symbol is t_{DP} .

1.5.42.3 Required thickness

The minimum thickness of material required for the material to be capable of withstanding applied stresses, as calculated according to the equations in the design section of this Standard.

NOTE: The quantity symbol is t_w .

1.5.43 Partial relief

A device/regulator that vents a small amount of gas to atmosphere.

NOTE: For example, to prevent slam shuts from tripping or to assist slow reaction regulators. These may also function as a breather port.

1.5.44 Upstand

A section of the service pipe that connects the underground part of that service to the consumer meter assembly.

NOTE: The upstand is also known as the riser.

SECTION 2 NETWORK SAFETY

2.1 BASIS OF SECTION

This Section outlines the overall systems and processes to be established and implemented to ensure that risk to people, property, environment and supply, is managed throughout the lifecycle of a gas distribution network.

2.2 GENERAL

Management of gas distribution networks shall result in an acceptable level of risk with respect to the safety of personnel, the public (including consumers), property, or the environment. Measures shall be identified, reviewed and documented for the following:

- (a) Safety of the public (including consumers).
- (b) Safety of personnel working on the gas distribution network.
- (c) Integrity of the gas distribution network, including continuity of supply.
- (d) Capacity of the gas distribution network to reliably supply consumers.
- (e) Minimization of environmental impacts.
- (f) Protection of property.

This is undertaken through Formal Safety Assessment (FSA), see Clause 2.3. The controls identified via FSA shall be incorporated into the Safety and Operating Plan (SAOP), see Clause 2.4.

2.3 FORMAL SAFETY ASSESSMENT (FSA)

2.3.1 General

Risk management is a continuous process that is conducted at all stages throughout the lifecycle of a gas distribution network. The primary principle in managing risk is to achieve an acceptable level of risk. Risk management in gas distribution networks shall be undertaken through FSA. FSA shall identify hazards, determine the threats from these hazards, assess the risk of these threats and determine the level of control(s) to remove the threat(s) or reduce the risk to an acceptable level.

NOTE: FSA is compatible to the identification and control of significant hazards section of NZS 7901.

The approach to FSA shall be appropriate to the complexity, age, operating history and other characteristics of the gas distribution network. FSA may be undertaken on a whole of gas distribution network basis, or on an asset class by asset class basis or combination thereof, or on a lifecycle basis.

NOTE: In some jurisdictions technical regulators may wish to take part in the FSA, representing the interests of the public and Government.

2.3.2 Acceptable level of risk

The acceptable level of risk is defined in Clause 1.5.1 and shall be determined in accordance with Appendix B. The controls identified via FSA to ensure that all risks are either eliminated or reduced to an acceptable level during the lifecycle of the gas distribution network shall be documented through the SAOP framework.

The mechanism outlined in Appendix B shall be used for determining an acceptable level of risk.

NOTES:

- 1 Further details regarding risk management are available in AS/NZS ISO 31000.
- 2 IGE/TD/3 and other suitable publications provide information on safety assessment of mains or services.
- 3 IGEM/GM/7B; IGEM/UP/16; IGEM/G/5/Ed2 IGEM/SR/25/Ed2 provide information on safety assessment of gas meter installations.

2.3.3 Hazard identification

Matters to be taken into account when identifying hazards should include as a minimum, the type of gas, release and spread of gas above and below ground, entry of gas into confined spaces, occupancy of sites and confined spaces, detectability of released gas, and possible accumulation of gas and subsequent ignition of explosive mixtures. Hazards related to the gas distribution network shall be identified and documented, including but not limited to the following:

- (a) Due to or during construction of gas infrastructure.
- (b) Loss of containment.
- (c) Loss of supply.
- (d) Decommissioning of gas infrastructure.

NOTE: Appendix C provides lists of the hazards associated with a gas distribution network, the potential threat categories that may lead to the hazard, and typical risk reduction strategies.

2.3.4 Determination of threats

Threats that may lead to a hazard shall be determined. For each threat, the following shall be determined and documented:

- (a) What is the threat to gas distribution network?
- (b) Where does it occur?
- (c) Who is responsible for the activity leading to the threat?
- (d) How does the threat develop?
- (e) How often does it occur?
- (f) Can the threat lead to a hazard event?

2.3.5 Assessment of risks

A risk assessment of threats shall be undertaken. Principles and guidance of risk management are given in AS/NZS ISO 31000.

Appendix B provides the requirements for FSA assessment of risk.

2.3.6 Control of risk

Where a risk is above the acceptable level of risk, (further) controls shall be established to reduce that risk to at least an acceptable level of risk.

The hierarchy of control effectiveness is as follows:

- (a) Elimination.
- (b) Physical/engineering controls.
- (c) Procedural controls.
- (d) Reduction.
- (e) Mitigation.

NOTE: Appendix C identifies examples of control mechanisms for risks posed by various hazards.

2.3.7 Review of overall FSA

As part of any substantive change to the operating environment, and at a period not exceeding five years, review of FSA shall be undertaken to confirm controls in the SAOP are adequate to maintain an acceptable level of risk. The review shall identify any changes or new information since previous FSA, including as a minimum, the following:

- (a) Variations in operating environment.
- (b) Amendments to design, operations or maintenance practices, where a means of conformance no longer is valid.
- (c) Current asset(s) condition
- (d) New or modified threats.
- (e) Incidents, including causes and frequency, see Clause 9.3.

FSA shall be used to confirm an acceptable level of risk is maintained.

The SAOP shall be updated to reflect any new or modified controls.

2.3.8 Situation-specific FSA

From time to time, situations arise in the lifecycle of a gas distribution network that require assessment but do not affect the whole gas distribution network and thus a review of the overall FSA in accordance with Clause 2.3.7 is not required. However, FSA should be used to confirm the controls for these situations ensure an acceptable level of risk.

The scope of these situation-specific FSA should be determined. Only those elements affected by the situation are required to be reviewed as part of the situation-specific FSA.

2.3.9 Validation

FSA shall be validated. The validation shall be undertaken by a competent person(s).

Validation shall ensure that—

- (a) FSA process is in accordance with this Standard; and
- (b) where aspects of the management of the gas distribution network are not in accordance with the means of conformance as identified in this Standard, the risk control measures result in an acceptable level of risk.

Validation shall be undertaken by one or a combination of the following means:

- (i) Workshop constituted by competent personnel with the ability to ensure that controls are implemented.
- (ii) Self-appraisal by competent personnel with the ability to ensure the controls are implemented. Self-appraisal is only suitable for situation specific FSA.
- (iii) External review followed by implementation by competent personnel with the ability to ensure the controls are implemented.

The means of validation shall take into account the competence of the personnel and the elements of the gas distribution network included in the scope of FSA and the level of risk. The means of validation shall be approved, see Clause 1.5.3.

NOTE: Appendix L contains a checklist for the confirmation of the process followed for FSA.

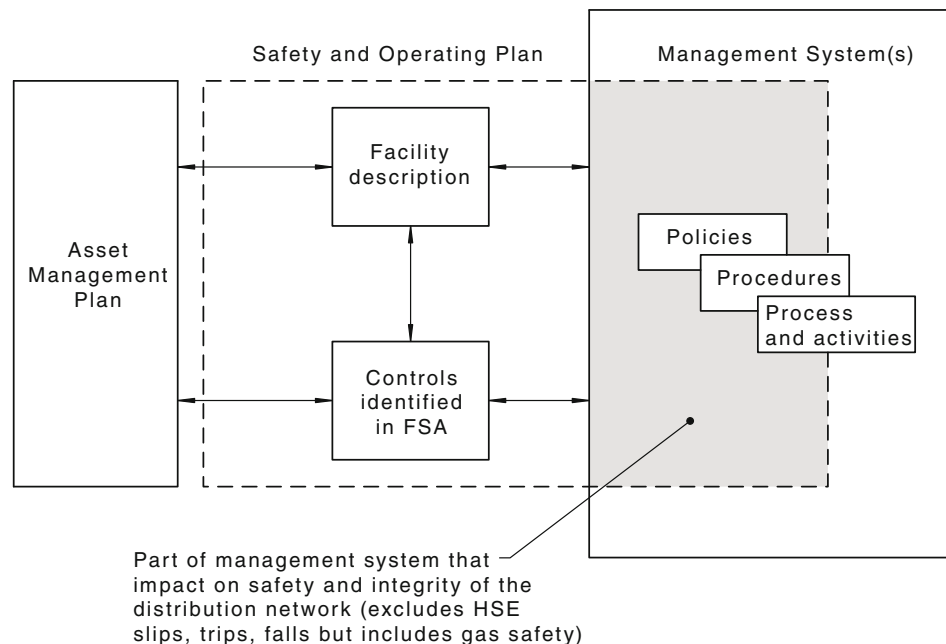
2.4 SAFETY AND OPERATING PLAN (SAOP)

2.4.1 General

A Safety and Operating Plan (SAOP) shall be established, implemented, monitored, periodically reviewed and maintained. A SAOP shall be appropriate to the extent of the gas distribution network, its location, type of fuel gas, the hazards and risks involved, the size, type and complexity of the gas distribution network. A SAOP may be integrated with or supplement other management systems. The construct of the SAOP may be a framework that references relevant documents. The SAOP shall be approved.

NOTES:

- 1 The SAOP framework may be an individual document or reference a set of design documentation, manuals, specifications, policies, procedures, guidelines or other similar documentation.
- 2 A typical management structure that includes the SAOP framework is described in Figure 2.1.
- 3 In some jurisdictions the SAOP is equivalent to a 'safety case' or other similar documents.



NOTE: Asset Management Plans are developed to ensure appropriate plans are in place for the whole lifecycle of assets under control.

FIGURE 2.1 OVERVIEW OF TYPICAL SAOP

The controls required to mitigate risks that are identified via FSA shall be documented within the framework of the SAOP. Controls shall include measures to—

- (a) protect the gas distribution network from identified threats;
- (b) safely operate and maintain the gas distribution network;
- (c) respond to gas emergencies; and
- (d) promote public awareness of the gas distribution network, e.g. Dial Before You Dig, and emergency contacts.

The plan shall cover the lifecycle phases of all elements of the gas distribution network for the defined period of the plan.

This plan shall be implemented prior to the gas distribution network being placed into operation.

2.4.2 Elements of SAOP

The framework of the SAOP shall include or reference, but not be limited to, the following:

- (a) Administrative requirements:
 - (i) Scope and objectives of the SAOP.
 - (ii) Review period for the SAOP.
 - (iii) The process for auditing in accordance with Clause 10.3.
- (b) Description (by listing) of primary legislation, codes and standards of design and construction, maintenance and operation of the gas distribution network.
- (c) Description of the gas distribution network physical scale and dimensions, including:
 - (i) Geographical location and spread.
 - (ii) Materials used for mains.
 - (iii) Length and diameter of mains.
 - (iv) Materials used for services.
 - (v) Number of services.
 - (vi) Operating pressures.
 - (vii) Number and technical outline of city gates affecting the safety of the system and gas supply.
 - (viii) Number and technical outline of network pressure control systems.

NOTE: This information should be in summary form, including use of, or reference to, suitable maps, drawings, diagrams, lists and registers.
- (d) The operating parameters of the gas distribution network in sufficient detail to allow assessment of the risks from loss of supply and over-pressure of supply.
- (e) Accountabilities and resources:
 - (i) A description of the organization structure and responsibilities of key positions including the positions with approval authorities as required by this Standard.
 - (ii) Description of the responsibilities for participants in the gas supply chain with respect to consumer education and public awareness programs, including information on how to report gas leaks or other gas related occurrences on the gas distribution network, such as broken main or service, leaks in public areas.
NOTE: Appendix E provides information on consumer safety and public awareness programs.
 - (iii) Description of the resources to safely operate and maintain the system throughout its lifecycle. These resource details may include—
 - (A) numbers, competence (in accordance with Clause 2.5) and span of control over the necessary workforce;
 - (B) description of other necessary resources;
 - (C) means to ensure that resources are monitored and maintained; and
 - (D) system support availability and backup provisions.
 - (iv) Description of the means utilized to ensure that all persons involved in critical activities within design, construction, operation, monitoring and maintenance of the gas distribution network are competent to carry out their duties.

- (f) Outcomes of FSA, including:
- (i) The threat identification, consequence and likelihood assessment and level of risk from each threat.
 - (ii) The controls identified via FSA to ensure that all risks are eliminated or reduced to an acceptable level during the lifecycle of the gas distribution network.
 - (iii) FSA outcomes and the controls in the SAOP framework shall be linked through utilizing a risk register or other appropriate means.

NOTES:

- 1 The controls may be described in the items contained in Item (g) below.
- 2 This may be relevant for verifying the robustness of the FSA through the establishment of a line of sight from identification of a risk to the actual procedures, as well as the training of staff and contractors.

- (g) Functional requirements, specifications, plans, procedures, designs, including:
- (i) Functional requirements in accordance with Clause 3.3.
 - (ii) The methods for control, identification and traceability for materials and equipment in accordance with Clause 4.5.
 - (iii) Effective processes for the control of construction and commissioning activities to ensure that they are implemented in accordance with the specifications.
 - (iv) Operational and maintenance plans, processes and/or procedures, including—
 - (A) requirements for third party liaison;
 - (B) maintenance;
 - (C) work practices;
 - (D) permit to work;
 - (E) leakage management, including the classification of leaks;
NOTE: Appendix D provides guidance on leak classifications.
 - (F) condition monitoring; and
 - (G) capacity management.
 - (v) Description of the quality specification for the gas to be delivered including the safe range and/or limits of relevant gas characteristics.
 - (vi) Description of the odorant and detection levels of odorant.
 - (vii) The emergency plan for implementation in the event of emergencies in accordance with Section 9.
NOTE: The plan should be developed in order to mitigate the consequences of the failure, accident or emergency.
 - (viii) The process for establishment and maintenance of a system of emergency load management to mitigate the consequences of a gas supply failure.
NOTE: Include, where possible, preserving gas supply to critical consumers through load reduction of less critical consumers.
 - (ix) The process for investigation of failures and the subsequent analysis for their implications on the management of risk.
NOTE: For the purposes of this Clause, failure may include pipe, material breakdown, third party damage, acceptance test failures and supply interruptions.
 - (x) Records management in accordance with Clause 2.6.

- (xi) For each system or process identified by FSA as critical to control the risk, the network operator shall utilize a process of monitoring and review of system performance to ensure that the system continues to operate as designed.
- (xii) Description of change management processes. These processes shall address—
 - (A) the technical basis for any proposed change;
 - (B) impact of change on safety and health of personnel, plant and environment;
 - (C) modifications to operating or maintenance procedures;
 - (D) necessary time period for the change; and
 - (E) authorization requirements for the proposed change, if applicable.

2.5 COMPETENCY OF PERSONNEL

A competent person is defined in Clause 1.5.7.

Personnel involved in the design, construction, testing, commissioning, operation and maintenance of a gas distribution network shall be competent, relevant to their accountabilities, to a level that ensures an understanding of the gas distribution network and its effects on the safety of employees and public, environmental obligations and reliability of supply. Personnel shall have a sound knowledge of the areas of the SAOP framework relevant to their accountabilities.

The training and results of initial and ongoing competency assessments shall be recorded.

NOTES:

- 1 Competency requirements will vary significantly depending on an individual's role and level of responsibility. Network operators can be assisted in assessing, training and developing the competency of personnel for the specific tasks and functions by use of relevant competency frameworks.
- 2 Detail on the framework for National Competencies for Distribution Operators can be found at www.e-oz.com.au.
- 3 Detail on the engineering competencies some of which are relevant to gas distribution networks can be found at the APGA website www.apga.org.au.
- 4 Gas qualification pathway at <http://mito.org.nz/oil-and-gas/gas>.
- 5 IGEM qualifications at <http://www.igem.org.uk>.

Training should emphasize specific health and safety hazards, operating procedures and emergency operations for the pressure system to be operated.

A full range of normal operating duties and emergency procedures, sufficient reference manuals and drawings or relevant information should be readily available to provide immediate knowledge. Reference materials and information should be reviewed as appropriate. A schematic diagram for the system should be available to the operators. It should include all materials that have been identified as critical and relevant operating parameters with those of importance in an emergency clearly identified. It should be revised when any changes are made to the system. The information should be clearly identifiable with the system and parts of the system to which it refers.

Where any alteration to equipment or procedures occurs, training to cover such alterations should be undertaken as part of the change management process.

Where necessary, refresher training shall be provided to ensure understanding and adherence to the current operating procedures. The relevant parties concerned should determine the frequency and extent of refresher training.

2.6 RECORDS MANAGEMENT

Records management shall provide for the efficient and systematic creation, receipt, maintenance, use and disposal of records. As a minimum, this shall include the establishment and implementation of records of design, construction, testing, commissioning and operation. The retention time and other record keeping criteria shall be documented in the SAOP framework.

NOTE: AS ISO 15489.1 provides guidance for records management.

Records shall be taken and maintained, sufficient to demonstrate the implementation and application of controls throughout the lifecycle of the gas distribution network. The objective of records management is for the creation and maintenance of authentic, reliable and usable records capable of supporting the management of gas distribution networks.

Where the effectiveness of an emergency response depends upon accessing specific components (e.g. isolation valves or regulators) the location and other pertinent data of such components should be recorded in a manner that enables the response to be executed effectively.

Recording of as-built details, calibration records, test records, competencies and all other relevant information shall be sufficient to provide adequate input to FSA and provide information required to monitor the effectiveness of controls.

Details of the location of buried mains shall be suitably recorded and maintained up-to-date with sufficient accuracy to provide for their location. Where service locations are not recorded, suitable means of locating services shall be established and maintained.

Details of decommissioned assets that could pose a future risk shall be recorded, and information provided on the location to anyone needing that information for safety reasons.

2.7 MEANS OF CONFORMANCE

Means of conformance are identified throughout this Standard that deliver controls which result in an acceptable level of risk being achieved. These means of conformance are specific to the design, construction, operation, maintenance and decommissioning of the gas distribution network. Where a means of conformance is not adopted, an accepted level of risk in accordance to Appendix B shall be achieved through controls identified or developed from—

- (a) the use of appropriate standards or specifications; or
- (b) tests and/or investigations.

FSA shall be used to ensure the controls identified or developed result in an acceptable level of risk. These controls shall be documented within the SAOP framework.

SECTION 3 PLANNING

3.1 BASIS OF SECTION

The network operator shall identify the functional requirements over the intended life of the gas distribution network, including the initial performance requirements, changes in installed and operating environment, and changes in supply demands.

3.2 GENERAL

Planning processes based on systematic analysis of functional requirements shall be established. The functional requirements shall be documented and shall be reviewed when changes occur.

3.3 FUNCTIONAL REQUIREMENTS

3.3.1 General

The functional requirements shall be established to ensure safety, including security of supply and integrity of the gas distribution network.

Functional requirements shall include the following:

- (a) Planned operational life.
- (b) Capacity management and security-of-supply parameters.
NOTE: Requirements for security of supply are related to the risks related to loss of supply. Appendix B identifies the consequence levels for various loss of supply situations.
- (c) Composition and properties of gas to be transported.
- (d) Failure mode requirements, e.g. leak before rupture, limiting potential for full flow escapes at higher pressures.
- (e) Fitness for purpose of materials.
- (f) Competency of personnel.
- (g) Criteria for response to incidents and emergencies.

When establishing the functional requirements, identified future changes to the environment in which the gas distribution network operates should be taken in to account. This may include mechanisms by which elements of the gas distribution network may degrade over time or due to usage.

NOTE: IGE/GL1 provides information on supply planning of gas distribution networks.

3.3.2 Gas specification

The composition and properties of the gas to be transported is a key input to the functional requirements. The gas specification shall be compatible with the operating environment of the gas distribution network.

The relevant Standard for gas specification (AS 4564 or AS 4670 in Australia and NZS 5435 or NZS 5442 in New Zealand) should be adopted where ever possible. If the relevant Standard gas specification is not adopted, the suitability of the alternative gas specification for distribution and use within the gas distribution network shall be assessed. Where an alternative specification is adopted, FSA shall confirm suitability of all controls, including those provided by means of conformance.

3.4 ONGOING NETWORK PLANNING

Action shall be taken to identify and address any supply and pressure problem likely to jeopardize the future safety and performance of the gas distribution network. Gas flow and/or network pressure shall be monitored to achieve this objective.

A process to forecast load and model constrained sections of the gas distribution network in order to determine suitable augmentations to maintain supply, in accordance with functional requirements shall be established.

3.5 UPRATING OF MAOP

3.5.1 General

This Clause (3.5) specifies requirements for uprating parts of a gas distribution network to a higher maximum allowable operating pressure (MAOP). Any higher MAOP determined under this Clause shall not exceed the maximum pressure limit set by the Scope of this Standard. Any part of a gas distribution network that has been uprated shall be operated and maintained to conform with this Standard thereafter (including being covered by FSA, see Clause 2.3).

Where Appendix A is applicable, this Clause shall also apply to elements of the gas distribution network where the pressure is greater than 1050 kPa and less than 1965 kPa.

3.5.2 Maximum allowable operating pressure

A higher MAOP shall not exceed the design pressure of the weakest element in the segment to be uprated.

3.5.3 Planning

Before uprating mains and services to allow a higher MAOP, a written plan shall be prepared.

3.5.4 Investigation

Before increasing the MAOP of a segment of a gas distribution network, an engineering assessment shall be carried out to the following:

- (a) Review the design, method of initial installation, depth of cover, method and date of previous testing, materials and components to determine that the proposed increase does not exceed an acceptable level of risk and is consistent with the requirements of this Standard.
- (b) Review the operating and maintenance history of the elements of the gas distribution network being targeted for uprating.
- (c) Review location, and future life expectancy.
- (d) Assess the condition of the segment to be uprated by leakage surveys, other field inspections (including pot holing) and by examination of maintenance records.
- (e) Ensure that repairs, replacements or alterations found to be necessary by Items (a), (b), (c) or (d) have been completed.
- (f) Determine pressure testing requirements, or if pressure testing is not available, the requirements of Clause 3.5.5 shall be followed as an alternative means of ensuring the proposed MAOP will be within an acceptable level of risk.

NOTE: Pressure testing, either through review of records or a new pressure test is the primary means of ensuring integrity at the new MAOP.

- (g) Determine the requirements for repair of Class 3, or equivalent, leaks following testing or staged increase of pressure.

NOTE: Appendix D provides guidance as to the definition of a Class 3 or equivalent leak.

- (h) Review the impact of increasing the MAOP on downstream systems.

3.5.5 Staged increase of pressure

When uprating is carried out, and where a pressure test is not required in accordance with Clause 3.5.4, Item (f), and there is no evidence that would suggest that the section of gas distribution network would fail a pressure test, gas pressure shall be increased in increments, with a leak survey performed after each incremental increase. The number and magnitude of increments shall be decided after taking in to account—

- (a) the total pressure increase;
- (b) the stress level at the new maximum working pressure;
- (c) the known condition of the line; and
- (d) the proximity of the line to other structures or utility services.

The selected increments shall be sufficient to assure that any leaks are detected before they can create a potential hazard. Any leaks detected shall be repaired, before further increasing the pressure.

If during the testing there is evidence that leaks are due to a potential failure of a class or type of fitting, measures shall be undertaken to ensure that these fittings are repaired or replaced prior to the finalization of the new MAOP.

As part of the uprating, a final leak survey shall be conducted at the new MAOP.

3.5.6 Records

Records for the uprating, including each investigation required by this Section, any corrective actions taken, and any pressure tests conducted, shall be retained for the life of the uprated segment.

SECTION 4 NETWORK DESIGN

4.1 BASIS OF SECTION

Designs based on proven principles and Standards shall be developed to be in accordance with the functional requirements and to contribute to an acceptable level of risk.

4.2 GENERAL

The design of a new gas distribution network or modification to an existing gas distribution network shall take into account safety, demand, operating parameters and the environment to which the gas distribution network is exposed.

The design of a new gas distribution network or subsequent modifications shall be planned and controlled. The planning of the design of a gas distribution network shall determine—

- (a) the design stages;
- (b) the validity of existing design policies, procedures or standards;
- (c) the review and validation that are appropriate to each design stage;
- (d) the responsibilities and authorities for design stages; and
- (e) communication requirements between interfaces across the design process.

Planning output shall be updated, as appropriate, as the design and development progresses.

4.3 DESIGN PROCESS

4.3.1 Design inputs

Key inputs to the design process shall include as a minimum, the following:

- (a) Controls identified via FSA.
- (b) Functional requirements.
- (c) Constructability, operability and maintainability requirements.
- (d) Current and proposed gas distribution network operating parameters.
- (e) Applicable statutory and regulatory requirements.
- (f) Where applicable, information derived from the design of similar assets.

NOTE: Care should be taken when using existing designs to ensure that they are suitable for the intended use.

- (g) Lessons learnt from previous incidents, operational experience or technological changes.

These inputs shall be reviewed for adequacy. Requirements shall be complete, unambiguous and not in conflict with each other.

4.3.2 Design process controls

Controls over the design process should include—

- (a) policies, procedures and standard practices;
- (b) use of competent personnel;
- (c) change management requirements;
- (d) document and drawing control; and
- (e) quality assurance and quality control requirements.

4.3.3 Design review

During the design, systematic reviews shall be performed—

- (a) to confirm any means of conformance is appropriately used in the design;
- (b) to evaluate the ability of the design to deliver the controls identified in the design input;
- (c) to ensure the functional requirements will be met; and
- (d) to identify any problems and set out necessary actions.

Participants in such reviews shall include representatives of functions concerned with the design, construction, operation and maintenance of the assets being reviewed. Records of the results of the reviews and any necessary actions shall be maintained, see Clause 2.6.

4.3.4 Design outputs

The design outcomes may be in the form of—

- (a) selection of existing standardized designs;
NOTE: Standard designs for repetitive elements of gas distribution networks are used to ensure efficient creation of assets.
- (b) new or modified standardized designs assessed through the design process as suitable for repeated use; or
- (c) specific designs, to meet a set of new or unusual circumstances, assessed through the design process.

The outputs of design shall be provided in a form that enables verification against the design input. The outputs from design shall—

- (i) be in accordance with the performance standards identified in the design inputs, both in terms of risks and operational performance;
- (ii) provide appropriate information, procedures and specifications for purchasing, construction, testing, commissioning, initial operation and maintenance of the elements of the gas distribution networks being proposed;
- (iii) contain or reference acceptance criteria;
- (iv) specify operational procedures required for safe and reliable operation of the gas distribution network; and
- (v) be in a form suitable for acceptance through quality control procedures.

4.4 CONTROL OF DESIGN AND DEVELOPMENT CHANGES

Design modifications shall be identified and records maintained. The modifications shall be reviewed, to ensure an acceptable level of risk is maintained, and endorsed through quality management processes before implementation. The review of design modifications shall include evaluation of the effect of the modification on—

- (a) other existing infrastructure; and
- (b) maintenance or operational controls.

Records of the results of the review of modifications and any necessary actions shall be maintained, see Clause 2.6.

4.5 MATERIALS AND EQUIPMENT

4.5.1 General

Materials, and equipment used in construction, maintenance and operation of the gas distribution network shall be 'fit-for-purpose' and selected on the basis of the following:

- (a) Compatibility with functional requirements.
- (b) Compatibility with the specification of gas being conveyed.
- (c) Importance of the material to the safe and reliable operation of the gas distribution network.
- (d) The failure mode of material.

NOTE: The more critical a material, or its application, or the more unique its design (e.g. propriety items), the more attention and detail needs to be applied to the requirements. For some materials this may include a failure mode and effects analysis in accordance with AS IEC 60812.

- (e) The pressure to which they may be subjected under both operating and fault conditions.
- (f) The operating environment.
- (g) The intended operational life of the installation including any time dependant failure mechanisms.

NOTE: Appendix F provides information on matters to take into account for the selection of some materials.

Materials specified in Table 4.1, AS 4809, AS 4041, and AS/NZS 4645.2 and AS/NZS 4645.3 of this series, are a means of conformance and thus deemed to be 'fit-for-purpose' when applied as intended.

TABLE 4.1
MAINS AND SERVICES MATERIALS

MAOP	Pipe		Fittings		Joining	
	Pipe	Limiting conditions	Fitting	Limiting conditions	Method	Limiting conditions
515	Black steel in accordance with AS 1074 Medium grade Screwed ends or plain ends	External corrosion protection required Not permitted in the ground unless coated with high-density polyethylene (PE) in accordance with AS/NZS 1518 (see Note below) or covered with a proprietary wrapping which is acceptable to the Technical Regulator	Malleable cast iron fitting	External corrosion protection required	Taper external and parallel internal threads in accordance with AS ISO 7.1	Maximum permissible size is DN 100 External corrosion protection required
			Copper alloy screwed pipe fitting in accordance with AS 3688			
			Screwed flange, carbon steel or steel alloy to— AS 2129; or ASME B16.5 Class 150; or EN 1759-1 Class 150 (Class 125 for cast iron valves or regulators)	Not to be used for joining pipe lengths unless other joining methods are impracticable Flanges forming a joint shall be of the same size and face type External corrosion protection required		
			Steel butt-welded pipe fitting in accordance with— BS 1640-1; or BS 1640-3; or in accordance with ASME B16.9	External corrosion protection required	Butt weld to AS 4041, Class 3 piping	External corrosion protection required
			Socket-welded fitting to BS 3799, or in accordance with ASME B16.11	External corrosion protection required	Fillet weld in accordance with AS 4041 Class 3 piping	

(continued)

TABLE 4.1 (continued)

MAOP	Pipe		Fittings		Joining	
	Pipe	Limiting conditions	Fitting	Limiting conditions	Method	Limiting conditions
			Welded flange carbon steel or steel alloy to— AS 2129; or ASME B16.5 Class 150; or EN 1759-1 Class 150. (Class 125 for cast iron valves or regulators)	Not to be used for joining pipe lengths unless other joining methods are impracticable Flanges forming a joint shall be of the same size and face type External corrosion protection required	Slip-on type flanges: Double fillet weld in accordance with AS 4041, Class 3 piping Other type flanges: Butt weld in accordance with AS 4041, Class 3 piping	
High-density PE coated steel pipe may be used above ground in an indoor location.						
515	Galvanized steel in accordance with AS 1074 Medium grade Screwed ends or plain ends		Malleable cast iron fitting in accordance with ISO 49	Fitting to be galvanized	Taper external and parallel internal threads in accordance with AS ISO 7.1	Up to 7 kPa, maximum permissible size is DN 100 Over 7 kPa, maximum permissible size is DN 80 External corrosion protection of bare threads is required where installed in the ground
			Wrought steel fitting in accordance with EN 10241	Not to be connected directly to pipe in the ground without the use of an insulation coupling		
			Copper alloy screwed fitting in accordance with AS 3688	Not to be used for joining pipe lengths unless other joining methods are impracticable Flanges forming a joint shall be of the same size and face type External corrosion protection required.		
			Screwed flange, cast iron, carbon steel or steel alloy in accordance with— AS 2129; or ASME B16.5 Class 150; or EN 1759-1 Class 150 (Class 125 for cast iron valves or regulators)			

(continued)

TABLE 4.1 (continued)

MAOP	Pipe		Fittings		Joining	
	Pipe	Limiting conditions	Fitting	Limiting conditions	Method	Limiting conditions
1050	Stainless steel to be Grade 316 Materials, dimensions, design and performance in accordance with AS 5200.053 and/or ASME B36.19 M	Refer to manufacturer for advice where a high concentration of chlorides (salt) is to be found, particularly in a marine environment Not permitted beneath a building if in the ground or in a concrete slab unless plastic coated or protected by anti-corrosion tape wrapping system Where plastic coated stainless steel tube is used underground or where adverse environmental conditions exist, all joints and fittings shall be protected from corrosion and made watertight	Press-fit end connectors in accordance with AS 3688 or capillary fittings or threaded end connectors in accordance with AS 3688	Fittings to be compatible with pipe material (Grade 316) and pipe manufacturer's specifications Fittings for press-fit end connectors to have yellow HNBR 'O' rings Press-fit end connectors not to be used for applications where the operating temperature exceeds 70°C unless the manufacturer's specification warrants higher	Minimum thickness for mechanical jointing is 1.2 mm Minimum thickness for welding is 2.5 mm	Welding to be tungsten inert gas (TIG) or manual metal arc (MMAW) Welding shall be in accordance with AS 4041 Joints in the ground beneath a building to be kept to a minimum and protected from corrosion
100	Stainless steel pipe, corrugated semi-rigid, in accordance with BS 7838	Not permitted in the ground beneath a building unless plastic coated	Components that terminate with a BSP thread in accordance with the pipe manufacturer's specifications	Not permitted in the ground beneath a building Operating limit of 7 kPa applies where malleable cast iron fittings are used	Mechanical jointing using components in accordance with the pipe manufacturer's specifications	Not permitted in the ground beneath a building In other locations, joints to be accessible for inspection and renewal. Not to be welded or jointed by any other method

(continued)

TABLE 4.1 (continued)

MAOP	Pipe		Fittings		Joining	
	Pipe	Limiting conditions	Fitting	Limiting conditions	Method	Limiting conditions
515	Galvanized and black steel pipe in accordance with AS 1074 medium grade, or API 5L Grade B, or ASTM A53/A53M Grade B, or ASTM A106/A106M Grade A or Grade B Screwed ends	External corrosion protection required Pipe in accordance with API 5L or ASTM A53/A53M or ASTM A106/A106M	Wrought steel fitting in accordance with BS EN 10241 (BSP) or in accordance with BS 3799 (NPT) Copper alloy screwed fitting to AS 3688	External corrosion protection required	Taper external and parallel internal threads in accordance with AS ISO 7.1 or NPT to ASME B1.20.1	Up to 7 kPa, maximum permissible size is DN 100 Over 7 kPa, maximum permissible size is DN 80 External corrosion protection required
1050	Galvanized and black steel pipe in accordance with AS 1074 medium grade, or API 5L Grade B, or ASTM A53/A53M Grade B, or ASTM A106/A106M Grade A or B or A333 Plain ends	Not permitted in the ground without external corrosion protection Not permitted in the ground beneath a building Pipe in accordance with API 5L or ASTM A53/A53M or ASTM A106/A106M	Butt-welded fitting in accordance with— BS 1640-1; or BS 1640-3; or in accordance with ASME B16.9 Welded flange, carbon steel or steel alloy to— AS 2129, or ASME B16.5 Class 150, or EN 1759-1 Class 150. (Class 125 for cast iron valves or regulators)	Not to be used for joining pipe lengths unless other joining methods are impracticable Flanges forming a joint shall be of the same size and face type External corrosion protection required	Butt weld to AS 4041 Class 3 piping Slip-on type flanges: Double fillet weld in accordance with AS 4041, Class 3 piping Other type flanges: Butt weld in accordance with AS 4041, Class 3 piping Fillet weld in accordance with AS 4041, Class 3 piping	External corrosion protection required

(continued)

TABLE 4.1 (continued)

MAOP	Pipe		Fittings		Joining	
	Pipe	Limiting conditions	Fitting	Limiting conditions	Method	Limiting conditions
515	Copper tube in accordance with AS 1432 Type A or Type B	Refer to AS 4809	Fitting in accordance with AS 3688	Refer AS 4809		
1050	Polyethylene in accordance with AS/NZS 4130		Compression or electrofusion fitting in accordance with AS/NZS 4129	Compression fittings may require internal stiffeners if specified by manufacturer	Electrofusion, butt-fusion, or mechanical joints carried out in accordance with AS/NZS 4645.3	PTFE (Teflon) tape is the only thread sealant tape to be used on plastics fittings Other manufacturer recommended sealants are acceptable
100	PVC-HI in accordance with AS ISO 6993.1		Solvent-cement fitting in accordance with AS/NZS 1477, PN 12 or PN 18 or in accordance with AS ISO 6993.3	Internally threaded fittings are not permitted	Solvent-cement jointing or mechanical joints carried out in accordance with AS/NZS 4645.3	PTFE (Teflon) tape is the only thread sealant tape to be used on plastics fittings Other manufacturer recommended sealants are acceptable
	PVC-U in accordance with AS 1464.1		Solvent-cement fitting in accordance with AS/NZS 1477, Class 12 or Class 18 or ASTM D2467 or BS EN ISO 1452.3		Solvent-cement jointing or mechanical joints carried out in accordance with AS/NZS 4645.3	
400 (Class 400)	Polyamide (Nylon 11 and 12) in accordance with AS 2944.1, Class 300 or Class 400		Polyamide fitting in accordance with AS 2944.2	Compression fittings may require internal stiffeners if specified by manufacturer	Adhesive jointing, or mechanical joints carried out in accordance with AS/NZS 4645.3	Adhesive shall be in accordance with pipe manufacturer's specifications PTFE (Teflon) tape is the only thread sealant tape to be used on plastics fittings Other manufacturer recommended sealants are acceptable
300 (Class 300)						

(continued)

TABLE 4.1 (continued)

MAOP	Pipe		Fittings		Joining	
	Pipe	Limiting conditions	Fitting	Limiting conditions	Method	Limiting conditions
70	(a) Polyethylene/aluminium/polyethylene (PE/AL/PE) and cross-linked polyethylene/aluminium/cross-linked polyethylene (PE-X/AL/PE-X) multilayer pipe in accordance with AS 4176.8 and relevant Australian Technical Specifications (ATS)	Ensure conformance with any instructions or warnings in accordance with the manufacturer's instructions Not permitted for use external to buildings or where exposed to UV	In accordance with AS 4176.8 and relevant Australian Technical Specifications (ATS)	Same temperature limitations as for pipe Not permitted in the ground beneath a building	Joints to be formed using method(s) and tool(s) in accordance with the manufacturer's specifications	Consumer piping installed in the ground beneath a building shall be multilayer pipe without joints
	(b) Cross-linked polyethylene/aluminium/polyethylene (PE-X/AL/PE) multilayer pipe in accordance with AS 4176.8	PE/AL/PE and PE-X/AL/PE not to be used for applications where the operating temperature exceeds 60°C PE-X/AL/PE-X not to be used for applications where the operating temperature exceeds 80°C Not permitted for use external to buildings or where exposed to UV				

(continued)

TABLE 4.1 (continued)

MAOP	Pipe		Fittings		Joining	
	Pipe	Limiting conditions	Fitting	Limiting conditions	Method	Limiting conditions
70 (cont'd)	Cross-linked polyethylene (PE) pipes for pressure applications in accordance with AS/NZS 2492, PEX-Yellow 100, no lighter than RAL 1033	Not permitted beneath a building Not permitted above ground without mechanical protection Not permitted external to a building	Compression fitting	Compression fitting in accordance with AS/NZS 2537.5. May require internal stiffeners if specified by manufacturer	Joints to be formed using methods and tools in accordance with the manufacturer's specifications	
300	NA	NA	Aluminium to AS/NZS 1867	As per AS/NZS 1867	Proprietary unions	As per manufacturers recommendations

NOTE: This Table originally appeared in AS/NZS 5601.1. It has been amended to meet the limitations of this Standard.

4.5.2 Materials and equipment selection process

A documented system shall be adopted to manage the processes for the evaluation and acceptance of materials and equipment to record the 'fitness-for purpose' evaluation. The process shall review the importance of the material to ensure or maintain an acceptable level of risk. The process shall cover specification, quality control, identification and traceability, handling and installation of materials and should cover pipes, fittings and other materials that convey or control gas, as well as any equipment that may impact on the performance of the gas distribution network. The process shall also cover management of defective product(s).

For the avoidance of doubt, the documented system pertains to materials currently being installed in the gas distribution network.

NOTE: The Gas Technical Regulator Committee at www.GTRC.gov.au contains a database of certified components.

4.5.3 Materials identification and traceability

Where required by the materials selection process in Clause 4.5.2 identification and traceability shall be met by one or a combination of the following:

- (a) The material or component can be traced back to their test certificate that confirms the material or components specification.
- (b) Identification with a Standard nominated in the AS/NZS 4645 (series), and each material marked with the name or mark of the manufacturer and the markings as specified in this Standard with which the material conforms.
- (c) Where the traceability or identification cannot be met by Item (a) or Item (b) above, the process for the traceability and identification of those materials and components shall be documented in the SAOP.
- (d) Where there is no record of a 'fit for purpose review' of a proprietary item still being installed; then this review shall be retrospectively performed, and where needed, a failure mode and effects analysis be also performed.

NOTE: Proprietary fittings that are not being installed anymore but are still in use and that were not validated may utilize FSA to determine the level of 'fit for purpose analysis' for continued use.

4.6 RECLAIMED MATERIALS AND RECLAIMED COMPONENTS

Any reclaimed materials and reclaimed components shall be accepted through a quality management process and conform with the following requirements:

- (a) Are traceable to a Standard identified in Table 4.1, AS 4645.2 or AS 4645.3 and used for the purpose they were originally intended.
- (b) Have a known history.
- (c) The expected life for which the material is to be used.
- (d) Be suitable for the proposed operation in light of the history of the material or component.
- (e) Be inspected since its previous use to reveal any defect that could impair its safety, strength or pressure tightness.
- (f) Components shall be cleaned and examined and, where necessary, reconditioned and tested, to ensure that they conform with this Standard.

- (g) Pipes and components shall be inspected for distortion, flattening, gouging, grooves, notches and every other harmful defect. Defects shall be repaired or removed in accordance with documented procedures to ensure fitness for purpose and tested in accordance with Item (g) below.
- (h) Where the integrity of reclaimed pipe or reclaimed components have been reduced by any type of deterioration, including corrosion or fatigue, and where pipe or components conform with a Standard that does not specify the manufacturer's test, the pipe or components shall be pressure tested either individually in a test similar to a manufacturer's test or as part of the gas main or service to the test specified for the system.

NOTE: Testing in accordance with Section 5 still applies.

4.7 ROUTE/SITE ASSESSMENT

4.7.1 General

A route/site assessment should be undertaken to determine the conditions that exist along the route, or at that site where infrastructure is to be established. The route/site assessment is used to identify any potential threats to or from the infrastructure and determine the most suitable route or site from a construction perspective. The assessment shall identify, as a minimum, any of the following conditions:

- (a) Land usage, in particular, the presence of high density community use areas.
- (b) The nature of the infrastructure proposed to be installed, including the MAOP and size of infrastructure.
- (c) Land ownership.
- (d) Environmentally and culturally sensitive areas, as determined by local authorities.
- (e) Areas subject to natural hazards, see Clause 4.10.6.
- (f) Other utilities in the area.
- (g) Other key above and below ground infrastructure in the area that may affect or be affected by the gas distribution network.
- (h) Areas where there is a heightened susceptibility of damage to the asset, due to the environment, land usage, or the design of the asset.
- (i) Future access for maintenance and/or service connection.

The assessment shall review and document any known changes that may occur to the conditions along the route, or at the site.

NOTE: Section 5 includes additional requirements for construction.

Where the conditions are not equivalent to those either already assessed and managed in other areas of the gas distribution network, or suitable for a means of conformance solution (such as those in AS/NZS 4645.2 or AS/NZS 4645.3), FSA shall be conducted to determine any additional controls that are required to ensure an acceptable level of risk due to site or route conditions.

4.7.2 Energy release rate

In areas where the route/site assessment identifies that the gas distribution network will be operated in a high density community use area, the maximum energy release rate for the largest credible defect in that area shall be restricted by design to less than 1 GJ/s after 30 s to reflect steady state.

NOTES:

- 1 AS 2885.1 identifies a method for calculation of energy release rate. AS 2885.1 provides information as to potential damage from excavators to steel pipes, which could be used to determine defects.
- 2 Pipes covered by the AS 2885 (series) are often designed for internal pressures greater than 1050 kPa. That higher pressure may result in greater wall thickness and therefore much greater resistance to penetration for AS 2885 pipelines compared to similar diameter mains in this Standard. The potentially higher frequency of incidences of penetration in AS/NZS 4645 (series) gas mains should therefore be recognized in the FSA.

4.8 MAXIMUM ALLOWABLE OPERATING PRESSURE (MAOP)

For a gas distribution network, or part thereof, in good operating condition, the MAOP is the lowest of the following:

- (a) The maximum operating pressure defined in the design.
- (b) The design pressure of the weakest element of the pipes or items connected within the network.
- (c) The pressures determined from testing (in accordance with Section 5).
- (d) Otherwise determined as part of ongoing integrity management.

4.9 NETWORK PRESSURE CONTROL**4.9.1 General**

The design shall ensure gas pressure within the gas distribution network is controlled by pressure regulating stations within safe limits throughout the gas distribution network and does not exceed MAOP in normal operating conditions.

The location, capacity, hazardous areas, operational conditions and remote monitoring should be taken into account in the design.

Design and operation of network pressure control stations shall take into account any foreseeable effects of freezing, hydrate formation or liquid drop out.

NOTE: This may be due to the Joule-Thomson effect.

Heating may be necessary where freezing would cause damage to or unsafe operation of components. Where liquid dropout is anticipated, coalescing filters or liquid traps may be required.

Where solid matter in gas is a threat to safe performance of the network pressure control station, a filter or strainer shall be fitted to the inlet of the network pressure control station.

Any noise shall be controlled to comply with the requirements of any relevant statutory authorities. The effect of high sound levels on operating and maintenance personnel shall be taken into account and suitable measures taken as necessary.

Operating procedures shall ensure prevention of unauthorized operations that will make any pressure-regulating system or over-pressure protection system inoperative. Suitable protection, including tagging and identification and locking of valves, etc. as appropriate should be implemented.

NOTE: IGE/TD/13 provides useful material for the selection of pressure control equipment.

4.9.2 Over-pressure protection

To ensure that gas distribution networks downstream of pressure regulating stations operate within safe limits, over-pressure protection devices shall be utilized.

The first over-pressure protection device (e.g. slam shut, relief valve or monitor regulator), shall be designed to limit network pressure—

- (a) for systems with a MAOP less than or equal to 7 kPa, to a pressure that will not—
 - (i) adversely affect the operation of the connected equipment; or
 - (ii) exceed the rated pressure of the downstream equipment.
- (b) for systems with a MAOP greater than 7 kPa, to 110% of the MAOP on the outlet.

Where more than a single over-pressure protection device is installed, only the first over-pressure is limited to Items (a) and (b). However, the highest outlet pressure of all devices shall be less than or equal to the lowest test pressure of any directly affected downstream gas distribution network or segment of the gas distribution network.

Where a failure or malfunction of the working regulator has occurred that has led to the activation of the over-pressure protection system then the failure or malfunction shall be evident by one or more of the following:

- (i) An interruption to gas supply.
- (ii) An audible or monitored alarm.
- (iii) Gas odour.
- (iv) Operational surveillance.

Any single incident that can lead to the loss of both pressure control and over-pressure protection at the same time should be addressed at the design stage. Examples of these are—

- (A) material failure;
- (B) vehicle impact damage;
- (C) general damage to common sense lines;
- (D) fire damage to diaphragms;
- (E) pilot regulators and seats;
- (F) loss of control gas supply; and
- (G) poor design.

4.9.3 Types of over-pressure safety devices

The following types of first over-pressure protection devices are acceptable:

- (a) Spring and pilot operated relief valves. These devices shall be specified to maintain downstream pressure in the worst case scenario which is—
 - (i) all regulator(s) in the stream are in the fully open position;
 - (ii) the gas distribution network demand is at its minimum level; and
 - (iii) the inlet pressure is at its maximum value.

- (b) A monitor regulator that is installed in series with the active regulator.

NOTE: Some monitor regulators can be set to provide a first pressure cut and on failure of the active regulator they are able to maintain downstream pressure limits, as outlined in Clause 4.9.2.

- (c) Any automatic shut off device, such as an over-pressure shut off valve (OPSO) that is installed in series with a pressure regulator and is set to shut off before the pressure in the downstream system exceeds a maximum of 110% MAOP. The device shall remain closed until it is manually reset. The potential for supply interruption if OPSOs are used should be considered in the selection of these devices. The potential for supply interruption can be reduced through the selection of suitable separation of set points, partial relief systems, twin streams, active monitor, or other forms of protective devices or multiple supply runs.

NOTES:

- 1 Automatic shut off devices that automatically reset are considered as 'on-off regulators'.
- 2 Where there are several active pressure control systems in parallel, relief valve sizing should be based on failure of the system with the largest capacity.
- 3 Safety devices in network pressure control stations may be either integral with the regulator or a separate unit.

4.9.4 Location of network pressure control equipment

The following shall apply when locating network pressure control equipment and their components:

- (a) Where pressure-relief valves are located adjacent to any structure, public building, road or railway, the method of venting gas and controlling the associated noise shall be appropriate to that location and shall comply with the requirements of any relevant statutory authorities.
- (b) The choice of location shall take account of the risks inherent to the location that could result in damage to the installation, e.g. traffic, overhead power cables, large trees, flooding, subsidence, and naturally occurring hazards.
- (c) The location shall provide ready and safe access for authorized persons carrying out maintenance.
- (d) Readily accessible isolation valves shall be located on the inlet and outlet supply lines for purposes of emergency shutdown. Such isolation valves shall be outside buildings or structures and shall be located a safe distance away.

NOTES:

- 1 Isolation valves should be in line of sight of the network pressure control station.
- 2 Consideration may be given to providing blow down systems for reducing network pressure safely in the case of emergencies where reducing pressure in part of the gas distribution network becomes necessary.

4.10 MAINS AND SERVICES**4.10.1 General**

Mains and services shall be designed to be fit for purpose and shall be in accordance with the functional requirements specified in Clause 3.3.

Design inputs for mains or services shall be defined for the following:

- (a) Diameter to be in accordance with the functional requirements in Clause 3.3.
- (b) Wall thickness as described in Clause 4.10.3.
- (c) Depth of cover as described in Clause 4.10.4.
- (d) Natural hazards as described in Clause 4.10.6.
- (e) Alignment and separation from other utilities as described in Clause 4.10.7.
- (f) Other inputs, including requirements for:
 - (i) Mains and services under structures as described in Clause 4.10.2.
 - (ii) Exposed mains and services as described in Clause 4.10.5.
 - (iii) *Flexibility and expansion* Design of mains and services shall prevent excessive stresses in the pipe or materials, and shall include but not be limited to—
 - (A) connection requirements to new or existing mains or services; and
 - (B) use of anchors, supports or other means of restraint.

- (iv) *Pipe identification and warning systems, and contents identification* A systematic and rigorous approach, consistent with good industry practices, for identifying and warning of the presence of a gas distribution network shall be described, and documented as part of the design and then implemented during construction. The following inputs shall be used in determining the requirements of identification and warning systems:

- (A) Locations where mains and services may not be expected.
- (B) Supply criticality of the main or service.
- (C) Mains or services laid in High Density Community Use locations.
- (D) The MAOP of the main or service.
- (E) Locations where mains or services cannot be laid in accordance with a means of conformance.

NOTE: See Appendix H for more information about signs and markers.

- (v) *Water ingress or condensing conditions* Where water ingress or condensing conditions may occur within the pipe, the main or service shall be laid to grade. Syphons shall be installed at all low points and the main shall be located to facilitate, as far as possible, the grading of all services back to the main. Provision for liquid removal shall be in an accessible location and the position indicated clearly and easily identified.

NOTE: Where only a single main is laid in a street that has a cross fall, it is recommended that the main be laid on the low side of the street.

- (vi) *Railway crossings design.*

NOTES:

- 1 AS 4799 covers underground utilities within railway corridors.
- 2 Kiwirail Specification for installation of pipelines on railway land—E1322.

- (vii) *Other authority requirements.*

4.10.2 Mains and services under buildings

Mains or services shall not be installed, buried under buildings and in and through foundations where—

- (a) the integrity of the main or service will be affected;
- (b) the integrity of the structure or foundation will be affected; or
- (c) a gas leak may accumulate in a confined space where adequate controls as described in Appendix G are not in place.

Where mains or services are installed under buildings, the design of the main or service under buildings shall take into account the following:

- (i) *Building loads* Any main or service under a building shall be designed to ensure that building loads have no effect on the integrity of the service.
- (ii) *Leakage paths* Any potential leakage paths shall be reviewed to determine the potential for gas to enter the building and the consequence of the gas entering the building.
- (iii) *Maintenance and repair requirements.*
- (iv) *Isolation* Any main or service installed or buried under a building shall have a means of isolation.

NOTES:

- 1 Service isolation is outlined in Clause 4.10.10.
- 2 Mains isolation is outlined in Clause 4.11.2.