



**Report for  
Hall & Wilcox and APA Group**

# **Wollert Precinct Structure Plan - Implications for APA Pipelines**

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## DISCLAIMER

Risk can be minimised but not eliminated. This report should not be construed as implying that pipeline failure and the resulting consequences are impossible.

The conclusions of this report may depend on effective implementation of recommendations made in it. Peter Tuft & Associates has no control over implementation of those recommendations and is not responsible for consequences flowing from shortcomings in their implementation.

## 1 INTRODUCTION

This report has been prepared in response to a request from Hall & Wilcox. APA Group owns pipelines and other assets in the area affected by the proposed Wollert Precinct Structure Plan. The land use changes proposed under the PSP have implications for the safety of the pipelines and the public. Pipeline safety is addressed by Australian Standard AS 2885, Pipelines - Gas and Liquid Petroleum, and particularly by Part 1 of that Standard (AS 2885.1, Design and Construction). This report contains my advice on the following matters:

- (a) Description of APA's pipeline assets within the Wollert PSP
- (b) Application of AS 2885 to the pipelines within the Wollert PSP
- (c) Implications for the pipelines of the proposed changes in surrounding land use and urban development
- (d) Comment on development of policy by the Australian Pipelines and Gas Association regarding urban development around pipelines
- (e) Recommendations for use of land surrounding the pipelines in accordance with AS 2885

Failures of high pressure gas pipelines are extremely rare, particularly in Australia. In fact there has never been a death or serious injury to a member of the public in Australia as a result of failure of a transmission pipeline. Nevertheless the consequences of a worst-case failure are potentially devastating if it occurs in a populated area where multiple fatalities may be possible. Notable examples overseas are 24 deaths and 150 serious injuries at Ghislenghien (Belgium) in 2004 and eight deaths at San Bruno (California) in 2010. For this reason AS 2885 considers the safety of pipelines to be paramount and pipeline companies in general are deeply concerned to maintain the highest levels of safety.

## 2 PERSONAL BACKGROUND AND EXPERTISE

I have worked as a pipeline engineer since 1985 and have been a self-employed consultant since 1995. For the first 15-20 years of my time in the industry I worked primarily on design of new pipelines with major responsibilities for a number of large projects. In the latter part of my career I have tended to specialise in pipeline risk assessment and safety management.

Since approximately 2002 I have been a member of Standards Australia sub-committee ME-038-01, the committee responsible for AS 2885.1 (and also AS 2885.0, General Requirements). As a member of that committee I played a role in the major revision of the Standard published in 2007 and subsequently revised slightly in 2012. I took a particular interest in the risk assessment (safety management) aspects of the Standard as well as some more analytical subjects.

In mid-2013 I took over chairmanship of sub-committee ME-038-01 and also become a member of Standards Australia committee ME-038, the "main committee" responsible for the full AS 2885 suite plus some related Standards. The ME-038-01 sub-committee is currently working on another major revision of Part 1 including particularly the safety management requirements.

## 3 APA PIPELINES NEAR WOLLERT

APA Group owns three pipelines and a major compressor station near Wollert, of which two pipelines are affected by the Wollert PSP. The APA assets are key parts of the system for transporting natural gas to Melbourne and northern and western Victoria.

The pipelines relevant to this report are the Pakenham to Wollert Pipeline, which transports gas originating in the Bass Strait gas fields for distribution to northern Melbourne and northern Victoria, and the Wollert to Keon Park Pipeline which transfers some of that gas to northern Melbourne.

Details of these pipelines, as advised by APA Group, are:

Pipeline	Pakenham - Wollert	Wollert - Keon Park
Diameter, mm	762	610
Wall thickness, mm	10.6 & 12.7	7.9 & 9.5
Steel grade	API 5L X60	API 5L X42
Max allowable operating pressure, kPa	7070	2760
Measurement length, m	708	377
Critical defect length, mm	185	298

The last two rows in the table require some explanation:

Measurement length is a term defined by AS 2885.1. It is the distance from the pipeline at which the radiation intensity from an ignited full-bore rupture is 4.7 kW/m<sup>2</sup>. An unprotected person exposed to this radiation level for a short period (around a minute) is likely to be hospitalised for a long time with severe burns. AS 2885.1 requires that land use within this distance from a pipeline be taken into consideration in developing pipeline protection measures, and by the same token changes in the land use within this distance must also be considered. (Note that radiation intensity increases strongly as distance from the fire decreases and would be extremely high in close proximity to an ignited release. AS 2885.1 also mentions a radiation level of 12.6 kW/m<sup>2</sup> representing the level at which an unprotected person is likely to receive fatal burns after short exposure. However use of this higher radiation intensity is only for assessing consequences of failure during risk assessment; it has no explicit significance in land use assessment.)

The critical defect length is the length of through-wall defect (hole or crack) above which the remaining metal is unable to contain the internal pressure and the pipe will peel open to a full-bore rupture with gas discharging from the two open ends. Holes shorter than the critical defect length will result in a leak (possibly very large) rather than a rupture. It is evident that the critical defect lengths for these pipelines are large. It would be difficult to create holes of this size in a pipe of this wall thickness, meaning that it would be difficult to cause these pipelines to rupture.

## 4 AS 2885 REQUIREMENTS

### 4.1 General

Clause 1.3 of AS 2885.0 (General Requirements) sets out the basis of the Standard. Key items in that clause are:

The fundamental principles on which the Standard is based are:

- (a) The Standard exists for—
  - (i) the safety of the general public and pipeline personnel;
  - (ii) the protection of the environment; and
  - (iii) security of supply.
- (b) The Licensee is responsible for the safety of the pipeline.
- (c) All threats to a pipeline are to be identified and either controlled or the associated risks shall be evaluated and managed to an acceptable level.
- ...
- (h) Where changes occur in or to a pipeline or its surroundings, which alter the design basis or affect the original integrity, appropriate steps are to be taken to assess the changes and where necessary implement modifications to maintain safe operation of the pipeline.

Similarly, Clause 4.1 (Basis of Section) of AS 2885.1 (Design and Construction) lists aspects to be considered in pipeline design, construction and operation and begins with the statement that "Safety of the pipeline and public is paramount".

## 4.2 Location Classification and Safety Management

AS 2885 generally takes a risk-based approach. In common with virtually all pipeline codes around the world it addresses issues of land use and population density through location classification. Primary location classes are broad rural (designated R1), rural residential (R2), suburban (T1) and high density (T2), as defined in Clause 4.3.4 of AS 2885.1; every point on a pipeline must be assigned a primary location class. There are secondary location classes that reflect special or atypical land uses where applicable. Secondary location classes relevant to the Wollert PSP include sensitive use (S), industrial (I) and possibly common infrastructure corridor (CIC). Sensitive land use is for "... sectors of the community who may be unable to protect themselves from the consequences of a pipeline failure. ... include schools, hospitals, aged care facilities and prisons ..." (Clause 4.3.5(a)).

Location class is based on the land use within the measurement length (described in Section 3 above). The wording in the Standard may be slightly ambiguous but careful reading shows that the intention is for the location class to be set by the highest land use within the measurement length, even if that is not the dominant land use (see AS 2885.1, Clause 4.3.3). That applies particularly to the Sensitive location class which is required to apply wherever there is *any* sensitive land use within the measurement length.

Roads are considered to be part of the general land use and do not require special treatment in the location classification process, with one exception. Where a pipeline runs along a road (as opposed to the more usual situation of only crossing roads) a special secondary location class of Common Infrastructure Corridor (CIC) is required. CIC also applies where a pipeline runs parallel to other infrastructure such as power lines, other pipelines, etc. The only significance of the CIC location class is that the pipeline company should make best endeavours to reach an agreement with other parties in the corridor (e.g. the road authority) for mutual protection of their assets.

Regardless of location class, AS 2885 mandates a safety management study (SMS) which must be undertaken at multiple points in the life cycle of a pipeline including whenever there is a land use change. The SMS process involves considering all identifiable root causes of pipeline failure, mitigating them to the extent possible, and assessing the residual risk of those that cannot be eliminated. Risks are assessed via a risk matrix that takes as inputs the likelihood of the event and the severity of the consequences, leading to a risk rank that may be Negligible, Low, Intermediate, High or Extreme. High and Extreme risks are not acceptable and must be reduced. An Intermediate risk is only borderline tolerable and can be accepted only if it is shown to be As Low As Reasonably Practicable (ALARP).

The SMS must be validated by a workshop of relevant stakeholders including engineers, operations personnel, land and community liaison personnel and possibly other specialists from the pipeline company plus, in some cases, external stakeholders. The completed SMS must be approved by the pipeline Licensee (a defined term in AS 2885, usually represented by a senior executive).

## 4.3 Change of Location Class

Clause 4.7.4 of AS 2885.1 specifically addresses change of land use along existing pipelines. It requires that where the use changes to "... Residential, High Density, Industrial, or Sensitive ... in areas where these uses were previously prohibited, a safety assessment shall be undertaken and additional control measures implemented until it is demonstrated that the risk from a loss of containment involving rupture is ALARP."

## 5 APPLICATION OF AS 2885 TO WOLLERT PIPELINES

The pipelines passing through the area of the Wollert PSP have to date existed in a rural environment. Implementation of the developments proposed by the Wollert PSP will invoke the requirement of AS 2885 for a revised safety management study. That SMS must consider the land use change and because the new location class will be at least Residential (and possibly Sensitive or High Density) it must show that the risk of rupture is ALARP.

The pipeline Licensee has undertaken an SMS to address the change in land use that would occur under the Wollert PSP. The report concludes that "... the Pakenham to Wollert and Wollert to Keon Park Natural Gas Pipelines will continue to be in compliance with the SMS requirements of AS2885.1-2012 in the area located within the 'revised' Wollert Precinct Structure Plan", subject to some relatively minor qualifications concerning further work. I have seen nothing in the report that would cast doubt on this conclusion, nor am I aware of any shortcomings or omissions in the report that would materially affect this conclusion.

I do disagree with some of the location classifications in the SMS report which involve a significant misinterpretation of the AS 2885 requirements. The most significant is the statement that there may be some Sensitive land uses (details undefined) within the industrial area between Andrew and Epping Roads but "... this is not the dominant use of land in this area and therefore these areas do not require the sensitive classification." That is not correct - **any** Sensitive land use within the measurement length requires the S location classification. The Pakenham to Wollert pipeline in the relevant area happens to meet the requirements that apply to a Sensitive location class so fortunately this error has no practical implications. Later in this report I discuss the undesirability of Sensitive uses near the pipeline, regardless of compliance with the current AS 2885 rules. (There are other location classifications in the report that I also consider to be in error but they err in the direction of being more conservative than necessary so are not material.)

The report does not clearly state that the risk of rupture is ALARP as required by AS 2885.1 Clause 4.7.4. However that conclusion can be inferred from other statements in Section 4.9 of the report. It is also supported by calculations that I have done independently.

Overall, the pipelines would continue to comply with the requirements of AS 2885.1 if the Wollert PSP is implemented. Nevertheless, as discussed below it is highly desirable that within the measurement length there are no future sensitive or high density developments (schools, pre-schools, hospitals, aged care facilities, large retail premises, cinemas, places of assembly, etc). In my opinion best practice would be for the Wollert PSP to monitor and control developments of this type within the measurement length. It would also be highly desirable for the pipeline Licensee to be consulted about any application for a development that be classed as sensitive or high density.

## 6 IMPLICATIONS OF CHANGED LAND USE

Increasing population density around a high pressure pipeline has implications that can be categorised as either:

- Subject to specific requirements in AS 2885
- Good practice, covered by the more general obligation to maintain safety as nominated in Clause 1.3 of AS 2885.0 (see Section 4.1 above)

Compliance with the specific requirements of AS 2885 has been discussed in the previous section. In this section I will discuss the more general implications of changed land use.

The risk from pipeline failure decreases with increasing distance from the pipeline but there is no precisely defined separation which can be said to be "safe". The measurement length is somewhat arbitrary for two reasons:

- The calculation method provided in AS 2885.1 is based on a large number of generalisations and assumptions, many of which are listed in Appendix Y of AS 2885.1 and others relate to unknowable details of an individual failure (operating pressure at the time, wind speed and direction, effect of crater shape on gas jets, etc). The values derived from AS 2885.1 are at best rough approximations.
- The measurement length does not define a "safe" distance. If there is an ignited full bore rupture an unprotected person at that distance may suffer very severe burns but people who remain within buildings will almost certainly be unharmed. Increasing or decreasing the separation changes the harm that may occur at that location but it would be wrong to believe that harm cannot occur outside the measurement length or that it will necessarily occur within it.<sup>1</sup>

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<sup>1</sup> Nevertheless it is worth noting that on balance the measurement length is conservative and serious harm outside it is unlikely unless there are people present who are both unprotected and unable to flee.

Hence it is wrong to assign undue significance to the measurement length and misleading to define it with excessive precision.

More generally, risk assessment as a whole is very imprecise. Apart from anything else it can only consider foreseeable events. The significance of unforeseen failure modes becomes relatively greater as risk management reduces the risk from identifiable failure modes towards very low levels. Some well-known major disasters were a result of failures that were unforeseen by those responsible for managing the assets involved. Examples include the Longford gas plant explosion of 1998, the World Trade Centre attacks in 2001 and the 2010 San Bruno pipeline failure in California. (Being unforeseen by those responsible is not the same as unforeseeable by anyone, but it is the knowledge of those responsible that counts.) This concept has been popularised as “black swan” events by Taleb’s book of the same name; swans other than white were simply unforeseeable to Europeans until the exploration of Western Australia.

For these reasons it is desirable to maximise the separation of potentially vulnerable populations from pipelines. Taken to extreme this would lead to huge depopulated buffer zones around all pipelines, which is clearly not practical. Rather, maximising separation is a principle that should be adopted wherever it can be implemented without unreasonable difficulty. In other words, putting high concentrations of people close to a pipeline without a compelling reason is unwise. Should a catastrophe occur, those responsible for developments close to a pipeline may be found by a subsequent inquiry to have contributed to the disaster.

There is a loose parallel with planning for urban development near flood-prone rivers. It seems to be generally accepted that urban development within the 100-year flood level is not acceptable because of the risks to property and life. However the analogy between risks due to rivers and pipelines is not perfect because flood prediction, although somewhat uncertain, is more precise than prediction of pipeline failure and subsequent consequences. In particular the area inundated by a flood of given frequency can be clearly defined and has a discrete boundary (safe above, hazardous below), unlike the hazard area around a pipeline which is both less precise and a continuous gradient of potential harm. The greater uncertainty around pipeline failures suggests greater caution is necessary.

The principles discussed here lead to my recommendations in Section 8.

## 7 RELEVANT INDUSTRY POLICIES

### 7.1 APGA Pipeline Corridor Committee - Notification Zone

The Australian pipeline industry has been concerned for many years about the lack of control over urban development close to pipelines, particularly around pipelines that are not designed for urban conditions. In 2010 the Australian Pipelines and Gas Association (APGA) formed a Pipeline Corridor Committee (PCC) to develop policy in this area and to seek change to land use planning processes around pipelines.

The key platform of the PCC is the establishment of a notification zone, described in the following extract from the *APGA Proposal for Notification Zones*:

It is proposed to implement a notification zone around pipelines to ensure that high pressure pipelines are given due consideration in planning decisions. The presence of the notification zone would inform planning authorities and development proponents of the need to consider public safety around the pipeline when considering planning policy amendments and development applications.

The notification zone will establish an area around a pipeline where the pipeline will be informed of planning and development proposals that have the potential to change a land use classification for a pipeline. In effect, it would give a pipeline operator an opportunity to comment on proposals and enter a dialogue with the proponent to assess risks the development proposes to a pipeline. Early engagement allows greater opportunity to modify developments to achieve ALARP. Typically, the later the dialogue with a pipeline operator commences, the less flexibility there is to change aspects of design that could achieve a better ALARP outcome.

The notification zone concept must be implemented across the whole planning regime including high level state planning, regional planning managed by councils and development applications within planning zones that may impact locally on the pipeline safety profile.



The essence of the proposal is contained in its name - it seeks only to ensure that pipeline companies are notified of developments within the measurement length so that they have the opportunity to participate in the normal planning process rather than finding out about planning decisions after they have already been made.

Some egregious failures of planning around pipelines in both the distant and more recent past may have been avoidable if pipeline owners had been informed and given the opportunity to become involved. The Pipeline Corridor Committee is seeking to minimise the likelihood of such failures occurring again.

If establishment of a notification zone requires legislative change then it is probably outside the scope of the Wollert PSP. Nevertheless this proposal indicates the agreed position of the Australian pipeline industry on management of urban development around pipelines.

It would be desirable for the Wollert PSP to as far as possible incorporate the principle that the pipeline Licensee should be notified of all development applications so that they have the opportunity to review and comment on any that may increase the consequences of a pipeline failure. This would not eliminate risk but the potential for further increase in the consequences of pipeline failure could be reduced if the pipeline Licensee is given the opportunity to make submissions on proposed developments.

## 7.2 Possible changes to AS 2885.1 - consequence-only risk management

The committee responsible for AS 2885.1, which I chair, is considering possible introduction of a consequence-only approach to assessment and management of pipeline failures that have potential to cause serious harm to multiple people (i.e. in populated areas). Under the current Standard, and consistent with risk management practice generally, risk assessment considers both consequences and likelihood as described earlier (Section 4.2). In this way failures that have catastrophic consequences but very low probability can be tolerated if the overall risk (combination of consequences and probability) is low enough and the risk is shown to be as low as reasonably practicable (ALARP).

The proposal under consideration would remove low likelihood as an automatic justification for tolerating high-consequence failures. The objective is to reduce harm due to unforeseen "black swan" failures. There is a lot of other detail in this proposal including particularly a due-diligence obligation on senior company officers to satisfy themselves that the risks are tolerable. However the relevance to the Wollert PSP is that the pipeline industry is seriously considering low-likelihood/high-consequence failures and contemplating further steps to minimise those consequences. Bringing increased populations close to a pipeline, particularly high concentrations of population or groups of vulnerable people, is contrary to that approach.

## 8 RECOMMENDATIONS

To maintain best practice pipeline safety I recommend as follows:

- The Wollert PSP should maximise separation of all population concentrations from the pipeline, particularly land uses that would be classed as High Density or Sensitive.
- Future developments that would create High Density or Sensitive location class should not be permitted; i.e. preschools, residential health care facilities, etc should be prohibited within the measurement length.
- The pipeline Licensee should be notified of development applications within the measurement length so that they have the opportunity to make a submission on the implications for pipeline safety and the consequences of pipeline failure.
- Activities that pose the most significant threats should be prohibited near the pipelines (e.g. horizontal directional drilling, rippers, etc, as recommended by the safety management study). Consideration should be given to making the exclusion zone somewhat wider than the easement, and all horizontal drilling towards pipelines should be prohibited unless special arrangements are made with the pipeline Licensee.
- The restrictions recommended above should be explicitly linked to pipeline safety so that future revision of planning rules is less likely to dilute them.

The first of the above points appears to be largely covered by the current version of the PSP. It shows that all proposed educational facilities are outside the measurement length, the

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proposed town centres are mostly outside the measurement length, and specifies that future retirement living and aged care facilities must be outside the measurement length although it fails to control other types of sensitive land use.

The remaining recommendations above have not yet been addressed by the PSP, which should be amended to constrain the future location of all types of sensitive and high density developments, to control activities near the pipeline, to keep the pipeline Licensee fully informed, and to explicitly link all of these items to pipeline safety.

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I have made all the inquiries that I believe are desirable and appropriate and no matters of significance which I regard as relevant have to my knowledge been withheld from the Panel.