2006

Advanced Welding and Joining Technical Workshop: Pipelines

NISTIR 6641

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The proceedings of a workshop held January 25-26, 2006,
at the
National Institute of Standards and Technology
Boulder, Colorado

Edited by:
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National Institute of Standards and Technology
Technology Administration, U.S. Department of Commerce

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Sponsored by:
The Office of Pipeline Safety

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U.S. Department of Commerce
Carlos M. Gutierrez, Secretary

Technology Administration
Robert Cresanti, Under Secretary of Commerce for Technology

National Institute of Standards and Technology
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Executive Summary

The National Institute of Standards and Technology (NIST) strongly supports the drive toward safer pipelines, and joined with the Pipeline and Hazardous Materials Safety Administration (PHMSA) to advance this goal. NIST in collaboration with PHMSA and several pipeline industry trade organizations, organized and executed the Advanced Welding and Joining Technical Workshop on January 25 and 26, 2006 workshop in Boulder, Colorado.

Assistance in organizing the workshop came from an 18-person steering committee selected to represent the different interests in the pipeline industry. This committee helped to prepare the agenda, identify speakers, organize the working groups, and promote attendance.

The workshop had 69 participants representing pipeline owners, technology developers, trade and standards organizations, and government agencies. The workshop structure included six keynote presentations to suggest some issues, five working groups (by topical area) to identify and rank the research needs, and summary presentations (back to the whole group) to compare results and comment on any overlaps or omissions.

The five working groups were:

- Weld Design in Emerging Materials,
- Construction,
- Weld Inspection and Assessment Methods,
- Weld Maintenance and Repair, and
- Joining Issues for Nonmetallic Materials

Their charge was to identify topical goals that could improve pipeline safety and the actions required to have these become reality. The working groups convened just after the keynotes were finished (by lunch on the first day) and continued on the second morning. The top goals identified by the groups were:

WG 1 – Weld Design in Emerging Materials

<u>Goal #1</u> – Testing Methods for Mechanical Strength Properties
- Deciding what data is necessary for weld metal base metal
- Defining how to attain that data and procedures
- Making judgments based on data

<u>Goal #2</u> – Acceptance Criteria
- Establish required inputs/information for different design methodologies
- Fill gaps in available ECA technologies to determine flaw acceptance criteria
    - Stress-based – undermatching, heat affacted zone 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

WG 2 – Construction

Goal #1 – GMAW Automation
Arc dynamics (single wire/tandem)
Process monitoring
Start/stop control (stability)
Seam tracking

Goal #2 – Fabrication standards for high strength (>/= X80) steels and processes
X-80 +
Recommended practices (endorsed by PHMSA/OPS)

Goal #3 – End preparation technology
Equipment survey to identify a path forward
Optimize joint design

Goal #4 – Laser Hybrid Welding
Move towards a production system

Goal #5 – Pipeline Construction Tie-In Automation

WG 3 – Weld Inspection and Assessment Methods

Goal #1 – Develop, validate and implement a set of methodologies and standards to quantify the reliability of automated ultrasonic testing (AUT) systems, procedures and operators for critical pipeline weld inspection applications

Goal #2 – Investigate, develop and quantify 3-D digital image capture radiography

Goal #3 – Investigate the practical applicability of AUT matrix phased array probes and 3-D imaging

WG 4 – Weld Maintenance and Repair

Goal #1 – Improve Methods of Technology Transfer
Better ways of informing operators of results of completed research and industry practices (e.g., manuals, notes for guidance documents, websites, training courses, videos, interactive CD-ROMs)

Goal #2 – Further Develop Understanding of Metallurgical Factors that Affect Hydrogen Cracking
Microstructure/hardness limits as a function of hydrogen, chemistry, and wall thickness
Methods for determining chemical composition of in-service pipelines (e.g., database development, development of new analytical methods, etc.)

Goal #3 – Develop Better Predictive Models for Pre-Weld Planning
Cooling rate/microstructure/hydrogen model for predicting hydrogen cracking
Thermo/mechanical model for predicting burn through

WG 5 – Joining Issues for Nonmetallic Materials

Goal #1 – Develop NDE technology that can determine the integrity of all fusion joints.

Goal #2 – Improve on current joining technologies, including process validation to ensure proper equipment operation to mitigate human error.

Goal #3 – Develop quicker methods or testing practices for accurately predicting the integrity/residual life of older PE pipe joints.

This report will be distributed in several formats: CDROM and electronically from the PHMSA web site (http://primis.phmsa.dot.gov/rd/mtg_012506.htm) and from the NIST Materials Reliability Division web site (boulder.nist.gov/Div853). Both of these sites have many more files and reports that may be of interest to the pipeline community, and you are encouraged to search through both of them.

Incidentally, this is the second workshop in this series. The first one, "Advanced Coating R&D for Pipelines and Related Facilities," was published by NIST as Special Publication 1044. It is available from the OPS website and the NIST Metallurgy Division website, www.metallurgy.nist.gov/reports/NIST-SP1044-2005-PL-coatings.pdf and http://primis.phmsa.dot.gov/rd/mtg_060905.htm .

Steering Committee

- Nate Ames – Edison Welding Institute
- David Dorling – Transcanada
- D. Dzurko – Optonline
- Michael Else – Minerals Management Service
- J. Gianetto – CANMET Materials Technology Laboratory
- Harvey Haines - PRCI
- David Horsley – Transcanada
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- A. Johnson – API
- David McColskey – NIST
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- K Paulson – National Energy Board (Canada)
- Marie Quintana – Lincoln Electric
- Christina Sames – American Gas Association
- Tom Siewert – NIST
- Robert W. Smith - Office of Pipeline Safety, DoT
- Jim Swatzel – Columbia Gas
- B. Tyson – Natural Resources Canada

Please find all presentations given at http://primis.phmsa.dot.gov/rd/mtg_012506.htm