U.S. Department
of Transportation

Office of Pipeline Safety Presentation on

Design-Construction Materials-Welding

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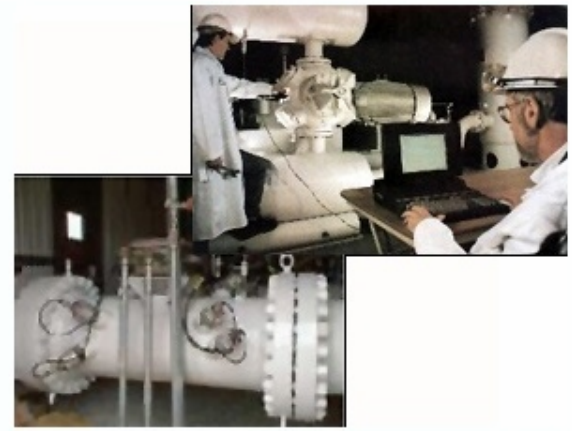
Research & Development

Welcome to RSPA's Pipeline Safety Research and Development Website.



This site is dedicated to the coordination and dissemination of Research and Development information related to Pipeline Safety.

OPS conducts and supports research to support regulatory and enforcement activities and to provide the technical and analytical foundation necessary for planning, evaluating, and implementing the pipeline safety program. OPS is sponsoring research and development projects focused on providing near-term solutions that will increase the safety, cleanliness, and reliability of the Nation's pipeline system.

Recent R&D projects are focused on: leak detection; detection of mechanical damage; damage prevention; improved pipeline system controls, monitoring, and operations; and, improvements in pipeline materials. These projects are addressing technological solutions that can quickly be implemented to improve pipeline safety.

In 2003, a study by the General Accounting Office (GAO) found that OPS's R&D program is aligned with OPS's mission and pipeline safety goals.

Design-Construction-Materials-Welding Research

Project Title	Researcher	OPS	Co-Share	(MO)	%
Validation of Sleeve Weld Integrity and Workmanship Limit Development	BMT Fleet Technology	$45,000	$93,550	24	100
Alternate Welding Processes for In-service Welding	BMT Fleet Technology	$90,000	$265,700	24	100
High CP Potential Effects on Pipelines	CC Technologies	$80,000	$80,000	36	100
Emerging Padding and Related Pipeline Construction Practices	Battelle	$70,000	$70,000	24	85
Corrosion Assessment Criteria: Rationalizing Their Use Applied to Early vs Modern Pipelines	Battelle	$196,000	$221,000	24	73
A Comprehensive Update in the Evaluation of Pipelines Weld Defects	Engineering Mechanics Corporation	$312,309	$417,299	24	73
First Major Improvements to the Two-curve Fracture Arrest Model	Engineering Mechanics Corporation	$305,051	$263,976	24	73
An Assessment of Magnetization Effects on Hydrogen Cracking for Thick-Walled Pipelines	Colorado School of Mines	$150,000	$50,000	12	60
Fatigue Fracture and Crack Arrest in High-Strength Pipeline Steels	National Institute of Standards and Technology	$250,000		24	41
External Corrosion of Line Pipe Steels	National Institute of Standards and Technology	$250,000		24	41
Innovative Welding Processes for Small to Medium Diameter Gas Transmission Pipelines	Edison Welding Institute, Inc.	$399,989	$700,000	18	23
Strain-Based Design of Pipelines - Phase II	Edison Welding Institute	$74,881	$224,881		20
Optimizing Weld Integrity for X80 and X100 Linepipe	Edison Welding Institute	$303,956	$587,000	24	19
Evaluation of Hydrogen Cracking in Weld Metal Deposited using Cellulosic Electrodes	Edison Welding Institute	$149,968	$150,000	24	19
A New Approach to Control Running Fracture in Pipelines	Battelle	$259,855	$320,000	24	11
Integrity Management for Wrinklebends and Buckles	Battelle	$274,971	$480,000	24	11

Design-Construction-Materials-Welding Research

Portfolio Summary (16 Projects)

Total OPS Funding	$3,211,980
Total Industry Co-Funding	$3,923,406
Average Project Duration	22 months
Average % Complete	53 %

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OPS R&D Projects

Project Title: Validation of Sleeve Weld Integrity and Workmanship Limit Development

Researcher: BMT Fleet Technology

Goal: The object of this project is to support current efforts towards the development of a Guidance Note for Fillet Welded Connections to pipelines.

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OPS R&D Projects

Project Title: Alternate Welding Processes for In-service Welding

Researcher: BMT Fleet Technology

Goal: Project is to support efforts towards the development and application of procedures for welding on in-service pipelines using alternate welding processes.

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OPS R&D Projects

Project Title: High CP Potential Effects on Pipelines

Researcher: CC Technologies Laboratories, Inc.

Goal: The objective of the proposed research is to develop a set of guidelines for operators, which would enable the users to determine the limiting cathodic protection potentials for a given steel metallurgy and coating type and thickness to mitigate possible hydrogen-induced damage and coating disbondment and/or blistering.

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OPS R&D Projects

Project Title: Emerging Padding and Related Pipeline Construction Practices

Researcher: Battelle Memorial Institute

Goal: The objective of this project is to quantify the merits of modifications to existing construction practices and emerging practices related to pipeline padding. The work will assist in determining the value of such construction practices when made in the context of performance-based inspection or re-inspection plans in response to pending pipeline safety legislation. The proposed project will complement and follow an INGAA Foundation project, which acts as co-funding and which is directed primarily at a qualitative evaluation of the potential of these techniques to improve productivity and improve safety. The combined effort will involve a field evaluation of these emerging approaches for benching pipelines and for bedding and padding in areas where native soils contain rock and other debris that could damage the pipeline or degrade its integrity over time.

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OPS R&D Projects

Project Title: Corrosion Assessment Criteria: Rationalizing Their Use Applied to Early vs Modern Pipelines

Researcher: Battelle Memorial Institute

Goal: Develop quantitative measures that determine which of the current corrosion assessment criteria are valid to assess corrosion defect severity and determine failure pressure.

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OPS R&D Projects

Project Title: A Comprehensive Update in the Evaluation of Pipelines Weld Defects

Researcher: Engineering Mechanics Corporation

Goal: This project will provide a major update to the alternative girth weld defect acceptance criteria. The focus of the project will be in two primary areas: a) To update the alternative defect acceptance criteria to address the immediate need of pipeline construction in the USA, typically with pipeline longitudinal strains less than 0.5%; and b) To develop alternative defect acceptance criteria for ultrahigh strength pipelines (e.g., X100) in geotechnically challenging environments, such as arctic areas and deep water offshore. Update Appendix A of API Standard 1104 for girth weld defect acceptance criteria as specified in Federal regulations (49 CFR, Parts 192 and 195), to reflect the increased use of mechanized welding and automated ultrasonic testing in new pipeline construction.

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OPS R&D Projects

Project Title: First Major Improvements to the Two-curve Fracture Arrest Model

Researcher: Engineering Mechanics Corporation

Goal: The proposed program is to make the first major improvements to the most commonly used ductile fracture arrest criterion.

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OPS R&D Projects

Project Title: An Assessment of Magnetization Effects on Hydrogen Cracking for Thick-Walled Pipelines

Researcher: Colorado School of Mines

Goal: This research program is proposed to:

(1) Experimentally determine the role of high strength magnetization during frequent pigging on the possibility of hydrogen damage in thick-walled, high-strength steels, both in base metal and the heat affected zone of welds [HAZ]; and
(2) Determine the hydrogen damage mechanisms through polarization studies.

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OPS R&D Projects

Project Title: Fatigue Fracture and Crack Arrest in High-Strength Pipeline Steels

Researcher: National Institute of Standards and Technology

Goal: To identify the steels with the necessary crack arrest toughness. Currently used tests require so much material that it is not feasible or economical to perform these tests on many steels. However, modern linepipe steels are likely to exhibit ductile tearing rather than cleavage. In this case, knowledge of the rate dependence of plastic yielding could point the industry in the right direction. NIST has an instrument (Kolsky bar) that would be ideal for studying this as it uses very small quantities of material and can probe very high rates of deformation such as those near a rapidly propagating crack. This would provide the needed understanding of how different steels achieve crack arrest.

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OPS R&D Projects

Project Title: External Corrosion of Line Pipe Steels

Researcher: National Institute of Standards and Technology

Goal: Stress corrosion cracking (SCC) has become an important issue in pipeline reliability. There is increasing need for an understanding of the fundamental mechanisms involved in SCC in order to develop improved detection and monitoring technologies. In the past, NIST developed an extensive database on underground corrosion of linepipe steels, and ran the NACE Corrosion Database Program for many years. One method to transfer improved data on SCC could be an expansion of the NACE database.

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OPS R&D Projects

Project Title: Innovative Welding Processes for Small to Medium Diameter Gas Transmission Pipelines

Researcher: Edison Welding Institute, Inc.

Goal: The project aims to develop innovative welding processes and technologies for single-sided pipeline girth welding. Root pass welding techniques will be emphasized since they have the greatest potential to improve pipeline integrity and facilitate the use of new and existing GMAW fill pass techniques. Advanced automation techniques will be used to improve weld quality, process control, seam tracking, and robustness.

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OPS R&D Projects

Project Title: Strain-Based Design of Pipelines - Phase II

Researcher: Edison Welding Institute, Inc.

Goal: The major objective of the proposed project is to develop design and assessment guidelines for pipelines that may experience high strains in service. This effort draws its basis from a previously concluded project which laid the groundwork to begin the framework of these guidelines. The guidelines will include:

- Recommended pipeline material specifications to minimize strain localization (soft HAZ)
- Recommended welding specifications to minimize strain localization at pipeline girth welds
- Descriptions of the range of cases where combinations of operating pressure, strain localization, and high strain affect pipeline performance.

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OPS R&D Projects

Project Title: Optimizing Weld Integrity for X80 and X100 Linepipe

Researcher: Edison Welding Institute, Inc.

Goal: The major objectives of this program are as follows:

- To provide a better understanding of the factors that control strength and toughness in high strength girth welds.
- To develop optimized welding consumables and welding procedures for high strength pipelines.
- To develop best practice guidelines for the welding of high strength pipelines.
- To disseminate best practice information to the pipeline industry.
- To enable high integrity girth welds to be more reliably and economically achieved in high strength pipelines.

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OPS R&D Projects

Project Title: Evaluation of Hydrogen Cracking in Weld Metal Deposited using Cellulosic Electrodes

Researcher: Edison Welding Institute, Inc.

Goal: The objectives of the proposed project can be summarized as follows:

- To determine the effect of electrode drying and arc length on weld metal chemistry, mechanical properties and hydrogen cracking susceptibility.
- To determine the effect of electrode re-hydration on weld metal chemistry, mechanical properties and hydrogen cracking susceptibility.
- To develop practical guidelines on how to prevent hydrogen cracking in welds deposited using cellulosic covered electrodes.

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OPS R&D Projects

Project Title: A New Approach to Control Running Fracture in Pipelines

Researcher: Battelle Memorial Institute

Goal: (1) Develop and validate fracture arrestor design basis in reference to fracture speed, wall hoop stress and toughness, and gas properties; (2) Quantify differences in flow properties, fracture initiation formulation, and backfill coefficient today vs initial empirical calibration, reformulate arrest model accordingly, and validate in reference to trends evident in full-scale test database; (3) Characterize essential differences for modern high strength grades vs historic steels, such as elastic strain energy and dissipation near the fracture; (4) Formulate a first-principles model reflecting active sources of dissipation; (5) Establish the implications for a shift from fracture-controlled to flow-controlled running fracture as processes other than fracture become significant as toughness increases; and (6) Quantify role of grade, yield to tensile ratio, toughness, and parameters that characterize line pipe properties and those of the transported product in reference to the fifth goal, and formulate a model for fracture arrest as the deliverable.

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OPS R&D Projects

Project Title: Integrity Management for Wrinkle Bends and Buckles

Researcher: Battelle Memorial Institute

Goal: (1) Broaden the utility of severity assessment criteria to cover pipelines with diameters from 12" to 36" in Grades from B thru X60, for wall thickness typical of products and natural gas transport, and operational histories for such service, and validate by full-scale test; (2) Quantify effects of corrosion pitting on the corrosion-fatigue resistance of line pipe steels, and combine with analysis of the effects of ID and OD corrosion on wrinklebends, and modify assessment criteria. (3) Quantify effects of pipe restraint applied local to the wrinkle or globally near the wrinkle, and assess implications for fieldwork on or nearby wrinklebends; (4) Quantify differences in hot-formed vs. cold-formed wrinkles in regard to fatigue resistance of line pipe and shape of the wrinkle; (5) Update severity assessment criteria to embed effects of corrosion, constraint, and forming temperature; and (6) Evaluate differences between wrinkles and large-scale buckles.

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