AMERICAN GAS ASSOCIATION
PIPELINE RESEARCH COMMITTEE
NINTH SYMPOSIUM ON LINE PIPE RESEARCH
HOUSTON
30 SEPTEMBER - 2 OCTOBER 1996

THE CHANGING FACE OF THE AUSTRALIAN PIPELINE INDUSTRY

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ABSTRACT

The Australian gas pipeline industry began in 1969 using capital and technology from the United States of America. Subsequently, state and federal governments became the dominant owners and operators of most of the long distance gas pipelines, and the Australian industry adapted and developed its own technology to suit its environment. In 1993 the industry entered another, and very significant chapter in its development, in which pipeline ownership began to revert to private companies, new pipeline access regulations were implemented by state and federal governments, and new technology was developed to ensure that long distance pipelines could be built economically to serve relatively small markets. This new era of deregulation and the privatisation of government owned pipelines has encouraged U.S. and Canadian companies to return to Australia to look for investment opportunities and to share in Australian developed technology.

In 1994 and 1995, more than $A1 billion was committed to new pipeline construction and more than $A0.8 billion was spent on the acquisition of government owned pipelines, predominantly by North American companies. This transfer of ownership from the public to the private sector, together with a major review of Australia's competition policies, forced the federal and state governments to make major changes to the regulatory environment. In parallel with this, the community demanded tougher environmental and native title legislation, which has forced the industry to comply with an increasingly complex set of rules for the construction and operation of pipelines.

This paper describes the current situation in the Australian gas pipeline industry, the drivers for change, the ways in which the industry is responding to new regulatory regimes and the development and use of new pipeline technology, such as Grade X80 for small diameter ERW pipe, to adapt to the new environment.

INTRODUCTION

The Australian natural gas pipeline industry is small and comparatively young. It is a geographically fragmented industry, characterised by relatively small markets centred on state capital cities, each served from separate sedimentary basins through long, small diameter pipelines. Table 1 lists the major pipelines which serve Australia's gas markets. The pipelines listed cover a total distance of more than 7500 miles (12,000 km) and deliver 550 bcf [*] (580 PJ) per year. From these figures, it can been seen that the Australian pipeline industry is very small when compared with that of North America.

[*] Note that the Australian natural gas industry uses energy to express pipeline deliveries, measured in terajoules (TJ) or petajoules (PJ).. Conversions in this paper assume gas heating value is 1000 BTU/cubic foot and use the normal US nomenclature for pipeline deliveries in billions of cubic feet (bcf)

NEW SOUTH WALES
Annual gas demand 88 bcf (92 PJ)

From	To	Length km	Diam. mm
Moomba	Wilton	1299	864
Wilton	Sydney	57	864
Sydney	Newcastle	214	508
Young	Wagga	130	324
Young	Orange, Bathurst, Lithgow	270	168 114
Dalton	Canberra	58	273
Junee	Griffith	179	168
	TOTAL	2207	

VICTORIA
Annual gas demand 180 bcf (190 PJ)

From	To	Length km	Diam. mm
Longford	Dandenong	174	762
Morwell	Dandenong	129	457
Brooklyn	Ballarat & Bendigo	197	219 168
Keon Park	Wodonga & Shepparton	326	609 324 168
Mt Franklin	Bendigo	53	324
Pakenham	Wollert	91	762
Allansford	Portland	115	168
Codrington	Hamilton	54	168
	TOTAL	1139	

NORTHERN TERRITORY
Annual gas demand 12 bcf (13 PJ)

From	To	Length km	Diam. mm
Palm Valley	Alice Springs	146	219
Palm Valley	Darwin	1577	356 324
Daly Waters	McArthur R.	330	168
	TOTAL	2053	

SOUTH AUSTRALIA
Annual gas demand 83 bcf (88 PJ)

From	To	Length km	Diam. mm
Moomba	Adelaide	781	559
Whyte-Yarcowie	Whyalla	166	219 168
South East System		67	168
Riverland System		215	168 114
	TOTAL	1229	

WESTERN AUSTRALIA
Annual gas demand 162 bcf (171 PJ)

From	To	Length km	Diam. mm
Dongara	Kwinana	415	356
Dampier	Kwinana Jct	1399	660
Kwinana Jct	Pinjarra	84	508
Pinjarra	MLV156	24	273
MLV156	MLV158	25	219
Dampier	Robe River	57	273
MLV55	Carnarvon	164	168
Dampier	Port Hedland	204	457
Yarraloola	Kambalda*	1378	406 356
	TOTAL	3750	

QUEENSLAND
Annual gas demand 37 bcf (39 PJ)

From	To	Length km	Diam. mm
Roma	Brisbane	440	273
Roma	Gladstone	530	323
Gladstone	Rockhampton	96	219
SW Queensland	Roma*	756	406
	TOTAL	1822	

* Under construction as at July 1996
All gas demands for year 1994/95

Table 1 Major Pipelines in Australia

The natural gas market is immature. There are no significant interconnections between pipeline systems nor gas producing basins and, as a result, there is negligible gas-on-gas competition. The market is characterised by long term contracts between producers and major users (mostly local distribution companies and power generators). There is little, if any, pipeline capacity trading, nor is there any secondary market in pipeline capacity. However, the market is undergoing enormous change, with open access required on most pipelines and being extended to gas distribution systems. These changes, together with Australia's burgeoning minerals industry, augur well for significant growth in the natural gas pipeline industry.

The years 1993 to 1996 have seen important changes to the industry with the sale of three government owned pipelines to North American companies, either as sole or part owners, and development of plans to interconnect the separate markets and to provide open access to pipelines. In this period $A1 billion has been committed to new pipelines to serve petrochemical and mining projects.

HISTORY

Oil and gas were first found in commercial quantities in Australia in 1960 in the Surat Basin in Queensland, and during the rest of that decade, commercial discoveries were made in the Cooper Basin in South Australia (1963), the Perth Basin in Western Australia (1964), the Amadeus Basin in Northern Territory (1964) the Gippsland Basin in Victoria (1965) and the Carnarvon Basin in Western Australia (1974). See Figure 1 for locations.

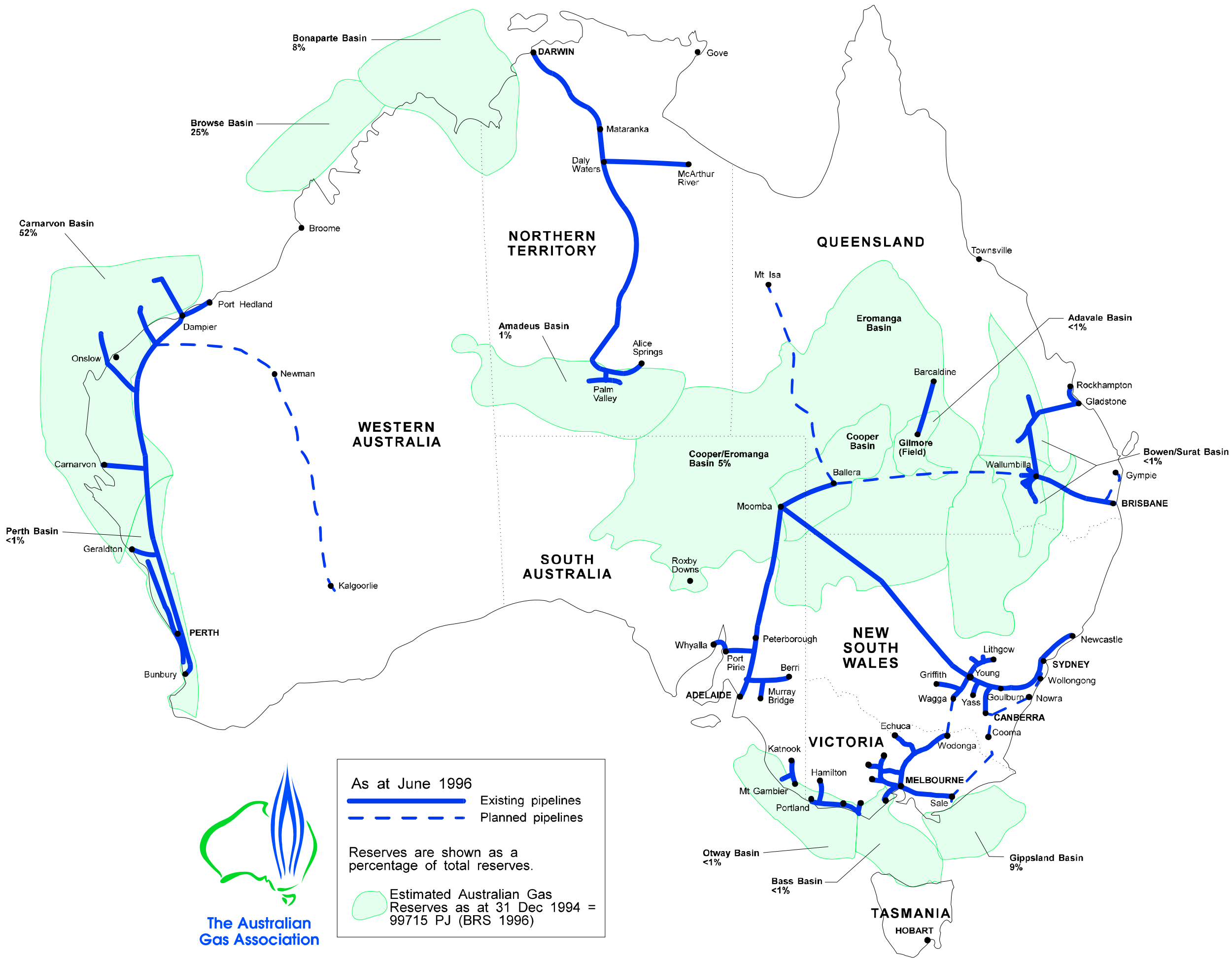

Figure 1 Location of Natural Gas Reserves and Natural Gas Pipelines - Australia 1996

Map courtesy of the Australian Gas Association and reproduced by permission

In each case, the development of the gas fields was inhibited by a lack of infrastructure, a lack of knowledge of the reserves, and the reluctance of gas utilities and industries to take the risk of large investments in an uncertain market. However, State Governments stepped in, and, with the support of the gas industry and several major potential industrial consumers, encouraged the exploration companies to prove up more reserves and to develop their fields. Natural gas was first supplied to an Australian market in March 1969, when gas flowed from the Surat Basin to Brisbane. This was followed by a flurry of new pipelines and supplies from the Gippsland Basin to Melbourne in April 1969, then from the Cooper Basin to Adelaide in November 1969, the Perth Basin to Perth in 1971 and the Cooper Basin to Sydney in 1976. Subsequently, gas supplies were provided to other regions as listed in Table 1.

OWNERSHIP CHANGES

Up to 1992, of the pipelines listed in Table 1, together with other smaller laterals, approximately 8000 km were owned by state or commonwealth governments. In the last four years 3670 km of these pipelines have been sold to Australian, Malaysian, US and Canadian companies as shown in Table 2.

PIPELINE	OWNED BY	GOVERNMENT	SOLD TO	DATE SOLD
Moomba to Sydney + Laterals (1960 km)	The Pipeline Authority	Federal Government	Australian Gas Light (51%) Nova (25%) Petronas(24%)	30 June 1994
Moomba to Adelaide + Laterals (1110 km)	Pipelines Authority of South Australia	South Australian Government	Tenneco Energy	30 June 1995
Roma to Gladstone + Laterals (630 km)	State Gas Pipeline Unit	Queensland Government	Pacific Gas Transmission	30 June 1996

Table 2 Listing of Government Owned Pipelines Sold 1993 -1996

By the end of 1997, most of the remainder are most likely to be sold, (see Table 3) thus completing the transition to majority of private ownership of all gas transmission pipelines in Australia.

PIPELINE	OWNED BY	GOVERNMENT
Dampier to Bunbury * + Laterals (1950 km)	AlintaGas Transmission	Western Australian Government
Victorian Gas Transmission System (2330 km)	Gas Transmission Corporation	Victorian Government

* Possible partial sale of up to 60%

Table 3 Listing of Government Owed Pipelines that are Likely to be Sold Before 1998

This transfer of ownership brings with it a number of changes to the commercial and engineering approaches of the pipeline companies. The commercial changes result from a more cost driven attitude of private sector owners, and an expectation by the market that the transfer from government to private ownership should result in lower haulage tariffs. The latter has not always proved to be the case, since in some cases, governments have revalued assets and increased tariffs to attract higher market values for their assets. The governments were less concerned about market development than improving their budget deficits.

In association with the sale of government owned pipelines, there has been strong government commitment to the development of robust and internationally competitive industries in Australia. As part of this process - referred to as “micro-economic reform” - governments and industry associations have combined to develop a market approach to infrastructure industries, such as railways, ports, and electricity and gas supply, transmission and distribution. The gas pipeline transmission industry is in the forefront of such scrutiny and is undergoing significant commercial and regulatory changes as a result.

COMMERCIAL AND REGULATORY CHANGES

Most of the commercial and regulatory changes have been driven by what are known as the "Hilmer Reforms". In August 1993, Professor Fred Hilmer, Dean of the Australian Graduate School of Management, University of New South Wales, presented a report [i] to the Federal and State Governments, which proposed the implementation of a national competition policy with the aim of removing restrictive practices and rent seeking by :-

1. Limiting anti-competitive conduct of companies
2. Reforming regulation which unjustifiably restricts competition
3. Reforming the structure of public monopolies to facilitate competition
4. Providing third party access to certain facilities [eg pipelines] that are essential for competition
5. Restraining monopoly pricing behaviour
6. Fostering "competitive neutrality" between government and private businesses when they compete

The Federal and State Governments all agreed to these reforms and undertook to put the appropriate legislation in place to implement them.

These reforms have had a very significant effect on the ownership, regulation, management and economics of natural gas pipelines. The natural gas industry and governments have expressed a strong preference to implement a "light-handed" form of regulation, rather than follow the prescriptive process adopted by North American regulators, such as the Federal Energy Regulatory Commission or the National Energy Board of Canada. However, the process is still evolving, and there are signs of prescriptiveness emerging because of a history of owners of pipelines, whether government or private, seeking economic rent through monopoly pricing.

Several state governments have already implemented the necessary regulatory regimes and all state governments and industry representatives are cooperating with the Federal Government in a joint project to develop a National Natural Gas Pipeline Access Code, which will probably be applied to both inter- and intra-state pipelines and be overseen by the Australian Competition and Consumer Commission (ACCC). For the first time in the history of Australian's natural gas industry, the concept of "open access" to pipelines has become mandatory.

Another driver for change in the natural gas pipeline industry has been an initiative by both governments and industry to seek "value adding" to Australia's vast resources industry - ie to carry out preliminary processing of minerals prior to export, rather than exporting metallic ores. This has resulted in the development of alumina, nickel, iron, rare earths, copper, silver, lead and zinc refineries/smelters, most of which use natural gas as a primary energy source or as a reducing agent. Gas is also being used extensively and increasingly for electricity generation rather than coal, because of the shorter lead times and lower pollution levels.

Despite these significant new uses, Australia's gas demand is low in North American terms, so the industry cannot take advantage of economies of scale to reduce delivered gas prices to industries which have to be world competitive. Other economies have to be found, and the Australian industry has been most successful in applying technical innovation and applied research to justify engineering and design changes to reduce pipeline construction and operation costs.

ENGINEERING AND DESIGN CHANGES

The engineering changes which have resulted from the transfer of ownership and increasing competition have been cost driven. There has been a consistent drive to reduce capital and operating costs, but, fortunately for the Australian natural gas pipeline industry, there has always been a recognition by pipeline companies (whether government or privately owned) that extending the boundaries of pipeline technology to reduce costs requires commitment to research. Most of the government owned pipeline companies contributed quite heavily to cooperative research programs both locally and through the American Gas Association's Pipeline Research Committee. The industry benefited significantly from these programs.

Competition and market expectations of lower gas haulage tariffs are driving down expectations for capital and operating costs, so the industry has to develop new and improved technology. Since the late 1980's, the Australian pipeline industry has examined all the major capital and operating cost drivers in a widely accepted strategy to reduce costs without compromising safety and reliability. The response has been to step up research in the field of high strength steels, the use of triple random lengths of pipe as standard, refinement of vertical down welding using cellulosic electrodes, with no pre-heat to increase production rate, improvements in coatings, refinement of risk analysis, higher operating pressures, application of consistency in third party protection techniques and the development of a pipeline code and welding standards that provide flexibility and innovation yet ensure safety and quality.

There is clear evidence that the industry has been most successful in reducing the capital cost of pipelines. In a recent paper [ii] Venton reviewed the trend of the cost of construction of pipelines in Australia, using, as a benchmark, the cost per millimetre-kilometre, in constant 1995 Australian Dollars for all pipelines constructed in Australia from 1981 to 1996. This indicated a most significant trend to reduced prices - See Figure 2.

Costs have fallen from in excess of $A1000/mm.km in 1981 to around $A700/mm.km in 1996. It should be noted that most of the costs depicted in Figure 2 include the purchase of easements, spares, SCADA systems and operating and maintenance infrastructure, so they are representative of 'greenfields" pipelines as well as expansions to existing pipeline systems. The trend of these costs augurs well for the continuing health of the pipeline industry in Australia.

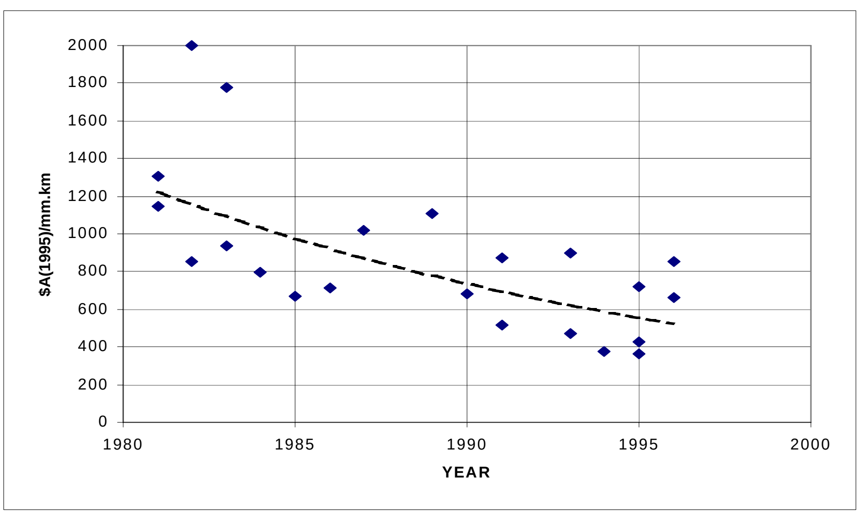

Figure 2 Trend of capital cost of long distance natural gas pipelines - Australia 1981 -1996

Two of the most important cost items in pipeline construction are pipe and welding, with items such as coating and trenching being very significant also. In the case of the former two, a great deal of research and product development has been carried out in Australia in the fields of steel and welding technology.

CHANGES TO STEEL TECHNOLOGY

With the encouragement of the pipeline industry, and in an effort to reduce the cost of new pipelines, Australia's steel manufacturer, BHP Steel and its affiliated ERW pipe maker, Tubemakers of Australia, recently embarked on a program to develop X70 and X80 steel for pipelines. The use of higher grades of pipe results in decreased costs, provided that other costs, such as those associated with welding or NDT are not increased. The companies' primary aim was to ensure that the higher grade steels would be weldable with cellulosic electrodes, using normal pipeline production welding techniques. In a recent publication, Tubemakers made the following statement:-

"The X80 grade alloy design is based on a C-Mn-Mo-Nb-Ti alloying system, characterised by a low carbon content (typically 0.07%), a restricted carbon equivalent level particularly in terms of the well recognised Pcm carbon equivalent such that the final ERW pipe can be field welded without preheat using cellulosic consumables. The alloy design also utilises a small Mo addition to assist with microstructure strengthening, Nb to provide precipitation hardening, a micro titanium addition to restrict grain growth during rolling and the weld thermal cycle and a low S content to provide high fracture toughness. This alloy system has been well proven internationally, particularly with heavy wall SAW pipe, and has been successfully applied by BHP and Tubemakers for the recent production of X70 grade line pipe. The alloy design of the X80 grade represents an incremental enhancement of the C-Mn-Mo-Nb-Ti system." (see also [iii] [iv])

ERW pipe made from X70 steel has already been used successfully on a total of 1000 miles (1600 km) of pipeline with negligible welding problems in both 14" and 16"(356, 406 mm) with MAOP of up to 2220 psi (15.3 MPa). Normal cellulosic electrodes were used and production rates were high. The use of X80 remains a strong possibility in the near future on a number of projects.

CHANGES TO WELDING TECHNOLOGY

The majority of Australia's new pipelines have diameters less than 18" (457 mm). Automated welding techniques are not readily available for these small diameters, so the Australian pipeline construction industry continues to rely upon the use of cellulose electrodes and, in doing so, achieves very high production rates. A recent 860 mile (1380 km) 8" (219 mm) diameter, 0.22" (5.6 mm) wall thickness X65 pipeline was built at a rate of 3.8 miles (6 km) per day. This is an average of more than 330 joints per 10 hour day. Similar results have been achieved on X70 pipe. Recent research work [v] shows that these production rates should be achieved on X80 pipelines. This means that worthwhile savings should be possible. The high welding speeds required to meet such high production rates can, if not carefully controlled, sometimes result in hollow bead problems. The industry recently completed a successful cooperative research program to investigate the causes of hollow bead and the ways of overcoming the problem.

The research work on hollow bead is nearing completion. The results [7] show what has long been suspected, but never proved. Serious problems with hollow bead begin to occur in the root bead when very high welding currents and travel speed are used. The research indicates that other variables have only second order effects. This research work and many other programs continue to contribute to the lower cost of Australia's new pipelines.

INCREASED RESEARCH TO REDUCE COSTS

The Australian industry is justifiably proud of its cooperative and practical research in areas such as:-

- Development of an Australian Standard (AS 3862) for fusion bonded epoxy coatings for pipelines based on local research work [vi]
- Development of a methodology and laboratory facilities for the determination of the threshold stress for stress corrosion cracking of pipeline steels
- Analysis of cold field bending of pipelines to extend the empirical boundaries for rejection of pipe bends
- Analysis of the mechanism of high voltage holiday detection on coated pipe to define inspection speeds and to ensure that test voltages will be sufficiently high to detect coating faults, but low enough not to damage coatings
- Analysis of the causes of hollow bead in pipeline girth welds [vii]
- Girth weld defect acceptance level criteria
- Development of PIPESAFE software, based on BS PD6493, for engineering critical assessment of girth welds [8]

The Australian pipeline industry's commitment to research has been further encouraged by the emergence of Cooperative Research Centres (CRC), which are associated with major universities and through which the Federal Government encourages public sector research providers to undertake industry relevant research by offering funds which can be used to match contributions made by industry.

The CRC is similar in concept to the US National Science Foundation's Engineering Research Centres program. Australia has about 60 CRC which cover a wide range of scientific disciplines, but the centre currently of most interest to the pipeline industry is the CRC for Materials Welding and Joining, which is a partnership of Australian Nuclear Science and Technology Organisation (ANSTO), Commonwealth Scientific and Industrial Research Organisation (CSIRO), Welding Technology Industry Association (WTIA), BHP Limited, and the Universities of Adelaide and Wollongong.

The CRC for Materials Welding and Joining has just embarked on an extensive program to improve the productivity and quality in welding high strength thin walled pipelines. The program will build on the research work already carried out, and will extend over two years. In the context of reducing the cost of pipelines and ensuring their safety and integrity the research will address:

- Non destructive examination of girth welds
- Determination of defect acceptance criteria for high strength, thin walled pipe
- Establishment of crack free welding procedures
- Welding on thin walled in-service pipelines
- Establishment of automatic girth welding procedures for small diameter thin walled pipe

Progress has already been made on some of these aspects. An engineering critical assessment (ECA) procedure for assessing girth weld defects has been established and implemented through a software package [viii]. As a result of this work and the application of considerable field and laboratory work, Standards Australia has issued a second part to the current Australian Pipeline Code (AS 2885 Pipelines - Gas and Liquid Petroleum) which simplifies radiography procedures, revises the definition of essential variables and, most importantly, establishes a three tier system of acceptance for assessing weld discontinuities. Tier 1 is a workmanship standard similar to API 1104; Tier 2 is a generalised fitness for purpose standard based on European Pipelines Research Group (EPRG) guidelines and Tier 3 requires a specific engineering critical assessment. The use of the new Code AS2885:2 - 1995 has already led to cost savings on a recently constructed pipeline [ix].

CHANGES TO RISK ANALYSIS

Pipeline regulators and licensing authorities are placing increasingly complex demands on pipeline owners to provide detailed quantitative risk assessments for new and existing pipelines. These demands are proving to be very expensive to satisfy and do not necessarily make for safer pipelines. Of particular concern is a trend to the use of European and North American pipeline (including gas distribution systems) failure statistics as inputs to the risk modelling software, when the age, design, population densities and environmental conditions encountered by European and North American pipelines are very different from those which affect Australia's pipelines. Some risk modelling software providers contend that these differences are inconsequential. The debate between qualitative and quantitative risk assessment continues in the Australian natural gas pipeline industry, with strong proponents for each case. Some pipeline operators have achieved very good results from the use of the modified PRC/Battelle procedure [x] to equilibrate risk throughout the length of a pipeline to ensure that sections of pipe in urban or hazardous locations have the same risk of failure as a section in a remote rural environment. This process is known as "comparative risk assessment" and does not suffer the inadequacies of a quantitative risk analysis in the absence of a good and representative statistical data base.

Australia's natural gas transmission pipelines have an enviable safety record. Gas releases have occurred on only four occasions due to third party damage and on one occasion due to stress corrosion cracking. Of these five pipeline failures, two caught fire. No injuries or fatalities occurred.

The Australian Pipeline Code, AS 2885, addresses risk in a more qualitative way and provides for third party protection through either the reduction in ratio of operating stress to specified minimum yield stress (which may or may not lead to increased wall thickness) or the provision of secondary protection, such as concrete slabs over the pipe, increased depth of burial or other means. When class locations change as a result of urban encroachment, the Code allows for the pipeline to maintain its original operating pressure, provided secondary protection is applied. This is a practical means of minimising the cost while at the same time providing adequate protection of the public.

CHANGES TO ENVIRONMENTAL REQUIREMENTS

During the construction of the Moomba to Sydney pipeline (see Figure 1) in 1975-76, the industry become aware that care and understanding of the environment was necessary. A noted environmentalist of the time, Harry Butler, and the author, developed a comprehensive environmental management plan to ensure that the pipeline would merge back into its surroundings as soon as possible after construction clean up was completed. In the 20 years of pipeline construction history which have followed the Moomba to Sydney pipeline, the industry has had an enviable record in care for the environment. However, in the meantime, federal and state governments have introduced a plethora of environmental legislation which is designed to encompass any project which might affect the environment.

Although pipelines are environmentally benign and the industry is well versed in minimising environmental disturbance during construction and operation, the environmental legislation requires the preparation of comprehensive environmental impact reports, even for the simplest of pipelines passing through grazing and cereal growing country. Public environmental enquiries are also required. In addition, very detailed archaeological and anthropological studies are necessary to ensure that pipeline construction does not threaten Aboriginal heritage sites. While it is essential to avoid damage to such sites and the environment in general, the cost of compliance is high and is a significant contributor to the capital costs of new pipelines. The excessive cost still faced by pipeline companies could well be ameliorated by a more reasoned approach by environmental authorities and a recognition that pipelines represent one of the most environmentally friendly forms of transport and are essential as energy highways to maintain and improve our quality of life. These increases in the costs of some aspects of pipeline construction place even more pressure on refinement of pipeline technology by the application of well directed research.

CHANGES TO LAND TENURE

In 1994, the Federal Government legislated to provide for the Aboriginal people to claim title over unalienated Crown land throughout Australia. Since most natural gas pipelines cross unalienated Crown land, often for hundreds of kilometres, there is a very high probability that claims will be made on sections of a pipeline easement. Usually, careful management of the land acquisition process and extensive consultation with Aboriginal people results in a satisfactory settlement. However, despite these precautions, disputes on Aboriginal land title do occur. In the second quarter of 1996, the construction of a 100 km section of a 700 km pipeline was delayed for many months at great cost to the owners and risk of failure to meet contractual commitments. The risk of cost overruns as a result of native title is real and quite significant.

THE FUTURE

The future for continued development of Australia's natural gas pipeline infrastructure is bright. Gas demands are growing and the development of open access principles for all natural gas transmission and distribution pipelines heralds a much more market focussed industry. Within the next few years gas-on-gas competition will apply to supply, pipelines, and retail marketing. No longer will high cost operators be able to pass the cost of their inefficiencies on to their customers.

The Australian pipeline technology research community is well aware of the cost drivers and is determined meet the challenges of cost reduction while still ensuring the safety and integrity of Australia's growing natural gas pipeline network.

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Mr Kimber the Principal Consultant and Director of M. J. Kimber Consultants Pty. Ltd. and during his 23 years in the Australian gas pipeline industry, Mr Kimber has made significant contributions to the new regulatory regimes and technological innovation in that industry. He provides consulting services to major corporations and governments involved in the Australian gas and pipeline industries, including Tubemakers of Australia, Nova Gas Australia, Pacific Gas Transmission, AlintaGas, Pipeline Authority, Gas Transmission Corporation, Government of South Australia and Federal Government. Since 1994, he has advised governments and pipeline companies on the privatisation of three government owned pipelines.

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