Welding and Repair Technology Center – Overview

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Outline - Summary

• Welding & Repair Technology Center (WRTC)
  – WRTC Mission/Strategic Plan
  – Advisory Structure/Meetings
  – Technology Roadmaps/Key Areas
WRTC Strategic Plan

- WRTC balances fundamental research (long-term) with tactical projects (short-term)

- WRTC focus on tactical support and short-term, utility-requested R&D.
- emergent repair needs
- code cases
- repair and welding process optimization
- information exchange

- Apply resources toward proactive resolution of major industry gaps & development of advanced solutions
- Collaborations to develop and deploy materials joining and repair fundamental solutions
- Align WRTC resources, program objectives, and projects for long term research
WRTC Strategic Plan

- WRTC Strategic Plan (Roadmaps)
  - Technology gaps were identified in the area of welding and repair
  - Six areas were highlighted for further development
  - Three roadmaps address fundamental R&D
    1. Develop new welding technology and guidance for the repair of highly irradiated material (PWR and BWR Internals)
    2. Alloy 52M Nickel-base filler metal weldability solution
    3. Develop a new SCC resistant nickel based or alternative alloy with high weldability for dissimilar metal weld applications
WRTC Strategic Plan

- Three roadmaps address tactical applications
  4. Development & Implementation of Advanced Welding Technologies
     - Residual Stress Assessment Solutions
     - Welding Impact on Inspectability
     - Production Rates
  5. Small Bore Pipe Asset Management
  6. ASME Code Issues and Support – White papers and technical bases

• Other Key WRTC Activities
  - Root Cause Analyses
  - Best Practices and Guidelines - Benchmarking
  - Information exchange
  - Training Guidelines (Overlay, Failure analyses, Temperbead welding)
WRTC Advisory Structure

- 25 of 26 US Utility Organizations (operating BWR and PWRs) participate in WRTC
- 5 International members
  - EDF - France
  - KNHP – Korea (New 2011)
  - COG - Canada
  - CEZ NPP (New 2011)
  - British Energy Generation Ltd.
RRAC – WRTC Team

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Welding Technology Conferences

- Established conference series for Welding and Repair Technology
  - *Welding and Repair Technology for Power Plants, 9th International Conference, Marco Island, FL (2012)*
  - *Welding and Fabrication Technology for New Power Plants and Components (June 21-24, 2011, Omni Champions Gate, Orlando)*
  - Sponsored by WRTC and Fossil Materials Repair (Program 87), Boiler Life and Availability (Program 63), HRSG Dependability (Program 88)
Workshops Planned for 2011 Conference

B31.1 Materials, Fabrication, & Examination - Doing It Right
- Discuss the bases for the B31.1 Power Piping Code rules for materials, fabrication, and inspection/examination. Special emphasis will be placed on rules that are different from other ASME Codes
- Course conductor: Philip D. Flenner, PE

Basics of Conducting a Failure Investigation
- Intended to educate the power plant engineer on the proper steps to take when conducting a failure analysis
- Course conductor: Dr. Jude Foulds, P.E., Principal, Clarus Consulting, LLC

- Discuss the basics of heat treatment and its growing significance in power construction. Emphasis on material quality and illustration of potential failures in base and weld material
- Course conductor: Gary Lewis and Joe Borror, Superheat FGH
ISSUE STATEMENT

• Continued operation of light water reactors will require repairs or replacement of reactor internal components as degradation occurs (Welding will play an important role)

• Weldability of the materials is altered by the formation of helium (helium-induced cracking)
Project Objectives and Scope

- Develop advanced welding technology required for reactor repairs
- Collaborate with industry experts to support reactor life extension beyond 60 years
- Development Modeling Simulation to Guide Process Development and Predictive Application on Irradiated Materials
- Validate Processes
  - Hot Lab Welding and Testing
    - Laser, hybrid, friction stir
  - Neutron Irradiated Sample Set (Standard)
Alloy 52M Nickel-Base Filler Metal Weldability Solutions

Issue............

- INCONEL 182 (ENiCrFe-3) filler metal extensively used in DMW welds for critical reactor coolant system components
  - Over time 182 is degraded by primary water stress corrosion cracking (PWSCC)
- High Cr filler metal (52M) has high resistant to PWSCC and required for;
  - Mitigation, Repair and Fabrication
- Weldability and crack susceptibility of 52M are complex, requiring
  - Adequate composition limits
  - Narrow weld process controls
  - Isolation of susceptible base materials
  - Adequate experience required
Roadmap - Development of New SCC Resistant Nickel Based or Alternative alloy

ISSUE…….

• Alloys 52 and 52M currently required for DMW repairs
  – High-chromium, nickel-based weld metals developed specifically for their superior resistance to SCC
  – Alloys are susceptible to weld cracking and have less than optimum weldability.
• A new high-chromium welding alloy is needed
  – With desired mechanical properties and corrosion resistance
  – With significantly improvement in weldability and superior resistance to weld cracking.
Development of New SCC Resistant Nickel Based or Alternative alloy

PLAN.....

- Fundamental research performed to understand cracking mechanisms and weldability problems
- Development of alloy composition
  - Model welding behavior and mechanical properties of target compositions
  - Validate modeled behavior with experimental weld wire heats
  - Perform mechanical, corrosion, and crack growth rate testing
- Assess welding and nondestructive evaluation of alloy composition
  - Assess process parameters for gas tungsten arc and gas metal arc welding
  - Large scale mockups and assessment of nondestructive evaluation
  - Assess feasibility of alternative advanced welding processes (laser welding, magnetic stir, hybrid, etc.)
Roadmap - Development & Implementation of Advanced Welding Technologies

Objectives

- Roadmap for advance welding process and application development
  - residual stress improvements
  - welding impact on inspectability
  - increase production rates
Development of Advanced Welding Processes

- **Welding Process Studies**
  - Controlled dilution and material interactions (residual stress)
  - Evaluate processes that do not create a molten weld pool
  - Evaluation of weld filler materials interactions

- **Advantages compared to traditional welding processes**
  - Creation of a wider repair welding window
  - Effectively changing the local stress/strain field to a compression
  - Reduced heat affected zone (HAZ)
Development & Implementation of Advanced Welding Technologies

Magnetic Stir Welding Process Evaluations

- Initial results with overlay configuration with Alloy 52M
  - Show reduction in weld metal grain size
  - Significantly improved NDE (UT) examination capability by reducing ultrasound attenuation

- Work in 2011 will evaluate
  - Potential for reduction in hot cracking
  - Capabilities to address groove welding application for new construction and repair (single sided applications)
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