IIW Annual Assembly – Singapore.
July 12th to July 15th, 2009.
Summary of Commission XI Activities.
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Summary

Dr. Martin Prager from the USA chairs this commission. Its focus is in the areas of pressure vessels, boilers and pipelines. The IIW meetings have two main purposes: to gather together experts from around the world to discuss welding related issues, and to allow the flow of information between the member welding societies in the parent countries. The meetings with commission XI were done in the form of papers given by experts in the field of welding and some discussions regarding the working groups. I will provide short descriptions of the papers given. The full texts of the papers are available by contacting the CCIIW.

July 13th, 2009 – Commission XI Meetings

The theme of the papers presented on July 13th was pipelines.

- **Paper 1 –** Assessment of the Pipelines State Based on the Metal Magnetic Memory Method, S. Kolokolnikov, Russia, XI-921-09. Provides an overview of the metal magnetic memory (MMM) technique and how it detects stress concentration zones by detecting self magnetic leakage fields (SMLF). It uses the natural magnetization of the part and detects changes that are frozen into the metal due to inherent discontinuities. This method detects the presence of a discontinuity, in some cases before it grows and becomes a flaw. Advances in scanning devices and magnetic field measurement were described.
- **Paper 2 –** Double Jointing of High Strength Pipelines, D. Widgery, UK, XI-922-09. Double jointing of welds is done to increase field production speeds. For lower strength steels, the welding parameters are well known, but these procedures do not work adequately for all higher strength steels. The results of a welding study for a variety of welding parameters is provided, in the context of pipe manufacture for northern environments. Weld dilution is identified as a cause of the reduction in yield strength, and some solutions are presented to rectify this that allows sufficient yield strength at lower production rates.
- **Paper 3** – Technical Aspects of Welding Pipe Steels with High Power Fiber Laser, S. Grunenwald et al, Germany, XI-923-09. Focuses on a feasibility study on welding in pipe mills with high power fiber lasers. A GMA laser hybrid welding process was used to provide a deeper penetration, higher welding speeds and better gap bridge-ability. Welding speeds and destructive testing results are presented for a variety of different combinations of parameters for both X65 (thickness 9.5 mm) and X70 (thickness 14 mm) steels.
- **Paper 4** – The Pipeline Steels X-100 and X-120, S. Felber, Austria, XI-929-09. This paper contained significant detail in terms of the properties of the X100 and X120 pipeline steels. The information draws on both this research and the body of current knowledge in industry.
- **Paper 5 –** Report on Intermediate Meeting of Subcommission XI-E on Transmission Pipelines, M. Prager, USA. This presentation summarized the results of the two day meeting in Subcommission XI-E in Cleveland, USA. Summaries of a number of papers on pipeline research were given.
- **Paper 6** – Report on Subcommission XI-H: Hydrogen Effects on Welded Components, B. Dogan, USA. This paper deals with the potential hydrogen economy, and what needs to be done to allow this. Included in this are discussions on production, infrastructure, transportation (pipelines and storage), codes/standards, economics and public acceptance. For transmission, pipelines are seen as the only effective solution, but there are significant issues that need to be addressed in order to qualify existing pipelines for hydrogen service. A quick summary of the NIST hydrogen work (which includes Sandia, National Labs, ORNL) and the work in Japan was given. This subcommission is looking actively for participation by people interested in this topic.

- **Paper 7** – Pad-Weld Repairs of In-Service High Strength Steel Plate Used in Seawater Environments, Z. Sterovski, Australia, XI-924-09. Pad welds (also referred to as weld build-up, renovation or weld-surfacing depending on the standard) are welds that are undertaken to restore corroded areas. The corroded areas are first beveled and then welded. Of special concern are the weld start/stop locations, which are susceptible to hydrogen assisted cold cracking, stress corrosion cracking and higher hardness. Welding guidelines are provided.

July 14th, 2009 – Commission XI Meetings

The theme of the papers presented on July 14th was: welds in elevated temperature service, weld strength reduction factors, life predication, heat treatment issues and extrapolation of strength parameters.

- **Paper 1** – The New Standard GOST R 53006-2008 "Engineering Diagnostics. Estimation of Potential Dangerous Objects Lifetime on the Basic of Express Methods. General Requirements", S. Kolokolnikov et al, Russia, XI-925-09. This paper discussed the Russia standard involved in estimating the remaining lifetime of pressurized equipment. There was also a discussion of NDT techniques only being able to detect discontinuities once they have progress to macroscopic flaws, and other techniques that can detect the stress strain state of materials and thus determine where future flaws will develop. This GOST standard provides guidance on how to combine these two strategies into an inspection plan, and includes acoustic emission, metal magnetic memory, heat control and vibration monitoring as techniques to detect future flaw locations.
- **Paper 2** – Acoustic Emission Monitoring of High Energy Piping, B. Ham et al, Australia, XI-928-09. Discussed a project in Australia applying AE to high energy piping. PAC hardware was used for this work. AE (acoustic emission) was applied to hot reheat, HP (high pressure) bypass and LP (low pressure) bypass, all of which operate at 540 ºC. The piping did not have any existing cracking, but locations were chosen that were expected to be susceptible to cracking. They used AE wave guides welded onto the piping at an axial spacing no less than 5 m. Loading of the system was accomplished at turn on after shutdown. They detected a total of seven strong AE signals; analysis revealed that three were flow induced, two were due to hanger noise, one was extraneous and one occurred before any significant stress was applied. None of the AE signals was due to flaws, as determined by applying conventional NDT and replication to the AE locations. They used some advanced signal processing that lowered the false call rate of the technique, which in the past has been the main problem with this application.
- **Paper 3** – ISO Standard "Test Procedure for Creep Crack Initiation and Growth Testing of Metallic Materials", B. Dogan, USA. This is a technical report published through ISO dealing with creep crack growth that better quantifies the material and design parameters to improve service life of high temperature components. An engineering approach was used that deals with: processing, properties and structural integrity that integrate the structural design, material and process selection and defect assessment. There are some detailed recommendations on how to assess defects in different services and conditions.
- **Paper 4** – Current Research on Life Predication and Failure Modes of Welds on Elevated Temperature Service – Discussion of Papers Presented at 2nd ECCC Creep Conference. This was a summary of a number of contributions from this conference. Some select papers were:
    - Long term degradation mechanisms in creep strength enhanced ferritic alloys
    - Computer modeling of type IV damage
    - Void growth in welds
    - Weld lifetimes depending on type I or II behaviour
    - Experimental characterizations and modeling of P92 creep properties
    - Creep strength of high chromium steel welds under multi-axial stress
    - Creep void growth simulation based on grain boundary local stress analysis
    - Experimental and numerical investigations on the behaviour and assessment of martensitic welds
    - Creep properties of weld repaired low alloy heat resistant CrMo and Mo steels at 540 ºC
    - Cold weld repair of T91
    - Creep life evaluation of low-alloy steel weldment by small punch method
    - Investigations of accelerated creep properties

    - Influence of substructure on creep failure of P91
    - Material creep qualification testing for next generation of nuclear reactors
    - Effect of boron on creep strength of high Cr steel welds
- **Paper 5** – Correlation of Creep Strength and Micro-Structural Evolution of a Boron Alloyed 9Cr3W3CoVNb Steel…, P. Mayr, Austria. This steel is designed to be operated at 650 ºC and reduce some of the existing problems with loss of creep strength in welds at high temperature. Japanese work indicated that the addition of boron improved creep strength if it is in solution in the steel. This work used the same steel composition as the Japanese work and tested this hypothesis. Chemical compositions, oxidation behaviour and phase diagrams for this steel are given. This steel has some interesting behaviour with its ability to retain its grain structure after temperature cycling – micro-structure memory. Its creep behaviour at 650 ºC shows higher creep strength than P91 and P92 steels. Despite not having a conventional fine grained HAZ, it still fractures in the same location as typical Type IV failures.
- **Paper 6** – Summary International Conference Welds 2009, B. Dogan, USA. This is a summary of the contributions for an EPRI conference. It deals with design, testing, assessment and safety of high temperature welded structures. Dogan provided a summary of a select number of papers.

July 15th, 2009 – Commission XI Meetings

The theme of the papers presented on July 15th was: fabrication of advanced ferritic steel pressure vessels with special emphasis on 2¼Cr-1MoV and dissimilar metal welding. The CEO of the IIW addressed the Commission on administrative matters. At the end of this session, Prager discussed a number of potential areas that Commission XI could start working groups on in collaboration with other Commissions. Prager was looking for the level of interest within Commission XI in order to set future work group direction.

- **Paper 1** – Report for 2009 of IIW WG on Creep, P. Mayr, Austria. Mayr is the new chairman for this working group, taking over from Hald. There was little activity in this group in the last year.
- **Paper 2** – Welding Issues in API Fabrication Standard 934 for Advanced Chrome Moly and Higher Strength Steels, M. Prager, USA. This standard deals with welding issues on the advanced Chrome Moly steels, with the talk discussing narrow gap welds in relatively thick pressure vessels. Results from toughness testing for different materials and under different parameters were given. Information was also provided on welding rods, stress-rupture testing, hydrogen issues, PWHT and type IV cracking. There was also data presented to show the behaviour and lifetimes of these materials.
- **Paper 3** – Annealing Flux Cored Wires and Reduction of Diffusible Hydrogen, T. Kasuya et al, Japan, XI-926-09. In the production process of FCW (flux cored wires), there is an annealing process used to suppress the hardness of the wire. Kasuya evaluated different FCW parameters (e.g. wire diameters, annealing conditions, etc) with diffusible hydrogen content and cold cracking measurements through groove crack testing. Some comprehensive quantitative results are presented that determine FCW hydrogen content.
- **Paper 4** – A Study of Residual Stresses in Heavy Section Narrow Gap and EB Welds, P. Dong, USA. Narrow gap welds were done with TIG welding, and were modeled using an axisymmetric finite element model of material stresses. Stress concentrations through the weld thickness are given for both electron beam (EB) and TIG welding, both in the transverse and parallel directions. In the case of EB welds, the weld volume is under compressive stress in the transverse direction, which can be a significant benefit to field welds. For EB welds in the hoop stress direction, the main tensile stresses are sub-surface, which is different than for TIG welding. This indicates that EB welding is preferential, as it will not lead to more critical surface cracking. In the vertical direction, the TIG welding process has low stresses, and the EB weld has large stresses.
- **Paper 5** – What Toughness to Use for Assessment of Advanced Steels for Low-Temperature, High Pressure Hydrogen Service, M. Prager, USA. Prager presented overviews of a number of papers from various sources. There was a discussion on the diffusivity of hydrogen in steels, for a wide variety of materials, temperature and weld preparations. Both experimental and finite element modeling results were also presented on hydrogen charging of specimens.

- **Paper 6** – Creep Testing Welded Components to Estimate Weld Stress Rupture Strength Reduction Factors and Design Life, M. Prager, USA, XI-927-09. This paper deals with the question of how to extrapolate results from tests that are either done at different locations in phase space or incomplete in order to make decisions on equipment. Modeling of behaviour is done to help extend these results to be able to determine the correct failure modes. This is very important as it is not possible to do full scale testing with real samples due to the cost and the limited phase space captured. Prager wants to get people involved in a working group focused on this.
- **Paper 7** – Dissimilar Metal Welds Filler Metal for High alloys and DMW Research Needs, M. Prager, USA. Prager asked if there is interest within the Commission in this area as applied to power plant applications.
- **Paper 8** – Commission Activity – Updating IIW on the GNIRSS Report for New Materials, M. Prager, USA. This paper provides information on how to handle dissimilar metal welds for P91/12CrMoVW and records the welding parameters have been successful in the past. Prager asked about the level of interest in the Commission for extending this work.
- **Paper 9** – Commission Activity – Compendium of Repair Welding Procedures, M. Prager, USA. Prager asked about the level of interest in the Commission for supporting this work.
- **Paper 10** – Discussion of Commission XI Strategic Plan and Other Hot Topics, M. Prager, USA. Every Commission under IIW needs a business plan and a strategy to accomplish these goals. The key strategies in this business plan are divided into a number of areas. The first is in the area of initiating and developing worlds best practices, and for Commission XI includes:
    - Develop a practice for calculating weld strength reduction parameters for components in creep service
    - Develop a practice for heat treatment of dissimilar metal welds that optimizes performance of the joint
    - Develop systematic procedures for estimating the long-term stress rupture properties of welds
    - Develop a best practice document for repair welding ferrous alloys
    - Develop a practice for optimizing joint design and consumable selection for heat treatment of component in creep service

  The second area is in organizing the exchange and transfer of technical information and provide an environment to encourage this. If interested in the details of this plan, see the IIW strategic direction document, which can be provided by CCIIW. An open discussion in the Commission occurred to allow the group to have input into future direction of the Commission.