



VALIDWELD

VERIFIED APPROACHES to LIFE MANAGEMENT and IMPROVED DESIGN for HIGH TEMPERATURE WELDED CONSTRUCTION

An International Joint Industry Sponsored Program of MPC and TWI

To Provide Superior Joining Technology for High-Temperature Applications

Today we have the tools to properly address the issues of long-term strength, design and life assessment of welds for elevated- temperature service. Industry must understand and prevent the detrimental effects of time and stress on the safe, operating lives of welded components in elevated temperature service. Solutions will be found in improved designs and welding procedures and in application of validated life prediction tools based on long-term welded joint test data. These are the objectives of VALIDWELD.

VALIDWELD is a comprehensive program that will uniquely deliver the long term performance data that Sponsors require to ensure that the maximum economical service lives of welded components can be achieved reliably. The essential variables needed to optimize weld performance and fabrication specifications will be addressed. Modern welding concepts and tools will be applied to develop and validate design and life assessment guidelines for high temperature service. Current costly, poorly directed overdesign and ineffective inspection procedures will be avoided.

The Primary Deliverable will be comprehensive implementation guidelines and data for design and life evaluation of welded components operating at elevated temperatures in the form of a proprietary web-based tool for Sponsor implementation. These guidelines will be based on a reliable and fully validated suite of Weld Strength Reduction Factors developed by objective analysis of long duration tests of appropriate test specimens that consider critical materials and welding variables.

Sponsor benefits include:

1. The most advantageous design concepts for high temperature welded components with current and advanced high temperature alloys;
2. VALID remaining life evaluation strategies enabling planning of repair or refurbishment of existing plants in operation
3. A database with long term test results on alloys of current interest and protocols for developing needed data for materials that will be introduced in the future.
4. Avoidance of costly service failures and the high cost and inconvenience of plant down time.

Why hasn't this been done before and why must it be done now?

VALIDWELD is a significant undertaking in time and resources. It can only be accomplished through a systematic and carefully planned program of testing by those with extensive experience and knowledge of elevated temperature materials and weldment behavior and welding procedures. Existing databases and traditional design and fabrication procedures are inadequate to address the problem. Making do with inadequate data and applying only minimum standards to design and



fabrication has been proven to be the recipe for failure. Simplified methods of stress analysis are inappropriate for welds of complex, modern alloys. However, it has been shown that with proper attention to details at every step the useful lives of welds of these materials can be extended many times over, premature failures prevented and punitive weld strength reduction factors avoided.

The scope of **VALIDWELD** will include data collection and evaluation applicable to new creep strength enhanced ferritic (CSEF) steels, modern austenitic alloys and high-strength nickel base alloys. Dissimilar metal welds will also be addressed. The key to success will be drawing conclusions from well designed, long term, systematic testing. For the test program, specimen design, material compositions, consumables, thermal processing, welding procedures and test stresses and temperatures will be carefully and statistically planned. The focus will be on developing data and optimized welds in the materials of highest priority to the sponsors.

It is recognized that new alloys will continue to be introduced. Therefore the template to develop the essential data and optimal welding procedures to similarly demonstrate long term performance will be among the deliverables.

This collaborative program of the Materials Properties Council (MPC) and TWI Ltd brings together two organizations with extensive experience in elevated-temperature materials and weld performance, welding procedure optimization, setting allowable stresses, failure analysis and fitness-for-service. Augmenting the MPC-TWI team are internationally recognized experts with long experience in elevated temperature materials performance, metallurgy and testing from industry and academia. **VALIDWELD** is the international effort that is needed now.

VALIDWELD Tasks

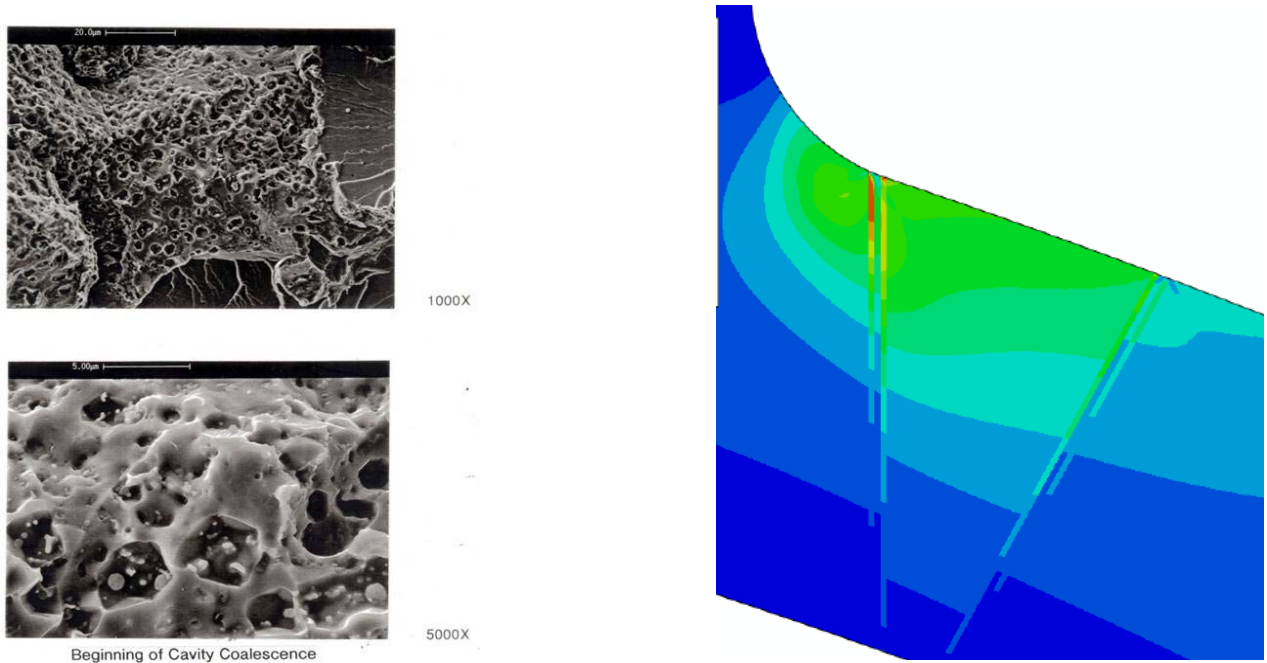
1. Relevant published data including those generated from large scale tests and associated materials properties will be compiled and evaluated and used to benchmark finite element models and life prediction tools
2. Material procurement focusing on CSEF Steels, but also with consideration of advanced austenitic steels, high strength nickel base alloys
3. Comprehensive long-term creep and rupture tests over a ranges of heats fully representative of alloys studied to develop relevant database for high priority alloys
4. Identification and verification of optimum welding procedures
5. Development of high temperature weldment test protocols appropriate to industrial service conditions
6. Application of advanced analytical tools for incorporation of useful data from existing databases
7. Investigations of welding procedures, consumables and heat treatments
8. Finite element modeling of different weld geometries and configurations to optimize performance
9. Development and verification of weld strength reduction factors for seam welds and girth welds in high temperature service
10. Field demonstration of rational probabilistic life prediction tools
11. Verified repair procedures for temporary or long term service
12. Development of a proprietary web based tool for use in design and for the prediction of long-term elevated temperature performance

Participation Fees, Duration and Reporting

In view of the diversity of potential Sponsors of this programme, a graduated fee scale has been developed. The participation fee is determined based on the size and nature of a Sponsors activities. It is envisaged that this programme will run for five years to allow sufficient long term creep data to be generated to validate the design lives. Topical reports, recommendations and data collections will be provided to sponsors on a confidential basis several times each year.

How to find out more about VALIDWELD

For further details on the scope, details, duration and membership in the MPC/TWI joint industry program **VALIDWELD** contact Dr. Martin Prager, Executive Director, the Materials Properties Council or Ms Adrienne Barnes / Dr. Brian Cane at TWI Ltd [mprager@forengineers.org , adrienne.barnes@twi.co.uk or brian.cane@twi.co.uk]



Low ductility and creep voids (as seen in the photos) on the left are associated with actual long term weld failures. Only data obtained under conditions leading to such service like failure modes can be properly extrapolated to develop allowable stresses for welded construction. The results of modern FEA modeling (as seen on the right) are applied to joint design in order to optimize life, minimize cost and identify where weld inspection efforts need to be focused. For example, calculated creep damage contours after long term service (figure on the right) show maximum damage in the fine grain weld heat affected zone just beneath the outside surface. Damage will progress toward the inside surface and can lead to failure before leak.