ATTACHMENT 10.101
SECURITY OF SUPPLY - ASSUMPTIONS & REVISED RISK ASSESSMENT - TCO RP 0380

ATCO 2020-24 REVISED PLAN

EIM # 99050816

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AA5 SECURITY OF SUPPLY ASSUMPTIONS & REVISED RISK ASSESSMENT

TCO RP 0380

GAS DIVISION

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Contents

1. EXECUTIVE SUMMARY

The ERA has provided feedback on ATCO's AA5 Security of Supply Project submissions as part of *Economic Regulation Authority, Draft Decision on the Proposed Revisions to the Mid-West and South-West Gas Distribution System Access Arrangement for 2020 to 2024, Submitted by ATCO Gas Australia, 18 April 2019*.

The ERA have agreed with the findings related to Security of Supply assessment assumptions put forward by technical consultant EMCa, documented in *EMCa, ATCO Gas Australia Proposed Access Arrangement for the Mid-West and South-West Gas Distribution Systems, Review of Technical Aspects of the Proposed Access Arrangement, March 2019*.

EMCa assessed the frequency and consequence components of ATCO's Security of Supply Risk Assessments and disagreed with key aspects of ATCO's risk assessment methodology. As a result, EMCa assessed that the expenditure proposed by ATCO to address supply risk was unlikely to satisfy capital expenditure criteria.

This document provides further clarification of ATCO's Security of Supply Risk Assessment methodology and assumptions to address concerns noted by the ERA and EMCa as part of the AA5 Draft Decision.

In particular, this document addresses:

- Actions taken by ATCO to address feedback received by the ERA as part of the AA4 submission in relation to assessment of supply risk (Section 2).
- Justification of ATCO's assumptions used to establish frequency of loss of gas supply scenarios, as well as the further consideration and implementation of a fifth Risk Reduction Factor as recommended by EMCa (Section 3.1).
- Justification of ATCO's assumptions used to establish consequences of loss of gas supply scenarios, as well as further consideration of the reduction of time taken to repair a pipeline from 7 to 3 days.
- Overview of revised risk assessment methodology and outcomes (Section 4).

The justification of assumptions coupled with amendments made to the risk assessment methodology as a result of EMCa's recommendation, result in a revised risk assessment which supports the High risk outcomes for pipeline segments within the Two Rocks, Bunbury and Caversham networks.

The revised methodology better accounts for the times of year that a pipeline puncture would not result in a loss of positive pressure to the network. Due to this additional frequency reduction factor, the risk reduction provided by concrete slabbing and additional pipeline patrol is now adequate to feasibly reduce High supply risk to Intermediate for the assessed pipelines by reducing frequency to Hypothetical. These two options have now been considered as part of revised Security of Supply Business Cases.

2. AA4 FINAL DECISION FEEDBACK

During Access Arrangement 4 (AA4), ATCO submitted proposals for two Security of Supply projects, including the Two Rocks Spur Line Project, and Peel Spur Line Project.

The *Economic Regulation Authority (ERA), Final Decision on Proposed Revisions to the Access Arrangement for the Mid-West and South-West Gas Distribution Systems, Submitted by ATCO Gas Australia, 30 June 2015, As amended on 10 September 2015*[1] (Final Decision) determined that the proposed Security of Supply expenditure was not required for ATCO to comply with 79(2)(c)(iii) of the National Gas Rules (NGR), and that the expenditure did not satisfy rule 79(2)(c)(i) of the NGR.

Table 2.1 provides an overview of key feedback provided by ERA and their technical consultant EMCa with regard to Security of Supply projects during AA4, and summarises actions taken by ATCO in preparation for AA5 to improve assessment methodologies and address feedback.

Table 2.1: AA4 Final Decision Feedback

Final Decision Excerpt	ATCO Response to Feedback
635. "…EMCa considers that ATCO has been inconsistent with the guidelines in AS 4645. EMCa states that ATCO has principally misapplied the framework by failing to apply realistic probabilities to the consequences that it is considering and has, instead, applied the probabilities of events that may lead to such consequences." 652. "…EMCa highlights that ATCO provides no new statistical information to support its risk frequency assessment."	Security of Supply assessments submitted as part of AA4 proposals involved qualitative probability assessments, whereby Remote was selected on the basis of "The event is not anticipated to occur for the asset at this location". In order to determine realistic probabilities, ATCO investigated and applied quantitative methodologies and statistical assessment to support qualitative supply risk outcomes. This methodology is documented within *TCO RP 0253 HP Steel Pipeline Semi-Quantitative Risk Assessment (Methodology)*[2] and was applied to all of ATCO's high pressure steel pipelines.
639. "EMCa considers that this guidance links the failure event to the outcome. Specifically, it is the consequence and frequency of the outcome (e.g. loss of supply to customers for an extended period), rather than the event (e.g. pipeline failure) that is the key consideration. In addition, the focus must be on the outcome with the highest risk ranking."	ATCO has ensured that the frequency stipulated within supply risk assessments relates to the outcome of loss of supply to customers, rather than the initiating pipeline failure event. The frequency assessments steps through the probability of a strike occurring on each pipeline segment, and the probability of that strike resulting in a loss of containment requiring isolation, taking into consideration risk reduction controls on the network. Modelling was then used to determine whether this event would or would not result in a supply loss impact during average consumption, which is not the case for the majority of the network. Modelling has also determined the customer loss of supply impact for the different consumption periods and whether not supply from other gate stations and pipelines are able to provide sufficient gas pressure to maintain supply into the affected area, or not.
648. "…EMCa states that in cases in which there is risk of interruption to continuity of supply to 25,000 customers or more, it has conservatively applied a consequence rating of 'Catastrophic'."	ATCO understood EMCa's assessment that supply interruption to 25,000 customers may be a conservative assessment of a catastrophic supply consequence.

Final Decision Excerpt	ATCO Response to Feedback
	With the introduction of Customer Weeks Lost into AS/NZS 4645.1:2018[3] to determine supply consequence, ATCO considered this to be a more suitable criteria for assessing consequence. While customer numbers lost provides an understanding of the immediate magnitude of supply impact, this does not assess ongoing impact to customers. Ascertaining customer weeks lost enables assessment of overall supply consequences from loss of supply through to reinstatement. Note: This approach is less conservative than ATCO's previous approach whereby 25,000 customers lost was assessed as catastrophic. Approximately 31,000 customers would need to be lost to correlate to a catastrophic consequence of 100,000 customer weeks lost.
651. "…EMCa considers that the appropriate approach to designating the frequency class of the interruption to the continuity of supply is to consider the likelihood of the assessed consequence actually occurring with the existing risk mitigation controls in place…"	ATCO has ensured that quantitative methodology developed to support supply risk assessments adequately accounted for effective risk mitigation controls already in place. The methodology implemented requires that once a baseline probability is established, that risk reduction factors are applied to account for controls in place, such as design factor, wall thickness, depth of cover and patrol frequency.
675. "EMCa considers that there are a number of other pipeline options ATCO could have considered for mitigating the supply risk…" 690. "…The Authority shares EMCa's view that for intermediate risks AS 4645 and the prudent service provider test in rule 79(1)(a) requires ATCO to diligently consider all options for reducing the risk ranking to Intermediate or lower, applying a cost-benefit analysis test to determine if an Intermediate ranking is ALARP".	ATCO ensured that any proposed Security of Supply Projects resulting from the network wide assessment prudently considered all available options to reduce risk to an acceptable level, or ALARP. The Two Rocks, Bunbury and Caversham Security of Supply Business Cases provide an overview of the various options assessed. Additional options assessed included procedural controls (such as increased patrolling), virtual LNG pipelines and various network reinforcement options. A cost and benefit assessment was undertaken on all proposed options to assess the cost of the option (in terms of dollars) and the benefit (in terms of risk reduction) in order to determine the lowest cost solution to reduce risk to an acceptable level. Due to ATCO's assessment of High gas supply risk, the lowest cost solution to reduce risk to an acceptable level was presented, and an ALARP Test was not required to be presented.

3. AA5 DRAFT DECISION FEEDBACK

The ERA have provided feedback on ATCO's AA5 Security of Supply Project submissions as part of *Economic Regulation Authority, Draft Decision on the Proposed Revisions to the Mid-West and South-West Gas Distribution System Access Arrangement for 2020 to 2024, Submitted by ATCO Gas Australia, 18 April 2019.*[4]

ERA have agreed with the findings related to Security of Supply assessment assumptions put forward by technical consultant EMCa, documented in *EMCa, ATCO Gas Australia Proposed Access Arrangement for the Mid-West and South-West Gas Distribution Systems, Review of Technical Aspects of the Proposed Access Arrangement, March 2019*.[5]

EMCa assessed the frequency and consequence components of ATCO's Security of Supply Risk Assessments before assessing the justification for the three proposed individual projects.

This section aims to provide further clarification and explanation of aspects noted by EMCa within their report.

3.1 Frequency – Loss of Gas Supply

3.1.1 Frequency Descriptors and Risk Tolerance Criteria

EMCa have provided the following comments in relation to ATCO's frequency descriptors which influences risk tolerance:

> *564. ATCO's descriptions for 'Remote' and Hypothetical' are an order of magnitude more conservative (risk averse) than the AS4645.1:2018 definitions. This is an important factor when ATCO combines the Likelihood class with the 'severity class' to determine the risk rating of events. ATCO advises that it selected the quantitative ranges by referring to a British Standards Institution (BSI) publication in the absence of suitable Australian criteria.*
>
> *565. It appears that ATCO has 'cherry picked' the definitions from the BSI publication, including a more conservative approach to the assessment of likelihood. We consider that the applicable reference for likelihood class is AS4645.1:2018 Table B2.*
>
> *580. As we have not seen compelling reasons from ATCO to support its alternative measures, definitions and criteria, we refer to the AS4645.1:2018 measures, definitions and criteria in our AA5 capex assessment.*

In developing a suitable risk framework, ATCO undertook an analysis of applicable Australian Standards, Land Use Planning criteria, proposed draft revisions to Australian Standards, and industry best practice guidelines. While AS4645.1:2018 establishes a minimum baseline for a gas distribution network risk tolerance criteria, AS2885.1:2012 and more recently AS2885.6:2018[6] (for ATCO gas transmission pipelines), additional state-based criteria and other applicable Australian Standards and guidelines must be considered to establish an overall risk framework which meets minimum requirements of all applicable standards and guidelines.

A detailed overview of considerations and references in developing ATCO's risk management approach is provided in *TCO RP 0379 AA5 Risk Management Approach Response.*[7] This document

illustrates how ATCO's developed approach is in line with both the referenced British Standard Publication, but also other applicable Australian Standards and Land Use Planning Criteria.

ATCO's risk management approach is documented within the ATCO Gas Australia Gas Distribution Safety Case.[8] Building and Energy (previously Energy*Safety*) are responsible for ensuring ATCO's approach to managing risk on the network is in line with any regulatory obligations, and takes into consideration industry good practice and state requirements as applicable. Building and Energy provided no objections to ATCO's alternative risk management approach, and supported the approach by way of acceptance of the Safety Case.

With regard to legislative precedence, if there is a conflict between the accepted Safety Case and the Standards prescribed in the Safety Case, the obligations in the accepted Safety Case prevail.

ATCO disagree with EMCa's findings that ATCO's Risk Management Framework should consider only AS4645.1:2018 measures in isolation. ATCO in developing its risk management framework, has in addition to AS4645, considered the requirements of AS2885, other Australian Standards and land use planning publications. In developing its framework ATCO has documented and approved the reasons for its changes to for example the likelihood class frequencies defined in AS4645.1:2018 Table B2 in accordance with rules defined within AS4645 and AS2885.

3.1.2 Link between Puncture and Supply Outage

EMCa have provided the following comments in relation to the link between the probability of a puncture and the probability of supply loss event

368. *"Our concern is that ATCO assumes that a Loss of Containment (LOC) via a puncture will result in a total supply outage, such that 'it is assumed that positive pressure will not be maintained for parts of the network downstream of the LOC event'. This is a conservative assumption because, based on our experience, the likelihood of shutting off the downstream system will vary with the location and size of the puncture…"*

369. *"Even if a network must be shut down (i.e. none of the above operational/repair methods is practicable) positive network pressure can be maintained by load shedding, and air ingress into the network can be prevented"*

370. *"We therefore consider it reasonable for ATCO to include a fifth Risk Reduction Factor (RRF) to account for the likelihood that no isolation is required..."*

EMCa have stated "the likelihood of shutting off the downstream network will vary with location and size of the puncture". The occurrence of a puncture does not result in active efforts to shut down the downstream network, however results in the requirement to isolate the segment of damaged pipeline at its closest upstream and downstream mainline isolation valves.

In the event that a high pressure pipeline segment requires isolation, this results in significantly reduced capacity within the downstream network. The consequence of that reduced network capacity, in terms of ability for the impacted downstream parts of the network to maintain positive pressure, differs based on gas consumption rates, location of the pipeline and configuration of the downstream network.

ATCO have not assumed that a puncture will result in a total supply outage in all instances, whereas documented in TCO RP 0287 *Supply Interruption customers Week Lost Assessment*

formal safety assessment, this is not the case. Network modelling has been undertaken using Synergee to determine whether positive pressure will or will not be maintained to impacted downstream areas on the distribution network should a given high pressure pipeline segment require isolation. Modelling of supply loss has taken into consideration variation in gas consumption on the network during different times of the year. Modelling was undertaken for every isolatable section of the high pressure steel network individually, at four different consumption conditions.

ATCO's supply risk assessment methodology assessed customer lost consequences using a weighted average approach, and did not base risk outcomes on worst case customer loss scenarios.

Using this approach, ATCO assessed that of approximately 760 km of high pressure steel on the network:

- 47 km (6%) if isolated would result in a Catastrophic supply loss;
- Approximately 448 km (59%) of high pressure steel pipelines would result in no loss of customers if isolated, and are rated as having Negligible supply risk (driven by Trivial consequence); and
- The remaining 35% of high pressure steel pipelines if isolated would result in a weighted average supply loss between 3,000 and 30,000 customers. These pipeline segments have been assessed as being Low or Intermediate risk, depending on frequency of isolation outcomes.

ATCO have further considered EMCa's commentary that fifth risk reduction factor should be included to account for the likelihood that no isolation is required. While ATCO maintain that pipeline isolation will occur in all instances, consideration has been given to the likelihood that isolation will not result in a loss of positive pressure. This has been reflected in an additional risk reduction factor, further outlined below. This refined methodology requires ATCO to consider the varying supply loss consequences at different consumption conditions, which have previously been averaged.

3.1.2.1 Fifth Risk Reduction Factor – Likelihood that Puncture Results in No Supply Loss

EMCa have stated that "positive network pressure can be maintained by load shedding, and air ingress into the network can be prevented."

When a loss of containment occurs at high pressures, the pressure in the network reduces as a result of both consumption and loss of gas through the damaged pipeline segment, until such time the puncture is identified and isolated. At this point, any consumption of the network continues to draw down any remaining positive pressure to impacted networks.

The number of customers lost, and time to lose customers is extremely sensitive to network consumption rates at the time of the isolation. Gas consumption is strongly linked to weather conditions, with colder months resulting in more gas usage. The highest consumption period typically occurs for four months of the year over winter, while the lowest consumption period is noted for approximately 6 months of the year over the warmer summer and intermediate season months.

When a high pressure pipeline is isolated, there are three potential outcomes for the downstream network including:

1. **No supply impact** – network is adequately back-gassed and consumption does not result in any loss of positive pressure, or requirement to curtail customers. No customers are impacted.
2. **Supply impact without loss of positive pressure** – network is not adequately back-gassed to allow for normal consumption conditions to occur without action taken to mitigate against supply loss. Curtailment or load shedding must be enacted to prevent loss of positive pressure in the network. Impacted customers must remain "off gas" for the time taken to repair the damaged pipeline. Once repaired, gas supply can resume without the requirement to isolate, purge and reconnect the network.
3. **Supply impact with total loss of positive pressure** – network is not adequately back-gassed and gas consumption results in the loss of positive pressure to impacted networks. Loss of positive pressure occurs before effective isolation and curtailment can be enacted, resulting in potential air ingress into the network. Gas supply cannot resume until the damaged pipe is repaired and the downstream gas network is isolated, purged and reconnected.

ATCO have estimated utilising Synergee modelling and first principal calculations that the time between a high pressure pipeline puncture, and the loss of positive pressure in the impacted network can occur within a time period of less than one to two hours during peak winter conditions.

Table 3-1 provides the times for positive pressure to be lost to impacted parts of the network should the High risk pipeline segment be isolated during peak winter conditions.

Table 3.1 Security of Supply – Peak Winter Supply Loss Outcomes

Network	Time to Lose Positive Pressure (Peak Winter Conditions)	Customers Lost (Peak Winter Conditions)	Customer Weeks Lost[1] (Peak Winter Conditions)
Two Rocks	Approximately 40 min	126,201	1,370,208
Bunbury	Approximately 95 min	80,000	560,560
Caversham	Approximately 100 min	37,125	127,178

As such, during peak winter conditions, it is highly unlikely that a curtailment plan could be effectively enacted prior to the loss of positive pressure within the network.

As a refinement of the annual weighted average network consumption assessments (as documented in TCO RP 0253 *HP Steel Pipeline Semi-Quantitative Risk Assessment Methodology* and TCO RP 0287 *Supply Interruption customers Week Lost Assessment* which determined whether or not on the annual weighted average consumption would result in loss of downstream connection pressures), ATCO has applied a fifth risk reduction factor by determining the period of time within the year that would result in highest loss of gas supply consequence. For peak winter conditions, whereby loss of positive pressure would be rapid, occur for approximately 6 hours of the day, 120 days of the year (or 8.25% of the year).

[1] Customer Weeks Lost model updated with 3 days to repair pipeline

ATCO has therefore further considered the consumption conditions and consequences for each pipeline segment separately, and applied a Risk Reduction Factor of 0.0825 to assess the probability of isolation of a pipeline segment resulting in loss of positive pressure.

Refer to Section 4 for the revised risk assessment of the High risk supply pipeline segments in the Two Rocks, Caversham and Bunbury regions.

3.1.3 Repair Methods and Probability of Pipeline Isolation

EMCa have provided the following comments in relation to actions taken in the event of a high pressure pipeline puncture:

> *368. "…Other operational/repair methods will determine if a complete shutdown is required. Such options include:*
>
> - *lowering the pipeline pressure, fitting a temporary repair clamp, and then completing a full repair under controlled conditions (noting that some load shedding may be required);*
> - *allowing the leak to continue (under reduced pressure) and constructing a temporary by-pass, then doing a full repair (some load shedding may be required also for this option); or*
> - *isolating the leak by closing upstream and downstream valves, implementing load shedding and effecting a temporary repair (bolt on repair clamp) or a permanent repair."*

ATCO consider EMCa have applied their knowledge of lower pressure distribution networks when providing this commentary, as the stipulated options are typically only suitable in lower pressure distribution network applications and not high pressure steel pipelines with MAOP of ≥ 1900 kPa up to 6900 kPa.

In the event of a loss of containment from of one of these MAOP ≥ 1900 kPa up to 6900 kPa high pressure steel pipelines, ATCO assesses safety, environmental and loss of gas supply risks to determine is risk is acceptable, or otherwise intermediate and ALARP.

In the event of a high pressure loss of containment resulting from a puncture, isolating the damaged segment by turning off the valves immediately upstream and downstream is typically required in all instances.

EMCa's third option proposes isolating the leak by closing upstream and downstream valves. This describes the scenarios modelled by the Security of Supply Risk Assessment. Security of supply assessments only consider the closing of valves immediately upstream and downstream of the pipeline segment, and does not consider ATCO taking action to actively shut off the downstream system.

In regard to EMCa's first proposed option; lowing the pipeline pressure and fitting a temporary repair clamp is typically only a suitable methodology when no significant loss of containment has occurred (e.g. strike has occurred resulting in wall thickness loss, or pinhole leak resulting from corrosion).

In regard to EMCa's second proposed option; allowing the leak to continue and constructing a temporary bypass is not a viable option for high pressure steel due to the following reasons:

- In ATCO's experiences associated with lower loss of containment flowrates than would be expected from for a relatively small puncture within a high pressure steel pipeline, Department of Fire and Emergency Services (DFES) under the powers of the Emergency Management Act 2005, would mandate for safety and environmental risks the isolation of the pipeline and that decision would be supported by the technical safety regulator (Building and Energy).
- The required length of the bypass would not be practicable due the required exclusion zone around the puncture site. The size of credible punctures from third party impact have been assessed for each pipeline and are documented within each pipelines Fracture Control and Isolation Plans prepared in accordance with AS2885. Taking Pipeline 91 (Two Rocks) as an example, credible puncture hole sizes range between 25mm to 125mm in diameter. If ignited, the 4.7 kW/m^2 radiation contour (at least second degree burns will occur after 30 seconds exposure) for a 125mm diameter puncture would be 143.54 m. Any exclusion zone set up around the pipeline puncture prior to isolation would need to be greater than this radiation contour either side, making a Class 600 bypass of this length more difficult to achieve than a permanent repair.
- Temporary bypasses are not applied during emergencies due to the time taken to construct and inability to construct around gas escapes.
- Isolation of the pipeline at some point in time would be required to enable personnel and equipment to safely reach the site of the required repair.

In addition, AS2885.1:2012 states the following in relation to loss of containment events, indicating that isolation is a required practice in the event of a high pressure steel pipeline loss of containment:

- Clause 4.6.1 "Equipment shall be provided within a pipeline or pipeline system for the isolation of segments of the pipeline or pipeline system for maintenance purposes and for the isolation of segments of the pipeline or pipeline system in the event of a loss of containment within the segment".
- Clause 4.6.4 "Valves shall be installed so that, in the event of a leak, the valves can be expeditiously operated."

AS 2885.3:2012 prescribes the requirements for assessing and undertaking remedial action in the event of a pipeline loss of integrity (without loss of containment). Clause 9.3 Initial Assessment and Remedial Action discusses pressure reduction and temporary bypass repairs as steps to "prevent loss of containment of the pipeline until the integrity of the pipeline is restored."

The calculated reduction in pressure is required to be such that any anomaly or defect is stabilised and will maintain pressure containment. Once loss of containment has occurred, these remedial steps to prevent isolation are no longer viable.

3.1.4 Concrete Slabbing and Patrolling

EMCa have provided the following commentary in relation to the assessment of concrete slabbing and increased patrolling frequency as potential options to reduce supply risk to an acceptable level:

> *379. "ATCO also considered two non-network options: (i) concrete slabbing; and (ii) increased pipeline patrol frequency. It considers that although slabbing provides a 'strike' frequency reduction of 90%, this is not sufficient to reduce the risk levels within the Caversham region to an acceptable level. However, ATCO has provided no analysis*

to support this claim in its business case. Similarly, ATCO estimates that patrolling the pipeline segments daily instead of weekly will reduce the corresponding RRF from 0.75 to 0.1. However, ATCO contends that this is not sufficient to reduce the risk to an acceptable level."

Similar commentary was provided for both the Two-Rocks and Bunbury Security of Supply Projects.

As discussed within Security of Supply Business Cases, the effectiveness of additional controls including concrete slabbing and increased patrolling frequency was assessed in accordance with methodology provided in TCO RP 0253 High Pressure Steel Pipeline Semi-Quantitative Risk Assessment.

The purpose of installing slabbing over high pressure pipelines is to reduce the likelihood of third party impact. An excavator or auger operator will likely notice they have struck a concrete slab, and cease operation therefore preventing a strike on the pipeline the slabbing is protecting. While concrete slabbing provides protection from third party damage from open trench works, slabbing is not considered an effective control against impact from Horizontal Directional Drilling (HDD) activities.

A risk reduction factor of 0.1 has been applied to the probability of a pipeline being struck where a pipeline segment is slabbed across its entire length, in line with industry data and research outcomes (effectively reducing the likelihood of a third party strike by 90%).

The purpose of patrolling pipelines is to identify third party works occurring within the vicinity of the pipeline, and to ensure appropriate controls are in place to prevent the third party from impacting the pipeline. ATCO currently undertake high pressure pipeline patrols at weekly or monthly intervals.

A risk reduction factor 0.75 is applied to pipelines patrolled at weekly intervals, however increasing patrol frequencies to daily reduces this factor to 0.1, in line with industry data and research outcomes. To assess the risk reduction afforded by daily patrolling a risk reduction factor of 0.1 was applied to the probability of a strike calculation within ATCO's Security of Supply Risk Assessments.

For ATCO's original supply risk assessment, while both options provided risk reduction benefit, the magnitude of risk reduction afforded was not enough to reduce risk to an acceptable level (remains High risk).

The following Table 3.2 provides results of the original assessment with additional controls considered, illustrating that resultant probabilities with patrolling or slabbing considered are still within the "Remote" range between 1×10^{-4} and 1×10^{-6} events per annum.

Table 3.2 Pipeline Segment Isolation Frequencies - Patrolling & Slabbing

Pipeline	Segment	Calculated Frequency of Isolation	Frequency with Concrete Slabbing	Frequency with Daily Patrolling
Bunbury Region				
HP104	GS017 - MLV156 - MLV157A - 56V10- 104V1- 104V6 - MLV158	5.85×10^{-5}	5.85×10^{-6}	7.80×10^{-6}
Caversham Region 4				

Pipeline	Segment	Calculated Frequency of Isolation	Frequency with Concrete Slabbing	Frequency with Daily Patrolling
HP105	EPLV1 - EPLV2	1.84×10^{-5}	1.84×10^{-6}	2.46×10^{-6}
HP105	EPLV2 -EPLV2A - EPLV5 - 105V1-EPLV11 - EPLV7	1.39×10^{-5}	1.39×10^{-6}	1.85×10^{-6}
HP 107/105	GS007 - EPLV10 - EPLV15 - EPLV16 - EPLV1	1.00×10^{-5}	1.00×10^{-6}	1.33×10^{-6}
HP106	GS007 - EPLV9 - PRS009	1.64×10^{-5}	1.64×10^{-6}	2.18×10^{-6}
Two Rocks Region				
HP91	GS005-PRS005	9.40×10^{-5}	9.40×10^{-6}	7.23×10^{-6}
HP140	PRS005-140V1-140V2-140V4-140V5-140V6	3.79×10^{-5}	3.79×10^{-6}	5.06×10^{-6}

Remote frequencies coupled with catastrophic consequence results in risk rankings for each of the pipeline segments remaining High.

With ATCO's revised supply risk assessment approach, taking into consideration EMCa's recommendation to reduce time to repair to 3 days, and include an additional Risk Reduction Factor, both slabbing and patrolling are able to reduce risk to Intermediate by lowering the frequency to Hypothetical (Refer to Section 4). These options are therefore considered feasible, and have been further considered within the revised Security of Supply Business Cases.

3.1.5 Australian Pipeline Puncture and Isolation Incidents

EMCa have provided the following commentary in relation to their knowledge of requirements for networks to be isolated following a puncture:

> 368. *"…We are not aware of an instance where network isolation following a puncture has been required anywhere in Australia and we consider it unlikely that network isolation will be required for a puncture of the GDS pipeline segments identified by ATCO to pose the highest customer supply risk."*

ATCO are aware of at least two high pressure steel pipeline punctures which have occurred in Western Australia:[8]

- 13 May 1978 – A bulldozer punctured the 356mm diameter West Australian Natural Gas (WANG) Pipeline (now known as the Parmelia Gas Pipeline). An eight metre split occurred along the top side of the pipeline and propagated into a rupture.
- 6 Aug 1984, a ripper punctured the WANG Pipeline resulting in large volume of gas escape and jet fire. This incident initiated the creation of the Dial Before You Dig one call service. Employees of the State Energy Commission at the time of the incident have recalled that the pipeline was isolated north and south of the incident, and large customers were curtailed. Flow-stopping and bypassing was not an option due to the large volumes of gas escaping and then igniting.

Other more recent third party impact incidents resulting in supply loss events within Australia include:

- Loss of supply to 2,800 customers within the Whyalla network in May 2012, resulting from third party damage to a key supply main. The gas supply took approximately 4 days to be fully restored by the APA Group.[8]
- Loss of supply to approximately 5,000 gas customers (including the Dreamworld complex) in the Gold Coast region in Jun 2018 as a result of third party damage to the gas network.[11]

Although not initiated by a third party puncture, stress corrosion cracking of the transmission pipeline to Port Pirie in April 2015 resulted in the loss of supply to approximately 10,000 customers in Port Pirie and Whyalla. Supply was isolated for repairs for a period of six days, and supply was impacted for a period of approximately 8 days in total. As a result of this event, positive pressure was lost to Port Pirie (5,300 customers), however Whyalla was able to maintain positive pressure by injecting LNG into the network.[10]

The South Australian Gas Distribution Network Operator, Australian Gas Networks (AGN) provided the following commentary regarding Port Pirie / Whyalla incident and supply risk as part of their Access Arrangement Information document:[12]

- "Customers were left without gas supply for up to nine days, with significant disruption to residential, industrial and commercial businesses as well as to the local economy more broadly. This follows a gas outage in May 2012 when a third party damaged a key supply main in the Whyalla network resulting in the loss of supply to 2,800 customers in that region. Another outage occurred in May 2008 as a result of another failure upstream of the AGN network, which left 3,300 Whyalla customers without supply for an extended period of time."
- "Such incidents highlight the vulnerability of some parts of the Network that rely on a single source of gas supply, which is often the case in regional areas. While severe interruptions to major pipelines are relatively rare, the experience above shows how communities can be impacted, including multiple times within a short period of time. Furthermore, when major supply pipelines or gas processing facilities do fail, not only are large numbers of consumers impacted, but the repair and recovery time can be lengthy. As an example, the recent Whyalla and Port Pirie outage required six days for repair to Epic Energy's transmission pipeline and a further three days before AGN could reconnect all customers to the Network."
- "While most of the metropolitan gas network has multiple supply feeds, the continuing elongation of the Adelaide metropolitan area to the north and south means that sections of the Network are becoming increasingly vulnerable. Outages on these parts of the Network are likely to have significant safety and economic consequences"

AGN have made reference to their networks increasing vulnerability to supply risk as a result of elongation of the network, due to reduced number of feeds to these networks. The Perth metropolitan area is similarly elongated and subject to the same vulnerabilities, which is why understanding supply risk and assessing suitable options is necessary.

3.2 Consequence – Customer Weeks Lost

EMCa have provided the following commentary in relation to key assumptions in deriving the customer weeks lost as part of security of supply assessments.

Table 3.3: Customer

372. *The table below summarises ATCO's key assumptions in deriving the customer weeks lost for various scenarios and our assessment of them.*

Customer Weeks Lost – Key Assumptions

Activity	ATCO assumptions	EMCa comments[129]
HP pipeline isolation and repair	7 days - 4 days to procure/pre-test the new section of steel pipeline; one day each to weld, conduct non-destructive testing, and commission the repaired section	3 days is a more reasonable estimate - as part of its Emergency Preparedness, ATCO should have tested pipe and fittings in an Emergency Store; other steps should take no more than one day in an emergency
Network isolation Network reconnection	- 4 hours per crew (competent) per isolation point - excavation by contractors one isolation/purge point per 50 customers - 3-person crews for each isolation/purge point - 16 trucks are available to isolate - one truck (3 crew) per isolation point	Network isolation (or sectionalisation) is unlikely to be required (per LOC) and even if it is, more reasonable assumptions are: - 4 hours per crew per section/isolation - sectionalisation size of 1,500 - 2,000 customers - many more trucks available - one truck (2-3 crew) per isolation point
Customer isolation	- 10 min per property per resource - isolation of inaccessible meters has negligible impact	A more reasonable estimate is 5 min per customer[130]
Customer reconnection	- 21 min per property per resource - one operator per customer	21 minutes is a reasonable estimate

376 *"…taking into account our assumptions in ATCO's model in the table above, we estimate that the number of customer weeks lost is unlikely to be greater than 100,000 unless supply to more than 50,000 - 60,000 customers is lost.*

The following subsections provide further information regarding ATCO's assumptions impacting customer weeks lost calculations.

3.2.1 HP Pipeline Isolation and Repair

As referred to in Section 3.1.5, the 2015 Whyalla and Port Pirie gas supply outage required six days for repair to Epic Energy's transmission pipeline, before network and customer reconnection activities could be undertaken. As such, ATCO maintain that 7 days is not an unreasonable assumption.

ATCO has revised the assessment methodology to include a reduction of "time to repair pipeline" from 7 to 3 days, however this does not reduce the consequence outcomes of the supply risk assessments.

When all three security of supply projects are remodelled with 3 days, customer weeks lost remain above 100,000 and therefore still considered "catastrophic".

Section 4 outlines the outcomes of the revised supply risk assessment which has incorporated 3 days to repair the damaged pipeline.

3.2.2 Network Isolation & Network Reconnection

ATCO have stated that one isolation/purge point is required every 50 customers. EMCa have stated that in their experience, sectionalisation size of 1,500-2,000 is a more reasonable assumption, however have not provided any basis or evidence for this statement.

The loss of gas supply poses a safety risk to the public at the time of reinstatement. Reduction of positive gas pressure down to atmospheric conditions may result in air ingress into the network. Air must be fully purged from the gas network and consumer appliances before for use after supply has been reinstated. If not adequately purged, air ingress within the network can result in:

- Potentially explosive air gas mixture which may result in property damage and injury; and/or
- Inefficient gas combustion at consumer appliances, which could result in potentially hazardous levels of combustion gases (carbon monoxide and/or nitrogen oxides).

In order to adequately purge air from the network, the impacted network must be purged in sections. The configuration of the network determines the number and locations of points where gas should be vented, as purging needs to be undertaken with a “dead end”. As such, whenever there is a loop, the loop needs to be isolated and purged end to end. The typical Perth suburban layout requires approximately one isolation point per 50 customers in the event of a loss of supply of gas.

ATCO have operational experience in minor loss of supply events resulting from third party impact or water in the main events, and actions required to reinstate gas to networks.

A review of recent supply loss incidents on the network identified the following:

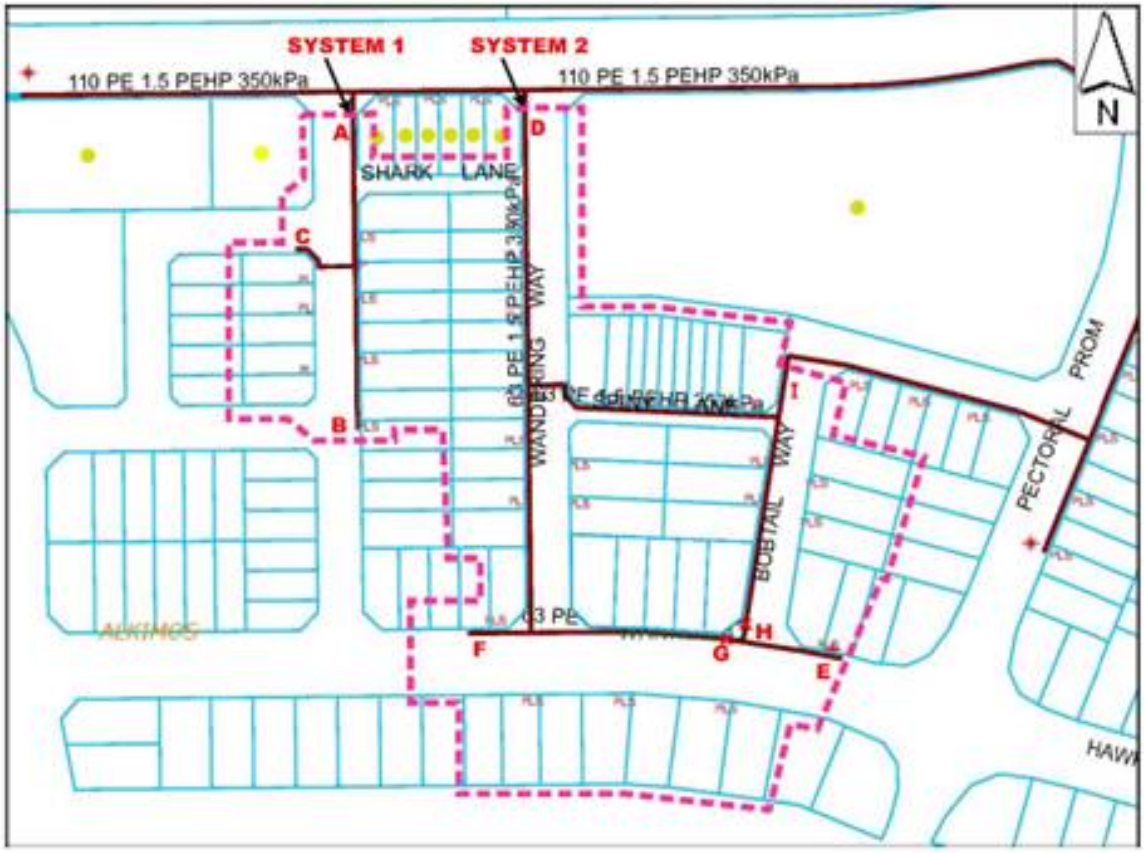
Table 3.4 ATCO Recent Supply Loss Incidents – Number of Customers per Isolation/Purge Point

Location	Incident Type	No. Customers Lost	Number Isolation / Purge Points on Mains	Customers per purge point
North Fremantle	Equipment Failure	705	21	34
Carine	Water in the Main	111	9	12

Both incidents indicate that 50 customers per purge point is a reasonable assumption to ensure adequate purging of air from the network. This assumption was validated during a workshop and desktop response exercise attended by ATCO personnel with operational experience in restoring gas. The validation exercise is documented in Appendix D of TCO RP 0287 Supply Interruption Customer Weeks Lost Assessment.

The removal of air from the network is also a normal operation conducted by ATCO when commissioning mains. This activity is performed regularly for sections of main of varying sizes. ATCO’s Safe Work Instruction Commission Mains (SWI CO 023)[13] provides instructions for purging branched systems. Figure 3-1 is provided within the Safe Work Instruction to provide an illustration of isolation and purge point requirements when commissioning mains. The same principals apply in the event of loss of positive pressure within the network.

Figure 3-1 ATCO Commission Mains SWI – Isolation and Purge Point Requirements



System 2 (DEFGHI) requires the following steps to ensure adequate purging of air from the network:

- Isolate at Point H, purge at Point E, and connect purged and live gas main at Point D.
- Purge through Point E (this purges gas from Point D to Point E, via Point G)
- Isolate at Point G, remove isolation at Point H. Purge at Point E (this purges gas from D to E via Point H).
- Remove purge pole from Point E, remove isolation Point G and Point D.
- Connect purge pole at Point I, purge, and then connect Point I to the purged and live gas main.
- If the dead leg at Point F is greater than 5m, this requires purging through point F.

Failure to adequately follow these guidelines has resulted in ATCO receiving calls of “no gas” in the legs of pipe which were inadequately purged and contained significant amounts of air. As such, failure to appropriately sectionalise loops of gas mains on the network for the purpose of purging would expose consumers to a safety risk. The safety of consumers would not be compromised in a supply loss event with the aim of reducing supply loss impact.

In addition to ensuring all mains are adequately removed of air, ATCO’s purging guidelines have been developed to ensure that purging is undertaken in a controlled manner with regard to purging velocity. Purging velocity that is too low can cause gas and air to stratify into an explosive mix, whereas velocity that is too high can cause static electricity which may ignite a gas air mix resulting in fire.

ATCO therefore maintain that in the event of a significant supply loss, isolation points for approximately every 50 customers is a conservative number and would be maintained as per normal practice. Isolation points in the order of 1,500 to 2000 customers would pose a significant safety hazard and would be considered an unsafe and impractical practice.

3.2.3 Customer Isolation

The reduction of time to isolate a customer from 10 minutes to 5 minutes does not impact the customer weeks lost calculation. At the same time as customer isolation is occurring, network isolation and flow stopping is happening in conjunction, which is the limiting activity.

So long as time to isolate individual customers collectively is less than time to undertake network isolation, additional resources or reduction in time for this activity does not impact the customer weeks lost.

3.2.4 Availability of Resources

EMCa have provided the following commentary in relation to resources which could be brought into bear in an emergency:

> *373. "ATCO has determined the number of personnel available for each of the above activities and has assumed what we consider to be very conservative estimates of the resources that can and would be brought to bear in an emergency. Specifically, in our view, vehicles, equipment and qualified personnel is unlikely to be a constraint for the customer isolation and reconnection work because:*
>
> - *emergency planning will enable rapid response, including mobilising the hundreds of other gas fitters with vehicles and equipment in WA (i.e. that are not ATCO contractors); and*
> - *ATCO has assumed 37 qualified personnel and their vehicles will be required to attend to routine (BAU) matters during the 'catastrophic' emergency. Whilst some staff would need to be redirected for the most urgent work (e.g. class 1 leaks), we consider it more likely that all resources will be made available to assist with emergency response including cancelling planned works, and that ATCO's BAU resource assumption is unnecessarily conservative."*
>
> *374. The limiting factor is likely to be specialist gas equipment and not trucks. Emergency spares and/or rapid procurement plans should be proactively prepared to reduce customer outage time."*

In the event of a large supply emergency, it is likely that external gas fitters would be mobilised to assist in the isolation and reconnection of customers. ATCO's model is able to account for this, however network isolation and network reconnection activities remain the limiting factor in determining time off gas. As such, the addition of 500 additional gasfitters undertaking customer isolation and reconnection activities does not impact the customer weeks lost.

Business as usual requirements were determined considering typical operational workloads attending safety priority works (faults and emergencies) across all of ATCO's WA networks. Safety on the network remains a priority in event of a supply loss event elsewhere on the network, therefore ATCO maintain that 37 BAU personnel required on the network is a reasonable assumption and excludes utilisation of these personnel for non-faults and emergency response

duties. This number includes minimum numbers of personnel required to resource regional depots.

With regard to “number of trucks” used within the models, this represents the equipment available to undertake network isolation and reconnection activities. ATCO’s trucks are of a fit for purpose bespoke design which contain specialist Rogan flow stopping equipment, hoses, pipe fittings, electrofusion and jointing equipment, generators and other equipment required to undertake flow stopping and purging activities.

The size and scale of the ATCO PVC network is unique within Australia and requires flow stopping equipment which is fit for purpose. As such, there are no rapid procurement or “loan” options available within Australia for the required Rogan flow stopping equipment, as no other networks use this equipment.

Modelling indicates that to reduce the Consequence in Caversham down to below 100,000 customer weeks lost (using revised methodology) in the event that positive pressure is lost to the network, ATCO would require approximately 75 extra sets of flow stopping equipment. Rogan flow stopping kits cost approximately $30,000 to procure each, therefore would require ATCO to spend $2.25M in additional flow stopping equipment. Each extra set of Rogan flow stopping equipment would require a crew of three trained personnel to operate beyond ATCO’s available resources.

Similarly, due to the unique nature of ATCO’s PVC network within Australia, specialist training would be required for any additional personnel brought in to support network isolation and reconnection (flow stopping and purging) activities. Any available contractors with prerequisite Gas Operations training and qualifications would require additional training regarding how to use the specialist PVC flow stopping equipment and PE to PVC electrofusion and jointing techniques.

Note: ATCO no longer stocks significant quantities of PVC pipe as it is being phased out from the network. As such, when PVC pipe is isolated, the PVC segment typically replaced with a PE segments. As such, personnel undertaking PVC flow stopping activities must be training in PE to PVC jointing techniques.

It is anticipated that the process of sourcing additional resources with prerequisite qualifications, organising travel, undertaking due diligence, and training activities would take two weeks before additional resources would be available to assist undertaking flow stopping activities should the equipment available.

As such, ATCO maintain that the equipment and resourcing assumptions included within the Customer Weeks Lost assessment are reasonable estimates and that additional resources that could be bought into bear in a supply emergency would not significantly alter the risk outcome.

4. REVISED SUPPLY RISK ASSESSMENT

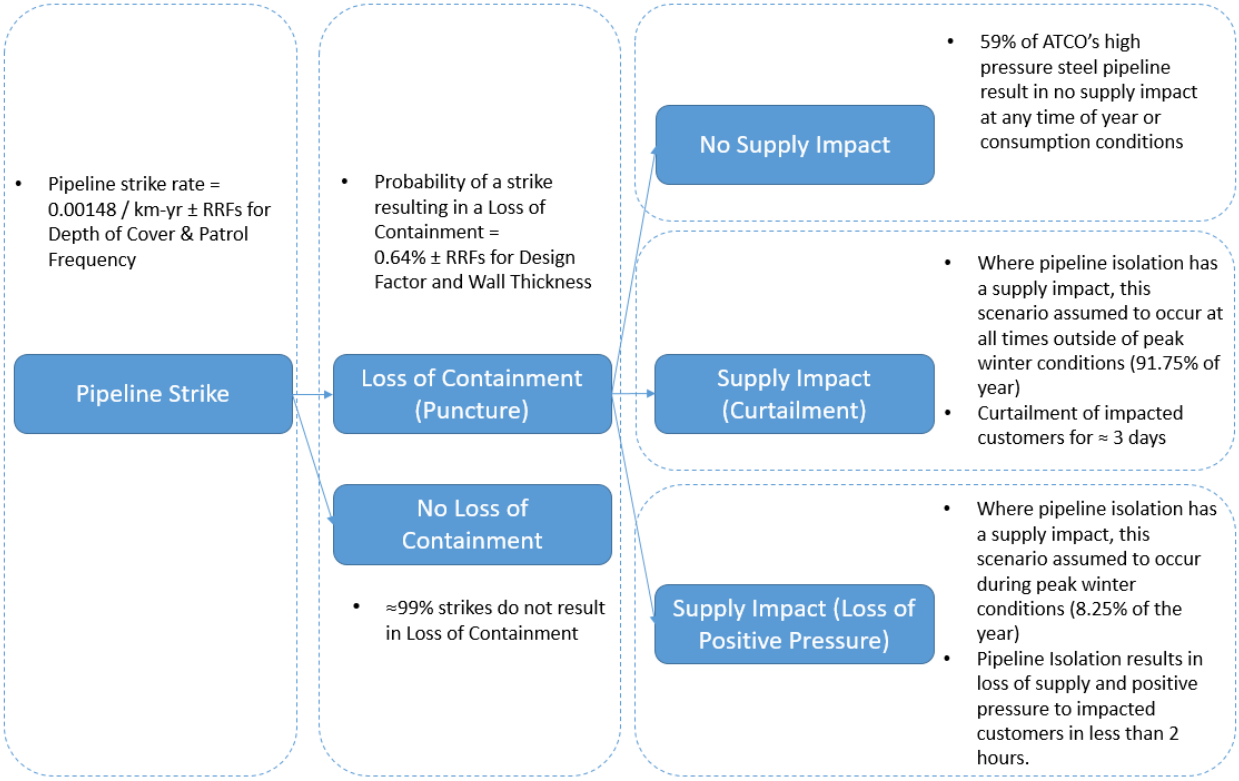
ATCO have undertaken a revised supply risk assessment for the pipeline segments previously assessed as High risk, taking into consideration the following feedback from EMCa:

- Additional Risk Reduction Factor (RRF) included to account for the probability that a pipeline puncture will not result in a loss of positive pressure; and
- Reduction of time to repair a punctured pipeline from 7 to 3 days.

In addition, the revised Two Rocks risk assessment takes into consideration the reduced customer impact resulting from the remote controlled isolation valve project undertaken during AA4.

Figure 4-1 provides a high level overview of the scenarios considered as part of the revised risk assessment. The scenario of positive pressure being maintained due to effective curtailment efforts in the event of pipeline isolation has now been considered by the inclusion of an additional Risk Reduction Factor.

Figure 4-1 Supply Risk Assessment Scenarios Considered



4.1 Application of Risk Reduction Factor

ATCO has revised the supply risk assessment to take into consideration different supply impact scenarios for differing consumption conditions throughout the year.

The consumption conditions (CC) experienced on the GDS can be broadly classified into four different categories:

- CC1 – High consumption condition, occurring for 4 months of the year, typically occurring over the coldest months (Winter).
- CC2, CC3 – Medium consumption conditions occurring for the transition between cold and warm conditions (Spring and Autumn), typically experienced for 2 months of the year.
- CC4 – Low consumption condition, typically during the warmest months of the year and experienced for 6 months of the year (Summer).

Table 4-1 represents the number of customers impacted on the network as a result of pipeline isolation during the different consumption conditions, if ATCO were to take no action.

Table 4.1 – Customers Impacted for Varying Consumption Conditions.

Pipeline	Segment	Customer Impact (CC1)	Customer Impact (CC2)	Customer Impact (CC3)	Customer Impact (CC4)
Two Rocks					
91	GS005-PRS005	126,201	99,493	73,340	0
140	PRS005 - 140V1- 140V2 - 140V4- 140V5- 140V6	126,201	99,493	73,340	0
Caversham					
105	EPLV1 - EPLV2	80,000	58,000	55,000	1,900
105	EPLV2 -EPLV2A - EPLV5 - 105V1- EPLV11 - EPLV7	80,000	58,000	55,000	1,900
107/105	GS007 - EPLV10 - EPLV15 -EPLV16 - EPLV1	80,000	58,653	55,823	27,558
106	GS007 - EPLV9 - PRS009	80,000	58,653	55,823	27,558
Bunbury					
104	GS017 - MLV156 - MLV157A - 56V10- 104V1- 104V6 - MLV158	37,125	37,125	37,125	37,125

Note: Bunbury is a sole fed network and as such, the potential customer impact remains constant regardless of the consumption conditions. The Two Rocks network however is highly sensitive to network consumption.

In the event that pipeline isolation occurs, the duration of customer impact will influenced by whether or not positive pressure is maintained within the network.

In the event that ATCO have suitable time to enact a curtailment plan and isolate customers on the impacted networks, the time off gas for curtailed customers will be effectively limited to the time taken to repair the pipeline (3 days).

In the event that ATCO do not have suitable time to enact a curtailment plan, positive pressure will be lost to impacted parts of the network. In this instance, the time off gas will be significantly longer due to the requirement to isolate, purge and reconnect the network prior to reconnecting customers.

For the purpose of this assessment, ATCO have assumed that two hours is the minimum time required to implement actions which may result in effective curtailment of the network. During peak winter conditions (approx. 6 hours per day, 120 days per year), the Two Rocks, Bunbury and Caversham networks would lose positive pressure within 40, 95 and 100 minutes respectively.

Peak winter conditions occur for approximately 8.25% of the year, therefore the probability of pipeline segment isolation per year can be multiplied by the Risk Reduction Factor of 0.0825 to obtain a probability of loss of positive pressure occurring on the network.

Note: For Two Rocks, the 2017 Remote Control Isolation Valve Project enables ATCO to remotely curtail parts of the Clarkson, Two Rocks, Carramar and Wanneroo networks. Remote isolation of 38,535 customers during high consumption conditions prevents loss of supply to 126,201 customers. It is assumed in the below assessment that ATCO will be able to respond remotely within 40 minutes to isolate the 38,535 customers and prevent further loss of supply. During peak winter conditions however (8.25% of the time), positive pressure will likely however be lost to the isolated 38,535 customers.

The outcome of this assessment is provided in **Table 4-2**.

Table 4.2 Peak Winter Supply Risk Assessment Outcomes

Pipeline	Segment	Customer Impact (CC1)	Customer Weeks Lost (CC1)	Frequency Loss of Positive P	Risk Rank
Two Rocks					
91	GS005-PRS005	38,535	136,319	7.76×10^{-6}	High
140	PRS005 - 140V1- 140V2 - 140V4- 140V5- 140V6	38,535	136,319	3.13×10^{-6}	High
Caversham					
105	EPLV1 - EPLV2	80,000	560,560	1.52×10^{-6}	High
105	EPLV2 -EPLV2A - EPLV5 - 105V1- EPLV11 - EPLV7	80,000	560,560	1.15×10^{-6}	High
107/105	GS007 - EPLV10 - EPLV15 -EPLV16 - EPLV1	80,000	560,560	8.25×10^{-7}	Intermediate
106	GS007 - EPLV9 - PRS009	80,000	560,560	1.35×10^{-6}	High
Bunbury					
104	GS017 - MLV156 - MLV157A - 56V10- 104V1- 104V6 - MLV158	37,125	127,127	4.83×10^{-6}	High

For the remaining 91.71% of the year, any pipeline isolation event would potentially have adequate response time (>2 hours) to begin to enact a curtailment plan and prevent loss of positive pressure on the network. In this event, the number of customers impacted would remain curtailed for the time taken to repair the pipeline (3 days).

The number of customer weeks lost in these instances are provided in **Table 4-3**:

Table 4.3 Supply Impact Positive Pressure Maintained Customer Weeks Lost

Pipeline	Segment	Customer Weeks Lost (CC1)	Customer Weeks Lost (CC2)	Customer Weeks Lost (CC3)	Customer Weeks Lost (CC4)
Two Rocks					
91	GS005-PRS005	54,086	42,639	31,431	0
140	PRS005 - 140V1- 140V2 - 140V4- 140V5- 140V6	54,086	42,639	31,431	0
Caversham					
105	EPLV1 - EPLV2	34,285	24,857	23,571	814
105	EPLV2 -EPLV2A - EPLV5 - 105V1- EPLV11 - EPLV7	34,285	24,857	23,571	814
107/105	GS007 - EPLV10 - EPLV15 -EPLV16 - EPLV1	34,285	25,137	23,924	11,810
106	GS007 - EPLV9 - PRS009	34,285	25,137	23,924	11,810
Bunbury					
104	GS017 - MLV156 - MLV157A - 56V10- 104V1- 104V6 - MLV158	15,910	15,910	15,910	15,910

All customer week lost impacts in the event that positive pressure can be maintained on the network are less than 100,000 and therefore a not considered catastrophic.

While the probability of a strike resulting in supply impact remains Remote, the consequences in terms of Customer Weeks Lost is now considered Severe (2000 to 50,000 Customer Weeks Lost), or Major (50,000 to 100,000 Customer Weeks Lost). This results in Intermediate or Low supply risk.

As such, the High risk outcomes are driven by the probability that positive pressure will be lost in the event of a pipeline puncture for 8.25% of the year.

4.2 Concrete Slabbing and Pipeline Patrol Risk Reduction

ATCO's original supply risk assessment identified that the risk reduction afforded by concrete slabbing and patrolling was not adequate to reduce the probability of a pipeline puncture from Remote to Hypothetical, as illustrated in Section 3.1.4.

An additional RRF has now been applied to the frequency to better account for and refine the times of year that a pipeline puncture would not result in a loss of positive pressure to the network. Due to this additional RRF, the risk reduction now afforded by concrete slabbing and additional pipeline patrol is now adequate to feasibly reduce High supply risk to Intermediate.

Results of supply risk with either pipeline slabbing or daily patrol included as a control is presented in **Table 4-3**.

Table 4.4 Risk Reduction from Slabbing and Daily Pipeline Patrol

Pipeline	Segment	Frequency Loss of Positive Pressure	Frequency With Slabbing	Frequency with Daily Patrol	Risk Rank (For either patrolling OR slabbing)
Two Rocks					
91	GS005-PRS005	7.76×10^{-6}	7.76×10^{-7}	5.97×10^{-7}	Intermediate
140	PRS005 - 140V1- 140V2 - 140V4- 140V5- 140V6	3.13×10^{-6}	3.13×10^{-7}	4.17×10^{-7}	Intermediate
Caversham					
105	EPLV1 - EPLV2	1.52×10^{-6}	1.52×10^{-7}	2.03×10^{-7}	Intermediate
105	EPLV2 -EPLV2A - EPLV5 - 105V1- EPLV11 - EPLV7	1.15×10^{-6}	1.15×10^{-7}	1.53×10^{-7}	Intermediate
107/105	GS007 - EPLV10 - EPLV15 -EPLV16 - EPLV1	8.25×10^{-7}	8.25×10^{-8}	1.10×10^{-7}	Intermediate
106	GS007 - EPLV9 - PRS009	1.35×10^{-6}	1.35×10^{-7}	1.80×10^{-7}	Intermediate
Bunbury					
104	GS017 - MLV156 - MLV157A - 56V10- 104V1- 104V6 - MLV158	4.83×10^{-6}	4.83×10^{-7}	6.43×10^{-7}	Intermediate

As such, the revised Security of Supply Business Cases include both concrete slabbing and daily patrolling as options for consideration.

4.3 Risk Assessment Review

Supply risk assessments will be reviewed on a periodic basis in line with Formal Safety Assessment (FSA) review requirements to determine whether changes to the configuration or growth of the network have significantly impacted supply risk over time.

In addition, ATCO will continue to refine the supply risk assessment methodology to take curtailment options into consideration and further study how operational response can impact the supply consequence.

5. REFERENCES

1. Economic Regulation Authority, Final Decision on Proposed Revisions to the Access Arrangement for the Mid-West and South-West Gas Distribution Systems, 30 June 2015, As amended on 10 September 2015

2. *TCO RP 0253 HP Steel Pipeline Semi-Quantitative Risk Assessment (Methodology)*
3. AS/NZS 4645.1:2018 Gas Distribution Networks Part 1: Network Management
4. *Economic Regulation Authority, Draft Decision on the Proposed Revisions to the Mid-West and South-West Gas Distribution System Access Arrangement for 2020 to 2024, Submitted by ATCO Gas Australia, 18 April 2019*
5. *EMCa, ATCO Gas Australia Proposed Access Arrangement for the Mid-West and South-West Gas Distribution Systems, Review of Technical Aspects of the Proposed Access Arrangement, March 2019*
6. AS/NZS 2885.6:2018 Pipelines – Gas and Liquid Petroleum Part 6: Pipeline Safety Management
7. *TCO RP 0379 AA5 Risk Management Approach Response*
8. ATCO Gas Australia, Gas Distribution System Safety Case, Rev 6, TCO PL00005, 01/12/2017.
9. M.A Cabral, M.J Kimber, Pipeline Fracture Experiences in Australia and North America, Version 3, 10 August 1997
10. Government of South Australia, Department for Manufacturing, Innovation, Trade, Resources and Energy, Annual Report of the Technical Regulator, Gas 2011-12
11. Allgas, Wednesday 13 June 2018, Gold Coast Gas Supply Interruption Update, http://allgas.com.au/wednesday-13-june-2018-gold-coast-gas-supply-interruption-update/
12. Australian Gas Networks, Access Arrangement Information, For Australian Gas Networks' South Australian Natural Gas Distribution Network, July 2015. (https://www.aer.gov.au/system/files/Australian%20Gas%20Networks%20-%20Access%20arrangement%20Information%20-%20July%202015.pdf
13. ATCO Gas Australia, Safe Work Instruction, Commission Mains, Rev 5, 2016.
14. Government of South Australia, Department of State Development, Annual Report of the Technical Regulator Gas 2014/15, http://www.energymining.sa.gov.au/__data/assets/pdf_file/0005/315428/OTR-Annual-Report-2015-gas.pdf, accessed 14 May 2019.
15. Government of South Australia, Department for Manufacturing, Innovation, Trade, Resources and Energy, Annual Report of the Technical Regulator, Gas 2011-12.

6. DOCUMENT APPROVAL

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