UPSTREAM NATURAL GAS SAFETY REPORT
PERIODS 1998 to 2008

Transmission and Distribution

Prepared by Energy Safe Victoria

2009

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Executive Summary

This is a second revision of the Upstream Review, adding additional 8 years review to the previous report of 1998 – 2000. The aim of this report is to assess and report upon the risks imposed on the community by natural gas supply activities, and based on the available information, identify opportunities for improvements to ensure the risks to the community are as low as reasonably as practicable (ALARP). This report assesses the quality of the information collected and reviews overseas data.

The scope of the report covers gas safety data relating to the Victorian natural gas businesses over the reporting periods 1998 – 2008. It also includes historical data to provide context.

This report reviews safety outcomes in the upstream sector of the Victorian gas industry. In this report, “Upstream” means “transmission and distribution systems upstream of the outlet of the gas meter at a customer’s premises”. This report attempts to identify trends in safety outcomes and the causes of these trends.

Safety outcomes in this report are grouped into loss of containment of gas (i.e. gas escapes) and loss of gas supply to end use customers.

In the transmission system, the zero frequencies in Victoria for deaths, serious injuries and property damage resulting from a loss of containment indicates the integrity of the transmission system and the associated operations and maintenance practices employed by the transmission businesses.

In the distribution system, the zero frequencies in Victoria for deaths, serious injuries and property damage resulting from loss of containment during the reporting period provides a level of confidence that the operational and maintenance strategies employed to date has led to a positive outcome. This does not necessarily imply that this is a reliable indicator of long term future frequencies because of the sensitivity of the frequency to changes when the total numbers of serious incidents are small. Greater focus is needed to relate the frequency of damages and escapes to the changing risks imposed by the distribution networks through continual revisiting of the formal risk assessment and developing improved KPIs.

There has been no loss of supply between 2000 and 2008 associated with the transmission system. This result can be attributed to Victoria’s commitment to ensuring that the transmission system is appropriately designed and managed to avoid the risk associated with any event that may cause an interruption to supply in a gas system.

In the distribution system, loss of supply where more than 5 customers are affected result mainly from two types of causes, third party damage and from water entering gas mains and services. The number of customers affected mainly depends on the configuration of the distribution network where the damage occurred. There were only two cases (in 2005 & 2007) of gas interruption in the distribution network which was attributed from unpredicted severe cold weather where the gas demand had exceeded the scheduled in the system.

Issues associated with water entering gas mains and services is associated with the condition of network, pressure in the mains, weather, location of mains, etc. and requires a combination of short and long term strategies to manage this risk. Each gas distribution business is currently developing asset management plans that will describe the strategies adopted for addressing these issues in the long term. In the short term, each gas business under its safety case have operational strategies to minimise the impact of such incidents.

In summary, the zero frequencies in Victoria for deaths and property damage for the periods 1998-2008 provides an indication that the level of risks associated with the upstream natural gas infrastructure (transmission and distribution networks) have been maintained at a level acceptable to the community.

For the transmission networks, the adoption of asset integrity management (compliance with AS2885.3) provides a platform for ensuring sustainability of gas safety related performances.

For the distribution networks, the development of asset management plans and a more meaningful set of KPIs (used in conjunction with the Essential Services Commission) provided assurance that the gas safety related performances are sustainable. A key element of the safety case regime in Victoria is the development of Asset Management Plans that sees the integration of risk and asset management strategies.

2 Introduction

2.1 What is this report about

The aim of this report is to assess and report upon the risks imposed on the community by natural gas supply activities, and based on the available information, identify opportunities for improvements to ensure the risks to the community are as low as reasonably as practicable (ALARP). This report assesses the quality of the information collected and reviews overseas data.

The scope of the report covers an analysis of gas safety data relating to the Victorian natural gas businesses over the reporting periods 1998 – 2008. In addition, historical data is included where available. This has been done to provide a context for the 1998 – 2008 data and also to make more readily retrievable data that is currently widely dispersed.

This report reviews safety outcomes in the upstream sector of the Victorian gas industry. In this report, “Upstream” means “transmission and distribution systems upstream of the outlet of the gas meter at a customer’s premises”. This report attempts to identify trends in safety outcomes and the causes of these trends.

Safety outcomes in this report are grouped into loss of containment of gas (i.e. gas escapes) and loss of gas supply to end use customers.

Loss of supply includes losses due to both security of supply issues and reliability of supply issues. In this report, security of supply relates to the overall balance between gas supply and customers’ gas demand while reliability of supply relates to the reliability of the transmission and distribution networks used for the transport of gas. See Figure 1 below:

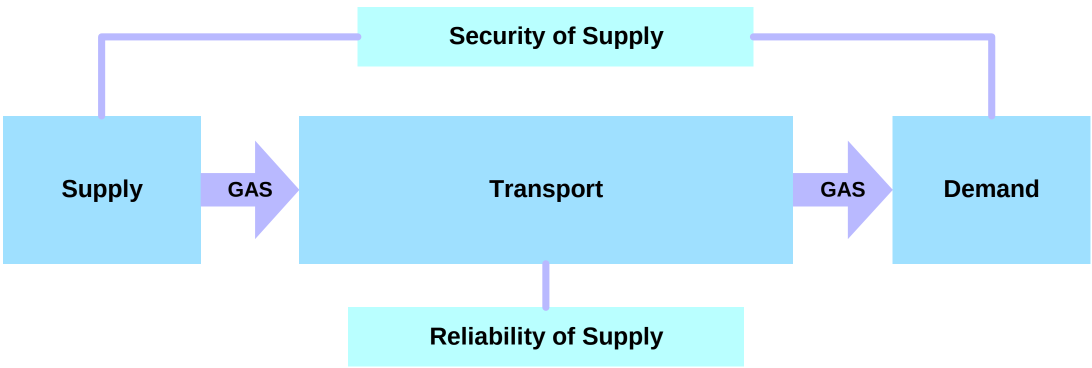


Figure 1: Security and Reliability of Supply

2.2 Natural Gas Industry

The terms used in this report to describe the various gas industry sectors as shown in the schematic structure of the Victorian natural gas industry in Figure 2 below:

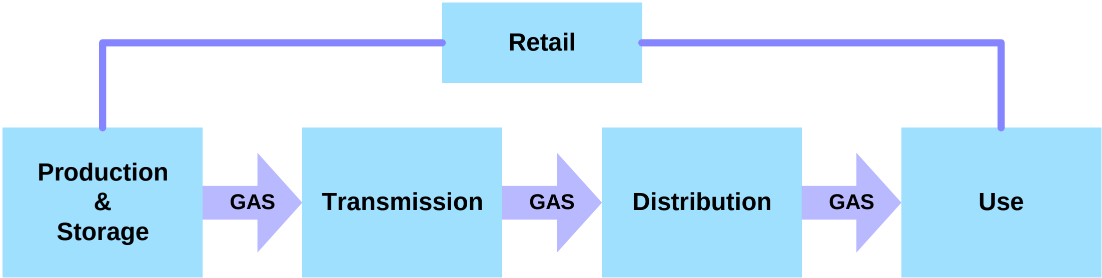


Figure 2: Natural Gas Supply Industry

2.2.1 Production & Storage

The gas transmission system primarily consists of the Principal Transmission System (PTS), with connections to other pipelines not forming part of the PTS. The PTS have seven different injection points (see Figure 3) at:

Injection Point	Injection Capacity
1. Longford – located at Longford, with gas supplied by Exxon-Mobil/BHP Billiton/Southern Natural Gas Development (SNGD). The group procures gas from the Bass Strait gas fields in Gippsland. 2. VicHub – located at Longford with gas flow to and from New South Wales through the Eastern Gas Pipeline (EGP).	Longford: (Esso and VicHub) 990TJ/d
3. BassGas – located at Pakenham with gas supplies from the Yolla gas field.	Bass Gas: 67TJ/d
4. Iona – located near Port Campbell with gas supplies from the Iona gas plant and the Underground Gas Storage (UGS) facility. Gas from the Casino gas field is processed at the Iona gas plant and flow to the PTS through the Iona injection point.	Iona (Iona gas plant and UGS): 214 – 294TJ/d
5. SEA Gas – located adjacent to Iona and the UGS facility. Gas from the Minerva gas filed flows to this injection point. The Otway gas project will also be able to inject gas into the PTS at the SEAGas injection point.	SEA Gas: 111TJ/d (winter peak)
6. Culcairn – located in New South Wales, gas from the Moomba gas field is injected at Culcairn and then flows into the PTS via the New South Wales interconnect. Longford gas can also be exported to New South Wales via Culcairn.	Culcairn Import: 50TJ/d
7. Liquefied Natural Gas (LNG) facility – located at Dandenong, LNG is stored here, and vaporised and injected into the PTS as required.	LNG: 150TJ/d for 3 days without replenishment

Table 1: Injection points and nominal injection capacity of the PTS.[1]

Mildura is not connected to the principal network and is supplied via Berri by an offtake on the Moomba to Adelaide pipeline.

[1] Victorian Annual Planning Report 2008, Page 41 – 42, 52 & System Security Guidelines (issue 8), Page 8 – 10

2.2.2 Transmission

In this report, transmission pipelines are those that have a maximum allowable operating pressure (MAOP) in excess of 1050 kPa.

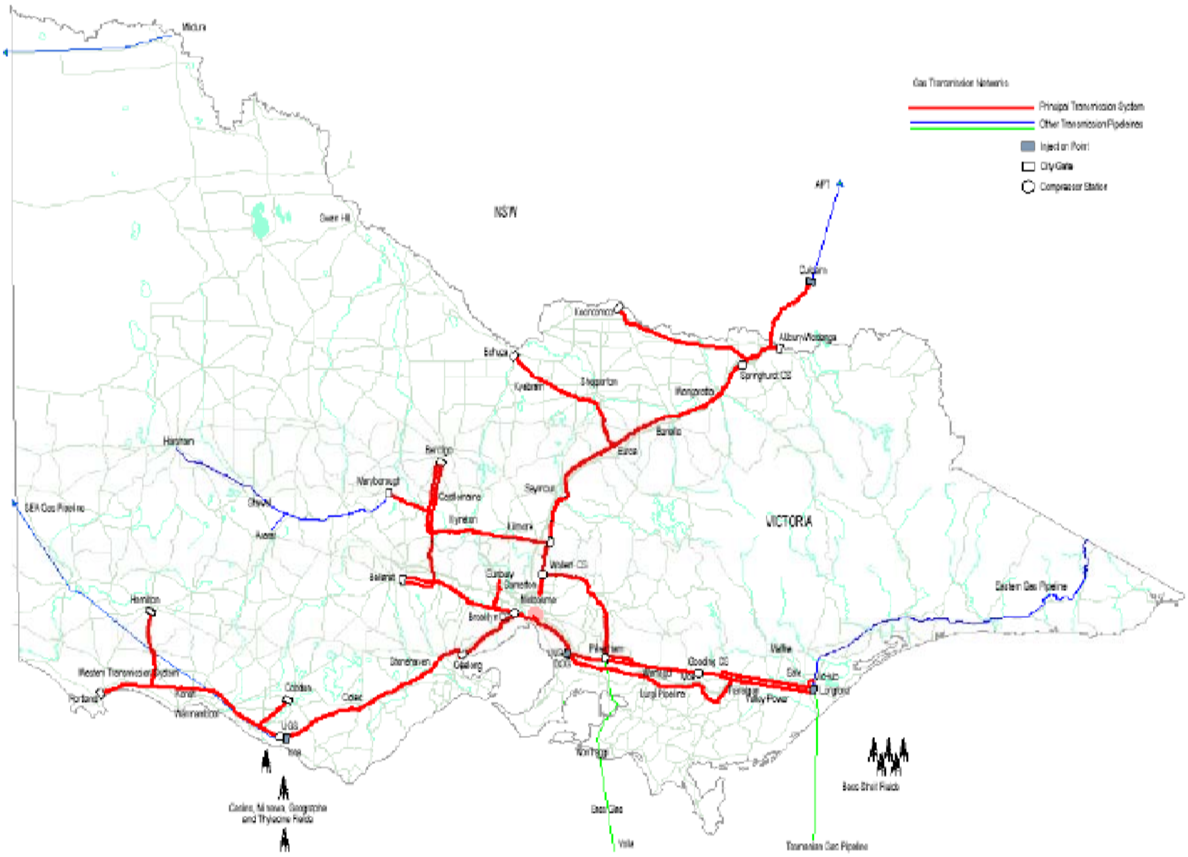


Figure 3: Victorian Gas Transmission Network[2]

The main Victorian pipelines are shown in Figure 3 above.

APAGasNet own the majority of these lines which make up the Principal and Western Networks. The Principal Network is operated by VENCorp and operates on a market carriage basis. The Western Network is also operated by VENCorp. The Western Network and all other Victorian pipelines operates on a contract carriage basis.

Apart from the Principal Transmission System and the Western Networks, there are also other natural gas transmission pipelines located or partially located within Victoria, these are as follows:

[2] Major Augmentation Report October 2005 Page 5

- Jemena Pty Ltd owns and operates the EGP from Longford to Sydney (& Bairnsdale) and the VicHub which interconnects the EGP to the Principal Transmission Network.
- Babcock Brown Infrastructure owns the Tasmania Gas Pipeline (TGP) which is operated by Tas Gas Networks.
- Gas Pipelines Victoria Pty Ltd owns and operates the Carisbrook to Ararat/Stawell/Horsham pipeline.
- Envestra own the Berri to Mildura pipeline which is operated under contract by APA – Group (Thomastown).
- IPM Australia Ltd owns the Loy Yang B pipeline which is operated under contract by APA GasNet.
- Origin Energy Resources Ltd owns the SESA pipeline which is operated under contract by APA GasNet as well as the Bass Gas Pipeline (from the Bass Strait gas field to Pakenham) - the connection at Pakenham is primarily a transmission injection point.
- Santos Ltd owns the Patricia Baleen pipeline which is operated by AGR.
- South East Australia Gas Pty Ltd owns the SEA Gas pipeline (from Iona to Adelaide) which is operated under contract by APA GasNet. This pipeline has two connections, one to the Underground Gas Storage (UGS) facility, and one to the PTS (known as the SEA Gas interconnect).

The three Victorian gas distribution businesses, Envestra / APA Group Thomastown, SP AusNet and Multinet, Jemena own and operate a number of smaller urban & rural transmission pipelines.

The Victorian transmission networks also contain a number of compressor stations. Jemena compressor station at Longford supplies the EGP and the TGP. GasNet has compressors at Gooding, Brooklyn, Wollert, and Springhurst.

2.2.3 Distribution

Supply of gas from the transmission networks to the distribution networks is at over a hundred city gates / custody transfer meters. Downstream of these, system pressures are controlled by a series of field and district regulators supplying the high, medium and low-pressure areas of the distribution system. High, medium and low-pressure systems have Maximum Allowable Operating Pressure (MAOP) of 515 kPa, 200 kPa and 7 kPa respectively. There are also a small number of distribution mains with a 700 kPa MAOP. Assets of the distribution businesses include the service pipe from main to meter as well as meter/regulator set at the customer's point of supply.

Distribution businesses also operate network control rooms and radio dispatch rooms.

Below is a table that summaries the gas transportation infrastructure currently managed by the gas businesses in Victoria:

Gas Businesses	Meters (units)	Mains (kilometres)	TP (kilometres)
Multinet	657,100	9,670	158
Envestra	535,328	9,517	314
SP AusNet	551,097	9,282	182
Gas Pipeline Victoria Pty Ltd			167
APAGasNet			2019
Jemena			282
IPM Australia Ltd			13
TOTALS	**1,743,525**	**28,469**	**3,135**

Table 2: Summary of Gas Infrastructure in Victoria in 2008

2.2.4 Retail

The principal function of the retail businesses is to buy gas from producers and sell it to end users. The retailers pay the transmission and distribution businesses for transporting gas from producers to end users (transmission and distribution "use of system" - TUOS and DUOS charges respectively). Retailers have a major role in issues of security of supply in that they must balance their purchase and sale contracts in the longer term and in the short term must submit their nominations for gas to be injected into the market to meet their customers' demand on a daily basis.

Retailers also operate customer call centres and have a safety role in responding to emergencies, either handling calls from individual customers or in managing customer curtailments in the event of major gas shortages.

Responsibility for the long-term security of supply also rests with VENCorp. In addition, on a daily basis, VENCorp are responsible for the collation of market injection nominations and system withdrawals, balancing the gas market and physically operating and balancing the Principal Transmission Network.

2.3 Victorian Safety Regime

The **Gas Safety Act** (**The Act**) specifies in sections 32 to 36 the general duties of gas companies. It also specifies in section 37 that a gas company must submit a safety case which sets out how the company will meet these general duties. The Gas Safety (Safety Case) Regulations specify the details that must be included in a safety case.

A safety case comprises 3 main elements, being a facility description (FD), a formal safety assessment (FSA), and a description of the company's safety management system (SMS).

(a) Facility Description
The 'facility' includes physical assets, activities and services that might be a source of gas safety hazards.

(b) Formal Safety Assessment
The FSA is the systematic assessment of risks associated with the hazards that might arise from the assets, activities and services identified in the FD.

(c) Safety Management System
The SMS is the system established by the company to ensure that the risks identified in the FSA are managed to be as low as reasonably practicable in the short and medium term. For distribution companies this includes a description of the Asset Management Plan (AMP) established by the company to ensure that risks identified in the FSA are managed to be as low as reasonably practicable in the long term.

2.4 Basis of analysis

The causes of an adverse event are commonly described by the use of fault trees. Similarly the outcomes of an adverse event are commonly described by the use of event trees. These two models can be linked together in the form of a cause consequence diagram with the loss of control being the common point. The analysis of causes and effects in this report is structured around cause-consequence diagrams of the types illustrated below.

The cause consequence diagram for Loss of containment is shown Figure 4 below.

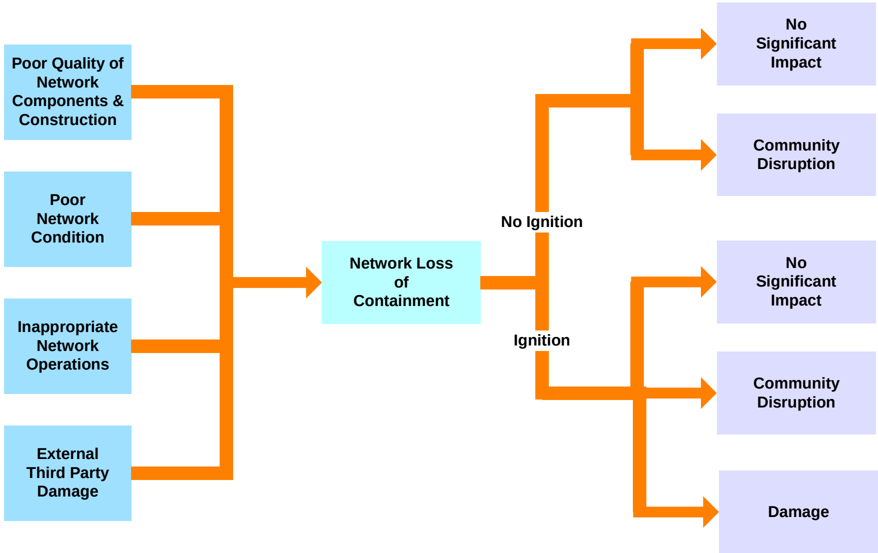


Figure 4: Loss of Containment

The Energy Safe Victoria regards loss of containment in any circumstance as a potentially dangerous and undesirable event. In the diagram above, “No Significant Impact” means that the community did not suffer the consequences of fires, explosions, death, injury, property damage, evacuations or traffic disruptions. This does not mean that the danger of these events was not present, just that these events did not eventuate in a particular case.

The cause consequence diagram for loss of supply is shown in Figure 5 below. Note that this diagram is restricted to reliability of supply issues only and does not include security of supply.

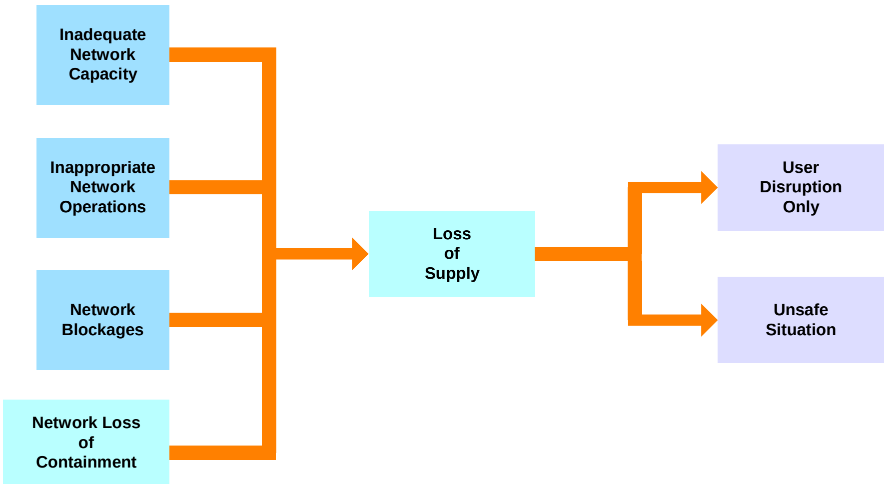


Figure 5: Loss of Supply

An unplanned loss of supply (or interruption) to a customer in any circumstance is regarded by the Energy Safe Victoria as a potentially dangerous and undesirable event. Unless gas supply to a customer is safely isolated and reinstated after an interruption, there is always the possibility of gas escapes at those few appliances which have had their supply interrupted and which do not have flame failure devices fitted. In the diagram above, “User Disruption Only” means that supply has been safely isolated and reinstated and the consequence for the customer is restricted to being unable to use gas for a period.

3 Data Collection

The Energy Safe Victoria has been collecting data formally through agreed arrangements with the regulated gas companies since 1998 under the Gas Safety Case regime. Under this regulated environment, there has been the obligation to report incidents (refer to Appendix 1: Incident levels), the establishment of key safety performance measures (refer to Appendix 2: OGS KPI Reports), immediate reporting of major incidents and other safety related information.

Wherever possible, historical data has been included to provide context and a baseline performance. For historical data to be meaningful in the context of gas infrastructure, it generally requires about 5 - 10 years of data depending on the nature of the analysis. Operationally focused strategies tended to require less history than asset management based strategies requiring generally a much longer period (for gas infrastructure with a life 50 years or more). Access to historical data has been limited and as such, interpretation of this data is also limited.

Changes in ownership and re-engineering of the gas companies have effected the collection of incident information over the period of disaggregation (1996/1997). These changes have resulted in variations in levels of incidents reported, the type of incidents reported, the way key performance indicators (KPI) are gathered and the quality of the data. Since disaggregation, the gas companies have instigated improvement programs relating to information gathering and processing needed to manage the gas transmission and distribution businesses.

External benchmarking has been attempted in this report with limited meaningful outcomes. Direct comparisons are not been very useful for many reasons and these are explained in the report. However, lessons can be learnt by analysing individual incidents and usefulness of existing safety performance measures. Gaps in current incident recording practices have been identified.

The Energy Safe Victoria also recognises that the underlying methodologies to collect information and to define terms and key performance indicators by other gas related authorities around the world and within Australia is not consistent.

4 Loss of Containment

4.1 Transmission – Loss of Containment

The following sections analyses information associated with loss of containment for the natural gas transmission system in Victoria and endeavours to compare appropriate benchmarks from within Australia and overseas.

In Victoria there have been no significant escapes, incidents involving deaths, injuries or property damage. Since events like these are so infrequent but have significant impacts if such an incident occurred, there is a need to continually monitor all events that could lead to an escape.

This analysis is in two parts, analysis of escapes and analysis of events associated with damages which is considered a primary risk to the transmission system. The analysis is based on information received by the OGS/ESV after its inception in 1997. Further historical information has been included in order to provide context and uncover any trends or issues.

4.1.1 Escapes

Below, Table highlights that there has been no event associated with the loss of containment that has resulted in deaths, injuries or property damage.

System Element	Impact	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	Total
Transmission system	Deaths, injuries, property damage	0	0	0	0	0	0	0	0	0	0	0	**0**
Compressor station	Escape	0	0	1[1]	0	0	0	0	0	0	0	0	**1**
Transmission pipeline	Escape	0	0	0	2	2	1	0	0	2	1	0	**8**
Total		**0**	**0**	**1**	**2**	**2**	**1**	**0**	**0**	**2**	**1**	**0**	**9**

[1]Unplanned gas venting at Wollert compressor station resulted in public reports of noise & strong smell of gas. There was also an accidental release of odourant during the removal of an odoriser at Mildura. While this caused a number of “gas escape” calls there was no actual loss of containment.

Table 3: Transmission events associated with loss of containment in Victoria

No meaningful deductions can be made from the frequencies below, particularly as the escapes are of a low risk nature. Other processes are used to ascertain the quality of the transmission businesses’ asset integrity management, for example, auditing of Safety Cases.

The 2007 frequency for escapes: 0.33 escapes per 1000 kms per year
The 2008 frequency for escapes: 0 escapes per 1000 kms per year

4.1.2 Damages

4.1.2.1 Transmission Incidents Reported to ESV

Below, Table 4 highlights that there have been no events associated with damages that have resulted in deaths, injuries or property damage.

System Element	Impact	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	Total
Transmission Pipeline	Deaths, injuries, property damage	0	0	0	0	0	0	0	0	0	0	0	**0**
	Escape	0	0	0	0	1	1	0	0	2	1	0	**5**
	Coating and/or Metal Damage	0	0	1	1	1	3	1	0	0	0	0	**7**
	Near Miss	*	16	7	3	5	11	5	3	3	2	0	**55**
Total		*	**16**	**8**	**4**	**7**	**15**	**6**	**3**	**5**	**3**	**0**	**67**

* Not reported

Table 4: Transmission events associated with damages in Victoria

Table 4 is broken up into four types of impacts resulting from a incident:

- *near misses* are any unauthorised excavation or 3rd party encroachments. (this is a loss of control event)
- *coating and/or metal damage* where no loss of containment occurred
- *escapes* where loss of containment did occur
- *deaths, injuries and property damage* resulting from damaging an element of the transmission system.

Reporting of near misses has been only required for distribution businesses from 2000 since the revision of incidents need to be reported individually (refer to Appendix 1: Incident levels).

Historical the transmission system in Victoria has been free of any serious incident, that is, involving a death, injury or property damage. However in 2002, a section of 100 mm steel pipework was ruptured on the Gas Pipeline Victoria's (formally known as Coastal) "Cransbrook to Horsham' Transmission Pipeline. This damage resulted from a bull dozer while laying cables. The resultant escape forced the closure of the busy Pyrenees highway between the towns of Elmshurst and Ampitheatre for more than three hours and threatened loss of supply to two Victorian towns.

No coating and metal damages have been reported in the past three years. One coating and metal damage was reported in 2004 on a 350mm transmission pipeline by excavation work for the developer. Three coating and metal damages were reported on 450mm transmission pipelines by excavation work mainly for water authority. One coating and metal damage was reported in 2000-2002, and this was to a 400 mm transmission pipeline by a excavator working for a water authority.

The overall frequency for incidents in 2007:	0.98 incident per 1000 kms per year
The frequency for damages in 2007:	0.00 damage per 1000 kms per year
The overall frequency for incidents in 2008:	0.00 incident per 1000 kms per year
The frequency for damages in 2008:	0.00 damage per 1000 kms per year

4.1.2.2 Victorian Historical Data

Gas transmission businesses in Victoria have patrolled their pipelines since construction of the transmission network commenced. Below is a summary of their logged incidents. These incidents include data collected when the Gas and Fuel still had control of all the transmission pipelines, and since then, when it was taken over by the 4 transmission and distribution businesses in 1997. This is not a complete set of data, particularly in the period after privatisation of the gas industry but it provides the best available baseline to establish initial frequency triggers.

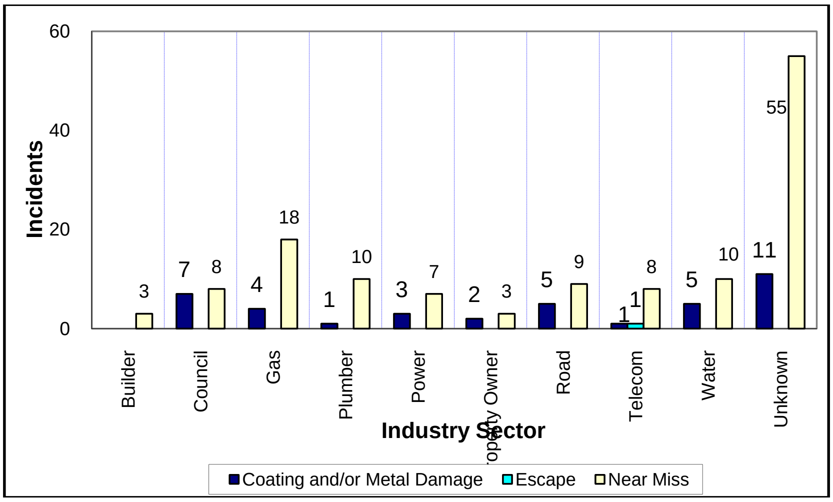


Figure 6: Victorian pipeline incidents by industry sector from 1971 to 2000

Historically, the gas distribution day labour and contractor crews undertaking work without a work permit was an issue. Since the disaggregation of the gas industry in 1997, the prominent issue now is unauthorised work by third parties. This is particularly evident where contractors are working for utilities and councils.

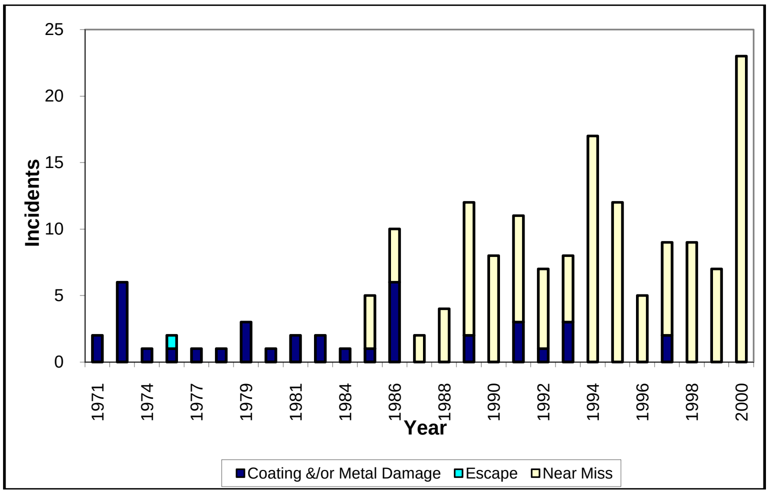


Figure 7: Victorian pipeline incidents by year from 1971 to 2000

These figures are related to “incidents” detected during pipeline patrolling. The frequency of actual damage to pipelines has reduced, resulting from a combination of the pipeline procedural protection strategies (e.g. signage, patrolling, etc) and the Dial Before You Dig (DBYD) Service.

Near misses are now a key safety performance measure and reporting of these began in the late 1980’s. This is a good measure of the effectiveness of the particular pipeline protection strategies (e.g. signage) and the DBYD Service. The increase in the reporting of near misses is associated with changes in reporting requirements. ESV (formally OGS) has focused on the general issues associated with pipeline easements in safety case compliance audits during 2000/2001.

It is acknowledged that incidents should also be analysed using such factors as equipment capabilities and planned excavation depth to determine their potential for causing actual pipeline damage but such data is currently not available.

Average frequency of near misses and coating &/or metal damage for the period between 1990 - 2000:

4.1 near misses/coating &/or metal damage per 1000 kms per year

Frequency of near misses for the year 2007: 0.64 near misses per 1000 kms per year
Frequency of near misses for the year 2008: 0.00 near misses per 1000 kms per year

4.1.3 Benchmarks

4.1.3.1 Australian and New Zealand

Pipeline Operating Group (POG)

The POG database was developed and implemented around 1970. The initial intent of the database was to capture records of damage to transmission pressure gas and liquid petroleum pipelines throughout Australia and New Zealand.

The following tables represents data extracted from the Pipeline Operator Group titled "Pipeline Incident Data Summary" dated 19 November 2007 and "Review of Pipeline Incident Data to 2004". The tables illustrate the incident causes from 1965 – 2007 in 5 yearly intervals and the incident rates by generic failure modes for period 2006-2007.

External interference constitutes 84.62% of all incidents in 2006-2007. This suggests that attention in Australia should be on minimising the effect of external parties and controlling work carried out by pipeline operators themselves. Corrosion is the next most frequent cause of incidents constituting 7.69% of the total.

	Construction Defects	Corrosion	Earth Movement	External Interference	Lightning	Material Defect	Total
1965	0	5	0	0	0	0	**5**
1970	0	6	0	1	0	0	**7**
1975	1	0	0	13	0	0	**14**
1980	0	1	0	14	0	0	**15**
1985	2	3	1	23	0	1	**30**
1990	0	1	2	20	0	0	**23**
1995	0	0	1	11	0	0	**12**
2000	0	0	0	4	0	0	**4**
2005	1	1	1	43	1	1	**48**
2010	0	1	0	11	1	0	**13**
Total	**4**	**18**	**5**	**140**	**2**	**2**	**171**

Table 5: Pipeline Operators Group's gas transmission and liquid petroleum pipelines incident causes for Australia and New Zealand from 1965 - 2007

For period 2006 - 2007	Incident Rate per 1000 km year	%
Construction Defects	0.00	0.00%
Corrosion	0.03	7.69%
Earth Movement	0.00	0.00%
External Interference	0.34	84.62%
Lightning	0.03	7.69%
Material Defect	0.00	0.00%
Total	**0.41**	**100.00%**

Table 6: Pipeline Operators Group's gas transmission and liquid petroleum pipeline incident rates by generic failure modes for Australia and New Zealand for period 2006-2007

The overall frequency for pipeline incidents in the period 2006 -2007: 0.41 incidents per 1000 kms per year
Frequency due to external interference in the period 2006-2007: 0.34 incidents per 1000 kms per year

South Australia

Natural gas is supplied from the transmission pipelines to the distribution networks in Adelaide and the regional centres from three gas sources:

- The Moomba to Adelaide pipeline (MAP) supplies natural gas via a 781km pipeline which has laterals to Whyalla, Port Pirie, Peterborough and the Barossa Valley. This pipeline is owned and operated by Epic Energy. A lateral pipeline to the Riverland and Murray Bridge is owned by Envestra Ltd and operated by Origin Energy Asset Management (OEAM).
- A more recent source of natural gas supply is the 680km SEA gas pipeline (commissioned in January 2004) which stretches from Port Campbell in Victoria to Adelaide in South Australia. The SEA Gas pipeline has off-takes located at Cavan, Naracorte, Jervois, Torrens Island Power Station and Pelican Point Power Station. One lateral, the South East South Australia (SESA) transmission pipeline, was constructed and commissioned in June 2005 by Origin Energy Retail and is not supplying natural gas to the south east of the State, the Limestone Coast Region.
- In the south east of the State, the Limestone Coast Region, natural gas from the Katnook gas field (near Penola) is transported by pipeline to Mount Gambier, Penola and Millicent. This transmission system is owned and operated by Epic Energy. In June 2005, Origin Energy Retail completed the construction of and commissioned the 45km SESA pipeline to enable the delivery of additional gas produced in the Otway and Gippsland Basins in Victoria via the SEA Gas pipeline to the existing Katnook/Ladbroke Grove facilities. This new lateral now enables gas shippers to meet the market demand for gas and provide greater security of supply. Previously, demand was met with gas from the Ladbroke Grove and Katnook fields only, which have a declining capacity to produce contracted quantities of natural gas.

South Australia's gas transmission system comprises the two main gas trunk lines, Moomba Adelaide Pipeline (MAP), South East Australia Gas Pipeline (SEAGas) and the smaller lateral pipelines connecting the trunk pipelines to a number of regional centres. This include the Port Pirie, Whyalla, Barossa Valley and Riverland laterals, and the Katnook to Mount Gambier pipeline in the Limestone Coast region. In addition, a 45 km lateral, the SESA pipeline, connects the SEAGas pipeline to Katnook. The lateral also provides a gas supply provides a gas supply to the Ladbroke Grove power station.
South Australian Energy Technical Regulator reported the following KPIs:

KPIs	1998/ 1999	1999/ 2000	2000/ 2001	2001/ 2002	2002/ 2003	2003/ 2004	2004/ 2005	2005/ 2006	2006/ 2007	2007/ 2008
Number of transmission pipeline damages or near miss reports by third parties	**0**	**1***	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**

(Source: South Australian Technical Regulator's Reports 1999/2000, 2000/2001, 2001/2002, 2002/2003, 2003/2004, 2004/2005, 2005/2006, 2006/2007 & 2007/2008 : Gas)

Table 7: South Australia KPIs for transmission pipeline damages or near misses caused by third parties

For 2007/2008, this equates to a frequency for damages/near miss caused by third parties:

Zero damages/near miss per 1000 kms per year

Average for the previous four years equates to:

Zero damages/near miss per 1000 kms per year

3.1.3.2 Europe

European Gas Pipeline Incident Data Group

European Gas Pipeline Incident Data Group (EGIG) has collected data from a number of European participants, see Table 8 covering approximately 130,000 km of pipelines. The criteria used for incidents in the EGIG database are only pipeline incidents with an unintentional gas release.

The participants are:

- DGC (Denmark)
- ENAGAS, S.A. (Spain)
- Fluxys (Belgium)
- Gasum Oy (Finland)
- N.V. Nederlandse Gasunie (The Netherlands)
- GRT Gaz (France)
- E.ON Ruhrgas AG (Germany)
- SNAM Rete Gas (Italy)
- SWISSGAS (Switzerland)
- National Grid (UK)
- RWE Transgas Net (Czech Republic)
- Ren Gasodutos S.A. (Portugal)
- Swedegas A.B. (Sweden)
- Bord Gais Eireann (Ireland)
- OMV Gas GmbH (Austria)

The major cause of incidents is external interference, which constitute 49.6% of all incidents, followed by construction defects/material failure (16.5%) and corrosion (15.4%). What mainly differs between POG (refer to 4.1.3.1) and this EGIG data is incidents resulting from defects, which is 0%. This is a much higher proportion than in Australia. It is not a high frequency event in Victoria.

	Incident Rate per 1,000km per year	%
External Interference	0.05	49.6
Construction defect/Material failure	0.02	16.5
Corrosion	0.02	15.4
Ground movement	0.01	7.3
Hot-tap made by error	0.01	4.6
Other and unknown	0.01	6.7
Total	0.11	

Table 8: European Gas Pipeline Incident Data Group incident rates for incidents in 2007

The overall frequency for pipeline incidents in 2007: 0.11 incidents per 1000 kms per year
Frequency due to external interference in 2007: 0.05 incidents per 1000 kms per year

4.1.3.2 USA

Gas Research Institute

Gas Research Institute (GRI) in 1995 ran a survey to determine the magnitude of risk exposure for the gas industry and establish a benchmark figure for the rate of damage per kilometre for the year 1993. The survey was not comprehensive but provides an indication of frequencies.

Overall frequency for damages: 3.4 damages per 1000 km per year

4.1.3.3 Comparisons

Table summaries frequencies for various levels of events associated with loss of containment or potential loss of containment drawn from the previous sections. The gaps in the table are where data was not available from those sources.

Benchmark	Near Miss, Coating &/or metal damage per 1000 km per year	Escapes per 1000 km per year	Damages per 1000 km per year	Overall Incidents per 1000 km per year
Victoria - 2008	0.00	0.00	0.00	0.00
Victoria - 2007	0.65	0.33	0.00	0.98
Victoria – 2001/2002	0.00	0.33	0.33/0.66	
Victoria - 2000	8.5	0.33	0.33	
Victoria – 1991/2000	4.1			
POG – Australia & NZ - 2007				0.41
POG – Australia & NZ – 1965 -93		0.3	0.2	
EGIG - 2007				0.11
EGIG – 1970-2007				0.37
EGIG – 1970-2004				0.40
EGIG – 2003-2007				0.14
GRI - 1995			3.40	

Table 9: Benchmark loss of containment – transmission system

Damages per 1000 kms year is very low in Victoria compared with the survey carried by GRI in 1995.

The main difficulty in comparing these statistics is that the km year of exposure is considerably larger in the USA and Europe than in Victoria. The quality and risk profiles differs to that in Victoria natural gas transmission network, influenced by parameters such as age, standards employed, management practices, population densities, etc.

The key focus therefore is to examine events overseas to see if there are any lessons that can be learnt to ensure similar incidents are avoided. Such an example has been the recommendation by OPS to direct pipeline operators to ascertain the integrity of the pipeline through a program utilising intelligent pigging. In Victoria, GasNet has developed and implemented an integrity assessment program for its pipelines using intelligent pigging.

4.1.4 Benchmark Triggers

Establishing triggers on the basis of death, injury or significant property damage for the transmission system is inappropriate. Every such event is treated as an incident requiring investigation by the ESV.

ESV Recommendation:
Since a third party activity constitutes the majority of the incidents in Victoria, an appropriate trigger would need to be based on changes in third party activities near or on the pipeline. Based on Table 9 an appropriate trigger should be based on the number of near misses and coating and/or metal damage. Such a trigger would monitor the performance of the preventative measures used by the pipeline operators, for example, patrolling, and require explanations to the ESV as to why such events have gone above the trigger point level.

Trigger: 4 near misses/coating and/or metal damage per 1000 kms per year

4.1.5 Assessment – Transmission

The zero frequencies in Victoria for deaths, serious injuries and property damage resulting from a loss of containment indicates the integrity of the transmission system and the associated operations and maintenance practices employed by the transmission businesses.

ESV acknowledges that monitoring third party activities is only one part of an overall strategy to ensure the integrity of the transmission system. The ongoing improvement regime for managing overall risks that underpins the Safety Case through the application of asset integrity management principles is seen as the principal driver for safety.

4.2 Distribution – Loss of Containment

The following section analyses information associated with loss of containment for the distribution system in Victoria and endeavours to compare appropriate benchmarks from within Australia and overseas.

In Victoria, we have been fortunate in recent times to avoid serious consequences of escapes, incidents involving deaths, serious injuries or property damage. Unlike the transmission system, escapes on the distribution system are high frequency events. These events, however, generally involve significantly smaller gas releases. As such, the management involves a range of reactive and proactive strategies to minimise the risk associated with escapes. The analysis of events is broken into two parts, analysis of escapes and analysis of events associated with damages. The nature of the analysis differs from that used for the transmission system due to the considerable amount of data available and the risks associated with them.

The analysis is based on information received by the ESV after its inception in 1997. Further historical information has been included in order to provide context and uncover any trends or issues.

4.2.1 Escapes

Escapes in the distribution system are detected through two main processes, those identified as a result of public reported escapes (reactive) and regular leakage surveys (proactive) prior to 2003. From 2003 onwards, data for escapes in the distribution system are only reported based on results from the regular leakage surveys.

4.2.1.1 Public Reported Escapes 1999-2002

An important part of the distribution business' maintenance strategies is the reactive strategy of responding to escapes reported by the public. The number of public reported escapes is impacted by the following parameters:

- level of odourant
- frequency of leakage survey activities (how long the escape has gone undetected)
- effectiveness of leakage survey
- effectiveness of the renewal strategies
- rate of deterioration of the assets
- physical characteristics of assets (e.g. pipe material)
- construction quality (e.g. bedding material)
- seasonal conditions
- pressure in the network
- ground conditions
- location of escape
- location of asset (proximity to buildings)
- population density.

In Victoria, when a public report is classed as a serious escape, the distribution business are obliged to ensure that a qualified representative attends the report within one hour. This is in order to ascertain the risks associated with the escape and instigate appropriate actions to protect the public from any danger posed by this risk.

The analysis below is broken up into three parts, assessing the current situation, consequences and historical trends.

4.2.1.1.1 Distribution Comparisons for 1999 and 2002

Public reported escapes per 1000 customers per year have been used as a key performance indictor (KPI) for reviewing the medium to long term gas safety performance. This is a general indictor of the risks to the public and has been used, with some reservation, to benchmark against other distribution systems. The parameters affecting the level of public reported escapes are stated above and these need to be understood.

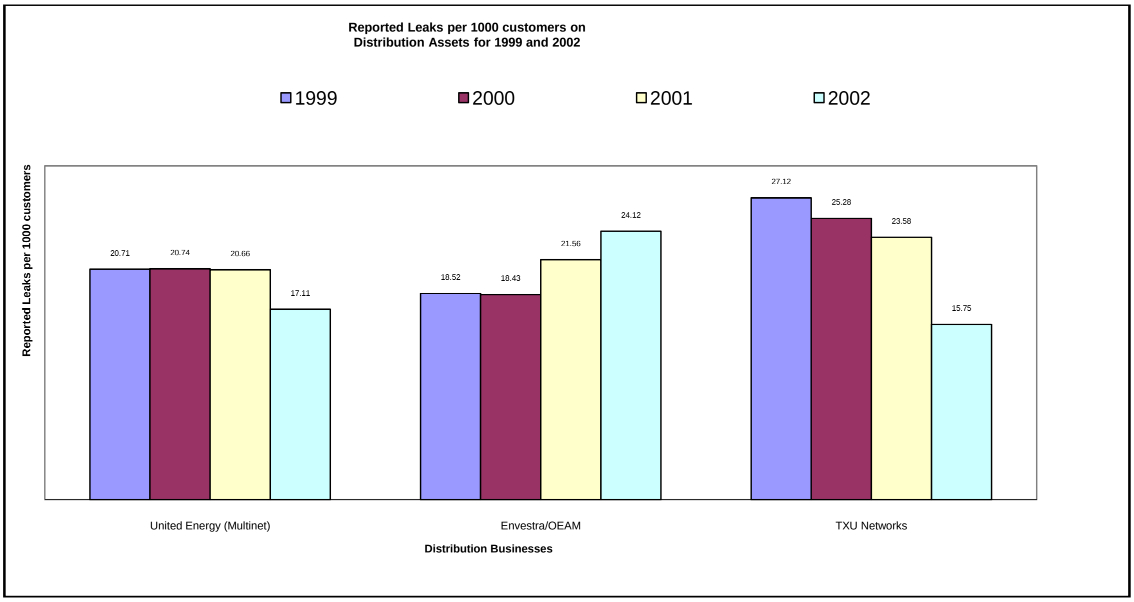
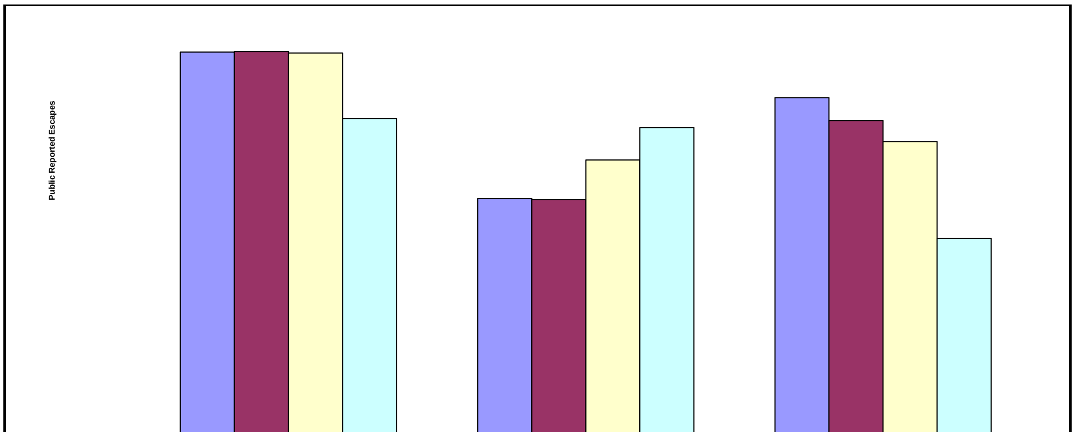


Figure 8: Public Reported Escapes per 1000 customers on Distribution Assets for 1999-200



	United Energy (Multinet)	Envestra/OEAM	TXU Networks
1999	12447	7667	10956
2000	12465	7630	10213
2001	12417	8926	9526
2002	10283	9986	6363

Figure 9: Total Number of Public Reported Escapes for 1999-2002

This averages 31,750 public reported escapes in year over 51000 kilometres of mains and services in Victoria.

Frequencies for public reported escapes: 620 public reported escapes per 1000 kms per year (mains & services)

4.2.1.1.2 Impact of public reported gas escapes

ESV obtains detailed information on incidents that are designated Level 2 (refer to Appendix 1: Incident levels for definitions). Table represents the incidents that are Level 2 or higher. These constitute 0.2% of public reported escapes.

The primary impacts relate to community disruption in the form of evacuations, major traffic diversions and loss of supply to 10 or more customers. It should be noted that there has been no incidents resulting in deaths, injuries or property damage. Level 2 incidents generally involve police and fire authorities where evacuations or traffic diversions occur.

2000

	Evacuations	Traffic Diversion	Loss of Supply (>10)	Other	Total
Envestra/OEAM	2	3	12	5	22
TXU Networks	6	2	9	3	20
United Energy	4	0	12	4	20
Total	12	5	33	12	62

2001-2003

	Injury	Evacuations	Traffic Diversion	Outage	Other	Total
Envestra/OEAM	0	2	5	18	8	33
TXU Networks	2	4	4	21	9	40
United Energy	3	2	2	16	13	36
Total	5	8	11	55	30	109

2004-2006

	Injury	Evacuations	Traffic Diversion	Outage	Property Damage	Others	Total
Envestra	0	0	0	6	0	0	6
SP AusNet	1	1	0	5	0	0	7
Multinet	0	2	0	2	0	0	4
Total	1	3	0	13	0	0	17

2007-2008

	Injury	Evacuations	Traffic Diversion	Outage	Property Damage	Others	Total
Envestra	0	1	0	3	0	0	4
SP AusNet	1	0	1	1	0	1	4
Multinet	0	2	0	5	0	0	7
Total	1	3	1	9	0	1	15

Table 10: Primary Impact of Level 2 Public Reported Escapes for Year 2000-2008

4.2.1.2 Leakage Survey

Leakage survey is a key pro-active maintenance strategy employed by the distribution businesses to manage leakage and determine condition of the gas distribution network. It is currently risk based with high consequence locations being surveyed more frequently. For example, leakage survey is undertaken half yearly and yearly rather than in 4 or 5 yearly cycles in these locations. The duration of escapes (time leaking) is dependent on the frequency of leakage survey and the repair schedule. It impacts directly on the amount of escapes that are reported by the public. Distribution businesses are reviewing the leakage survey cycles and are considering a condition based approach to improve the effectiveness of the pro-active maintenance strategy by reducing the duration of the escape and hence its effect on the public.

In addition, renewal strategies improve the condition of the gas distribution network and directly affect the number of escapes that form (refer 1.1.1.1) impacting on both escapes detected by leakage survey and the level of public reported escapes.

4.2.1.2.1 Distribution Comparisons for 1999 and 2002

Figure 80: Leakage Survey - Detected Escapes per Km (moving average) for Distribution Assets for 1999 and 2002" represents the number of leaks detected through leakage survey by the kilometres surveyed and averaged over 4 years. These figures include kilometres surveyed on half yearly, yearly and four yearly cycles. As such, the kilometres surveyed is considerably more than kilometres of mains actually in the ground, and the kilometres surveyed varies between distribution business based on the risk profiles used to develop survey cycles.

Also, because these are a four-year rolling average, one needs to collect data over a longer period of time (at least 10 years) to determine the effectiveness of renewal and maintenance strategies (knowing that infrastructure assets have a considerable latency period). Emphasis should be placed on appropriate categorisation of assets to establish the characteristics of classes of assets or problematic areas.

There have been changes in leakage survey frequencies (from a 4-year to a 5-year cycle) by some distributors in line with changes to specified minimum frequencies in national industry standards. This has resulted in inconsistencies in these KPIs.

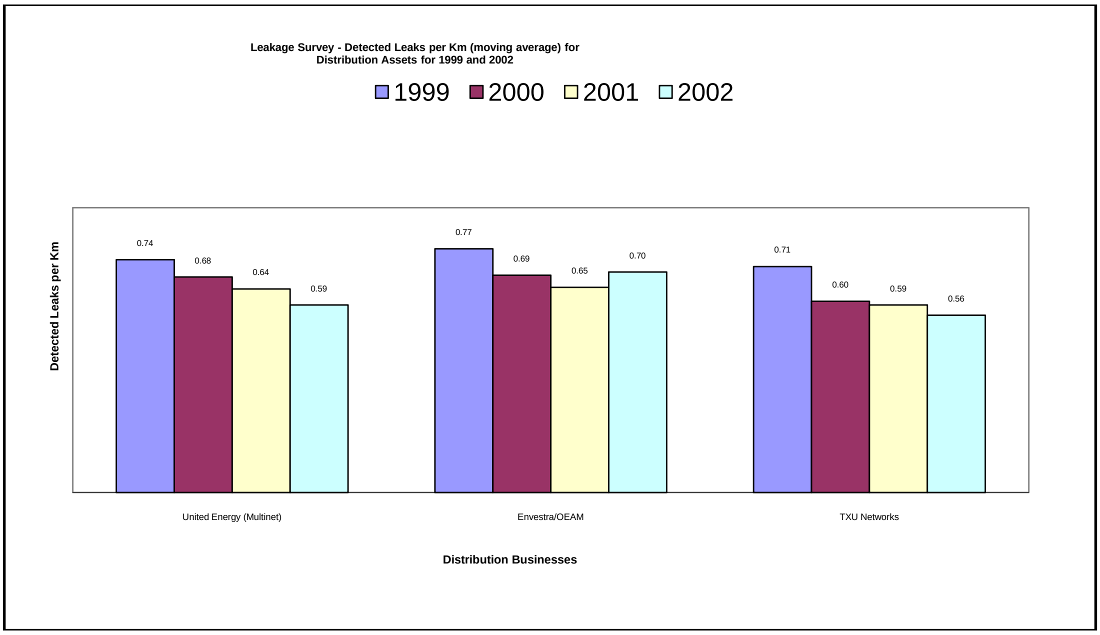


Figure 80: Leakage Survey - Detected Escapes per Km (moving average) for Distribution Assets for 1999 and 2002

4.2.1.2.2 Envestra/OEAM Historical Escapes Detected 1996 - 2008

Figure & 12 represents the number of escapes detected since 1996 in the Envestra/OEAM licensed areas. The variation is dependent on the areas being surveyed, the periods of surveys and the condition of those assets that are being surveyed. This differs between distribution businesses. The average of 150 detected escapes per month for Envestra/OEAM establishes a baseline indicator for their area in the period of 1996-2001 and an average of 134 escapes per month between 2003-2008.

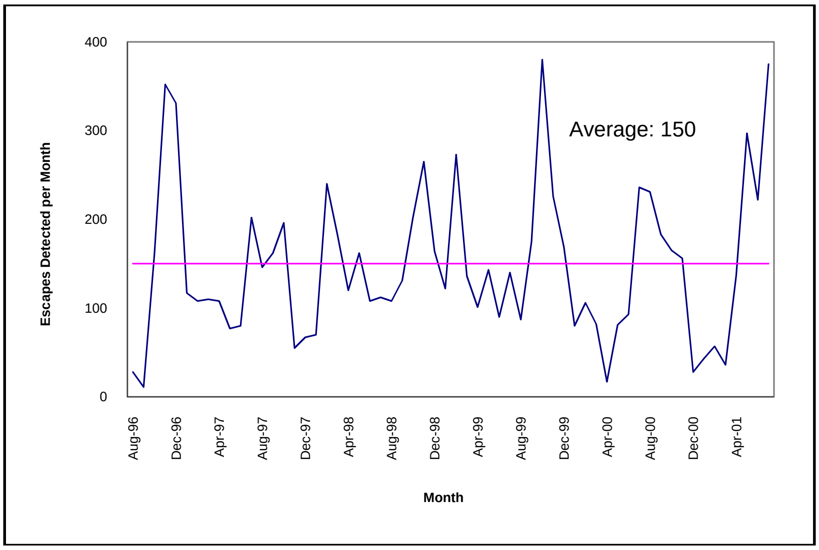


Figure 11: Escapes Detected per Month – Envestra/OEAM (1996-2001)

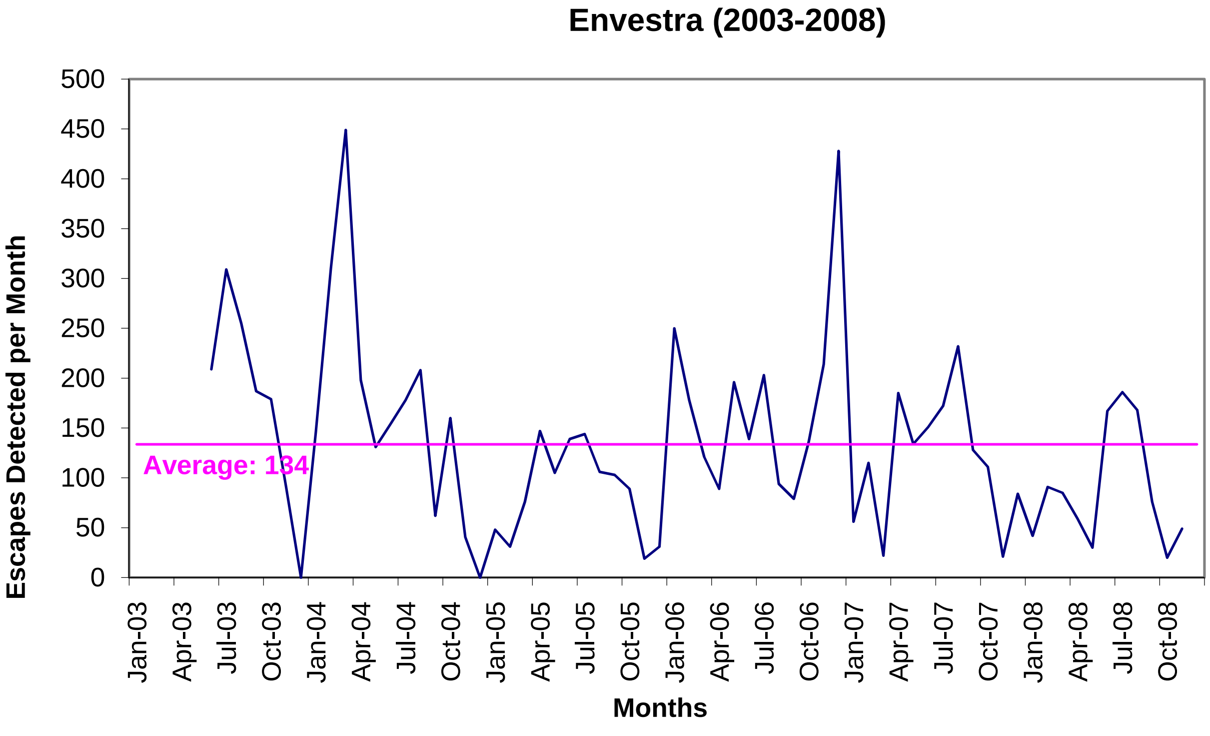


Figure 12: Escapes Detected per Month – Envestra/OEAM (2003-2008)

4.2.1.2.3 United Energy (Multinet) Historical Escapes Detected 1997 - 2008

Figure 1 represents the number of escapes detected since 1988 in the United Energy (Multinet) licensed areas. United Energy was able to provide data back to 1988. The average is 280 detected escapes per month for United Energy (Multinet) when averaging the data in the period of 1998 – 2001. Figure represents the number of escapes detected since 1997 and an average over the period of 150 detected escapes per month establishes a baseline indicator for their area. The improvement in the figures may be a lag effect from the renewal program of the early nineties. Figure 15 represents the number of escapes detected between 2003 – 2007, with an average of 122. This average could only be treated as an indication and cannot truly reflect the real average for this period as there are data missing for 10 months in 2006.

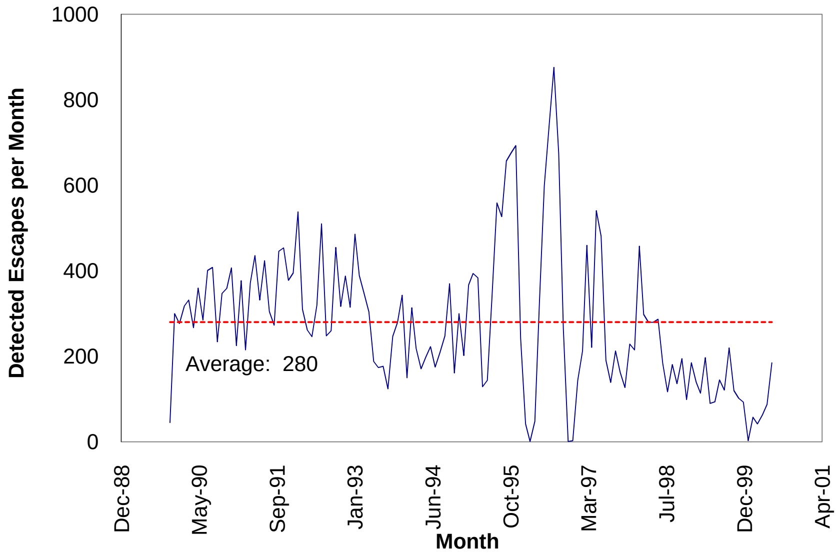


Figure 13: Detected Escapes per Month for United Energy from 1988 to 2001

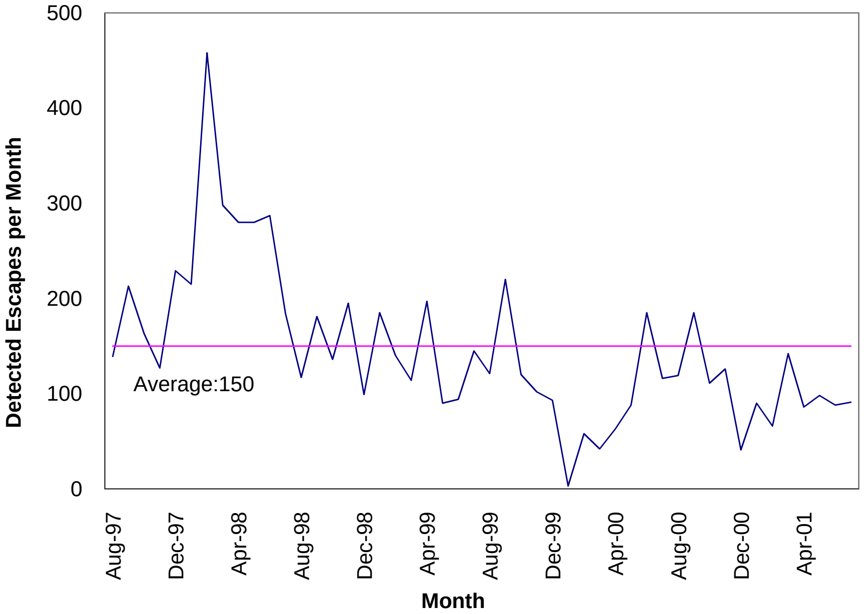


Figure 14: Detected Escapes per Month for United Energy from 1997 to 2001

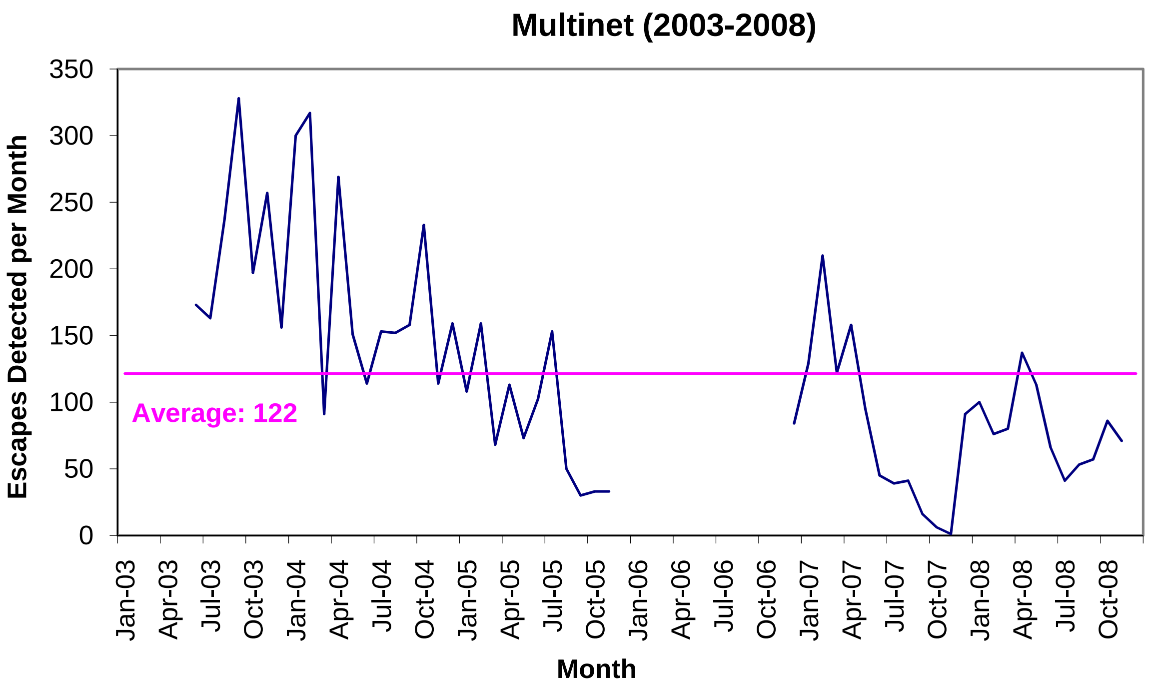


Figure 15: Detected Escapes per Month for United Energy from 2003 to 2008

4.2.1.2.4 TXU (SP AusNet) Networks Historical Escapes Detected 1995 – 2008

Figure & 17 represents the number of escapes detected between 1995-2007. The average over the period in 1995-2001 is 150 detected escapes per month and establishes a baseline indicator for this area and an average of 93 detected escapes per month in period between 2003-2008.

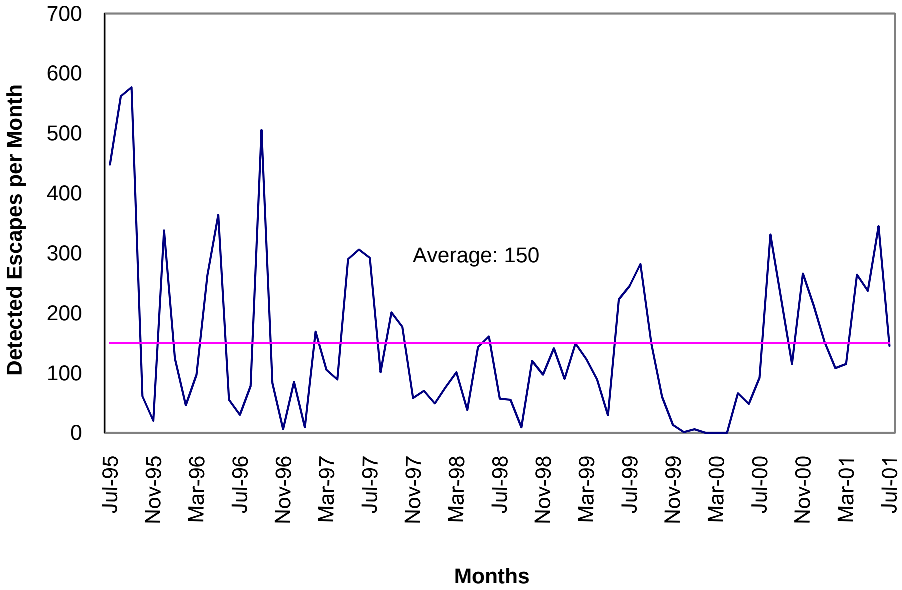


Figure 16: Detected Escapes per Month from 1995 to 2001 TXU Networks

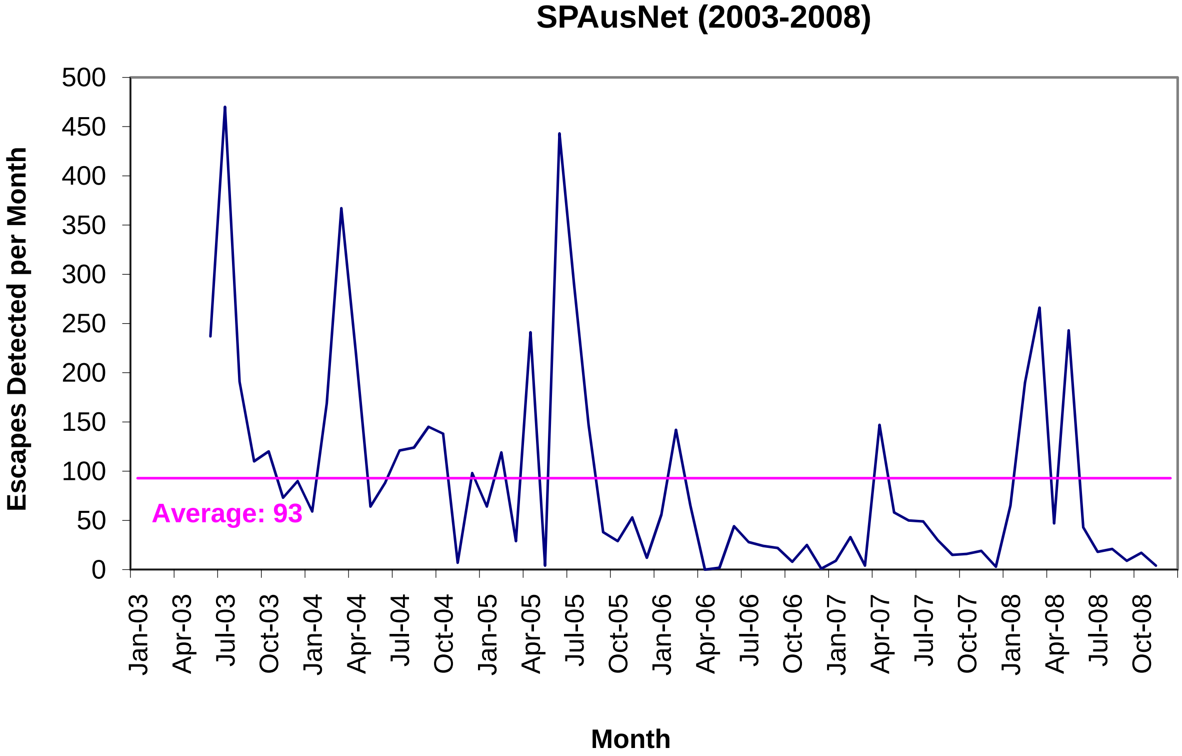


Figure 9: Detected Escapes per Month from 2003 to 2008 SPAusNet Networks

4.2.1.3 Gas & Fuel Corporation Benchmark Data (all escapes)

Gas and Fuel Corporation in 1993 determined the escape rates of pipe materials for low pressure and compared them with high pressure as shown in Table . This highlights that there are significant variations in leakage rates between different classes of mains.

Pressure	Material	Escapes/km/year	Ratio wrt Polyethylene
Low	Cast-iron	2.01	27
Low	Unprotected Steel	0.86	12
Low	Protected Steel	0.68	9
Low	PVC	0.46	6
LOW	**ALL**	1.44	20
High	Polyethylene	0.07	1
High	Protected Steel	0.12	1.6
HIGH	**ALL**	0.09	1.3

Table 11: Comparison of escape repairs per km per year

(Source: G&FC, “Strategic Analysis for the Replacement of the Low Pressure System”, 1993)

Further analysis undertaken by the Gas and Fuel Corporation in 1996 determined escape rates for polyethylene by diameter and year laid as shown in Table .

Pressure	Diameter & Material	Escapes/km/year Laid 1972-1974	Escapes/km/year Laid 1975-1992	Escapes/km/year Laid 1992-1994
High	50 Polyethylene	1.14	0.06	0.04
High	40 Polyethylene	-	0.03	0.04
Medium	50 Polyethylene	0.54	0.11	0.23

Table 12: Escapes rates for the polyethylene mains of certain diameter and pressure laid from 1972 - 1994

(Source: G&FC, "Forecasting Maintenance on Distribution Mains, Part 1", 1996)

This table above highlights several issues:

- standard of polyethylene mains laid in 1972-1974 reflected about 100 km of thin walled polyethylene laid prior to when the Gas and Fuel Corporation took over from Colonial Gas. These areas included Melton, St. Albans, Glen Waverley and Vermont South.
- Regression analysis showed that for mains laid between 1975 and 1992 showed negligible relationship between escapes and age of pipe. The escapes/km/year was constant during 1977 to 1992.
- There is a higher leakage rate during the earliest years of the pipe and construction quality problems are presumed to be the main cause (this needs to be substantiated).

This type of analysis suggests that an average escape rate of 0.03 average escapes/km/year for polyethylene is an appropriate benchmark escape rate.

Further analysis undertaken by the Gas and Fuel Corporation in 1996 determined escape rates for high and medium pressure steel by year laid as shown in Table .

Pressure	Material	Av. Escapes/km/year Laid 1910-1963	Av. Escapes/km/year Laid 1964-1974	Av. Escapes/km/year Laid 1975-1994
High	Steel	0.27	0.13	0.04
Pressure	**Material**	**Escapes/km/year Laid 1910-1969**		**Av. Escapes/km/year Laid 1970-1994**
Medium	Steel	0.59		0.21

Table 13: Escapes rates for the steel mains by pressure laid from 1910 - 1994

(Source: G&FC, "Forecasting Maintenance on Distribution Mains, Part 2", 1996)

The difference escape rates relate to the standard used to purchase and lay steel mains, and the introduction of cathodic protection in 1970. This type of analysis suggests that a average escape rate of 0.04 average escapes/km/year for cathodically protected steel mains is an appropriate benchmark escape rate.

The Boston Consulting Group in 1995 (Source: "Gas & Fuel Low Pressure to High Pressure Upgrade Review", 1995) reported that there was no demonstrable relationship found between main age and leakage for steel, PVC or polyethylene.

However, they have reported that there was a weak relationship between cast iron age and leakage. This is because the analysis was focused on assessing the immediate cause to the failure. That is, wall thickness, soil conditions, ground movement (prolonged dry weather), ground water, depth of cover, traffic loading, disturbance, etc. Failure rate of cast-iron mains generally involves a complex set of causes and effects. Age is a factor but only becomes apparent when other factors occur. For example, a long dry period that results in ground movement, effecting thinner walled cast iron mains resulting from slow corrosion.

4.2.1.4 Summary

Though the number of leaks detected per month in leakage survey had shown to be decreasing in the recent years, there are no direct comparison or relationship between each of the distribution companies in the results from the leakage surveys as each companies has its own methodologies/philosophies in conducting their leakage surveys.

Furthermore, the public reported escapes are no longer part of the ESV's KPI requirement as of 2003.

4.2.2 Damage

Damages to the distribution systems constitute one of the main risks to the public as it can result in large loss of containment. This section examines damages by examining events during the reporting period 1999 and 2000, reviewing these events in the context of the May 1999 survey and historical trends.

4.2.2.1 Periods 1999 and 2000

OGS obtains information from the distribution businesses in the form of KPIs on all damages and detailed information on incidents that are designated Level 2 or higher (refer to Appendix 1: Incident levels for definitions). Table below provides this information on damages for the periods 1999 and 2000 for mains and services, separately and in aggregated form.

Aggregate No. of Damages per Distribution Business	1999			2000		
	All	> Level 2	% Level 2	All	> Level 2	% Level 2
United Energy	1440	4	0.3%	673	11	1.6%
Envestra/OEAM	1309	8	0.6%	1300	13	1.0%
TXU Networks	1296	19	1.5%	1019	12	1.3%
Distribution Businesses	**4045**	**31**	**0.8%**	**2992**	**36**	**1.2%**
Exposure rate per 1000 km*	**77**			**57**		

*Includes total kilometres of mains and services

No. of Damages for Mains Assets	1999			2000		
	All	> Level 2	% Level 2	All	> Level 2	% Level 2
United Energy	85	3	3.5%	146	7	4.8%
Envestra/OEAM	122	6	4.9%	130	10	7.7%
TXU Networks	108	15	13.9%	86	8	9.3%
Distribution Businesses	**315**	**24**	**7.6%**	**362**	**25**	**6.9%**
Exposure rate per 1000 km	**12**			**15**		

No. of Damages for Services	1999			2000		
	All	> Level 2	% Level 2	All	> Level 2	% Level 2
United Energy	1355	1	0.1%	527	4	0.8%
Envestra/OEAM	1187	2	0.2%	1170	3	0.3%
TXU Networks	1188	4	0.3%	933	4	0.4%
Distribution Businesses	**3730**	**7**	**0.2%**	**2630**	**11**	**0.4%**
Exposure rate per 1000 km	**133**			**94**		

Table 14: Damages reported by the Distribution Business for 1999 and 2000

For mains, the likelihood of a damage to escalate to a Level 2 incident or higher varies but averages around 7 to 7.5%. This varies from year to year and between distribution businesses. Reporting to OGS is affected by the distribution business's interpretation of the incident level definitions. TXU Networks report currently the most Level 2 incidents.

For services however, the likelihood of a damage to escalate to Level 2 or higher varies across all distribution businesses, averaging between 0.2% and 0.4%.

To gain further insight to the events leading to Level 2 incidents, please go to section 0.

The differences between mains and services are not surprising as mains are much more difficult to isolate the escape (due the size and type of material) and the volume of gas escaping resulting from the damage. In most instances where services are damaged, the service will be made out of polyethylene and bending the service back or crimping the service can restrict the volume of gas escaping.

In Figure 10 and Figure 11, both Origin and TXU Networks appear to be have similar characteristics of overall mains and services damages. United Energy on average has the same proportion over the two years but had an increase in mains damages from 1999 to 2000. It has been suggested that the increase in damages was due to a increased in building activities emanating from the introduction of the Goods and Services Tax (GST).

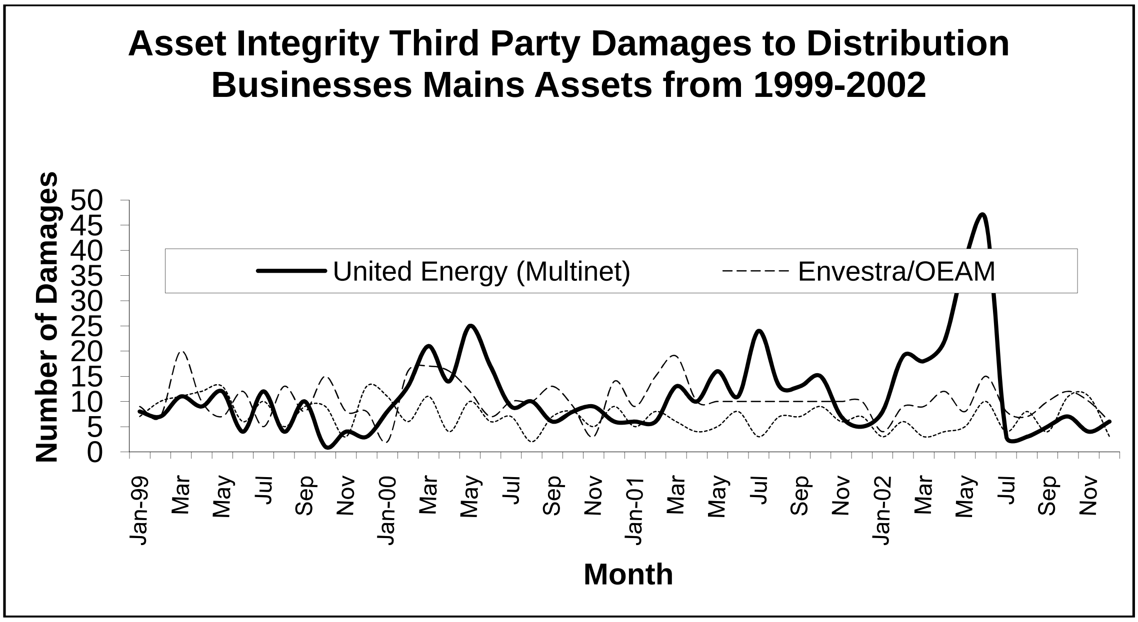


Figure 10: Third Party Damages to Distribution Businesses Mains Assets in 1999 & 2002

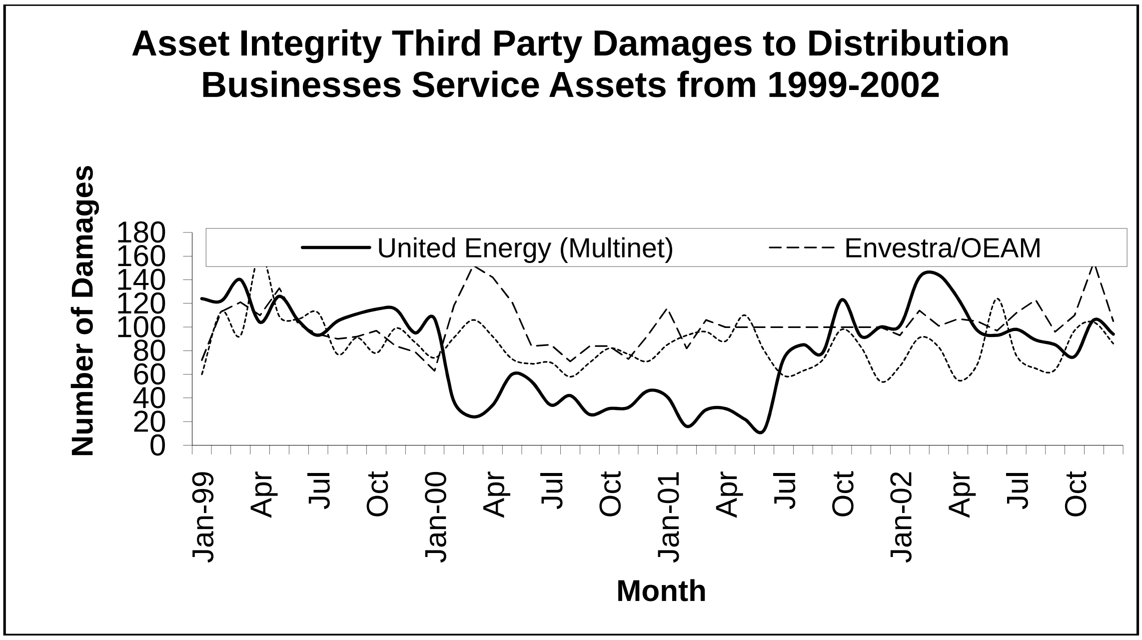


Figure 11: Third Party Damages to Distribution Businesses Service Assets for 1999 & 2002

4.2.2.2 Period 2003 – 2008

The KPIs provided by the distribution businesses had changed from 2003 and the information extracted from the new KPI format differs slightly in comparison to the previous version. Table 15 illustrates the damages for the periods 2003-2008 for mains and services.

Aggregate number of damages per distribution business in 2003-2008:

	2003			2004			2005		
	All	> Level 2	% > Level 2	All	> Level 2	% > Level 2	All	> Level 2	% > Level 2
Multinet	1319	12	0.9%	1292	6	0.5%	1394	19	1.4%
Envestra	1538	5	0.3%	1439	41	2.8%	1210	72	6.0%
SPAusNet	1335	2	0.1%	1140	1	0.1%	1153	1	0.1%
Total	4193	19	0.5%	3871	48	1.2%	3757	92	2.4%

	2006			2007			2008		
	All	> Level 2	% > Level 2	All	> Level 2	% > Level 2	All	> Level 2	% > Level 2
Multinet	1397	15	1.1%	1536	19	1.2%	1279	22	1.7%
Envestra	1063	74	7.0%	1036	64	6.2%	1127	64	5.7%
SPAusNet	1162	6	0.5%	1217	7	0.6%	1417	13	0.9%
Total	3622	95	2.6%	3789	90	2.4%	3823	99	2.6%

Aggregate number of damaged mains per distribution business in 2003-2008:

	2003			2004			2005		
	All	Main	% Main	All	Main	% Main	All	Main	% Main
Multinet	1319	79	6.0%	1292	78	6.0%	1394	66	4.7%
Envestra	1538	126	8.2%	1439	120	8.3%	1210	94	7.8%
SPAusNet	1335	108	8.1%	1140	294	25.8%	1153	96	8.3%
Total	4193	313	7.5%	3871	492	12.7%	3757	256	6.8%

	2006			2007			2008		
	All	Main	% Main	All	Main	% Main	All	Main	% Main
Multinet	1397	91	6.5%	1536	78	5.1%	1279	133	10.4%
Envestra	1063	107	10.1%	1036	94	9.1%	1127	39	3.5%
SPAusNet	1162	81	7.0%	1217	95	7.8%	1417	103	7.3%
Total	3622	279	7.7%	3789	267	7.0%	3823	275	7.2%

Aggregate number of damaged services per distribution business in 2003-2008:

	2003			2004			2005		
	All	Services	% Services	All	Services	% Services	All	Services	% Services
Multinet	1319	1240	94.0%	1292	1214	94.0%	1394	1328	95.3%
Envestra	1538	1412	91.8%	1439	1319	91.7%	1210	1116	92.2%
SPAusNet	1335	1227	91.9%	1140	846	74.2%	1153	1057	91.7%
Total	4193	3879	92.5%	3871	3379	87.3%	3757	3501	93.2%

	2006			2007			2008		
	All	Services	% Services	All	Services	% Services	All	Services	% Services
Multinet	1397	1306	93.5%	1536	1458	94.9%	1279	994	77.7%
Envestra	1063	956	89.9%	1036	942	90.9%	1127	1240	110.0%
SPAusNet	1162	1081	93.0%	1217	1112	91.4%	1417	1314	92.7%
Total	3622	3343	92.3%	3789	3512	92.7%	3823	3548	92.8%

Table 15: Damages reported by the Distribution Business for 2003 – 2008

4.2.2.3 March 1999 Survey Results

A survey was sent out in March 1999 to all distribution businesses to determine what factors contribute to damages of mains and services in order to develop appropriate strategies to minimise the likelihood of damage. The current KPI reporting by the distribution businesses does not provide detailed information about the events leading to a damage.

Mains damages were surveyed to examine whether the location of the mains had been determined prior to excavation. This generally involves contacting the Dial Before You Dig (DBYD) Service. The survey recorded whether this DBYD service was used, and if it was used, why the main was damaged.

Service damages were surveyed to examine whether services laid to "standard" practices or "non-standard" practices had any impact on frequency of damages. The variables used in this survey were alignment and cover. Standard alignment is a direct route from the meter to the main. Standard cover is where the covers are greater than 250 mm.

The survey also collected physical attributes of the mains and services (included material, diameter and pressure) and how they were damaged (identifying evacuation equipment).

The March 1999 survey results are shown in Table 16. The sample size involved 261 damages of the 396 reported for the month of March. The March-May period is found to have the highest level of damages of the year for 1999 and 2000 (refer to Figure 10and Figure 11).

Damage	**Mains**	**9%**
	Services	**91%**
Mains Damage	**DBYD**	**15%**
	No DBYD	**85%**
Service Damage	**Standard to**	**76%**
	Non-standard	**24%**

Table 16: Third Party Damage Survey Results from March 1999 from all Distribution Businesses

Survey highlights that 9 % of all damages were mains and 91% were services. This is similar to that for all of 1999 and 2000, where mains damages ranged from 8% to 12% respectively.

The percentage from this survey of mains damages resulted after a DBYD inquiry is 15% of all damages and 85% of all mains damages have resulted when no DBYD inquiry was made. In the cases where DBYD enquires were made, the damages resulted from instances such as distribution assets not shown on District Plan, incorrect interpretation of District Plans, or the third party carrying out work in a different location to what was originally shown on the District Plans.

The effectiveness of the DBYD Service for distribution business requires information about the total number of enquires made through the DBYD system and the number of activities where no DBYD inquiry has been made. This information is not gathered at this stage.

The survey found 76% of services damaged were laid to standard practices. This implies that these services were damaged without due care being taken to avoid such a damage. In cases where care was taken, the service was damaged by a shovel or crowbar while locating the service, no charge was applied to those responsible for the damage.

OGS Proposal
To continue support for Dial Before You Dig Service, improve reporting of KPIs from distribution business and the Dial Before You Dig Service to ensure effectiveness of the service. Develop strategies with the distribution businesses to minimise damages to services.

4.2.2.4 Level 2 Incidents for Periods 1998 to 2000

In section 4.2.2.1, the main focus was on the total number of damages, highlighting that about 8% of mains damages and 0.3% of service damages lead to a Level 2 incident. Refer to Appendix 1: Incident levels for a definition of Level 2. More detailed data is collected for these types of incidents enabling a greater depth of analysis.

The following sections analyses Level 2 incidents reported to the OGS/ESV for damages associated with mains, services and meter/regulatory assemblies.

4.2.2.4.1 Mains Damage

During the period 1998 – 2008, 129 Level 2 damaged mains incidents were reported to OGS/ESV. There were no deaths or property damage recorded and only two minor injuries. Reporting of Level 2 mains incidents has increased since the collection of data in 1998 and may due to a combination of improved reporting by gas companies and possibly due to increase construction activity prior to the introduction of the GST.

Table below summaries the impact of Level 2 incidents where there has been mains damage over the reporting period, 1998 – 2008. 67% of these incidents resulted in loss of supply, 15% in evacuations and 17% in traffic diversions.

	1998	1999	2000	2003	2004	2005	2006	2007	2008	Total
Evacuation	2	1	0	1	2	2	0	1	0	9
Evacuation, Loss of Supply		1	2	0	0	0	0	0	0	3
Evacuation, Traffic Diversion	2	3	0	0	0	0	0	0	0	5
Evacuation, Traffic Diversion, Loss of Supply	1	0	1	0	0	0	0	0	0	2
Injury	0	0	1	0	1	0	1	0	0	3
Loss of Supply	5	14	18	12	12	0	1	9	2	73
Loss of Supply, Traffic Diversion	0	2	4	0	2	0	0	0	0	8
No impact	1	1	1	0	0	0	0	1	0	4
Traffic Diversion	1	2	1	2	0	0	0	1	0	7
Property Damage	0	0	0	0	0	1	0	0	0	1
Unknown	0	0	0	3	1	4	6	0	0	14
Total	**12**	**24**	**28**	**18**	**18**	**7**	**8**	**12**	**2**	**129**

Table 17: Impact of Level 2 mains damage incidents for the period 1998-2008.

4.2.2.4.2 Services

During the period 1998 – 2008, 68 Level 2 damaged service incidents were reported to OGS. There were no deaths or property damage recorded and there were four minor injuries. Reporting of Level 2 services incidents has increased since the collection of data in 1998 and may due to a combination of improved reporting by gas companies and possibly due to increase construction activity prior to the introduction of the GST.

Table 1 below summaries the impact of Level 2 incidents where there has been service damage over the reporting period, 1998 – 2008. 9% of these incidents resulted in loss of supply, 10% in evacuations and 3% in traffic diversions.

	1998	1999	2000	2003	2004	2005	2006	2007	2008	Total
Evacuation	0	1	1	1	1	2	1	1	1	9
Evacuation, Loss of Supply	0	0	1	0	0	0	0	0	1	2
Evacuation, Traffic Diversion	0	0	0	1	0	0	0	0	0	1
Evacuation, Traffic Diversion, Loss of Supply	0	0	1	0	0	0	0	0	0	1
Injury	0	2	1	1	1	2	2	0	1	10
Loss of Supply	0	0	6	1	0	1	0	0	1	9
Loss of Supply, Traffic Diversion	0	0	0	0	0	0	0	0	0	0
No impact	0	2	0	6	0	11	1	1	9	30
Traffic Diversion	1	1	0	0	0	0	0	0	0	2
Property Damage	0	0	0	3	0	0	0	0	0	3
Unknown	0	1	0	0	0	0	0	0	0	1
Total	**1**	**7**	**10**	**13**	**2**	**16**	**4**	**2**	**13**	**68**

Table 18: Impact of Level 2 service damage incidents for the period 1998-2008.

4.2.3 Assessment – Distribution

The zero frequencies in Victoria for deaths, serious injuries and property damage during the reporting period provides a level of confidence that the operational and maintenance strategies employed to date has led to a positive outcome. This does not necessarily imply that this is a reliable indicator of long term future frequencies because of the sensitivity of the frequency to changes when the total numbers of serious incidents are small.

Greater focus is needed to relate the frequency of damages and escapes to the changing risks imposed by the distribution networks through continual revisiting of the formal risk assessment and developing improved KPIs.

5 Loss of Supply

This section covers only the short-term issues associated with reliability of supply.

5.1 Transmission

5.1.1 Incidents 1998 - 2000

Table 2 lists the production and transmission events that resulted in or had the potential to result in supply losses between 1998 and 2000 reported to OGS.

System Element	Impact	1998	1999	2000	Total
*Gas Production **	*Loss of Supply*	*2*			*2*
	Reduced Supply		*4*		*4*
Compressor Station	No impact	1	1	1	3
City Gate	Reduced Supply		2		2
Transmission Pipeline	Reduced Supply	1			1
	Loss of Supply	1			1
Total		**5**	**7**	**1**	**13**

Table 2: Loss of Supply in Victoria between 1998 and 2000

Six incidents occurred at gas production facilities that either caused substantial loss of supply or the potential to cause substantial loss of supply in the Victorian gas network. OGS has no regulatory jurisdiction over gas production facilities, but is responsible for overseeing the safety consequences if such facilities fail to supply gas to the Victoria gas network.

Two such incidents occurred in 1998 at Esso's Longford facilities. The first incident was caused by hydrates forming a plug in the plant slug catchers and restricting supply to the production facilities. This resulted in implementation of the Market System Operating Rules associated with curtailment and affected several large customers. The second incident, an explosion at Esso's Longford facility in 1998, resulted in loss of supply for about 2 weeks at all 1.4 million customers in Victoria. OGS with the co-operation of the VenCorp (transmission system operator) and, transmission, distribution and retail businesses, and Department of Human Services worked together to ensure that the system was:

- able to supply gas safely to essential services
- monitored unauthorised use of gas
- support specific hardship cases
- safely managed when supply was back on.

Four incidents in 1999 were associated with unplanned plant shutdowns due to maintenance problems. These incidents resulted in short term effects on the supply of gas, but did not require the implementation of the Market System Operating Rules associated with curtailment.

Component and maintenance issues associated with compressor stations and city gates resulted in 5 incidents that had the potential to cause supply issues.

Two incidents associated with the transmission pipeline system resulted in supply problems. The incident that caused a loss of supply to Horsham resulted from a pipeline cleaning operation. The tool used for this operation (known as a "pig") became stuck and blocked the pipeline. The other incident that reduced supply where dust had accumulated in the filters of a regulator supplied from the transmission pipeline.

5.1.2 Benchmarks

In both Europe and the USA, loss of supply is less of an issue, as their transmission systems are highly interconnected which offsets any impacts in relation to loss of supply and customers routinely have dual fuel (e.g. oil/gas) systems. This differs in Australia where there is much less interconnectedness and flexibility in fuel use.

5.1.3 Benchmark Triggers

No benchmark triggers have been set in this area. The focus has been on ensuring appropriate safety management systems (asset integrity management) are in place and are regularly audited as part of the ongoing improvement process underlying the safety case regime.

5.1.4 Assessment – Transmission

There has been only one loss of supply due to events associated with the transmission system. This result can be attributed to Victoria’s commitment to ensuring that the transmission system is appropriately designed and managed to avoid the risk associated with any event that may cause an interruption to supply in a gas system which until recently had only one injection point.

The other losses of supply were significant but resulted from events associated with gas production facilities and associated feeder lines.

5.2 Distribution

5.2.1 Distribution Comparsions

Loss of supply to end use customers is both a safety and customer service issue. From 2003 onwards, information in regards to the loss of supply to end use customers are captured as part of the quarterly KPI reports submitted by the gas distribution companies. The information is intended to be used in monitoring the extent and nature of supply interruptions. The information only relates to outage attributable to events in gas supply system and not loss of supply attributable to faults in customers' installations downstream of the outlet of a gas company's billing meter.

	2003				2004			
	Envestra	Multinet	SPAusNet	Total	Envestra	Multinet	SPAusNet	Total
Loss of supply affecting < 5 customers	3,861	4,163	3,991	12,015	5,712	4,858	8,677	19,247
Loss of supply affecting > 5 customers	15	37	31	83	8	30	25	63
Loss of supply affecting > 100 customers				1				3
Loss of supply affecting > 1000 customers				0				0
Average minute off supply per customer (SAIDI)	247	240	167		117	249	56	

	2005				2006			
	Envestra	Multinet	SPAusNet	Total	Envestra	Multinet	SPAusNet	Total
Loss of supply affecting < 5 customers	4,944	5,684	8,049	18,677	2,908	4,915	9,474	17,297
Loss of supply affecting > 5 customers	6	26	22	54	13	34	24	71
Loss of supply affecting > 100 customers				1				3
Loss of supply affecting > 1000 customers				0				0
Average minute off supply per customer (SAIDI)	55	258	45		61	203	44	

	2007				2008			
	Envestra	Multinet	SPAusNet	Total	Envestra	Multinet	SPAusNet	Total
Loss of supply affecting < 5 customers	3,242	6,310	9,888	19,440	3,326	4,332	9,486	17,144
Loss of supply affecting > 5 customers	25	21	29	75	14	16	22	52
Loss of supply affecting > 100 customers				1				0
Loss of supply affecting > 1000 customers				0				0
Average minute off supply per customer (SAIDI)	181	197	40		235	207	45	

Table 20: Loss of supply by number of customers affected for 2003-2008 for each distribution business.

5.2.2 Assessment – Distribution

Loss of supply where more than 5 customers are effected result mainly from two types of causes, third party damage and from water entering gas mains and services.

In the first case, the issue of damages is discussed in Section 4.1.2. The number of customers affected mainly depends on the configuration of the distribution network where the damage occurred.

Issues associated with water entering gas mains and services is associated with the condition of network, pressure in the mains, weather, location of mains, etc. and requires a combination of short and long term strategies to manage this risk. Each gas distribution business is currently developing asset management plans that will describe the strategies adopted for addressing these issues in the long term. In the short term, each gas business under its safety case have operational strategies to minimise the impact of such incidents.

There were two major gas supply outages in the distribution network in 2005 and 2007 where there was loss of gas supply to a large number of customers. In both events, the outages were mainly due to gas constraints in the Transmission system where the actual gas demand was much higher (due to severe cold weather) than the scheduled.

In the 2005 event, the gas supply interruption happened on 10th August 2005, where the actual peak gas demand was 1,210TJ with the scheduled system demand of 1,140TJ. A total of 29 networks with738 Customers (68% in HP) been affected were affected over state, where loss of supply have been reported in 65+% of the cases.

In the 2007 event, the gas supply interruption happened between 17th and 19th July 2007, where the peak gas demand in the PTS occurred on the 17th July with 1,278TJ (which is 4% higher than a 1 in 20 demand day). The high gas demand was due to severe weather of heavy rainfall and low temperature. The transmission network had operated without any curtailments to the transmission customers but at one occasion where there were a pressure breached in the system. However, the high and low pressure network in the distribution system had been affected with the loss of supply to a large number of customers in different suburbs across the state. The loss of supply was mainly due to demand exceeding network capacity in fringe areas in the distribution network. Water ingression in the network was also a factor that had contributed to the loss of supply in this event.

6 Conclusion

The zero frequencies in Victoria for deaths and property damage for the periods 1999 to 2008 provides an indication that the level of risks associated with the upstream natural gas infrastructure (transmission and distribution networks) have been maintained at a level acceptable to the community.

Assessing the sustainability of the frequencies requires a better understanding of the historical and future gas safety related performance, and the underlying factors that could affect these rates. This report has gathered historical data and overseas comparative data wherever possible to establish triggers that provide baseline gas safety indicators for assessing future gas safety related performances and instigating gas safety reviews.

For the transmission networks, the adoption of asset integrity management (compliance with AS2885.3) provides a platform for ensuring sustainability of gas safety related performances.

For the distribution networks, the development of asset management plans and a more meaningful set of KPIs (used in conjunction with the Essential Services Commission) provided assurance that the gas safety related performances are sustainable. A key element of the safety case regime in Victoria is the development of Asset Management Plans that sees the integration of risk and asset management strategies.

Appendix 1: Incident levels

Level Definitions	Examples
Level 1 This is an incident, which can be dealt with by a single gas company's site resources without any additional assistance. There is no adverse publicity, injury, environmental impacts, or involvement of the Emergency Services beyond routine response and there are no customer impacts.	Low level customer impacts affecting single or small number of non-sensitive customers (less than 5). Gas Quality excursions requiring notification but no action. These are generally reported to OGS as statistical summaries.
Level 2 This is an incident, which involves the potential for adverse publicity, may have environmental impacts, results in minor loss of supply, and may have minor business continuity or information technology impacts.	Generally loss of supply to more than 5 customers but also chronic single outages or a significant industrial or commercial customer, evacuations, media attendance, minor injury or property damage, significant traffic diversions. Gas Quality excursions requiring action. Incidents of Level 2 and above are reported to OGS as soon as practicable after they occur.
Level 3 This is an incident which involves the potential for adverse publicity, could involve substantial risk of serious injury or death, may have serious environmental impacts, result in serious loss of supply, may have serious business continuity or information technology impacts.	Generally loss of supply to between 100 and 1000 customers, fires or explosions resulting in serious injury, death or major property damage.
Level 4 This is an incident, which has escalated to the extent that the impacts of the incident are beyond a single Distributor or Transmission Company. The overall system safety and integrity is not in jeopardy but the impacts are such that they require the joint response of two or more Distributor Transmission Companies to combat the event.	Generally loss of supply greater than 1000 requiring the assistance of resources from more than one Distribution/ Transmission Company. Gas Quality excursions requiring implementation of specific mitigation measures and gas supply limitations effecting more than one Distributor Transmission Company.
Level 5 This is an incident which has escalated to the extent that: VenCorp reasonably believes that there is a situation which requires them to declare an emergency; the Governor in Council or the Minister declares an emergency under Part 6A of the Gas Industry Act; or the Director of Gas Safety issues a direction under section 107 of the Gas Safety Act.	Loss of supply from a major injection point or unplanned isolation of a significant transmission pipeline jeopardising the integrity of the Principal Network.

Appendix 2: OGS KPI Reports

Period 1999/2000

Outcome	Measure	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	YTD
Safety	Gas involved deaths	0	0	0	0	0	0	0	0	0	0	0	0	0
	Gas involved injury	0	1	1	0	0	0	3	0	0	0	0	0	5
	Publicly reported leaks/1000 customers/year	2.34	1.88	1.60	1.25	1.37	1.42	1.42	1.50	1.67	2.06	2.27	2.31	21
	Leakage survey detected leaks/km/year (4 yr av)	0.73	0.75	0.71	0.71	0.71	0.68	0.69	0.70	0.67	0.67	0.67	0.66	0.69
	Damage to assets < 1050 kPa	326	294	321	315	313	285	265	368	458	413	389	295	4042
	Damage to assets > 1050 kPa	0	0	0	0	0	0	0	0	0	0	0	0	0
	Emergencies >= Level 2	7	6	2	5	3	2	6	4	5	4	6	7	57
	Loss of Supply affecting > 5 customers	5	7	8	9	2	4	4	2	7	4	7	7	66
	Loss of Supply affecting > 100 customers	0	0	0	0	1	0	0	0	1	0	1	0	3
	Loss of Supply affecting > 1000 customers	0	0	0	0	0	0	0	0	0	0	0	0	0
	No. of aproved safety cases	9	9	11	12	15	17	17	17	18	17	17	17	18
	No. of safety case audits per company per annum	0	0.22	0.18	0.08	0.07	0.24	0.00	0.24	0.33	0.06	0.18	0.24	1.8
	Emergency management exercises per company per year	0	0	0.09	0	1.13	0.06	0	0.06	0	0.06	0.59	0	2
	% of priority 'A' emergency calls responded to within 60 minutes													
	Metro business hours	97	97	97	98	98	99	95	100	98	94	95	97	97
	Metro after hours	97	97	97	98	99	99	95	98	96	98	94	100	97
	Country all hours	97	100	100	100	99	100	88	98	89	92	96	94	96

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Period 2000/2001

Outcome	Measure	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	YTD	Target 00/01
Safety	Gas involved deaths	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Gas involved injury	0	1	0	0	0	0	1	0	0	1	0	0	3	0
	Publicly reported leaks/1000 customers/year	2.40	2.28	1.51	1.46	1.23	1.22	1.32	1.37	1.86	1.40	1.91	1.97	19.94	29
	Leakage survey detected leaks/km (4 yr av)	0.65	0.65	0.66	0.63	0.64	0.63	0.64	0.64	0.62	0.63	0.61	0.63	0.64	0.84
	Damage to assets < 1050 kPa	272	248	229	258	253	291	282	317	373	222	252	168	3165	3000
	Damage to assets > 1050 kPa	0	0	1	0	0	0	0	0	1	0	0	0	2	0
	Emergencies >= Level 2	8	9	3	5	4	6	7	7	8	6	3	4	70	48
	Loss of Supply affecting < 5 customers	2427	2216	1736	1514	1602	1229	1095	921	1301	1813	1431	1536	18821	N/A
	Loss of Supply affecting > 5 customers	8	5	0	12	6	9	3	7	6	6	2	9	73	30
	Loss of Supply affecting > 100 customers	1	0	0	0	1	0	0	0	0	0	0	0	2	2
	Loss of Supply affecting > 1000 customers	0	0	0	0	0	0	0	0	0	0	0	0	0	1
	No. of aproved safety cases	18	18	19	19	20	20	20	20	20	20	20	20	20	N/A
	No. of safety case audits per company per annum	0.11	0.11	0.26	0.21	0.30	0.15	0.10	0.10	0.20	0.30	0.25	0.05	2.15	2
	Emergency management exercises per company per year (Not including industry wide exercise)	0.00	0.17	0.00	0.16	0.10	0.15	0.00	0.00	0.25	0.30	0.05	0.00	1.17	2
	% of priority 'A' emergency calls responded to within 60 minutes														
	Metro business hours	98	96	99	98	99	99	96	98	99	96	96	97	98	95
	Metro after hours	100	95	100	95	99	99	94	98	99	100	95	100	98	90
	Country all hours	100	100	100	100	100	100	100	100	100	94	97	95	99	90