How Safe & Reliable are Our Pipelines?

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1 INTRODUCTION

Since the Australian natural gas pipeline industry began in 1969, its participants have been committed to good, high quality pipeline design, construction and operation. During the first few years after 1969, the pipeline industry relied primarily upon the United States for its design, construction and operational standards for petroleum pipelines in the form of ASME B31.4 and B31.8. Between 1969 and 1972, pipeline engineers developed an Australian Standard – CB28 – 1972 – for gas pipelines, which was, to all intents and purposes, a copy of the relevant US standards, and did not reflect Australian conditions.

During the early years of the 1980s, the next edition of the Australian Pipeline Standard was completed – AS1697–1981. While this new standard better reflected Australian conditions, it still bore a strong resemblance to the US standard. Local research into pipeline technology continued to be a low priority for the Australian pipeline industry. It was prepared to be a follower, rather than a leader.

A change in attitude to research began to appear in the mid to late 1980s. Membership of the US-based Pipeline Research Committee by both the Commonwealth Pipeline Authority and the Pipelines Authority of South Australia encouraged both organisations to send their pipeline engineers to meetings in the US, Canada and Europe. These engineers began to compare the overseas research programs with Australian needs and to redirect our research to better suit the local environment. In addition, contacts with their peers in other countries taught the Australian engineers new skills, which they applied to Australian pipelines.

Perhaps the most significant aspect of this improved perspective was a clear intention by a small number of pipeline engineers to develop the Australian pipeline standards according to the “laws of nature” rather than the earlier paradigm of “laws of man”. That is, to apply the outcomes of research and intelligent application of science and mathematics to setting standards, rather than relying upon empiricism and rules of thumb. This new approach was first implemented through AS2885-1987.

But the new approach came at a price. The Australian pipeline standard became less of a recipe book and more of a standard that set down principles and processes that relied upon the skills and experience of pipeline engineers and technicians to implement them in design, construction and operation of pipelines. At that time the Australian pipeline industry had the required skills and experience. This may not be the case now.

From 1987 onwards, the Australian pipeline industry placed more and more emphasis on research and its translation into the Australian Standard. Membership of the Pipeline Research Committee was continued by several companies until the mid-1990s, but ultimately the new owners of the pipelines decided that economies could be made by discontinuing membership. Many firms thought that their US or Canadian part-owners would bring the results of research with them, and that those results could be applied here. Unfortunately for the Australian pipeline industry, the overseas owners often forced a regressive approach – that is, back to the recipe book. Further, the intellectual stimulation for our Australian pipeline engineers provided by membership of international research organisations was stopped. We became a branch office, subject to the dictates of overseas principals. But for the APIA's Pipeline Research Program, and the dedication of a very small and diminishing band of pipeline engineers, that is where we would still be today.

2 THE AUSTRALIAN PIPELINE RESEARCH PROGRAM

Co-operative research into pipeline coatings and cathodic protection was undertaken by engineers from pipeline owners and coating companies from the early 1980s. Testing methods and ranking studies for coatings were done in the owners' and coating companies' laboratories which greatly benefited pipeline industry's corrosion mitigation and protection programs and procedures.

Since 1996, the Australian pipeline industry, represented by members of APIA, has contributed $2,150,000 in cash and $3,800,000 of in-kind to an industry-wide research program that has addressed almost every facet of the life cycle of high pressure gas and liquid petroleum pipelines. The value of the research program to the Australian industry has been estimated to be in excess of $200 million in savings in capital costs and improved efficiencies in design, construction and operation of Australia's long distance pipelines.

The results of these, and other research projects, have found their way into the various Australian standards that are still in use today. The approach of applying the laws of nature was increasingly implemented, and the resulting Standards were more practical and led to a lowering of costs of pipeline ownership.

3 INTERNATIONAL RECOGNITION

The author had been concerned that changes to the ownership and management of Australian pipelines were likely to result in increasing technical isolation. To counter this problem, and with the support of the APIA, the author worked with his colleagues in the two pre-eminent pipeline research groups in North America and Europe – the Pipeline Research Council-International (PRC-I) and the European Pipeline Research Group (EPRG) – to develop co-operative arrangements to share the results of pipeline research work.

In September 2002, the three organisations signed an memorandum of understanding to share, on a confidential basis, the results of their research programs. This ensures that the Australian pipeline industry has access to the most up to date technical data.

4 THE AUSTRALIAN PIPELINE STANDARD

There is considerable evidence that the Australian Standard for Gas and Liquid Petroleum Pipelines, AS2885, is one of the best, if not *the* best, petroleum pipeline standard in the world. Why is this so? The reasons were encapsulated in an Australian paper presented to a conference in Yokohama[1] and also the Joint Technical Meeting in Berlin, which stated:

The suite of Standards that makes up the Australian Standard AS2885 "Pipelines – Gas and liquid petroleum" has been benchmarked against equivalent international and national Standards including ASME B31.8, CSA Z662, ISO 13623, API 1104, and ISO 13847. The benchmarking shows that AS2885 is superior in many detailed technical respects to its counterparts elsewhere, and that it better represents the current international state of the art in the design, construction, testing, operation and maintenance of petroleum pipelines. It is accepted by all of the stakeholders as the

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[1] Fletcher L., Venton P., Kimber M., Haddow I., Bilston K., *Australian Standard AS2885: A modern Standard for design, construction, welding, operation and maintenance of high integrity petroleum pipelines*, International Conference on the Application and Evaluation of High-Grade Pipelines in Hostile Environments Hotel Pacifico, Yokohama, JAPAN November 7-8, 2002 [also presented to the Joint Technical Meeting in Berlin 20-22 May 2003]

single and sufficient set of technical requirements. It uses an integral risk assessment and threat mitigation process in design and for the whole of the life of the pipeline in operation and maintenance. It has explicit requirements for the design, documentation, and approval of key processes such as prevention of external interference, control of fracture, and welding procedure qualification. And it assigns responsibility for the key processes to suitably qualified, experienced, and trained people who take responsibility for their actions in writing.

5 THE FUTURE – WHERE TO FROM HERE?

Since the Australian pipeline industry has a robust research program and has a world class Standard for the design, construction and operation of our pipelines that makes them cost competitive to build and operate, one might conclude that the future for the engineering and technical aspects of our pipeline industry must be assured. Unfortunately, that conclusion is seriously in error. The reason for this is quite simple – the pipeline industry has become de-skilled, and very few pipeline companies are doing much to redress the loss of skills.

The application and administration of the Australian Standard, AS2885, requires engineering skills and experience. Our pipelines are high pressure, highly stressed pressure vessels and are extremely safe and efficient transporters of energy if they are designed, built and operated according to that Standard. Pipeline owners want to drive costs lower and the current Standard and pipelines legislation allow this to happen, but the price for lower costs is intelligent engineering at all stages in the life of a pipeline.

Pipeline owners and maintenance contracting organisations have progressively de-skilled their operations in pursuit of labour cost reductions without making the link between pipeline safety and integrity, and specialised skills. Clear evidence of the disastrous effect of this was the failure of Esso's Longford Gas Plant. The Longford Royal Commission found[2]:

Until 1991, engineers were stationed at Sale and worked at the Longford plant daily. In doing so, they had a close involvement with the ongoing operation of the plant and constant interaction with operations personnel. This placed them in an ideal position to monitor the plant operating conditions and operator practices.

In 1992, Esso relocated all its plant engineers to Melbourne as part of a restructuring of the company. . . . . .

The physical isolation of engineers from the plant deprived operations personnel of engineering expertise and knowledge which previously they gained through interaction and involvement with engineers on site. . . . . . .

The relocation of engineers qualified as a permanent change to operating practices requiring risk assessment and evaluation before implementation in conformity with Esso's management of change philosophy. Yet such relocation was implemented without any such assessment ever taking place.
There were no experienced engineers on site at the time of the accident on 25 September 1998. Expert knowledge from that source, of plant operating parameters, of the metallurgical limits of equipment and vessels..... [was] absent.

The dangers inherent in this type of management approach have been highlighted by a number of authors[3] commenting on the way in which complex organisations manage complex facilities. In

[2] Longford Royal Commission, *The Esso Longford Gas Plant Accident – Report of the Royal Commission No 61 – Session 1998-98*, June 1999, p. 209

[3].Hopkins, A, *Lessons from Longford - The Esso gas plant explosion*. 2000.CCH Australia Ltd, ISBN 186468 422 4;

particular, Perrow, Spiekhout[4] et al. and Hopkins refer to "High Reliability Organisations" (HRO) and conclude that high pressure gas pipeline companies fit into this category. HROs demand special management and skills.

Hopkins states: *The preoccupation of HROs with failure means that they are willing to countenance redundancy - the deployment of more people than is necessary in the normal course of events so that there are enough people on hand to deal with abnormal situations when they arise.*

Spiekhout et al. paraphrase Hopkins as follows:

High-reliability organizations (HROs) are aware of the importance of learning from 'near misses' and 'incidents'. . . . . . "They [HROs] act as if there is no such thing as a localised failure, and suspect instead that causal chains that produced the failure are long and wind deep inside the system".

Hopkins observes that a consequence of this attitude is that the maintenance departments in such organisations lie at the heart of 'the learning organisation'. This is because maintenance people are the people who are in direct contact with the infrastructure, and can highlight possible hazards at an early stage. Making good use of this information requires a powerful vehicle for providing communication between maintenance personnel and management. Important aspects of good communication between these different levels in the organisation are the feedback to the originator of a report and the commitment to the scheme demonstrated by senior management. In the case of Piper Alpha, the management adopted a passive attitude of 'no news is good news'. Safety monitoring was delegated to line management, and information from investigations of incidents and accidents was slow to reach those who were actually involved in doing the work.

At the Esso plant in Longford the incident reporting system was used to report lost time injuries. In Hopkins' view, the use of this system undermines its value for disaster prevention. In the Esso case, the focus on lost-time injuries led to a situation in which "process upsets which may have had minor commercial consequences were dealt with thoroughly; those which had the potential for devastating commercial consequences were not"

The author's observations of the Australian pipeline industry provide clear evidence that it will go down the same path unless there is an immediate commitment to employing sufficient skilled and experienced pipeline engineers and technicians. The pipeline industry must implement formal training and succession plans, and the development of an holistic approach to the design, construction and operation of pipelines.

6 THE SOLUTION TO DE-SKILLING

A considerable reservoir of skill is still contained in the pipeline industry, but it is a diminishing and disillusioned resource and seen as a cost, rather than an asset. This skills base is not being replaced or developed. Pipeline owners and their design, construction, operating and maintenance contractors must support targeted training programs for engineers and technicians. Consideration must be given to apprenticeships for tradesmen (welders, fitters), traineeships for technicians (metallurgy, drafting, NDT, machinery) and cadetships for engineers (mechanical, metallurgy, chemical, electrical).

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and C. Perrow,. *Normal Accidents*. Princeton 1999 University Press, New Jersey, ISBN 0 69100412 9, 2nd edition;

[4] Caerteling, Jasper S, Doree, Andre G, **Spiekhout** Jan, Suurenbroek Ynso E, Avoiding Safety Disasters In Opening Up The European Natural Gas Market, Pipeline Integrity Quarter 2, 2003 pp. 85 - 99

In-house training is also most important, and both internal and external mentoring programs could be put in place. There are many senior experienced engineers and technicians who have been made redundant or have chosen to become consultants, whose skills can be tapped as teachers and mentors. The resources are available, but the industry must recognise that it has a problem and then devote its energies to solving that problem. All our pipeline companies must become “Learning Organisations” as defined by Hopkins.

7 SUMMARY

The Australian pipeline industry is robust and appears to be able to manage most of its commercial and all of its technical risks, but there are underlying threats that we are not managing. We have a well-funded and comprehensive research program, that together with the research links we have with PRC-I and EPRG, lead to a pipeline standard that reflects some of the world’s best and most flexible processes for designing, building and operating pipelines. However, we are rapidly consuming, or casting aside, the engineering skills and technical competence that were, until recently, embedded in the pipeline companies. Pipelines are more and more owned by investor companies or superannuation funds with little or no technical competence or understanding of them. Pipelines are designed, built and operated by out-sourcing processes that do not encompass the need to address the requirements of the so-called High Reliability Organisations.

Unless these systemic threats to our pipeline industry are managed properly, we will squander all the gains we have made since our industry began in 1969.