Steel Mains Pty Ltd
ABN: 73 004 843 056

125-175 Patullos Lane
Somerton VIC 3062
Phone: +61 (0)3 9217 3110
Web: http://www.steelmains.com

# A comparison of API 5L X42 and AS1579 for water supply pipe

**by**

## Mr Leigh Fletcher

**Consulting Engineer**
Mobile: 0418 426 419
Welding and Pipeline Integrity Engineering
Email: leigh_fletcher@netc.net.au
ABN: 51 757 530 328

## Summary

A request was received from Ashley Fletcher on the 18th May, 2004 for a comparison to be made between the specifications API 5L X42 and AS1579 when used for welded steel pipe for water supply service.

My qualifications for this task include some 32 years of experience of pipe manufacture for both oil and gas and water supply pipelines and a further period of research and consulting concerned with the welding and integrity of pipelines. I am a former Chair of the Australian Standards committee responsible for AS1579. I am currently Chair of the Australian Standard concerned with welding of oil and gas pipelines, and a member of the design and construction committee. My resume is attached to this document.

My review and comparison of the two Standards is contained in the following pages. The review is based on submerged arc welded pipe of diameter ranging from 324mm OD to 1829mm OD and pipe wall thicknesses from 5mm up to 13mm.

My overall conclusion is that both Standards are suitable for specifying fit-for-service pipe suitable for the application. My additional comments are:

1. API 5L is an oil and gas industry Standard directed at that industry using the practices of that industry. Its use for water is incidental to its main use to convey oil and gas. It is silent on the effect of the pipe and its coatings on water quality. It covers a wide range of widely different kinds of pipe and is written principally by pipe manufacturers. Pipe purchasers rarely use it without specifying supplementary requirements, both for pipe supply and for pipeline design. It is intended for use with pipe intended for field welding, and its dimensional tolerances are such that experienced well-equipped field welding contractors are required. It does not include fittings such as bends, scours, tees etc and it is an implicit practice that pipeline deviations will be achieved by cold field bending and/or induction bends.

2. AS1579 is a water industry Standard having input from manufacturers but dominated by users of the pipe. It is a specialised and more complete Standard and covers aspects of pipeline design such as rated pressure. It covers fittings and nonwelding joining systems as well as the pipe, and specifies performance and assembly tests in order to demonstrate the compatibility and effectiveness of the joints and fittings. It also covers the effect of pipe coatings and linings on the quality of water conveyed. The efficacy of the Standard and the fitness-for-purpose of pipes produced to it over a long period of time in Australia are attested to by documents produced by customers of Tyco Water. Elastomeric seal jointed pipe (ie. rubber ring joints) complying with AS1579 can be joined by personnel without craft skills after only limited training.

The advice contained herein is an expression of opinion, given in good faith, based upon my knowledge. It should not be relied upon as the sole information on the subject covered, nor should it be construed as providing recommendations for the design/operation of particular pipelines.

This report is provided on the basis that any liability arising is limited to the repetition of any work which is found to be unsatisfactory.

**Mr Leigh Fletcher**
**Consulting Engineer**
**Welding and Pipeline Integrity Engineering**

**Leigh Fletcher** Lowen Drive, PO Box 413, Bright,

**Consulting Engineer** Phone: 61 (0)3 5755 1242 Fax: 5755 2342 MoVbicil,e 3: 704411,8 A4u2s6t r4a1li9a

**ABN: 51 757 530 328** Email: leigh_fletcher@netc.net.au

| No. | Item | API 5L 42nd Ed | AS1579-2001 | Comments |
|---|---|---|---|---|
| 1. | Constitution of the Standards Committee | *"… under the jurisdiction of the Committee on Standardization of Tubular Goods…"* | The representation on SAI Committee WS/9 is listed in the front of AS1579. | WS/9 includes representatives of all water supply Authorities from around Australia, all of whom rely upon the Standard for the purchase of pipe. There is only one major Australian pipe supplier, Tyco Water, and in practice, although the committee works on a consensus basis, the committee is dominated by user interests.<br><br>It is widely accepted that API 5L is dominated by manufacturer interests, and it is for this reason that it is rarely used for major projects as a single and sufficient Standard without supplementary requirements. |
| 2. | Scope/Purpose of the Standard | "… for use in conveying gas, water, and oil in both the oil and natural gas industries …" | "… for the conveyance of water and wastewater at rated pressures up to 6.8MPa and for use as piles …" | API 5L is an oil and gas Industry Standard primarily intended for pipe conveying oil or gas, and is specifically aimed at the oil and gas industries.<br><br>AS1579 is a specialized water industry Standard.<br><br>Both Standards are suitable for the specification of pipe for water pipelines, but in my opinion, AS1579 is more complete when used for pipe for water pipelines. The use of API 5L needs supplementary requirements to be specified. The term *"single and sufficient"* describes this condition where all or most of the minimum requirements are met in the one Standard and no supplementary technical requirements need to be specified by a purchaser in order to ensure a fit-for-purpose product. |

**Leigh Fletcher**
**Consulting Engineer**
**ABN: 51 757 530 328**
Lowen Drive, PO Box 413, Bright,
Phone: 61 (0)3 5755 1242 Fax: 5755 2342 MoVbicil,e 3: 704411,8 A4u2s6t r4a1li9a
Email: leigh_fletcher@netc.net.au

| | | | | |
|---|---|---|---|---|
| 3. | Effect on water | Silent | Contains requirements and methods of demonstrating suitability when used in contact with water used for human consumption. | AS1579 is designed to ensure that the pipe, including any coatings and/or linings, do not impart unacceptable taste, odour, appearance, or toxic properties to water. This includes any cement mortar lining supplied as part of the pipe supply contract. Care needs to be taken that equivalent performance is given by any field applied coatings and linings where potability is a requirement. |
| 4. | Rated pressure | Silent | 72% SMYS (or NMYS) and 80% of mill hydrostatic test pressure up to a limit of 6.8MPa. | AS1579 is a combined pipe manufacturing and pipeline design Standard.<br><br>API 5L is a pipe manufacturing Standard and leaves pipeline design to other Standards. However it is normal to use API 5L pipe at pressures up to 72% SMYS. Some design Standards such as ASME/ANSI B31.8 allow maximum allowable operating pressures above 72% SMYS, but the pipe used in such cases would never be purchased to API 5L alone without supplementary requirements. |
| 5. | Hydrostatic testing | Requires hydrostatic testing at 90% SMYS. | Requires hydrostatic testing at 90% SMYS (or NMYS) i.e. 1.25 times rated pressure. | See later comments on strength testing and leak testing. |
| 6. | Coating and lining | Silent | See Item 2 above. Provides reference to coatings and linings suitable for use in water pipelines. | AS1579 pipe is customarily intended for the application of water industry specific coatings and linings, including e.g. cement mortar lining applied whilst spinning the pipe. Pipe made to the limit of the straightness tolerance in either Standard may not be suitable for the application of linings applied by spinning the pipe. |

**Leigh Fletcher** Lowen Drive, PO Box 413, Bright,

**Consulting Engineer** Phone: 61 (0)3 5755 1242 Fax: 5755 2342 MoVbicil,e 3: 704411,8 A4u2s6t r4a1li9a

**ABN: 51 757 530 328** Email: leigh_fletcher@netc.net.au

| | | | | |
|---|---|---|---|---|
| 7. | Method of manufacture | Covers a wide range of manufacturing methods including seamless and welded pipe, using several different welding methods including methods that use filler metal and those that do not. | Covers arc welded (usually submerged arc welded) pipe. | API 5L is a complex Standard covering many products in different forms for different applications. AS1579 is a specialised Standard covering submerged arc welded pipe and fittings for use in water pipelines. |
| 8. | Standard sizes (Diameter) | Uses ISO standard sizes on outside diameter. | Allows all diameters, including ISO Standard sizes | This review is limited to submerged arc welded pipe of diameter ranging from 324mm OD to 1829mm OD.<br><br>AS 1579 allows more scope for design as pipe sizes include ISO sizes and all sizes in between. |
| 9. | Standard Size (Length) | nominal 12.0m<br>minimum 4.27m min.<br>av. 10.67m | Ordered length +/- 0.0075m<br>( 5% +/- 0.3m when advised) | The variation in length is generally much greater with API 5L pipe. |
| 10. | Wall thickness tolerance | API wall thickness tolerances are complex. The individual pipe wall thickness tolerance is + 19.5%, -8%. However in practice the over tolerance would never be supplied for commercial reasons, and the under tolerance could not be supplied because of weight tolerance limits.<br>Areas repaired by grinding are required to be within the -8% limit. | For 5mm ± 5%<br>For 6mm ± 4.5%<br>For 8mm ± 3.6% For 10mm ± 3.2%<br>For 12mm ± 3.0% | This review is limited to submerged arc welded pipe with wall thicknesses from 5mm up to 13mm.<br><br>The AS1579 limit is derived from the steel specifications from which the pipe is made. |

**Leigh Fletcher** Lowen Drive, PO Box 413, Bright,

**Consulting Engineer** Phone: 61 (0)3 5755 1242 Fax: 5755 2342 MoVbicil,e 3: 704411,8 A4u2s6t r4a1li9a

**ABN: 51 757 530 328** Email: leigh_fletcher@netc.net.au

| | | | | |
|---|---|---|---|---|
| 11. | Other dimensional tolerances | | | Roundness, ovality, and end squareness primarily affect field welding. See comments under item 13 Field Joints. |

| | | | | |
|---|---|---|---|---|
| 12. | Fittings | Provides coverage of the use of special couplings such as Dresser and Victaulic used primarily by the oil industry. Does not cover fabricated bends, tees and other water industry fittings. | Covers typical water industry fittings such as bends, tees, offtakes, and scours and provides compatibility between pipe and fittings. | |
| 13. | Field joints | "… plain-end line pipe meeting this specification is primarily intended for field makeup by circumferential welding …" | Covers pipes intended for field joining by welding, flanged joints, elastomeric seal (rubber ring) joints and others. | The field jointing methods for the AS1579 welded joints include spherical and other slip in joints capable of providing angular deflections between adjacent pipes.<br><br>AS1579 specifies assembly test requirements for all joint types and specifies Type Testing for elastomeric seal joints in order to demonstrate functionality.<br><br>Special care needs to be taken with the field welding of API pipe. Although the specified dimensional tolerances make it possible for experienced welding contractors to make good joints using the right equipment, inexperienced contractors operating without the correct internal line-up clamps etc may experience delays and difficulties when the pipe is at the limit of specified tolerances.<br><br>The dimensional tolerances such as body diameter and out of roundness are very commonly made much more stringent in API 5L users' supplementary specifications. |

**Leigh Fletcher** Lowen Drive, PO Box 413, Bright,

**Consulting Engineer** Phone: 61 (0)3 5755 1242 Fax: 5755 2342 MoVbicil,e 3: 704411,8 A4u2s6t r4a1li9a

**ABN: 51 757 530 328** Email: leigh_fletcher@netc.net.au

| | | | | |
|---|---|---|---|---|
| 14. | Field weldability and field welding | IIW Carbon equivalent equal to or less than 0.43 | IIW Carbon equivalent equal to or less than 0.40 | Field welding requires experience, care and great skill.<br><br>The make up of elastomeric seal (rubber ring) joints also requires care and skill, but there are much fewer variables affecting the outcome, and careful operators without a craft/trade background can be trained to make good joints within a short time. |

| | | | | |
|---|---|---|---|---|
| 15. | Field bending | Silent | Silent | It is normal practice for API 5L pipe to be cold bent in the field and because of this there is an implied requirement for such pipe to be suitable for this purpose.<br><br>It is not customary to cold field bend AS1579 pipe, and there would be no express or implied suitability for this purpose. Angular deflections in water pipelines made with AS1579 pipe are made by a combination of small deflections at joints, and by the use of fabricated fittings. |
| 16. | Strength testing | Pipe strength is demonstrated by:<br>a. tensile test pieces cut from pipe; and<br>b. a hydrostatic test for 10 seconds at 90% SMYS. | Pipe strength is demonstrated by a hydrostatic strength test conducted at 90% SMYS (or NMYS) i.e. 1.25 times rated service pressure of the pipe for 10 seconds. | AS1579 recognises the inaccuracy of measurements of yield strength on flattened test pieces cut from pipe, and relies upon a stringently defined hydrostatic strength test to demonstrate sufficient strength for the defined rated operating pressure. The manufacturer also relies upon a history of statistical property data in order to select steel grades that will reproduce proven strength levels. |

**Leigh Fletcher**
Lowen Drive, PO Box 413, Bright,
**Consulting Engineer**
Phone: 61 (0)3 5755 1242 Fax: 5755 2342 MoVbicil,e 3: 704411,8 A4u2s6t r4a1li9a
**ABN: 51 757 530 328**
Email: leigh_fletcher@netc.net.au

| | | | | |
|---|---|---|---|---|
| 17. | Leak testing | It is required that the hydrostatic test be withstood without leakage. | Following the strength test a leak test is conducted at rated pressure for a duration sufficient to allow visual inspection of the entire pipe surface. | AS1579 assures leak free performance by requiring visual inspection of the entire pipe surface during leak testing. This requirement addresses the concern that in conventional hydrostatic testing where the strength and leak tests are coincident leakage may not be noticed during the very short duration of only 10 seconds. |

| | | | | |
|---|---|---|---|---|
| 18. | Non-destructive testing of weld seams | Mandatory radiographic or ultrasonic testing of weld seams | Not required for hydrostatic tested pipe. | In terms of safe pressure containment, AS1579 is based upon the philosophy of "PROOF TESTING". That is; a pipe which is tested to a pressure higher than the allowable operating pressure (AOP), is thereby demonstrated to be strong enough for service at AOP. This demonstration is free from statistical sampling errors and from the spurious effects of flattening and other preparation effects inherent to conventional mechanical testing of tensile test specimens.<br><br>It is also demonstrated to be free of defects that could fail at AOP. In linear elastic fracture mechanics the safety factor conferred by proof testing is proportional to the square of the ratio of test pressure to the service pressure. In the case of a test pressure of 1.25 times AOP, the factor of safety is approx. 1.6.<br><br>For these reasons AS1579 does not require nondestructive testing (NDT) of seam welds. NDT is deemed to be redundant when the hydrostatic test is performed properly the way it is specified in AS1579.<br><br>The proof of performance is demonstrated for every pipe. |

**Leigh Fletcher**
**Consulting Engineer**
**ABN: 51 757 530 328**
Lowen Drive, PO Box 413, Bright,
Phone: 61 (0)3 5755 1242 Fax: 5755 2342 MoVbicil,e 3: 704411,8 A4u2s6t r4a1li9a
Email: leigh_fletcher@netc.net.au

| | | | | |
|---|---|---|---|---|
| 19. | Service experience | | | Tyco Water have estimated that over 6000km of steel water pipe has been produced to AS1579 and its antecedents, and has been installed in Australia without failure attributable to defects or workmanship in the pipe. Until 1996 this experience was also within my own knowledge.<br><br>A number of customers have provided Tyco with written statements supporting this experience. |

**Leigh Fletcher** Lowen Drive, PO Box 413, Bright,

**Consulting Engineer** Phone: 61 (0)3 5755 1242 Fax: 5755 2342 Mobile: 0418 426 419 Vic, 3741, Australia

**ABN: 51 757 530 328** Email: leigh_fletcher@netc.net.au

Leigh Fletcher
**PO Box 413**
**Bright**
**Vic 3741**
**Phone: 03 5755 1242**
**Fax: 03 5755 2265**
**Mobile: 0418 426 419**
**Email: leigh_fletcher@netc.net.au**

# Leigh Fletcher
# Curriculum Vitae

## 1 Qualifications

**ARMIT** (Met), MEngSc (Materials Eng) Monash

## 2 Experience

Managing Director, MIAB Technology Pty Limited Dec 2001-present
Consulting Engineer, 2000- present
Executive Director, CRC for Welded Structures (CRC-WS) Feb 1996-Dec 1999
Manager, Tubemakers Pipelines Research Centre Jul 1986-Dec 1995
Manager Technical Services Steel Mains Pty Ltd 1984-1986
Manager Research and Development, Steel Mains 1974-1984

## 3 Affiliations

Member APIA (Australian Pipeline Industry Association) Research and Standards Committee
Member Standards Australia Pipeline Code Committee ME/38
Member Standards Australia ME/38/1 Subcommittee Design and Construction
Chair Standards Australia ME/38/2 Subcommittee Welding
Former Chair, WS/9 Welded Steel Pipes for Water
Former Alternate Director CRC-WS (TWI Representative)
Former Research Board Chairman & Vice President WTIA (Welding Technology Institute of Australia)
Former Convenor APIA/WTIA Panel 7
Former Visiting Professorial Fellow, University of Wollongong 1998-2001

## 4 Awards

Jeff Macafee Prize, Best Final year Student, RMIT, 1970
Australian Institute of Metals 13th Metallographic Exhibit Best in Class (Student Class) Award 1969
Pyrox-Leitz Prize, Metallography, RMIT, 1969
Ramsay Moon Award for Best Paper to Australian Welding Institute, 1979
Inaugural Australian Pipeline Industry Association (APIA) Most Valuable Contribution Award, 1995

## 5 Specific Expertise

### 5.1 Technical

Since first commencing work on the Snowy Mountains Scheme in 1963 I have specialised in the manufacture and engineering integrity of pipelines and other welded structures including quality assurance,

non-destructive testing, welding processes and weldability, fracture safety assessment, and aspects of corrosion and corrosion protection.
Special emphasis has been given to the solution of problems affecting productivity and integrity through multi-disciplinary applied research programs. Two major lasting contributions to enhanced productivity in welding through research have been achieved. The first was an increase of 50% in the output of Tubemakers' spiral pipe machines, and the second was the CRC-WS's work which allowed a 50% improvement in pipeline construction speed by earlier release of the line-up clamp. This outcome was valued by the industry at $100m over 5 years.
A significant career influence has arisen from the role of being the key technical adviser in major litigation actions over losses involved in the failure of welds in the Moomba-Sydney pipeline during the 70s and the failure of adhesively bonded joints in the McArthur River pipeline during the 90s. These actions, which in present day $, were worth $100m and $20m respectively have made me acutely aware of the commercial risks in pipeline construction, and the careful and thorough approach which must be taken to the management of those risks.

### 5.2 Management
I have had continuous responsibility for profit centre performance since 1974 when I took charge of Steel Mains R&D Laboratory. During subsequent years I established a successful commercial testing service, I managed Steel Mains Technical Services Department, and at the time of Tubemakers' takeover was acting Steel Mains State Manager in WA. At that time the company was executing major contracts including a catalytic cracker for BP, jetty piles for the NW Shelf, and water supply pipe for WA Water. Following the Tubemakers takeover I ran Tubemakers Pipelines Research Centre in Melbourne before leaving to lead the CRC for Welded Structures. At the time I took over the CRC it was in some trouble after a poor 3rd year review. At the 5th year review I was credited with having achieved a "Copernican Revolution" in performance, and following that, the CRC was successful in the 1998 Selection Round. I left the CRC in Dec 1999 after completion of my 4 year contract. I was asked to renew but chose not to. I remain involved with the CRC in several different capacities.

### 5.3 Consulting
Since leaving the CRC I have undertaken consulting assignments in pipeline welding and integrity for various companies including Santos, Duke Energy, Agility, McConnell Dowell, Worley, Gasnet and others.

### 5.4 MIAB Technology Pty Limited
I am the founding and majority shareholder and Managing Director of a Start-Up company called MIAB Technology Pty Limited (MIABTech) which has been formed for the purpose of commercializing magnetically impelled arc butt welding for the girth welding of pipelines. The company has the support of several major Australian pipeline companies and is in the process of seeking funding.

## 6 Publications
**A selection of publications is given below:**

Fletcher L *"The role of longitudinal joint geometry in the fatigue behaviour of submerged arc welded linepipe"* Aust Weld J. Dec 1978

Fletcher L *"Practical COD fracture toughness measurement and evaluation"* Aust Weld J. Sept 1979

Fletcher L and Morrison R *"The effect of different pipe steels on the cellulosic manual metal arc stovepipe welding process"* Proc Symp "Weld Pool Chem and Met" TWI London 1980. Also published in Metal Construction

**Leigh Fletcher** Lowen Drive, PO Box 413, Bright,

**Consulting Engineer** Phone: 61 (0)3 5755 1242 Fax: 5755 2342 Mobile: 0418 426 419 Vic, 3741, Australia

**ABN: 51 757 530 328** Email: leigh_fletcher@netc.net.au

Fletcher L and Cotton H C *"The selection of linepipe for field weldability"* AWRA specialist symposium "Pipeline welding in the 80s" Melbourne 1981

Fletcher L and Nicholls D *"Hydrogen assisted cracking in submerged arc weld metal"* Proc. Joint AWI and NZWI Annual Conference Auckland 1981

Fletcher L *"Review of recent activity in applying fracture mechanics to pipeline girth welds"* Proc Symp "Alternative standards of acceptability for pipeline girth welds" AWRA Sydney 1983

Fletcher L and Walters C *"The weldability of steels"* Proc Joint WTIA/IMMA Conference Perth 1990 A review of WTIA Technical Note 1

Piper J, Morrison R, and Fletcher L *"The integrity of ERW weld seams in high strength linepipe"* Proc Symp "Welding of High Strength Thin-walled Pipelines" WTIA/APIA Wollongong 1995

Fletcher L *"Australia's CRC Program – The International Best Practice Model for Collaborative R&D"* AIC Conferences, Sydney 1998

Bilston K and Fletcher L *"The Australian Pipeline Code AS2885-1997"* Proc Int'l Pipeline Conference IPC'98, ASME-OMAE, Calgary 1998

Fletcher L and Yurioka N *"A holistic Model of Hydrogen Cracking in Pipeline Girth Welding"* IIS/IIW1468-99 Class A, recommended for publication by IIW Commission IX "Behaviour of metals subjected to welding" published in Welding in the World, Vol 44, No 2, 2000

**7 Conference Proceedings/Preprints**

L Fletcher (Technical Organiser and Editor) Proc Symp "Welding of High Strength Thin-walled Pipelines" WTIA/APIA Wollongong 1995

L Fletcher (Technical Organiser) Proc Int'l Seminar on "Fracture Control in Gas Pipelines" WTIA/APIA/CRC-MWJ Sydney, June, 1997

L Fletcher (Editor) Proc 1st Int'l Conf on "Weld metal hydrogen cracking in pipeline girth welds" WTIA/APIA/CRC-WS Wollongong, March, 1999

L Fletcher (Editor and Technical Director) "X80 Pipeline Cost Workshop" APIA, Hobart, 2002