Advanced Welding and Joining Technical Workshop

Boulder, Colorado, January 25-26, 2006

Working Group 1
Weld Design in Emerging Materials

Working Group Chair: William Mohr
Working Group co-Chair: Marie Quintana
Facilitator: William Mohr
Scribe: Joshua Jackson
**Attendance Breakdown**

Approximate total attendance 14 persons

<table>
<thead>
<tr>
<th>Category</th>
<th>Attendance</th>
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<tbody>
<tr>
<td>Federal Regulators</td>
<td>2 persons</td>
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<tr>
<td>State Regulators</td>
<td>0 persons</td>
</tr>
<tr>
<td>International Regulators</td>
<td>1 persons</td>
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<tr>
<td>Pipeline Industry</td>
<td>5 persons</td>
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<tr>
<td>Standard Organizations</td>
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<tr>
<td>Researchers</td>
<td>5 persons</td>
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<tr>
<td>Academics</td>
<td>1 persons</td>
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</tbody>
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WG 1 – Weld Design in Emerging Materials

Top 4 Identified Goals

Goal #1 – Testing Methods for Mechanical Strength Properties
- Deciding what data is necessary for WM and BM
- Defining how to attain that data and procedures
- Making judgments based on data

Goal #2 – Acceptance Criteria
- Establish required inputs/information for different design methodologies
- Fill gaps in available ECA technologies to determine flaw acceptance criteria
  - Stress-based – undermatching, HAZ Softening
  - Strain-based methodologies for all steel grades
  - Define limits of applicability

Goal #3 – Testing Methods for Fracture Toughness Properties
- Get more relevant fracture data than standard CTOD test for HAZ and WM
- Establish link between laboratory tests and full-scale.

Goal #4 – Essential Variables
- Update current welding standards to cover essential variables and procedure qualification for modern welding techniques to ensure property consistency

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Associated Actions (Goal #1)

Testing Methods for Mechanical Strength Properties
- Deciding what data is necessary for WM and BM
- Defining how to attain that data and procedures
- Making judgments based on data

Regulatory
1. Awareness and acceptance (1-X years)

Consensus Standards
1. Develop an (ASTM-like) weld tensile testing standard (1-3 years)

General Knowledge
1. Determine the properties of interest for various design methods (1-3 years)
2. Demonstration datasets (1 year from start of #1)
3. Develop testing procedures (1 year from start of #1)
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Associated Actions

(Goal #2)

Acceptance Criteria

Regulatory
1. Awareness and acceptance (1-X years)
2. Incorporation by reference (0-1 years after availability)

Technology
1. Develop ECA technology for strain-based design (1-3 years)
   - Rank importance of input parameters
   - Models for strain capacity
   - Correlation and validation among different scale of test specimens
2. Demonstrate limits for undermatching and HAZ softening for stress-based design (1-3 years)

Consensus Standards
1. Stress-based -> Continue updates (0-1 years)
2. Strain-based -> develop a standardized approach for (1) acceptance, (2) design, (3) maintenance (1-3 years)

General Knowledge
1. Connection between acceptance criteria and AUT capabilities/accuracy (1-3 years)

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Associated Actions (Goal #3)

Testing Methods for Fracture Toughness Properties

**Regulatory**

1. Awareness and acceptance (1-X years)
2. Incorporation by reference (0-1 years after availability)

**Consensus Standards**

1. Develop low-constraint fracture toughness test (1-3 years)
   - Include tearing and fracture initiation
   - For WM and HAZ testing

**General Knowledge**

1. Survey available low-constraint test methods (0-1 years)
2. Assess applicability of potential test methods (0-1 years)
3. Establish link between laboratory tests and full-scale (1-3 years)

- Get more relevant fracture data than standard CTOD test for HAZ and WM
- Establish link between laboratory tests and full-scale.
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Associated Actions
(Goal #4)

Regulatory
1. Awareness and acceptance (1-X years)

Technology
1. Develop a fundamental understanding of what controls cooling rate in various welding processes (1-3 years)
2. Develop control technology (1-3 years)

Consensus Standards
1. Establish consumable chemistry limits and qualification requirements (1-3 years)
2. Update standards to incorporate control of relevant essential variables (1-3 years after info is available)
3. Update standards to address procedure and welder qualification requirements (1-3 years after info is available)

General Knowledge
1. Establish cooling rate sensitivity and other factors for both WM and HAZ (1-3 years)
2. Determine what process parameters control cooling rate (1-3 years)
3. Identify consumable chemistry limits and qualification requirements (1-3 years)

Update current welding standards to cover essential variables and procedure qualification for modern welding techniques to ensure property consistency.
Additional Identified Goals

- Weld + pipe cladding: Acceptance
- Probability of detection
- Risk-based design
- Long-running ductile fracture prevention
- Low-cycle fatigue
- ECA for buckled pipe
- Determine effect post-weld thermal cycles on weld properties (e.g. coating thermal effects)
- Corrosion testing and SCC
- Welding procedures for clad pipe
- Expand traditional view of design to include practical aspects of field application (e.g. tie-in welds)
Additional Identified Goals

- Standardize practical guidelines for welding consumable selection
  - Chemical analysis & acceptance
  - Properties based on generic standard
    - Define overmatch. Does it involve more than strength?
- Examine the possibility of dissimilar metal consumables
- Establish recommended practices for defining weldability for emerging materials.
  - Basis should be on the unique failure modes of the material in the anticipated applications.
- Establish a framework for strain based design that involves general requirements. Must build in flexibility to accommodate a wide variety of applications.