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Stress Corrosion Cracking Study

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Stress Corrosion Cracking Study

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List of Acronyms

AC	Alternating Current
AGA	American Gas Association
AOPL	Association of Oil Pipe Lines
API	American Petroleum Institute
APIA	Australian Pipeline Industry Association
AS	Australian Standard
ASME	American Society of Mechanical Engineers
ASTM	American Society of Testing and Materials
CEPA	Canadian Energy Pipeline Association
CFR	Code of Federal Regulations
CIS	Close-Interval Survey
CP	Cathodic Protection
CSA	Canadian Standards Association
C-SCC	Circumferential Stress Corrosion Cracking
CTOD	Crack Tip Opening Displacement
C-UT	Circumferential Ultrasonic Testing
CVN	Charpy V-Notch
DC	Direct Current
DCVG	Direct-Current Voltage Gradient
DSAW	Double Submerged Arc Weld
EAC	Environmentally Assisted Cracking
ECA	Engineering Critical Assessment
EFW	Electric Flash Welded
EMAT	Electro Magnetic Acoustic Transducer
ERW	Electric Resistance Welded
ET	Eddy Current Testing
EW	Elastic Wave
FAD	Failure Assessment Diagram
FATT	Fracture Appearance Transition Temperature
FBE	Fusion Bonded Epoxy
FFS	Fitness-for-Service
GRI	Gas Research Institute
GTI	Gas Technology Institute
HAZ	Heat Affected Zone
HCA	High Consequence Area
HF-ERW	High-frequency Electric Resistance Welded
ID	Inside Diameter
IEC	International Electrotechnical Commission
ILI	In-Line Inspection
INGAA	Interstate Natural Gas Association of America
ISO	International Organization for Standardization
LF-ERW	Low-frequency Electric Resistance Welded
MAOP	Maximum Allowable Operating Pressure
MAWP	Maximum Allowable Working Pressure
MFL	Magnetic Flux Leakage
MIC	Microbiologically Influenced Corrosion
MOP	Maximum Operating Pressure
MPI	Magnetic Particle Inspection
NACE	National Association of Corrosion Engineers
NAPSR	National Association of Pipeline Safety Representatives
NDT	Non-destructive Testing
NEB	National Energy Board (Canada)
NPS	Nominal Pipe Size
NSS	National Standards System
OD	Outside Diameter
OPS	United States Department of Transportation, Office of Pipeline Safety

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PASC	Pacific Area Standards Congress
PRCI	Pipeline Research Council International
ROW	Right-of-Way
RSPA	Research and Special Programs Administration
SATT	Shear Appearance Transition Temperature
SAW	Submerged Arc Weld
SCADA	Supervisory Control and Data Acquisition
SCC	Stress Corrosion Cracking
SCCDA	Stress Corrosion Cracking Direct Assessment
SDO	Standards Development Organizations
SMYS	Specified Minimum Yield Strength
TCPL	TransCanada Pipelines Limited
TFI	Transverse Field Inspection
ULC	Underwriters' Laboratories of Canada
UT	Ultrasonic Testing

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Executive Summary

This report reviews the available information on Stress Corrosion Cracking (SCC) in liquid and gas pipelines. The information is contained in a number of locations and, although generally consistent in approach, reveals the uncertainty in both the understanding and practical operational methods to effectively prevent, detect, assess, and/or remediate SCC in pipelines. Additional research needs are outlined and prioritized in this regard.

Along with the review of existing information, a questionnaire was circulated to operators, and several detailed operator interviews were conducted. In addition, the applicability of the current regulatory oversight, including Integrity Management (IM) plan review, was considered. A review of procedures for conducting SCC failure investigations was also performed.

Recommendations were made to guide oversight in all areas of the study:

In regard to preventing the initiation of SCC, the single most important recommendation is the emphasis on coatings that remain bonded to the pipe, but allow the passage of CP current in the event of disbondment. Emphasis should also be placed on the QA/QC of the surface preparation and field application. These considerations would apply to both new pipe installation as well as to coating replacement projects. Apart from this consideration, there are limited practical recommendations for pipeline operation processes that can prevent SCC initiation.

In regard to SCC causal factors in pipelines and SCC prediction, the recommendations reflect the technical uncertainty surrounding the subject. Thus, emphasis is placed on written documents in operational and IM plans that stress awareness and the need for additional data collection to enhance understanding. The initial plan produced by an operator may follow several available references to prioritize potential SCC pipe segments and develop a consequent ranking and/or segment risk. However, the emphasis must be such that procedures, especially the collection and integration of data specific to SCC development from ILI and direct examinations, are identified and implemented to refine and update this model over time, which will help operators gain a better understanding of the SCC susceptibility. Therefore, it is recommended that operator plans reflect this need for continued data and knowledge development and sharing.

When SCC is identified, recommendations are made for data collection, data analysis, and planning for further action based on the assessment of the threat to pipeline integrity with an emphasis on written documentation that clearly establishes the decision flow from discovery to field action. Depending on the field conditions, a number of potential mitigation techniques are available and should be considered as alternatives for implementation by an operator. Linking the site-specific SCC data back to the operator linewide model for SCC is recommended for identifying analogous line situations and consequent direct examination needs.

Finally, written contingency plans, such as designation of pre-qualified personnel, data collection requirements, and return to service plans, for in-service failures due to SCC are recommended. Again, any plan should include linking the site-specific data to the operator linewide model for identification of additional potential SCC occurrences.

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