

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

WG 1 – Weld Design in Emerging Materials

Attendance Breakdown

Approximate total attendance	14 persons
Federal Regulators	2 persons
State Regulators	0 persons
International Regulators	1 persons
Pipeline Industry	5 persons
Standard Organizations	0 persons
Researchers	5 persons
Academics	1 persons

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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

- 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

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)

- Get more relevant fracture data than standard CTOD test for HAZ and WM
- Establish link between laboratory tests and full-scale.

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)

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Associated Actions

(Goal #4)

Essential Variables

- Update current welding standards to cover essential variables and procedure qualification for modern welding techniques to ensure property consistency

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)

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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.