OZWELD

EXPERT TECHNOLOGY TOOLS

Welding Technology Institute of Australia

Research, Education, Technical Support & Information

WTIA Technical Note No. 10

Fracture Mechanics

The SMART TechNet Project is supported by Federal and State Governments and Australian industry

AUSTRALIA AusIndustry™

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Welding Technology Institute of Australia

The Welding Technology Institute of Australia (WTIA) is the recognised national Australian Body representing the overall interests of the "welding" industry, with its primary goal to: "assist in making Australian Industry locally and globally competitive in welding-related activities". The Goal and Strategies within its Business Plan cover the 'Total Life Cycle of Welded Products/Structures'.

The WTIA is a membership based, cooperative, not-for-profit, national organisation representing the Australian welding industry and is registered as a 'Company Limited by Guarantee" under the Australian Corporations Law. WTIA is governed by a Council elected by the Divisions and Corporate Members.

Formed in 1989 through an amalgamation of the Australian Welding Institute (AWI) (founded 1929) and the Australian Welding Research Association (AWRA) (founded 1964), its key roles have been, and still are, predominantly in technology transfer, certification of personnel, education and training, provision of technical services and facilitating research and development.

Through its Council, Boards and Industry Support Groups, and Technical Panels it has representation from a tremendous range of industry, government authorities and educational institutions both locally and internationally.

Membership is offered within various categories and professional levels, presently consisting of approximately 1,400 individual members and 300 company members, whose annual subscriptions provide a significant portion of the operating costs of the organisation.

The current staff of 24 includes 14 engineer/technologists with a variety of specialist backgrounds in welding technology. This expertise is complemented by Industry Support (SMART and Technology Expert) Groups and Technical Panels with over 300 technical specialists, and by a number of WTIA voluntary Divisional Bodies in all States and Territories. Together they contribute on a significant scale to Australian Industry through its excellent network of volunteers throughout Australia and the wide cross-section of its membership from MD to welder.

The WTIA provides a very wide range of services to industry across Australia, Government and individual members. It is the body representing Australia on the International Institute of Welding, is a Core Partner of the CRC for Welded Structures, and it has a number of MOUs with kindred local and overseas bodies. It is actively involved in numerous initiatives to assist in improving the competitiveness of Australian Industry.

SMART TechNet Project

Welding technology in the broadest sense plays a major role in Australia's well-being and is utilised by over 20,000 Australian businesses large and small with over 300,000 employees. The WTIA is a significant player with industry in promoting improvements in industry through optimum use of Technology.

To ensure industries employing this technology are competitive globally, we all must become smarter. The WTIA SMART TechNet Project aims to do this by:

a) covering the *total life cycle* of welded products/structures i.e. a holistic approach to avoid critical gaps in technology and practice.

b) utilising *new* industry sectors (*SMART Groups*) to help identify problems and industry, Federal, State, Territory and Regional needs, to prioritise these needs, and to provide support, guidance and information for optimum solutions. (SMART is an acronym for *S*ave *M*oney *A*nd *R*e-engineer with *T*echnology).

c) using *new Technology Expert Groups*, interfacing at company/on site level, who will extract and consolidate local and global knowledge (from R&D, practice, and experience) into a form, which is available and diffusible to industry through *'Expert Technology Tools'*. This is currently a major priority particularly for SMEs.

d) absorbing and improving the current successful WTIA *OzWeld TSC Network* by expansion with overseas and other centres for latest information and by utilising training centres, at company and SME level to assist in its efficient diffusion and application.

The overall cost of this three-year project is $10.50m with $7.00m required from State bodies, industry and WTIA earned income and $3.50m from a Federal Government grant. The financial grant agreed by the Department of Industry, Science and Resources (DISR) Technology Diffusion Program required this other support and enables the complete network to be firmly established within the next three years. The Project represents an ideal example of Industry, State and Territory Governments and Federal Government working in a team effort for the overall benefit of Australia. It gives enormous leverage of upto 700 to 1 for each sponsor's financial contribution, the benefits of which are passed on to the sponsors.

The present project has 29 local and 7 overseas Technology Support Centres and 69 company sponsors from a wide variety of industries. These numbers are continually increasing.

Major benefits from this project are overall improvement and competitiveness of Australian industry through the use of latest proven technology, economically diffused by a greatly improved network, as well as improved and expanded services to sponsor companies. The project is believed to be the major practical strategy for rapid improvement of our "welding" businesses.

The return on investment for all parties on the WTIA OzWeld Technology Support Centres Project has been enormous. The return on this new SMART TechNet Project is expected to be even higher for parties involved.

EXPERT TECHNOLOGY TOOLS *for the Welding Industry*

What are they?

An Expert Technology Tool (ETT) is a medium for diffusion and take-up of technological information based on global research and development (R&D) and experience to improve industry performance.

It can be formatted as a hard copy, software (fixed, interactive or modifiable), audiovisual (videos and sound tapes) or physical samples. It can be complemented by face-to-face interaction, on-site and remote assistance, training modules and auditing programs.

The diagram overleaf and the information below show how the WTIA has introduced a group of ETTs to help companies improve their performance.

ETTs and the SME – how can they help my Total Welding Management System?

A Total Welding Management System (TWMS) is a major ETT with supporting ETTs created specifically to assist Australian industry, particularly those Small to Medium Enterprises (SMEs) that do not have the time or finance to develop an in-house system. These companies, however, are still bound by legal requirements for compliance in many areas such as OHS&R, either due to government regulation or to contract requirements. The TWMS developed by the WTIA can be tailor-made by SMEs to suit any size and scope of operation, and implemented in full or in part as required.

What is Total Welding Management

Total Welding Management comprises all of the elements shown in the left-hand column of the table shown overleaf. Each of these elements needs to be addressed within any company, large or small, undertaking welding, which wishes to operate efficiently and be competitive in the Australian and overseas markets.

The Total Welding Management System Manual (itself an Expert Technology Tool) created by the WTIA with the assistance of industry and organisations represented within a Technology Expert Group, overviews each of these elements in the left-hand column. It details how each element relates to effective welding management, refers to supporting welding-related ETTs, or, where the subject matter is out of the range of expertise of the authors, refers the user to external sources such as accounting or legal expertise.

Knowledge Resource Bank

The other columns on the diagram overleaf list the Knowledge Resource Bank and show examples of supporting ETTs which may, or may not, be produced directly by the WTIA. The aim, however, is to assist companies to access this knowledge and to recognise the role that knowledge plays in a Total Welding Management System. These supporting ETTs may take any form, such as a Management System e.g. Occupational Health, Safety and Rehabilitation (OHS&R), a publication e.g. WTIA Technical Note, a video or a Standard through to software, a one-page guidance note or welding procedure.

Clearly, ETTs such as WTIA Technical Notes, various Standards, software, videos etc are readily available to industry.

The group of ETTs shown overleaf relate to a general welding fabricator/contractor. The ETT group can be tailor-made to suit any specific company or industry sector.

A company-specific Knowledge Resource Bank can be made by the company omitting or replacing any other ETT or Standard.

Total Welding Management for Industry Sectors

Total Welding Management Systems and the associated Knowledge Resource Banks are being developed for specific industry sectors, tailored to address the particular issues of that industry and to facilitate access to relevant resources. A company-specific Total Welding Management System can be made by the company adding, omitting or replacing any element shown in the left hand column, or ETT or Standard shown in the other columns. This approach links in with industry needs already identified by existing WTIA SMART Industry Groups in the Pipeline, Petrochemical and Power Generation sectors. Members of these groups have already highlighted the common problem of industry knowledge loss through downsizing, outsourcing and privatisation and are looking for ways to address this problem.

The concept of industry-specific Total Welding Management Systems and Knowledge Resource Banks will be extended based on the results of industry needs analyses being currently conducted. The resources within the Bank will be expanded with the help of Technology Expert Groups including WTIA Technical Panels. Information needs will be identified for the specific industry sectors, existing resources located either within Australia or overseas if otherwise unavailable, and if necessary, new resources will be created to satisfy these needs.

How to Access ETTs

Management System ETTs, whether they are the Total Welding Management Manual (which includes the Quality Manual), OHS&R Managers Handbook, Procedures, Work Instructions, Forms and Records or Environmental Improvement System, can be accessed and implemented in a variety of ways. They can be:

- Purchased as a publication for use by industry. They may augment existing manuals, targeting the welding operation of the company, or they may be implemented from scratch by competent personnel employed by the company;
- Accessed as course notes when attending a public workshop explaining the ETT;
- Accessed as course notes when attending an in-house workshop explaining the ETT;
- Purchased within a package which includes training and on-site implementation assistance from qualified WTIA personnel;
- Accessed during face-to-face consultation;
- Downloaded from the WTIA website www.wtia.com.au

ETTs created by the WTIA are listed on page 69 of this Technical Note. Call the WTIA Welding Hotline on 1800 620 820 for further information.

TOTAL WELDING MANAGEMENT SYSTEM supported by KNOWLEDGE RESOURCE BANK

TOTAL WELDING MANAGEMENT SYSTEM MANUAL ETT: MS01 *(Including Welding Quality Management System)*	KNOWLEDGE RESOURCE BANK i.e. resources for the Total Welding Management System		
ELEMENTS:	ETTs: MANAGEMENT SYSTEMS	ETTs: OTHER RESOURCES	ETTs: STANDARDS
1. Introduction			
2. References			
3. Management System		TN19 Cost Effective Quality Management	AS/NZS ISO 9001 AS/NZS ISO 3834
4. Management Responsibilities		TN19 Cost Effective Quality Management	AS 4360
5. Document Control			
6. Production Planning			
7. Contracts			
8. Design		TN6 Control of Lamellar Tearing TN8 Economic Design of Weldments TN10 Fracture Mechanics TN12 Minimising Corrosion TN13 Stainless Steels for Corrosive Environments TN14 Design & Construction Steel Bins	AS 4100 AS 1210 BS 7910
9. Purchasing (incl. Sub-Contracting)			
10. Production Operations		TN1 Weldability of Steels TN2 Successful Welding of Aluminium TN4 Hardfacing for the Control of Wear TN5 Flame Cutting of Steels TN11 Commentary on AS/NZS 1554 TN15 Welding & Fabrication Q&T Steels TN16 Welding Stainless Steels TN17 Automation in Arc Welding TN18 Welding of Castings TN21 Submerged Arc Welding Videos – Welding Parts A & B PG02 Welding of Stainless Steel	AS/NZS 1554 AS 1988
11. Identification and Traceability		TN19 Cost Effective Quality Management	
12. Process Control		TN9 Welding Rates in Arc Welding	
13. Welding Coordination			ISO 14731
14. Production Personnel			
15. Production Equipment			
16. Production Procedures		TN1 The Weldability of Steel TN19 Cost Effective Quality Management	
17. Welding Consumables		TN3 Care & Conditioning of Arc Welding Consumables	
18. Heat Treatment			AS 4458
19. Inspection and Testing		PG01 Weld Defects	AS 2812
20. Inspection, Measuring and Test Equipment			
21. Non-Conforming Product			
22. Corrective Action		TN20 Repair of Steel Pipelines	AS 2885
23. Storage, Packing and Delivery			
24. Quality Records		TN19 Cost Effective Quality Management	
25. Auditing			
26. Human Resources			
27. Facilities			
28. Marketing			
29. Finance			
30. OHS&R	MS02 OHS&R – Managers Handbook MS03 OHS&R – Procedures MS04 OHS&R – Work Instructions MS05 OHS&R – Forms & Records	TN7 Health & Safety in Welding TN22 Welding Electrical Safety Fume Minimisation Guidelines Video – Fume Assessment	AS 4804
31. Environment	MS06 Environmental Improvement MS	TN23 Environmental Improvement Guidelines for Welding	AS/NZS 14001
32. Information Technology			
33. Innovation, Research and Development			
34. Security			
35. Legal			

This Technical Note:

- Summarises latest technical information available from a wide range of experience, research and literature on fracture mechanics of weldments.
- Applies in general to metallic materials as used for construction of a wide range of engineering components and to the various components of a welded joint in steel or other materials, i.e. the weld metal, heat affected zone, parent materials as affected by residual stresses.
- Provides guidance for the prevention of brittle fracture.
- Is intended for design engineers and fabricators engaged in the design and fabrication of welded structures, machines, vessels and components, but also aims to assist in the assessment of the severity of flaws detected by NDT during fabrication or service.
- Serves as an educational text for students of engineering and materials science on fracture mechanics of materials.
- Has been prepared by WTIA at the request of WTIA Technical Panel 1 Pressure Equipment members of which are listed as Appendix G of this Technical Note.

Particular thanks are extended to:

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