Managing Pipeline Integrity -
Technologies for the New Millennium

Tutorials: April 12, 1999
Workshop: April 13-15, 1999

Banff Centre for Conferences
Banff, Alberta, Canada

Proceedings
BANFF/99 PIPELINE WORKSHOP
Managing Pipeline Integrity -- Technologies for the New Millennium
Tutorials: Monday, April 12, 1999
Max Bell Building

9:00 - 4:30  In-Line Inspection
Max Bell Auditorium

Part 1 - 9:00 - 12:00
ILI tool selection, defect assessment and interaction criteria, coordination of ILI programs, and the use of low-resolution vs. high-resolution ILI technology from the operator's perspective.

Introduction of Case Histories
Arti Bhatia

Trans Mountain Pipe Line Inc.
Greg Toth

Enbridge Pipelines Inc.
Arti Bhatia

TransCanada PipeLines
Blaine Ashworth/Reena Sahney

Pipeline Integrity International Inc.
Patrick Vieth

Part 2 - 1:30 - 4:30
ILI vendors will present the current technologies available and the rationale for use of specific tools for various pipeline inspection applications.

BJ Pipeline Inspection Services
David Hektner

Pipeline Integrity International Inc.
Keith Grimes

Pipetronix Limited
Neb Uzelac

Tuboscope Vetco Pipeline Services
Patrick Porter

9:00 - 4:30  Risk Assessment/Risk Management
Room 253

Ian Dowsett, Conor Pacific, and Mark Stephens, C-FER Technologies Inc.
This tutorial will outline how quantitative risk analysis (QRA) can assist decision-makers with decisions about pipeline risks. The principal areas addressed include:

- The risk management process,
- Examples of risk analysis and risk assessment of pipeline systems, and
- Discussion of risk analysis and risk assessment within an overall risk management context.

Individual topics covered include: Definitions and terminology, the goals and objectives of risk management, hazard identification, consequence analysis, frequency analysis, risk estimation (with implications for linear systems) and risk acceptability.

9:00 - 12:00  Application of GIS Technologies to Integrity Management
Room 252

Overview of Technology
Bruce Dupuis, Integrated Integrity Inc.
Amoco Canada
Donald Powell
Foothills Pipe Lines Ltd.
Kyle Keith
TCPL
Martin Cairns

Case studies by operating companies

1:30 - 4:30  Database Development, Maintenance and Use
Room 251

Introduction
Keith Leewis, GRI, and Bruce Dupuis, Integrated Integrity Inc.

What You Should Know about Databases
John Wester, Net Shepherd

CEPA Database
Bruce Dupuis, Integrated Integrity Inc.

PRASC Database
Wayne Feil, Imperial Oil

Data Models, ISAT and POD
Keith Leewis, GRI
Tuesday, April 13, 1999

Max Bell Building

Plenary Session - Max Bell Auditorium

9:30  Workshop Opening, Larry Drader, AEC Pipelines
9:45  Technologies for the New Millennium
      Scott Rowland, IBM Canada Ltd.
10:20 CEPA Integrity Management Plan
      Richmond Graham, TransGas Limited

10:40 Break/Individual Contact Meetings

10:55 Pipeline Risk Assessment Steering Committee (PRASC) Database
      Ian Fraser, Imperial Oil Resources Limited
11:10 A New MFL In-Line Tool to Detect Longitudinal Cracks
      Francois Jacquot and Patrick Viltart, TRAPIL, Paris, France
11:35 Land Use Planning/Encroachment and Abandonment
      Ian Scott, CAPP
11:50 International Pipeline Conference 2000 (IPC 2000)
      Robert Hill, Canadian Energy Pipeline Association
11:55 Presentation of Plaques
12:00 Introduction of Facilitators
      Doug Macdonald, SNC Lavalin Engineers & Constructors

12:05 Lunch

1:15 Working Groups: Session A
      Working Group 1: Construction, Repair, Maintenance, and Geotechnical
      Working Group 2: Stress-Corrosion Cracking
      Working Group 4A: Risk Assessment/Risk Management -- General

2:45 Break/Individual Contact Meetings

3:30 Working Groups: Session B
      Working Group 1: Construction, Repair, Maintenance, and Geotechnical
      Working Group 2: Stress-Corrosion Cracking
      Working Group 4A: Risk Assessment/Risk Management -- General

5:00 Adjournment for the Day
Wednesday, April 14, 1999

8:15 Working Groups:
   Session C
   Working Group 1:  Construction, Repair, Maintenance, and Geotechnical
   Working Group 4D: Risk Assessment/Risk Management -- Communications, Public
                     Consultation, and Planning
   Working Group 5:  Information Management: Database Development,
                     Maintenance, and Use
   Working Group 7:  External Corrosion

9:45 Break/Individual Contact Meetings

10:30 Working Groups:
   Session D
   Working Group 4D: Risk Assessment/Risk Management -- Communications, Public
                     Consultation, and Planning
   Working Group 5:  Information Management: Database Development,
                     Maintenance, and Use
   Working Group 7:  External Corrosion

12:00 Lunch

1:15 Working Groups:
   Session E
   Working Group 3:  Coatings
   Working Group 4B: Risk Management/Internal Corrosion -- Producers
   Working Group 4C: Risk Assessment/Risk Management -- Transmission
   Working Group 6:  In-Line Inspection

2:45 Break/Individual Contact Meetings

3:30 Working Groups:
   Session F
   Working Group 3:  Coatings
   Working Group 4C: Risk Assessment/Risk Management -- Transmission
   Working Group 6:  In-Line Inspection

5:00 Adjournment for the Day

6:30 Reception
Thursday, April 15, 1999

8:15 **Working Groups:** Session G
    Working Group 1: Construction, Repair, Maintenance, and Geotechnical
    Working Group 2: Stress-Corrosion Cracking
    Working Group 3: Coatings
    Working Group 4A: Risk Assessment/Risk Management -- General
    Working Group 4B: Risk Management/Internal Corrosion -- Producers
    Working Group 4C: Risk Assessment/Risk Management -- Transmission
    Working Group 4D: Risk Assessment/Risk Management -- Communications, Public
                     Consultation, and Planning
    Working Group 5: Information Management: Database Development,
                     Maintenance, and Use
    Working Group 6: In-Line Inspection
    Working Group 7: External Corrosion

**Plenary Session**  Max Bell Auditorium
9:30  Working Group 1: Co-Chairs' Report and Discussion
9:45  Working Group 2: Co-Chairs' Report and Discussion
10:00 Working Group 3: Co-Chairs' Report and Discussion

10:15 Break/Individual Contact Meetings
10:30 Working Group 4A: Co-Chairs' Report and Discussion
10:45 Working Group 4B: Co-Chairs' Report and Discussion
11:00 Working Group 4C: Co-Chairs' Report and Discussion
11:15 Working Group 4D: Co-Chairs' Report and Discussion
11:30 Working Group 5: Co-Chairs' Report and Discussion
11:45 Working Group 6: Co-Chairs' Report and Discussion
12:00 Working Group 7: Co-Chairs' Report and Discussion

12:15 Workshop Wrap-Up, Distribution of Proceedings
12:25 Workshop Adjournment
12:30 Lunch
Working Groups and Co-Chairs:

Working Group 1: Construction, Repair, Maintenance and Geotechnical
Co-Chairs: Reynold Hinger (TMPL), Paul Wong (Skystone Engineering)

Working Group 2: Stress-Corrosion Cracking
Co-Chairs: Martyn Wilmott (Bredero Price), Blair Carroll (Enbridge)

Working Group 3: Coatings
Co-Chairs: John Baron (Shell), Matt Cetiner (Anteris Corrosion)

Working Group 4A: Risk Assessment/Risk Management -- General
Co-Chairs: Ian Dowsett (Conor Pacific), Mark Stephens (C-FER)

Working Group 4B: Risk Management/Internal Corrosion -- Producers
Co-Chairs: Dave Kopperson (PanCanadian), Karol Szkotarz (Shell)

Working Group 4C: Risk Assessment/Risk Management -- Transmission
Co-Chairs: Kevin Cicansky (TCPL), Glenn Yuen (Dynamic Risk Assessment)

Working Group 4D: Risk Assessment/Risk Management -- Communications, Public Consultation, and Planning
Co-Chairs: Dave DeGagné (AEUB), Terry Gibson (Gecko)

Working Group 5: Information Management: Database Development, Maintenance and Use
Co-Chairs: Keith Leewis (GRI), Bruce Dupuis (Integrated Integrity)

Working Group 6: In-Line Inspection
Co-Chairs: Arti Bhatia (Enbridge), Bruce Lawson (Westcoast)

Working Group 7: External Corrosion
Co-Chairs: Susan Miller (Enbridge), Bob Worthingham (TCPL)
In-Line Inspection Tutorial
Bryan Scott and Arti Bhatia, Enbridge Pipelines Inc.

The tutorial was divided into two segments. The first segment dealt with In-Line Inspection (ILI) tool selection, defect assessment and interaction criteria, coordination of ILI programs, and the use of low-resolution vs. high-resolution ILI technology from an operator’s perspective. The presentation summaries are as follows:

Trans Mountain Pipe Line Inc.
Title: Standard Resolution to High Resolution ILI Transition - An Operator’s Perspective
Presenter: Greg Toth

The presentation dealt with the difficulties of an operator moving from the use of low resolution ILI technology to high resolution inspection technology. The presentation identified the difficulties with physically launching and receiving the longer inspection tools; however the main focus appeared to be the volume of data received, the analysis and prioritization of the information.

Enbridge Pipelines Inc.
Title: The Use of In-Line Inspection Technology as an Integral Part of Integrity Management at Enbridge Pipelines Inc.
Presenter: Arti Bhatia

The focus of this presentation was the use of in-line inspection data as a method for performing dynamic analysis of repeat sections with high resolution data. The presentation also emphasized the need for proper communication with ILI vendors in order to obtain the information most useful to the operator for long term strategic integrity management.

TransCanada Pipelines (TCPL)
Title: TransCanada Pipelines MFL In-Line Inspection Program
Presenter: Reena Sahney – TCPL
              Blaine Ashworth – TCPL
              Patrick Vieth – Pipeline Integrity International

The presentation provided a company overview identifying the acceleration of the original 10-year program to a three-year program. The main focus of the presentation was how to deal with data analysis and prioritization.
Vendor Presentations
ILI vendors presented the current technologies available and the rationale for use of specific tools for various pipeline inspection applications. The presentation summaries are as follows:

BJ Pipeline Inspection Services
Topic: Geopig - Caliper tool and Vectra - MFL tool
Presenter: David Hektner

The presentation provided an understanding of the Geopig’s capabilities and its move from sonar to mechanical finger caliper assessment. The tool’s capabilities include:

- high speed and high resolution pipeline caliper information,
- GPS location of features,
- pipeline mapping and GIS integration,
- bending strain (structural analysis)

The second part of the presentation focussed on the technology associated with the Vectra MFL tool.

- speed control
- GPS feature for pipeline mapping
- triaxial sensor usage for defect sizing
- VectraView Software

Pipeline Integrity International (PII)
Topic: Current Available Technologies
Presenter: Keith Grimes

This presentation provided an outline of ILI tool and software technologies available in the industry today. An update was also provided on PII inspection tools and advancements in software. The discussion of PII equipment included the following:

MFL – Metal Loss Technology
TFI – Transverse Field Inspection
UT – Ultra Sonic Shear Wave Technology
Velocity Control
Software Improvements
GIS Platforms
Tool Development - Dual Diameter
Pipetronix Limited

Topic: In-line Inspection of Pipelines – Available Technologies and Tools
Presenter: Neb Uzelac

This presentation outlined the various technologies available through Pipetronix Limited.

- CalScan - caliper
- ScoutScan – inertial
- Leak Detection
- MagneScan SR – Standard Resolution MFL
- MagneScan HR – High Resolution MFL
- MagneScan XHR – Extra High Resolution MFL
- UltraScan WM - Ultrasonic Wall Measurement
- UltraScan CD – Ultrasonic Crack Detection

Pipetronix is also involved in the integration of their data into a GIS platform as well as providing turnkey inspection, data analysis, and investigative and dig program execution.

Tuboscope Vetco Pipeline Service

Topic: State of In-Line Inspection
Presenter: Patrick Porter

This presentation summarized the preceding presentations and provide information on equipment and software advancements within Tuboscope Vetco. Topics discussed included:

- MFL Technology in general
- Data Analysis Advancement within Tuboscope Vetco and the industry
- Strain Analysis Tools and Software
- EMAT Technology
- Velocity Control
- Mechanical Damage the leading cause of pipeline failure
# ILI Tutorial - Attendance

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<thead>
<tr>
<th>Name</th>
<th>Affiliation</th>
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<tr>
<td>Winston Revis</td>
<td>CANMET Pipeline Integrity International, Inc.</td>
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<td>Bob Vilyus</td>
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<td>Kevin Ennis</td>
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<td>Amour El Boujdaini</td>
<td>CANMET/OTTAWA</td>
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<td>Cristina Castro</td>
<td>Enbridge Enbridge Pipelines Inc.</td>
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<td>Arti Bhakta</td>
<td>Enbridge Pipelines Inc.</td>
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<td>Bryan Scott</td>
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<td>Deryl Rousey</td>
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<td>Guy Desjardins</td>
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<td>Doug Hill</td>
<td>Petro-Canada Oil &amp; Gas</td>
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<td>H. Parekh</td>
<td>Indian Oil Corporation Ltd (Pipelines, New Delhi, India)</td>
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<td>A. Dauzu</td>
<td>CANMET/WRC</td>
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<td>S. Papavinadom</td>
<td>CANMET/Mohila Technology Laboratory</td>
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<td>Robert Wade</td>
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<td>Rod Trepanenko</td>
<td>Gulf Midstream Services</td>
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<td>Bill Tyson</td>
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<td>Meredyth Gretzinger</td>
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<td>Walter Soerquist</td>
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<td>Darren Way</td>
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<td>Ed McClarty</td>
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<td>Brian Majewski</td>
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<td>P.R. Inc.</td>
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<td>Don McNabb</td>
<td>Apache Pipeline Products.</td>
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<td>Rick Stelmachuk</td>
<td>Rosenthal Pipeline Inspection.</td>
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<td>Bryce Brown</td>
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Overview of Risk Management, Risk Assessment and Risk Analysis
Ian Dowsett, Conor Pacific Environmental Technologies Inc.

Development, aging, and encroachment onto pipeline systems impose change. Change introduces risk and the perception of risk. There is a need to manage change and ensure that the risk and the perception of risk are acceptable (to industry, government and to the public). This session advances examples of the use of risk management, risk assessment and risk analysis as a means of managing change. The goals and objectives of the tutorial are to:

- demonstrate how risk management, risk assessment and risk analysis can benefit the pipeline industry in dealing with these issues;
- understand the concepts of risk management, risk assessment and risk analysis;
- apply risk management, risk assessment and risk analysis techniques to pipeline systems, and;
- apply this information to identify solutions to issues facing the pipeline industry.

The roles and responsibilities of industry, the public and government were advanced:

- industry is responsible for managing the risks through individual company activities (due diligence) and through industry organizations and associations: e.g., CAPP, CEPA

These responsibilities include:

- identifying and understanding the consequences and risks associated with a proposed development;
- demonstrating an industry based and a corporate commitment to address and minimize outcomes and risks;
- demonstrate sufficient resources and an ability to implement the proposed activities and actions;
- inform interested and affected parties of the proposed development and its potential effects and of the actions and activities planned to address them, and
- provide a meaningful opportunity for input into the project planning process, including the development of risk management strategies, and;
- earn the public's trust and confidence in all of these activities.

The public has a role in understanding the issues and becoming involved in the process.

The regulator holds the responsibility for facilitating decision-making, the decision itself, and for ensuring that agreed-upon provisions (designed to address the risks) are met (NEB, AEUB, US-EPA) through: Acts and Regulations and Standards & Guidelines.

Definitions and examples of risk management, risk assessment and risk analysis are provided and applied to pipeline systems and the role of industry. Copies of the presentation overheads can be obtained from the presenter by email at jan.dowsett@conorpac.com.
Risk-based Decision Making
Based on Quantitative Risk Analysis

- The process of risk control
  - To select and implement measures to ensure an acceptable level of operating risk
- Questions answered
  - How much should the risk be reduced?
  - At what cost?

Note: The preferred risk control strategy achieves an acceptable level of risk at the minimum cost.

Decision Analysis

- Decision analysis - an approach that utilizes risk analysis results in the decision making process
- Comments on the use of decision analysis
  - a formal process for choosing the best course of action in the presence of uncertainty
  - acknowledges that uncertainty and adverse consequences are influencing factors in any decision

Comments on Formal Decision Analysis Methods

- Can provide a rational answer to "How safe is safe enough?"
- Can achieve a balance between costs and risks
- Reflects decision makers preferences
- Requires
  - Detailed analysis
  - Explicit answers to difficult questions required
- Are there Alternatives?

Simplified Approaches to Risk-based Decision Making

- Available approaches
  - Fixed incremental cost of risk reduction
  - Predefined maximum risk level
  - Predefined maximum probability level
- When to use
  - Routine decisions
  - Application of regulations
  - To avoid explicit quantification of consequences

Summary

- Decision Analysis based on QRA*
  - a basis for objective risk management
  - Ensure acceptable operating risk at minimum cost
- Requirements of QRA*
  - Relevant historical incident data, or
  - Analytical models and fine condition data
- Benefits of QRA*
  - Gives pipeline-specific solutions
  - Quantifies the impact of proposed actions

*Quantitative risk analysis
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<td>Yara Research &amp; Tech</td>
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<td>Tim Edwards</td>
<td>Baseline Technologies Inc</td>
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<td>Bruce Fowlie</td>
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<td>Paul Meanwell</td>
<td>Union Oil Limited</td>
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ATIENANCE
RISK - PM

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Terry Chewey
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Warren Waldegger
Enbridge (Sask)

Keith Carr
Western Facilities

Stephen Gore
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Walter Goheer
Westcoast Energy Inc.

Mike Green
BTS - Airdrie Co.

Osko Kuleszar
Gibson Petroleum

Corak Lukansuk
TCPL

Shu C. Lee
EUB

Bruce Foulke
Nu-Trac Management Consulting

Tim Baldwin
IG Technology

Lyle Geritz
JLG Engineering Ltd.

Carlo Spinelli
SNAM SpA

Gordon Dow
N.E.B.

Ted Hamre
Canspec

Frank Christensen

Noel Billette
Natural Resources Canada
Miles Hackness - Centra Gas Manitoba
Max Buck - ConocoPhillips
Joanna Makomaski - Enbridge Consumers Gas
Lawrence Gales - Transportation Safety Board
Scott Oliphant - Chevron Canada Resources
Andrew Francis - BG Technology
Leo Hansen - National Energy Board
Gary Marbrook - Nova Red
N.W. Murray - Chair of Alberta
Application of GIS Technologies to Integrity Management
Chair: Bruce Dupuis, Integrated Integrity Inc.

Overview of GIS

Bruce Dupuis
Integrated Integrity Inc.

Introduced the structure and functionality of GIS and covered issues to consider in implementing a GIS

Utilizing GIS for an Integrity Management Project

Don Powell
Amoco Canada Petroleum Company

Presented an example of the application of a GIS to manage data from multiple ILI inspections (different vendors and opposite directions). Additionally, the value of a GIS to manage class location assessment was highlighted.

Using GIS to Choose Excavation/Investigation Sites

Kyle Keith/Erwin Kautz
Foothills Pipe Lines Ltd.

Presented an example of an application of GIS to correlate multiple parameters for the purpose of selecting and prioritizing investigative excavation locations. The queries and correlations were built in a real time demonstration of the Foothills Pipe Lines GIS.
Application of GIS Technologies to Integrity Management: Tutorial

A.M. Session

Attendance

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<thead>
<tr>
<th>Name</th>
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<td>Tom Cook</td>
<td>R. Coulombe Group</td>
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<td>Wayne Feil</td>
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<td>Lyke Gerutz</td>
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<td>Brad Watson</td>
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<td>Wes MacLeod</td>
<td>Nova Research &amp; Technology</td>
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<td>Katherine Ikeda-Cameron</td>
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<td>Stephen Jacobson</td>
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<td>Don Powell</td>
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<td>Paul Green</td>
<td>Exxon Gas</td>
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<td>Harro Fijon</td>
<td>G1S Consultant</td>
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Database Development, Maintenance and Use
Chair: Bruce Dupuis, Integrated Integrity Inc.

Databases and Things That Go Bump
The Rough Guide to Data Collection
John Wester, Net Shepherd

Overview of the different aspects of database development, more specifically:
• Data model and problem identification
• Data collection issues
• Single user, multi user and replication
• ODBC and what it means
• Back Ends: file based vs. server based
• Front Ends: integrated vs. separate

CEPA Data Capture Application: SCCdb32
Bruce Dupuis
Integrated Integrity Inc.

Overview of the history and scope of the application as well as the structure and data fields utilized. A real time demonstration of the application was given. A demo version of the application can be downloaded from the CEPA web site at cepa.com

PRASC Incident Database
Wayne Feil, Imperial Oil Resources
Don Kosolofski, CGI Information Systems

An overview of the PRASC mandate and their vision towards database development. The existing version of the Internet based incident database is to be revised. PRASC is currently determining what direction to go with their next version.

PODS (Pipeline Open Database Structure)
Keith Leewis, GRI

Overview of the initiative of GRI to develop an industry standard data structure to facilitate data sharing and reduce costs associated with application development and customization. GRI, in association with a number of application providers, is putting forward a process to create an independent organization to manage the continued development and maintenance of this standard.
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<td>Keith Lewis</td>
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<td>Josue Johnson</td>
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<td>Tanya Cook</td>
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<td>Robert Eiber, Consultant</td>
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<td>Gaby Lerleer</td>
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<td>Pulsis Geomatics</td>
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<td>Andren Nowinski</td>
<td>Imperial Oil Resources</td>
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BANFF99 PIPELINE WORKSHOP OPENING ADDRESS
By Larry Drader
Vice-President, Operations & Engineering
AEC Pipelines Ltd.

Introduction

Thank you Doug for the kind introduction. Ladies and gentlemen, I would like to take this opportunity to welcome all of you to the Banff/99 Pipeline Workshop. Not only can I guarantee you an enjoyable stay here in Banff and the majestic Rocky Mountains over the next few days, I can also assure you the experience of a world-class interactive forum dedicated to the prevalent issues and technologies associated with pipeline integrity. We must commend the work and effort put forth by this year’s Workshop Co-Chairs in planning such an exciting four-day program. I would like to take this opportunity to thank the entire organizing committee on behalf of all the workshop delegates.

The theme of this year’s workshop is “Managing Pipeline Integrity – Technologies for the New Millennium”. It is a two-part title focusing on technology, and the management of this technology. Ultimately, the effective integration of these two components should assist us in maintaining pipeline integrity. I’d like to briefly discuss both components of the theme and their importance in the overall direction pipeline companies will be taking in the new millennium.

Technology

Like so many other industries, the pipeline industry is about to embark on an era where technology will be heavily called upon to assess, remedy, and monitor several important issues. Pipeline integrity is no different. But why should we even embark on such a journey based on our industry track record? As we are all aware, pipeline infrastructures have been providing an efficient, economically viable and safe means of transport of petroleum-based products for several years. Statistics readily associate pipeline transport with safety records orders of magnitude better than other modes of transport. So why fix or change the way we do things if they seem to providing favorable results (i.e. safety wise, efficiency wise and financially)?

Certainly many pipeline companies have profited from these systems over the years, and if the efficiencies of these systems can be maintained at or near initial operating levels, without radically changing operating philosophies, why embark on potentially disruptive and costly changes? These mindsets are obviously affected by external forces (e.g. political issues, regulatory requirements, commodity prices, etc.) which directly affect the dynamics of the operation. A very competitive and global marketplace now also plays an important role in the type of operating decisions made. However, the danger of falling back onto standard ‘modus operandi’ based on past performances, techniques and accomplishments, still exists, and can literally dictate how an operation should be run. So why then should we adopt a “proactive” approach to pipeline integrity as opposed to a “reactive” one? Quite simply: aging pipeline infrastructures.
The majority of pipeline systems in operation today are obviously not new. They have not been new for many years now and they will not become new anytime in the near future. It is inevitable: everything ages, even newly constructed pipelines incorporating the most modern systems, technologies and advancements. Like anything else, aging also brings deterioration with it. The forces directly responsible for deterioration and the time-scales associated with them may differ from one phenomenon to another, but nonetheless, they exist.

Pipelines experience a multitude of forces and “other” significant events in their lifetime which contribute to their deterioration and eventually, their integrity (e.g. geotechnical forces, external/external corrosion, product specification and quality, pressure, temperature, coating damage, 3rd party damage, material defects, etc.). Recognition that some or all of these forces exist to some degree on all systems (i.e. no pipeline is immune) is the first step in a proactive approach to integrity management. Getting to the next phase is where hang-ups can occur: the efficient and effective implementation of technologies aimed at counteracting these forces and/or their effects. In no way does this statement imply that we abandon or limit the value of inputs, decisions and techniques formulated on past experiences when trying to implement new technologies. This “know-how” must still remain an integral part of the implemented pipeline integrity management program.

On the other hand, one must also be cautious to not stumble into the “techno-trap” of wanting to implement, incorporate, run and/or own every latest technological advance/device unless a value-added justification to the overall integrity management of the system can be realized. The tested and proven technologies of today, as well as those we will be embracing in the future, are all vital tools in maintaining pipeline integrity and should be used in the right circumstances. You don’t need to buy a Ferrari to go 4 x 4-ing! Such approaches almost inevitably become costly undertakings, with very little realized gains. Important questions regarding the applicability of specific integrity technologies to a specific pipeline system need to be addressed prior to implementation. This in itself requires a very thorough understanding of the pipeline system and its’ specific operational history. Such thinking now sends us back to the gathered “know-how” component previously discussed.

As you can see, a balance between past experiences and technological advancement must be created to establish an effective integrity management program. By doing so, we ensure that pipeline systems are maintained and operated at their safest levels as all avenues of due diligence are covered. Tipping the scales in either direction could have serious consequences from a safety, environmental, cost of repair, stakeholder and public perception/opinion perspective. Let us not discount the experiences and knowledge databases accumulated via past events, nor discount the technological advances that are being developed today and in the future.

**Pipeline Integrity Management System**

The other component of this year’s theme is Managing Pipeline Integrity. It does us no good to simply expend resources, time and dollars on integrity issues if we continually fall back into a
"reactive" mindset. When a functional balance between technological implementation and expertise gained from past experiences has been established, the next step should be the creation of a system aimed at managing this marriage. The integrity management system/philosophy represents one component of the overall operations management system of a pipeline company. It’s mandate, at the most basic level, should be to provide a “safe, prompt and continual delivery of product”. How this is accomplished from one pipeline company to another will vary based on operating philosophies and situational differences. Hand this mandate over to any level of management and almost assuredly the words “efficiently” and “cost-effectively” will be incorporated. Further refinement of the mandate would also include “environmentally responsible” and “satisfaction of all regulatory requirements”. As you can see, there are several factors that need to be constantly scrutinized and addressed if a pipeline integrity management program is to be successful in satisfying all concerning issues.

To manage pipeline integrity is to essentially manage risk. All factors affecting the integrity of a pipeline pose a risk to the realization of the adopted mandate, if not attended to. Each risk also comes with an associated consequence and potential loss. Consequences and losses in the pipeline industry can be in the form of unscheduled outages, leakage, ruptures, environmental damage, human suffering and/or loss, financial loss, etc. As a result, the risk assessment phase becomes the most important one in the risk management process. The cause and effect relationships established at this level allow us to prioritize and focus our efforts on the most critical scenarios affecting integrity. From this, cost-effective control and mitigation strategies can be created and executed. Once again, a balance between technology and system expertise must be utilized at this stage. To assess effectiveness, performance evaluation of the mitigation strategy must also be conducted. This determines whether or not the desired result was achieved whilst satisfying the mandates’ requirements of safety assurances, cost-effectiveness, efficiency, etc.

Risk assessment/risk management systems as those just described do indeed work. There are obviously several more details and concepts that need to be incorporated into a formal risk management plan. This would include things such as the tools designed to assist decision-makers with risk analysis (i.e. statistical models, software), the numerous informational databases which have been and are currently being developed, the evolution of geographic information systems, etc. The intent here was simply to highlight the fundamental concepts behind such plans.

However detailed and structured an integrity management plan becomes, its success will ultimately depend upon the commitment given to the plan. The New Oxford Dictionary of English defines commitment as “the state or quality of being dedicated to a cause or activity (a pledge or an undertaking)”. This dedication must come from all parties associated with pipeline integrity. From the front-line individuals directly involved (i.e. the engineers, operators, technicians, vendors, research and development teams) to those who are directly affected by the achieved results (i.e. management, shareholders, regulators, etc.). Commitments at all levels will only strengthen the direction our industry takes in ensuring safe and efficient pipeline infrastructures, new and old. An indication of commitment is present here today. Attendance at this workshop, regardless of the level of your involvement in the overall integrity management
plan of your company, indicates a commitment to the advances in technologies and methodologies showcased at this gathering. Hopefully, what is learned and discussed here this week will help form significant parts of several integrity management frameworks.

**Closing Remarks**

Ladies and gentlemen, over the next few days, you will all get the opportunity to focus on and discuss several state-of-the-art technologies as well as share experiences related to the design, construction, operation, maintenance, performance and abandonment of pipelines. Forums like these are necessary in ensuring that the transfer of knowledge and information related to new advancements takes place within our industry. Never has this been as important as it is now, mere months before we embark on a new millennium.

We are experiencing change in our industry as we have never experienced at any other time. The rate of change (i.e. predominately technological) is unfathomable. Just sit back and think for a moment at how a certain task accomplished today was handled 5, 10 or even 20 years ago! Now speed up the rate of change. One can only imagine how the execution of this task will now be handled in the future! Now incorporate a similar rate of change to the entire pipeline integrity industry via enhancements and continued research/development into in-line inspection tools, on-line real-time ROW monitoring, predictive models, coatings, and construction practices and operating procedures.

Although exciting in nature, it can also be quite an intimidating time if we don’t properly prepare ourselves for these inherent breakthroughs. Let’s not forget what got us to where we are today. Let’s not forget how we do things today. Additionally, let’s systematically and efficiently embrace the technologies of the future that will become essential in ensuring that all pipelines will be capable of operating at the highest standards of safety in the next millennium.

I thank you for your attention and wish you all a very successful four-day workshop.
Agenda

- Technology trends
- Themes for the millenium
- Key emerging technologies
- Impact on business
Storage and Bandwidth

Storage
- 1999: Can store a bit on an atom!
- Library of Congress on a dime!

Bandwidth
- 1988: 45 Million bits / second
- 2000: 1 Trillion bits / second (200 million faxes)

PC System Evolution
Speech/Voice Recognition

CyberPhone

Cyberhome 2000

Pervasive Computing
Household furniture: central heating at home when you're on vacation

Pervasive Computing technology allows new possibilities in the home as well. "Smart" furniture can be integrated to offer a personalized environment. In the future, furniture may be connected to networked appliances, allowing users to control them remotely. This could include lighting, heating, and entertainment systems. These features are integrated with the Internet and linked to service providers such as utilities, newspapers, and home health care.

The basis of the "intelligent" furniture system is the "Open Software Philosophy," which emphasizes the sharing of software among different companies, including IBM, Compaq, and Apple. This approach allows for greater flexibility and adaptability, as well as the potential for future integration of new technologies.

In the future, we will see a more seamless integration of technology into our homes, making our lives more convenient and efficient.
Personal Area Networks

Wearable Computing - Clothes that Think
- Conductive Threads
- Personal wireless local area network
- Sensors: GPS, cameras, microphones...
- Portable while operational
- Hands-free use

Purpose: Technician Support, Medical Monitoring, Memory Enhancement, Fun!
Source: IBM & MIT Media Lab

IBM at CeBIT:
"We're Driving Toward An e-Society"

IBM's message at CeBIT '99, the trade show billed as the world's largest for information and telecommunications technology, was "That's e-business." IBM and its partners showcased a wide variety of e-business products, technologies and services that show how the network is pervading everyday life and will create an e-society.

Several pervasive computing solutions with integrated IBM technology, based around smartphones, workpads, smart cards and wearable PCs are now entering the market and were shown this month at CeBIT.

Other CeBIT '99 highlights included the virtual EXPO2000, examples of Deep Computing and the digitization of Michelangelo's
Displays

Year 2005

- New Clients
- Readability Threshold

*Liquid Crystal Displays Will Dominate*

3DIX: Interactive 3D Visualization

We need to shift our mindset from one market of millions to a million markets of one

**Deep Computing**

- Large Servers and Storage

**Pervasive Computing**

- Universal Data, Voice & Video Network
- Persistence via Intelligent Agents
- at home
- everywhere
- in the office
- Traditional Clients

Summary

- Pace of technology will continue to accelerate
- The key will be to exploit these trends business advantage
What is e-business?

- Solving your business problems by transforming key business processes using Internet technologies

- e-business links employees, suppliers, partners and customers

New Business Designs are Emerging

e-business Spectrum

Seller Side
- e-Businesses
  - Boeing
  - British Airways
  - Cisco
  - Dell
  - IBM
  - Karstadt
  - Marriott
- Aggregators
  - Amazon
  - Boxman
  - e-Schwab
  - GE BuyerNet
  - JC Penney
  - Wal*Mart
- Marketers
  - Alba
  - AuctionOne
  - Auto-by-Tel
  - eBay
  - e*Trade
  - Oasis
  - On Sale
  - Priceline

Buyer Side
- Customer: Net
  - Branch Out
  - Hecklers
  - Motley Fool
  - Parent Soup
  - Polyport
  - Six Degrees
  - Tripod
- Portals
  - AOL
  - GeoCities
  - Netscape
  - Snap! Online
  - Tesco
  - Virtual Helsinki
  - Yahoo!
Key Business Impacts

e-business Transforms Traditional Business Dynamics

Market Dynamics

- Power Mergers
- Asset Revolutions
- Complete to Entry

Business Implications
- Customer is
- Intermediation: Eliminated
- Global Pricing/Supply
- Business Intelligence
- Flexible Product Customization
- Increased Service Expectations
- New Brands Emerge
- New Alliances Form
- Nimble Ops Essential

In the face of mandated standardization, how can Gas Pipelines differentiate themselves?

Download
Future (IBB's)

Today
(EBB's)

Functionality

"... and the Winners...?"

"the Rules of the Game"

The Natural Gas Industry is experiencing fundamental changes to the way business is done

- A greater number and diversity of players, all dynamically interconnected, requiring more information more frequently.
- Who will have which roles in the emerging environment?
- Deregulation and re-regulation
- Who are the competitors?
- Who is the customer?

Source: Rick Sanchez, Transenergy Insight, Inc.

The e-business cycle

Transform core business processes

Leverage knowledge and information

Build e-business applications

Run a scalable, available, secure infrastructure
Aggregator: U.K. On-line Gas Supplier Calculator

- UK Gas Market has 16M households
- Fully competitive marketplace
- Service helps consumer locate cheapest gas supplier
- buy.co.uk receives fee from utility when customer is referred

Data Mining to serve the "market of one": Safeway (UK)

Challenge
- Leverage existing data to better understand customer buying

Solution
- Application that mines data on purchases of 6 million customers

Business Value
- Clearer picture of customers has enabled smarter tradeoffs between customer loyalty and product profitability

Products
- DB2, Intelligent Miner

Summary
- Pace of technology will continue to accelerate
- The key will be to exploit these trends business advantage
CEPA
Pipeline Integrity Management

Share, Collaborate, and Leverage for success

Technology

- "a body of knowledge"
- "intellectual capital"
CEPA

- Member Companies (11)
- Technical Members (3)
- Operate 90,000 km of pipelines
- Transport 95% Natural Gas and Crude oil produced in Canada

CEPA - Pipeline Integrity Management

- Safe and Reliable system top industry priority
- CEPA have focused on SCC and General Corrosion
Framework for Pipeline Integrity Management

- Integrity Management Framework
- Developed for SCC
- Can be applied to General Integrity Issues

SCC Recommended Practices available at www.cepa.com
Condition Monitoring

- Susceptibility Assessment
- Investigative Programs
- Periodic Monitoring

Plan & Implement Mitigation

- Prioritize for mitigation
- Select & Schedule mitigation
Document and Learn

- SCCdb32
- Data Trending
- Share
- R&D

SCCdb32 available at
www.cepa.com

CEPA - Current Activities

- Corrosion White Paper
- Circ. SCC RP's
- Consequence Assessment
- Pipeline Integrity R&D
CEPA - Looking Forward

- Pipeline Safety & Reliability will continue to be CEPA's #1 focus
- CEPA will continue to share, collaborate, and leverage among its members to address complex technical and operating challenges

I leave you with this thought...

- Technologies for the new Millennium
  - What can you learn this week?
  - What can you share?
  - How can you contribute?
**Vision**

Enhanced pipeline operations safety performance
- manage pipeline risk through informed decision making
- industry acceptance and utilization
- harmonization of data collection and reporting
- computer based tools for better analysis

**Pipeline Risk Assessment Steering Committee (PRASC) Database Development**

*Ian Fraser*
PRASC Database Steering Committee

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<tr>
<th>Name</th>
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<td>Barry Broderick</td>
<td>CWNG</td>
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PRASC Database Task Force

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<td>Bryce Nolan</td>
<td>TransCanada Pipelines</td>
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History

- PRASC was created to guide the development of processes to determine and manage the risks associated with pipeline operations
- Co-operative effort of CAPP, CEPA, CGA, MIACC, EUB, NEB, TSB, CSA
- Directed by independent steering committee
- Supported by task force
- Funded by CAPP, CEPA and CGA
Database Task Force Mandate (cont.)

- Acting in a liaison role with related industry initiative/groups
- Evaluating and recommending an appropriate database & process solution
- Initially for downstream liquids and gas pipelines - upstream at a later date

Database Task Force Mandate

- Identifying all essential database elements
- Defining standards, measurement criteria and terminology
- Determining statistical and quantitative requirements
- Outlining the process for data collecting & reporting
- Estimating industry/corporate impacts
Opportunities

- Reduced reporting by pipeline operators
- Use for maintenance planning
- Access to a well designed data management product for the pipeline operator
- Access to a much larger base of data for risk management and statistical analysis

Achievements to Date

- Designed and developed prototype database
  - Preliminary load testing completed
- Internet Access
  - Domain Name: Can-Pipeline-Incidents.Org
Next Steps

- Compile all existing database elements
- Team of industry/regulators to compile required database elements
- Agreement of a common database data dictionary
- Agreement to and development of a harmonized database
- Develop an administration program
- Promote database to industry
- Database population
- Database reporting

Go Forward!

Harmonization of databases (Regulatory & Industry)
- common data dictionary
- data sharing

Database Administration
- database population
- data entry support
- development of data query protocol
- security issues
A NEW MFL IN-LINE TOOL TO DETECT LONGITUDINAL CRACKS

Introduction:
Axial flaws are certainly the most dangerous defects for pipeline operators as their location is a real challenge for the ILI industry. In addition, long or short axial defects are potentially a threat in very various forms: cracks, mechanical damages, grooving corrosion...

TRAPIL, the multi-product pipeline operator leader in Europe, has developed an original rotating transverse MFL tool to detect these flaws.

This tool has successfully inspected a refined product line affected by a SCC phenomenon. The inspection allowed the location of several critical cracks before starting the hydrotesting program and has saved this pipeline from a definitive interrupt of operations.

1 Transverse magnetisation for the detection of longitudinal cracks

The detection principle is the well known MFL used for metal loss location. But as defects are mainly axially orientated, the magnetic field has to be applied in the transverse orientation instead of the axial one. The transverse MFL measurement principle is reminded fig1: a magnetic flux is imposed by the two poles of a magnet in the pipe wall, the presence of a flaw with an axial component induces a distortion of the field lines which is measured by sensors.

During the feasibility studies, the field lines in the vicinity of the cracks have been modelled by using finite element calculations, an example of radial flux leakage generated by such a crack is shown fig2.

Fig1 : transverse field magnetisation

Fig2: flux leakage on a crack 2.5mm deep and 30mm long.
2 The transverse magnetisation applied by the CORRO-T

The tool is made up of 5 cars: a car for traction, a car for the power supply, a car for the processing and the storage of the data, the two last cars inspect the whole of the pipe wall. Each inspection car inspects 50% of the pipe wall. An inspection car includes four magnetic circuits with sensors in the middle of each circuit (see fig3). The free wheels of these modules are inclined at 30°, they induce a rotation of the tool on itself during its progression in the line. So, the whole of the pipe wall is integrally inspected according to eight spirals, each spiral is defined by the progression of a magnetic circuit and its sensors.

Rotating: an efficient way to improve the signal/noise ratio

Thanks to the rotating system, the sensors pass through the MFL signal not only on its axial direction but on its radial direction where it offers a large surface easier to catch by the sensors. In this way, all the energy of the signal is recorded by several sensors and the emergence of the signal is better than recorded on the axial direction.
3 The tool in operation

In 1998, this tool has successfully inspected twice a 12" diameter 240 km long line of refined products. This line is affected by a stress corrosion cracking phenomenon called 'near neutral pH SCC'. After the runs, 18 SCC colonies threatening the integrity of the line were located by the tool. Since then, several 110% MAOP hydrotests (79% of the SMYS) have been conducted without any ruptures.

Two examples of SCC colony after wet magnetic particle inspection are presented hereinafter fig4 and fig5, the scale is in centimetres.

![Fig4: SCC colony 3.5 mm deep](image1)

Fig5: non coalesced cracks, one is 2.5mm deep

4 Capabilities of the tool

At the issue of the inspections, 192 features were recorded by the tool. Till now, about one hundred of them were excavated by the owner of the pipeline. Each excavation has lead to a defect: SCC cracks, grooving corrosion, gouges, deep laminations and midwall defects.
PLAN

- TECHNOLOGY USED
- INTRODUCTION OF THE TOOL
- INSPECTION RESULTS
- CAPABILITIES OF THE TOOL

FINITE ELEMENTS CALCULATIONS

Radial flux leakage on a crack 2.5mm deep

TECHNOLOGY USED

- Transverse MFL principle
- NdFeBm magnets
- Up to date storage capacity technology

BACKGROUND

- 1995-1997: Feasibility studies in collaboration with the University of Grenoble (France), design and building of the 12" tool.
- 1998: Successful inspection campaign on a refined products pipeline.
- 1999: Second inspection campaign in progress

TRANSVERSE MAGNETISATION PRINCIPLE

THE CORRO-T
AN INSPECTION CAR

DEFECTS LOCATED
192 features recorded
- SCC cracks
- grooving corrosion
- mechanical damages
- deep laminations
- mid wall defects

CAPABILITIES
- Detection threshold in pull through tests conditions is a single crack 1mm deep and 30mm long.
- This detection threshold is to be confirmed in operation after the collect of field data during the inspection campaign in progress.

INSPECTION RESULTS
- 100 features have been excavated
- No false calls, 57% of the defects had lead to a repair
- 18 SCC colonies detected
- Several axial metal loss defects located
- No ruptures have occurred during the several 110% MAOP hydrotests conducted after the inspection campaign
"Pipeline Encroachment"

1999 Banff Pipeline Integrity Workshop

Presented by
Ian F.H. Scott
Manager
Pipelines, Environment and Frontier
April 12, 1999

Encroachment - Failures due to 3rd Party

Source: EUB 1999

Encroachment - 3rd Party Damage

Source: EUB 1999

Pipeline Encroachment - Stakeholders

Developers
PUBLIC
CSA
Municipalities
Regulators
Pipeline Companies
MIACC

Encroachment - 1997 P/L Integrity Workshop

- Key Issues raised:
  - No single source of data &/or incomplete
  - One Call Organizations
  - Improved Communication
    - shared responsibility
    - consistency of message
    - safety of P/Ls
- Roles & Responsibilities

Encroachment - Initiatives

MIACC

CAPP TASK FORCE

1997 P/L Integrity Workshop
Encroachment - MIACC

- Initiative began 1992 - meeting between CPA, ERGB and the NEB
  - Task Force currently chaired by John Whitaker, U of A
- Workshop held in October 1997
  - "SWG" formed to rewrite document
  - CAPP,CEPA,CGA, EUB,TSB, City of Regina
devolved new draft
- Land Use Planning With respect to Pipelines
  "A Guide for Local Authorities Developers and Pipeline Operators"

Encroachment - MIACC

- Purpose:
  "Increase awareness & encourage dialogue among key stakeholders when considering
  changes to existing land uses or new land use development near to or surrounding existing
  pipelines, or new pipelines adjacent to existing land developments."

Encroachment - CAPP Task Force

- Established April 1996 to:
  - Raise awareness with municipalities and counties
  - address implication s od developments
  - inform municipalities, developers & planners about sources of P/L information
  - Utilize a consultative communications process

Encroachment - CAPP Task Force - Proposals

- Improved/continued dialogue among municipalities, planners, developers
- Development of EUB IL
- Linkage with the MIACC document
Encroachment - CAPP Task Force

- Workshop in October 1997
  - Reviewed proposed IL
  - Reviewed Model By-law
  - Addressed Issue of Compensation
  - Communication
  - Improved data sources
- Awaiting MIACC document

Encroachment - Summary

MIACC

GAP Task Force

1999 F/L Integrity Workshop
"Pipeline Abandonment"

1999 Banff Pipeline Integrity Workshop

Presented by
Ian F.H. Scott
Manager Pipelines, Environment & Frontier
April 1999

Pipelines in Canada

PIPLEINES IN ALBERTA
Regulated by EUB

Pipelines - Abandoned/Discontinued Alberta [1989-1998]

Abandonment Options

- Abandon in place
  - no right-of-way maintenance or "CP"
  - right-of-way maintenance with "CP"

2. Remove the pipeline

Note: Large projects likely combine options
Pipeline Abandonment

- Two Discussion Papers developed:
  - Environmental/Technical Issues
  - Legal Issues

Pipeline Abandonment

- 1997 Banff Pipeline Integrity Workshop:

Pipeline Abandonment Plan

- Goals
  - Public Safety
  - Environmental Protection

Pipeline Abandonment Plan

- Key Characteristics of abandonment plan:
  - Project Specific
  - Opportunity for Public and Landowner input or other stakeholders
  - Cognizant of regulatory requirements
  - Provides for post-abandonment activities
Abandonment Plan

Pipeline Abandonment - Issues

Land Management
- Current uses
  - parks, protected areas, agric.
- Future uses
- Equivalent capability

Pipeline Abandonment - Issues

- Contamination Soil & Groundwater
- Internal pipe cleanliness (how clean?)
  - corrosion
  - leaching
  - pipe coating

Pipeline Abandonment - Issues

- Ground Subsidence/Erosion
  - Corrosion of pipe left in place
  - Removal of (large) diameter pipe
  - Instability of slopes

Pipeline Abandonment - Issues

- Stream Crossings, Muskeg, Wetlands
  - Pipe exposure - erosion, buoyancy
  - Cleanliness
  - Drainage

Pipeline Abandonment - Issues

- Associated apparatus
Pipeline Abandonment - Issues

Pipe Cleanliness
- How clean is clean?
- What is intended use of removed pipe?
- Prevent Water conduits

Foreign Crossings
- road, rail, utilities, pipelines
- proper notification/agreements

Pipeline Abandonment - Issues

Associated apparatus
- remove tanks, valves, fencing, etc.
- signage

Pipeline Abandonment - Issues

Legal
- Extent of corporate liability on abandoned in place pipeline and for how long?
- existing versus non existing company
- What are the conditions for removal of land title caveat?

Cost Considerations
- Abandonment Plan
- regulatory
- (Alberta - security deposit)
- site assessment
- Pipe abandonment
- disposal costs
- monitoring
- pipe if removed
- legal
- abandonment debris

Conclusions
- Pipeline abandonment is current issue
- Abandonment Plan = responsibility + diligence
- Operators must be accountable and responsible
- Communicate with stakeholders throughout
- Legal and financial issues important elements
IPC 2000

IPC has evolved into a premier world class event

IPC '98 a huge success
700 delegates from 30 countries
160 papers from 17 countries
Positive feedback from delegate survey
Strong support to hold IPC 2000 in Calgary

Third International Pipeline Conference

IPC 2000

Presented by: Robert A. Hill
IPC 2000

Tentative symposium topics:
- Integrity and Corrosion
- Design and Construction
- Environmental Issues
- GIS/Database Development
- Rotating Equipment
- Innovative Projects and Emerging Issues
- Regulatory, Codes and Standards
- Pipeline Automation and Measurement

Workshops/Panel Sessions/Tutorials

IPC 2000

IPC 2000 scheduled for October 1-5, 2000, in Calgary, Palliser Hotel - ASME primary sponsor

(World Petroleum Congress to be held in Calgary in June takes all hotel and convention space)

Added feature: Technology Exposition to be held in conjunction with IPC 2000 at Telus Convention Centre focused on pipeline industry and related products and services
IPC 2000

Tentative schedule for recruiting papers:

- Call for papers issued: Mid-June, 1999
- Abstracts received: October, 1999
- Abstracts accepted: January, 2000
- Manuscripts received: March/April, 2000
- Manuscripts accepted: June/July, 2000
- Final papers submitted for publication: July/August, 2000

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Technology Exposition
Betrouz Sadre-Hashemi
International Events & Marketing Promotions (EMFP)
Phone: (780) 448-9141 or E-mail: infolastics@composites.ca

The 3rd International Pipeline Conference (IPC 2000) is an American Society of Mechanical Engineers (ASME) Conference. The conference papers are being held at the Canadian Association of Pipeline Technologies (CAPT), and the Canadian Producers' Congress (CPC) and the Canadian Energy Technology Forum (CETIF).
Working Group #1  Construction, Maintenance, and Geotechnical

Co-Chairs: R. Hinger (TMPL); P. Wong (Skystone)
Rapporteur: G. Hill (Corridor / TMPL)

Tuesday, April 13, 1:15 P.M. Session
Topic: Bar Coding of Pipe

Session 1 Speakers: Paul Poirier - Shaw Pipe Protection; R. Pryor - Ellipse Spatial Services

Bar Coding Technology (Paul Poirier, Shaw)

- Shaw Pipe Protection has been using bar coding technology for pipe for 6 years in Canada, the USA, Australia, and the North Sea.
- Shaw is moving to more comprehensive integration of bar coding - automated bar coding will be standard in all Canadian plants.
- Why use bar coding?
  - traceability for Q/C programs - data is not lost or misread
  - efficiency in the plant - less manual transfer of data
  - inventory control - electronic tracking of materials in stockpiles
  - safety in the field - less manual transfer in the ditch
- Types of bar coding:
  - one dimensional, based on bar spacing (Code 39, Code 128, etc.)
  - two dimensional, allowing for more information (PDF 417, etc.)
  - matrix, allowing for significant amount of data in a small space (primarily used in small parts manufacturing)
- CSA has sanctioned Code 39 and PDF 417.
- Shaw is recommending that Code 128 be adopted by industry and will try to convince CSA that this is the right choice for the following reasons:
  - Code 128 allows for more data than Code 39
  - Code 128 can be printed smaller than PDF 417 and so is easier to read in bright sunlight
  - Code 128 does not require labelling technology so is less expensive than PDF 417
- Disadvantage of bar coding in general is that the bar code is difficult to find on the pipe, particularly in stockpiles or in ditches, unless put on in a number of locations.
- Disadvantage of Code 128 is that it does not provide redundancy so data is lost if bar code is damaged.
- To remedy these problems to date Shaw is generally using multiple labels on each joint (up to 6 only - more is too expensive).
- Shaw is now pioneering the ultimate solution - continuously repeating spiral bar code stencil applied using ink jet technology - trials are underway.
Bar Coding Advantages in the Field (Ellipse):

- Bar code data can be collected with scanners in the field with the following advantages:
  - elimination of manual data entry errors
  - one person can collect all the data
  - material data is immediately accessible in a database
- Bar code data can be overlaid with survey (GPS) data, bend information, weld numbers, pipe features (weights, etc.) to form a complete pipeline database.

General Discussion:

- Reynold Hinger stated that the continuously repeating spiral bar code stencil concept appeared to be the key to the success of bar coding in this application.
- It was noted that the continuous stencil concept would have significant advantages where a pup is cut from a joint - traditionally material data can be lost in this case.
  - Question: Can data be customized for clients?
    Answer: Shaw believes data should flow from pipe mill to coating mill to client, who can then do with the data as they see fit.
  - Question: Are different users of bar codes standardizing in any way?
    Answer: All industries that have adopted bar codes in the past have ended up standardizing on common data sets and rules - the pipeline industry will have to do the same. Otherwise, data could be inadvertently duplicated and become useless in the future. Shaw is trying to be proactive in this area.
  - Question: How long will the bar codes last in the ground?
    Answer: Ink suppliers only warranty for 5 years. In reality it is highly dependent on ground conditions - could last 1 year or 20 years.
  - Question: Is yellow jacket stencilling longevity a relevant experience source?
    Answer: No - inks are different.
  - Question: Is PDF 417 in use anywhere?
    Answer: American Steel Pipe still uses this type of bar code - field experience with A.S. Pipe was disappointing due to data reading and interpretation capability.
- It was noted that the ultimate extension of bar code technology is a visible code or electronic signature of some type that could be read by an in-line inspection tool. The tool could then be used to "as-built" the pipeline material data.
Tuesday, April 13, 2:15 P.M. Session
Topic: Integrity Management on the Echo Pipeline
Speaker: D. Kulcsar - Gibson Petroleum Company Ltd.

- The Echo Pipeline is a 12" diameter, 153 km pipeline from Elk Point (N.E. Alberta) to Hardisty, which has been operating since March 1, 1997.
- Echo is a hot oil line transporting 0.986 SG material at temperatures between 50°C and 95°C.
- Conventional pipelines can operate with material viscosity up to 1000 cS, but at conventional temperature of 5°C to 25°C this requires diluent content of up to 20%.
- The Echo Pipeline line operates in the same viscosity range, but with no diluent - thus the requirement for the high temperatures.
- The reason for operating with no diluent at high temperatures is capital cost savings due to the following:
  - half the amount of cooling required at the upstream end (1 cooler instead of 2)
  - no return diluent line required
  - smaller pipeline diameter required (or 20% higher capacity), due to no diluent in the oil
- Another advantage is increased marketing flexibility (custom blends can be made at the downstream end) - current blending is with condensate at Hardisty (to Enbridge 350 cS spec)
- Disadvantage is non-diluted oil must be kept moving so excessive cooling doesn’t occur and cause the oil to reach non-pumpable viscosities (oil could reach ground temperature in 10-15 days).
- Contingency plan for planned shut-downs is to add diluent ahead of time. Contingency plans for un-planned events include provisions for fast (2-3 day) response times.
- Design considerations with respect to heat loss to the ground included:
  - the effect on oil viscosity
  - the effect on the soils (interference with the natural freeze-thaw cycle) and root zone temperatures (for plant life)
- 2" of insulation and 6' of cover was required to mitigate heat loss effect to acceptable levels.
- Multi-layer coating system was required:
  - primer
  - corrosion protection tape
  - polyurethane foam insulation
  - rockshield tape
  - polyethylene jacket
- This coating had the following disadvantages:
  - it was difficult to apply over field welds
  - it was difficult to bend (a mandrill had to be used)
  - it prevents the cathodic protection system from working effectively (no soil/pipe bond)

Rapporteur’s Report – G. Hill, TransMountain Pipeline
- Other design problems included:
  - -40°C ambient to +100°C design temp range exceeds CSA-Z662 max. range of 59°C - hot air was used to raise temperature to 55°C prior to installation
  - detailed stress analysis had to be done at valves, traps, and riser - traps and valves were located near bends; risers were installed with 2" foam to allow movement
  - all station piping had to be insulated to prevent burns to operating personnel and overheating of equipment
- Proactive integrity management is required, since heat and lack of effective CP protection may accelerate corrosion - corrosion inhibitors are required.

Discussion:

- Question: What type of pumps are used?
  Answer: PD pumps due to extra capability during upset (low viscosity) conditions. It was noted that some pump failures have occurred due to high sand content in the heavy oil.
- Question: What type of fuel is used? Was the pumped product considered?
  Answer: Natural gas and no, the oil was not seriously considered as a fuel source.
- Question: Has an in-line inspection tool been run? Would it be run in the heavy oil?
  Answer: No, the line has only been in service since 1997 and no, unless the tool could withstand the temperatures - diluent could be added for a tool run.
- Question: Were there any special considerations (for coating protection) for crossings?
  Answer: All crossings were bored or drilled and no special protection was incorporated.
- Question: What would Echo do to repair the pipe in case of a failure (in time to prevent excessive cooling)?
  Answer: For a minor leak or puncture - sleeve and plan a cut-out later; for a catastrophic failure - stopple and replace.
- Question: How often is pigging required?
  Answer: Once per month.
- Question: Are higher temperatures being considered for other projects?
  Answer: Gibsons may look at 85°C to 110°C for other projects.
Tuesday, April 13, 3:30 P.M. Session
Topic: Non-Destructive Techniques for Measurement of Pipeline Corrosion
Speaker: Richard Kania - RTD Quality Services

- Existing technology for corrosion defect mapping includes:
  - pit gauges (external corrosion)
  - bridging bars (external corrosion)
  - ultrasonic pencil probes (internal corrosion)
  - ultrasonic mapping systems (internal corrosion)
  - laser based mapping systems (external corrosion)

- Why laser based mapping?
  - better accuracy of measurements
  - better repeatability
  - not reliant on operator skill
  - faster than manual methods

- Laser based mapping tools provide plan and profile plots and can do an automatic RSTRENG analysis if desired.

- RTD initially developed the MK I Laser Pipeline Inspection Tool (LPIT) but numerous problems were encountered during field trials:
  - baseline assumed perfectly straight, round, smooth pipe: in fact seams, bends, sags, dents, and bulges affected the accuracy of readings
  - map size was limited to 27" x 8"
  - tool stood 25" above the pipe surface - use below the pipe was limited
  - operating temperature was limited to 0°C

- As a result of the above problems, only 30% of corrosion defects could be mapped accurately.

- RTD has now developed the MK II LPIT, which has the following enhancements:
  - new software is capable of coping with surface irregularities, welds, etc.
  - the scan area is 103° circumferentially, unlimited length
  - grid is 1 mm x 1 mm
  - profile is only 8" above the pipe surface
  - resolution is +/- 0.2 mm
  - spot laser eliminates shadowing effects
  - operating temperature is -30°C to +50°C

- When trials are completed, the MK II LPIT should be much more successful than the MK I.

- RTD has two other tools for corrosion measurement:
  - PipeScan for MFL measurement of internal corrosion
  - MapScan for ultrasonic measurement of internal corrosion
Discussion:

- **Question:** Does the MK II have B31G or CSA-Z662 analyses built in as well as RSTRENG?
  **Answer:** No, these analyses are based only on defect length and maximum depth - there is no point in doing laser mapping if a B31G or CSA-Z662 analysis is planned.

- **Question:** What surface preparation is required?
  **Answer:** The tool measures what it sees - for accurate measurements, all corrosion products must be removed and sandblasting is best for this purpose.

- **Question:** How quick is the set-up?
  **Answer:** Very quick - the tool just has to be placed on the pipe.

- Some discussion ensued on RSTRENG, including the inference that with use of in-line inspection tools, RSTRENG is not required. It was noted that the discussion was not intended to spark debate about the appropriateness of methods of corrosion defect assessment. If a pipeline operator has already decided that RSTRENG is the appropriate method to use, manual methods of data collection do not necessarily provide enough data or enough good quality data to ensure that an RSTRENG analysis can be properly undertaken. The MK II tool, if successful, will provide operators with good quality data, quickly and efficiently.

*Wednesday, April 14, 8:15 A.M. Session*

**Topic:** Quality Control Systems for Construction, Repair, and Alteration of Pipelines

**Speaker:** L. Gerlitz - JLG Engineering

- Survey of representation in the room:
  - Regulators: 4
  - Involved in Codes / Standards: 6
  - Owners / Users: Producers - 4; Transmission - 15; Distribution - 3
  - Manufacturers: 2
  - Contractors: Construction - 2; Service - 3
  - Outside Canada: 1

- Who’s doing what?
- Regulators:
  - Provincial regulators do not require formalized QC/QA procedures for pipelines
  - Provincial regulators do require formalized QC/QA procedures for plants
  - Federal regulators (NEB) do have some non-specific QA requirements

- Industry Codes / Standards:
  - CSA standards require formalize procedures for equipment manufacture
  - CSA does not require formalized procedures for construction, repair, alteration

- Owners / Users:
  - Some require contractors to have approved QC/QA programs
  - Others require contractors to follow Owners programs

Rapporteur’s Report – G. Hill, TransMountain Pipeline
• Manufacturers:
  • Required by CSA to have formalized programs

• Contractors:
  • Generally have documentation systems, but these are not standardized throughout the industry
  • What is the experience here today? / What should the future hold?

Discussion:

• Question: CSA-Z662 requires that all companies have Operating and Maintenance Manuals. Isn’t that the same as a QC/QA program? Isn’t the difference just semantics?
  
  Answer: No, most company O&M Manuals lack critical elements:
  • commitment by management to QC/QA
  • clearly defined responsibilities for QC/QA
  • documentation requirements
  • defined audit processes

• A consultant, who writes O&M Manuals noted that he agreed with the previous answer.

• The attendee from the India noted that the India Oil Corporation operates 7000 km of pipelines and rigorously follows ISO 9000 and ISO 14000 Series QC/QA programs in materials, construction, and maintenance.

• A contractor noted that his company has recognize that more QC/QA service is required - they currently provides detailed QC/QA records on CD ROM to owners at the completion of construction.

• Another contractor echoed the previous comment and stated that their QC/QA documentation system has arisen from proactivity on their part - not because of requests from owners.

• John Hendershot noted that the NEB does distinguish between O&M Manuals and QC/QA Programs.

• Paul Wong asked (rhetorically) - do owners really always follow the procedures in our O&M Manuals?

• Reynold Hinger asked - are there any other ISO 9000 or 14000 Series owners in the room? There were not.
Wednesday, April 14, 9:15 A.M. Session
Topic: NEB Pipeline Integrity Management Program
Speaker: John Hendershot - National Energy Board

- NEB is an independent tribunal with a mandate under the NEB Act to ensure the safe design, construction, and operation of pipelines which cross provincial or national borders.
- There have been 22 major pipeline failures since 1991, most from corrosion, 5 from SCC, 3 from slope stability problems, a few from other causes.
- The 1996 SCC Inquiry recommended SCC Management Programs and the NEB mandated these, but the NEB is also concerned with broader pipeline integrity issues.
- NEB representatives met with 13 pipeline companies to assess the status of their Integrity Management Programs and begin the process of broader regulations.
- The new regulations include:
  - an emphasis on maintenance
  - a requirement for proactivity by owners
  - Integrity Management Guidelines
- The Integrity Management Guidelines are not a regulations. Instead they:
  - represent industry “best practices”
  - allow a degree of flexibility
  - allow enforcement based on “intent” and using an audit process
- The ultimate goal is safe and reliable pipeline systems.
- The Guidelines include four key elements:
  - a Management System
  - a Working Records Management System
  - Condition Monitoring
  - Mitigation
- The Management System contemplates:
  - lines of responsibility and reporting to senior management
  - training
  - change management
  - an audit process
- The Working Records Management System contemplates:
  - access to integrity data within 24 hours
  - documentation of procedures to track, analyse, and trend pipeline condition
  - documentation of records of pipeline condition
- Condition Monitoring contemplates:
  - baseline in-line inspection (ILI) within 6 months of construction
  - engineering assessments of pipeline integrity at 10 year intervals (pipeline integrity assessment will be addressed in the new version of CSA-Z662 but the NEB has added the time limit)
  - risk assessment (recognition that qualitative rather than quantitative can be valid)
• identification and prioritization of failure causes
• methods used to evaluate integrity (ILI, hydrotest, etc.)
• incident reporting procedures
• monitoring and surveillance programs

• Mitigation contemplates:
  • criteria for evaluation and action
  • consequences
  • procedures for repair
  • long term plans

• Current status of the Guidelines and future plans:
  • Onshore Pipeline Regulations and Guidelines currently out for industry review
  • NEB will be changing its approach to audits and inspections
  • will be developing facility (stations, tanks, etc.) guideline in 1999
  • will be developing a gas plant guideline in 2000

• The “intent” of the Integrity Management Program is:
  • proactive, comprehensive, and continuous integrity management processes
  • encouragement to use latest technologies
  • a common language in a single document
  • senior management support

• Measurements of the Program effectiveness will be:
  • the level of proactivity achieved
  • the level of information sharing achieved
  • increased research
  • direct CSA involvement
  • reduced pipeline failures

Discussion:

• Question: Is the sharing of information referred to company to company or company to NEB?
  Answer: The key will be company to company to develop best practices.

• It was noted that the NEB has mandated information sharing for SCC - this could presumably be extended to all aspects of pipeline integrity.
  • Question: What is the intent with respect to CSA-Z662?
    Answer: Hopefully the Guidelines will eventually become part of CSA-Z662.
  • Question: The 6 month ILI suggestion - is this really practical?
    Answer: The actual wording uses the term “consideration”. Common practice in industry is to do some form of baseline tool run.

• It was noted that the NEB’s apparent recognition of qualitative risk assessment is a very positive step - in addition, guidelines should be issued for carrying out qualitative risk assessment.
- It was noted that some companies have developed structured qualitative risk assessment methods.
  - Question: Are CEPA and CAPP involved in the review process?
    Answer: Yes.
  - Question: Are any training specifics included?
    Answer: No, concepts only
- It was noted that the representatives in the room generally support guidelines rather than regulations. However, guidelines often become regulations later and care has to be taken to ensure this does not happen.
- It was noted that one of the key advantages to guidelines is that they can be easily changed - regulations can take years to change.
- It was noted that the NEB intends to make the guidelines scalable to be appropriate for the size of companies involved.
  - Question: How often will changes be made?
    Answer: Not piecemeal but when necessary.
  - Question: How will the IMP be enforced?
    Answer: By audit, based on an evaluation of the level of risk.
  - Question: Won’t that be a major change from current NEB practice?
    Answer: Yes, and will require a major change in audit procedures and training of auditors.
  - Question: What about the AEUB?
    Answer: They have been kept informed.
- It was noted that the AEUB often follows NEB lead as practices become industry standard.
- It was noted that the fundamental premise is “due diligence”, which crosses jurisdictional lines.
  - Question: How do companies currently rank in IMP’s from the NEB’s viewpoint.
    Answer: On a scale of 10 - some 2’s and 3’s, some 8’s and 9’s.
  - Question: Current regulations require self-audit. Will this still be the case?
    Answer: Yes.

Recorded by GTH on April 13/14, 1999.
Working Group 1
Construction, Repair, Maintenance and Geotechnical
(Wednesday Morning)

CO-CHAIRS:  Reynold Hinger – TMPL
              Paul Wong – Skystone Engineering

TOPIC:  Steel Epoxy Compression Reinforcement Repair Sleeve

PRESENTER:  Robert Smyth, Petro-Line Group

Objective of the Presentation:  To present information regarding new technology.

It should be noted that the device discussed is not intended to be a pressure retaining device and is only used as reinforcing repair over defects found such as those described below.  Note that none of these sleeves have yet been applied to pipelines in NEB jurisdiction.  The sleeves have been applied to sizes up to 24-inch but larger sizes are possible.  Larger sizes would require a heater device rather than hand held devices.  Note that if corrosion were considered still active, then a pressure-retaining device would have to be installed.

A patent has been applied for.

This presentation covered Petro-Line’s efforts to develop a new external corrosion repair technique for in-service pipelines.  The CSA code (Z662) indicates that steel reinforcing sleeves are satisfactory for corrosion repairs and Petro-Line has developed an innovative way to install a steel reinforcing sleeve for that purpose.  The subject sleeves have been used successfully for SCC and general corrosion repairs and for the repair of dents, are burns, and various other defects – when the pipeline is in operation.  They do not have to be welded to the pipe.

Historically the following have been used:
- Weld on sleeves
- Bolt on sleeves
- Fiberglass reinforced sleeves
- Cut-outs

The “Petrosleeve”:
- Is easy to install
- Does not require line interruption
- Provides 100% support for the pipe
- Requires no welding
- Can be applied in a very severe (cold) environment
- Stays tight on the line
- Has no problem with disbondment
After installation the original pipe wall ends up in compression, which is confirmed by dial gage or caliper measurements.

Petro-Line has a computer program, which uses such data as diameter, wall thickness and grade to determine the installation parameters. The program tells you if the pipe wall will always be under compression at all pressures.

The pipe wall is sandblasted and:
- Epoxy is applied by hand to the wall of the pipe
- the sleeve is clamped in place
- jacks are used to hold the clamp in place, (jacks are not used for applying the correct degree of compression)
- heat is applied
- welders conduct 2 fillet welds on the attachment bars
- sleeve cools and shrinks the sleeve putting the pipe in compression

The time needed from sand blasting to completion of welding is about one hour.

The welds are given a magnetic particle inspection, coating is applied and the line is buried.

Verification testing has been conducted using strain gauges and cycling tests. Two samples were tested using pre-manufactured cracks. One test sample was not sleeved and the other was sleeved. In the latter case, under pressure, the pipe yielded outside the sleeve, while the unsleeved sample failed (ruptured). Another test was conducted using dents, where the dents were filled with epoxy and a sleeve was installed. The sleeve constrained the dent from moving as shown by measurements taken through a hole drilled through the hole and the epoxy. Petro-Line has installed these sleeves on a total of 504 repair sections since the spring of 1995 without failure. Five installations have been excavated and inspected to confirm integrity.

**QUESTIONS AND DISCUSSION:**

Does welding affect the epoxy?
The bars are 50% prewelded, and the field welding burns the adjacent epoxy without deleterious effect.

Purpose of the jacks?
To hold the sleeve in place only – the heat applied to the sleeve and subsequent cooling applies the compression to the pipe. A chain is applied with the jacks to hold the sleeve in place.

How do you control cooling?
Crude oil in the pipeline does not cool quickly. HVP materials cool quickly so the temperature applied is much higher than needed. No heat is applied after the first 2 passes of weld are applied to the bars. The weld must be completed before the pipe is sleeved is cooled down.

With regard to weld cracks?
Normally the tack welds on the bars are not magnetic particle inspected. The finished welds are inspected using magnetic particle methods.

Have these sleeves been used on spiral weld?
Not to date – but if done a cap would be ground in the weld cap or the sleeve. Butt welds would be similarly treated.

What about the very abrupt shoulder on the sleeve?
Epoxy is squeezed during installation so that moisture ingress is prevented. Close attention must be applied to the “zippers” during the application of the exterior protective coating. If a tape system is being used – then mastic is applied to the zipper area.

How is temperature measured during application of the sleeve?
By using heat guns and tempil sticks.

Questions regarding temperature effects/soak time?
The epoxy needs to set and cure. The sleeve must be applied before the epoxy has set. The “trick” is to heat as quickly as possible.

Has a finite element analysis been conducted?
No!

Any additional testing?
Two sleeves were applied to 10-inch pipe and then dismantled. With no epoxy installed under the sleeve, 2800 pounds of force were required to remove the sleeve. In the case where epoxy was applied – 40,000 pounds of force were required to remove the sleeve.

What weld rods are used?
7018 – small diameter.

Required labor skill?
Within Petro-Line, the same crews have always been used for the installations.
BAR CODING

Information Update

Why Bar Code
- Traceability
- Pipe Tracking and Inventory Control
- Safety, Accountability and Efficiency
- Information Transfer

Symbologies can be broken down into three categories
- Linear or one dimensional
- Two dimensional
- Matrix

Linear Bar Codes
Linear or 1 dimensional bar codes are the most popular and they are referred to as Code 39, Code 128, 12 of 5 UPC to name a few.
Dimensional bar codes include Code 49, 16K and PDF 417. These symbologies are used to encode data in a very small area as on a circuit board or for applications that require a large amount of data to be encoded as on a shipping manifest.

Matrix Symbologies
- Matrix symbologies have the capacity of storing a significant amount of data in a small space. They are most frequently used in small parts making in the electronics and medical industries and for sortation and tracking applications in the transportation and freight industries. The most popular matrix symbologies include Data Matrix, Code 1 and Maxicode.

What Symbology Will The Industry Use?
- Code 39 or 128
  - Easy to print/inexpensive
  - Limited information
  - Most compact
  - Shaw Pipe Protection choice

Barcoding - Paul Poirier, Shaw Pipe Protection
CSA Standard

- Pipelines conform to CSA Standard
- Pipeline steel/coating standard updated every two years
- CSA bar code standard adopted in 1998

What is Shaw Pipe Doing?

- Implementing automated bar coding at Canadian plants
- Working with manufacturers and clients on EDI of information
- Developing technology to print 1 dimensional bar codes directly on surface of coated pipe

Automated Bar Code System
The ECHO Pipeline

*Integrity Management on the ECHO Pipeline*

Presented to: Banff99 Pipeline Workshop
Managing Pipeline Integrity Technologies for the New Millennium

Date: April 13, 1999
Presented by: David Kulcsar
Hardisty Operations Engineer
Gibson Petroleum Co. Ltd.

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**Background**

- the ECHO (East Central Heavy Oil) Pipeline is a 12" pipeline that delivers heavy crude from the Elk Point area (S.G. = 0.986) to Hardisty a distance of 153 km
- it was constructed by Gibson and Ranger and has been operated by Gibson since March 1997

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**ECHO PIPELINE**

Presentation

- Background
- Pipeline Design
- Construction
- Operational Issues

---

**Background**

- what makes this pipeline unique is that it is a hot oil pipeline
  - the design operating temperature is 50°C to 95°C
  - no condensate is required
- ECHO heated pipeline technology uses higher crude temperatures to reduce viscosity

---

**ECHO Pipeline**

**Viscosity Comparison Graph**

D. Kulcsar, Gibson Petroleum Co. Ltd
Background

- advantages of a heated oil pipeline include
  - lower pipeline/producer capital costs
  - lower pipeline/producer op costs
  - increased pipeline capacity (~20%)
  - simplified pipeline operations (no blending)
  - inc. Marketing flexibility (custom blends)
  - no additional investment to meet 350 cSt

Pipeline Design & Construction

- the initial design parameter was to minimize the heat loss to the environment in order to maintain an acceptable viscosity
- during the design it became apparent that there were overriding environmental factors
  - freeze/thaw cycle on the Right-of-Way
  - root zone temperature effects on the ROW
- during construction, 2" of insulation and 6' of cover were required (environmentally)

Background

- disadvantages of a heated oil pipeline
  - the pipeline must remain in motion as the oil in the line is continually cooling and could set up if its temperature drops too low
  - response time to an upset is critical (2-3 days)
  - contingency plans include diluting the pipeline with condensate prior to a planned, prolonged shutdown

Seasonal Frost Depth

Response Time

Root Zone ΔT
**Pipeline Coating System**

- Paint on the outside of the pipe
- High density polyethylene
- Bitumen, hot tar (optional)
- Insulation

**Pipeline Design & Construction**

- During construction, hot air was blown into the pipe to raise its temperature to 55°C
  - Large sections of unrestrained pipeline were heated and then backfilled (Typical ~ 1.5 km took 6 hours)
  - Prior to doing tie-ins of two large sections, the pipe was heated in both directions for a minimum of 100 meters (virtual anchor)
  - The insulation allowed 4 to 5 hours for the tie-in to be completed

**Pipeline Design & Construction**

- Other design/construction issues that arose from the insulation were
  - Each pipe joint had to have the Coating System applied in the field
  - Consistent compressive strength is required in the insulation to accommodate bending (or use a mandrel)
  - Cathodic protection is not effective through insulation (great care is required to ensure the integrity of the coating system)

**Pipeline Design & Construction**

- Combined Hoop and Longitudinal Stresses (Z662-94) imposed a design limitation of 59°C - maximum pipe ΔT
  - Ambient temperature during construction was - 40°C
  - Normal operating temperature is as high as 100°C
  - At some sections of the pipeline ΔT = 140°C
  - Thus, the installation temp had to be changed

**Operational Issues**

- The heat will promote the activity of any corrosion cells if they can get started
  - CP will have little effect through the insulation
  - Be proactive in minimizing corrosion activity (chemicals)
  - Routinely monitor for corrosion activity (pig yield, In-Line-Inspection)
**Operational Issues**

- All above ground piping must be insulated
- Personal protection (pipe temperature)
- Equipment operating conditions (ambient air temperature)
- Pipeline operating temperature
- Response time

**Conclusion**

The ECHO Pipeline had many design considerations that had to be addressed before it could become operational, but once all issues were addressed, it can be seen as a pipeline with a bright future.
Non-Destructive Techniques For Measurement Of Pipeline Corrosion

Investigative Excavation Programs
- Corrosion, SCC and Mechanical Damage Investigations
- Data Management - Field Database
- Specialized Training
- Specialized Equipment

Corrosion Investigation Programs
- Existing Coating Evaluation
- Corrosion Product Analysis, Bacterial Testing
- Detailed Wall Loss, Mechanical Damage Investigation and Assessment
- Specialized Wall Loss Measurement Equipment

External Corrosion Measurement Techniques
- Pit Gages
- Bridging Bars with Depth Micrometers
- Ultrasonic Pencil Probes
- Ultrasonic Mapping Systems
- Laser-Based Mapping Systems
Laser-Based Pipeline Inspection Tool (LPIT)

First generation LPIT
Mk II LPIT

Purpose - Mechanized Inspection Tools

- Inspection Data Confidence
- Accurate Measurements and Assessments
- Increase Repeatability of Measurements
- Operator Independence
- Reduce Inspection Time

Principle of Operation
First Generation LPIT

Laser System Output - First Generation LPIT

LPIT Data Collection Density

Why Mk II LPIT?

- Pipes are not straight and round!
- Extensive field trials and projects define limitations of first generation LPIT
- Industry need for efficient and accurate external corrosion mapping system.
Limitations of First Generation LPIT

- Unable to accurately map corrosion in the presence of long seams, circ. welds, side and over bends, sags, dents, bulges.
- High system profile (25 in.)
- Limited single scan area (8 in. x 27 in.)
- Operating environment 0° C + (without hoarding and heating)

Topographical View Illustrating a Girth Weld On a Bend Section

Mk II LPIT Specification

- Software capable of coping with surface deformations and welds
- Increased scan area - max. 103° of any pipe diameter circumference x unlimited length (1mmx1mm grid)
- Low profile - 5 in.
- Fast setup, efficient data collection
Mk II LPIT Specification (cont.)

- Built-in RSTENG module for quick data assessment in the field
- Depth measurement resolution - +/- 0.2 mm (preliminary tests)
- Flying Spot laser sensor eliminates shadowing effect
- Working environment: -30°C / +50°C
- Digital format of data output
Internal Corrosion Measurement Techniques

- Manual ultrasonic hand scan / B-scan
- Pipescan - MFL scanner
- Mapscan - ultrasonic c-scan mapping

Pipescan MFL scanner for quick detection of internal corrosion
Benefits

- Data Collection Efficiency/Reduced Inspection and Data Assessment Time
- Operator Independence
- Increased Data Quality and Integrity
- Baseline for Comparison With Other Technologies, i.e., Calibration for ILI Inspector
- Growth Model Development

Summary

- Efficient delivery of corrosion Investigation Programs
- Qualified Staff
- Reduced Risk of Non-Conservative Assessments
- Reduced Repairs
- Fewer Excavations
QUALITY CONTROL SYSTEMS

for the CONSTRUCTION,
REPAIR and
ALTERATION
of PIPELINES

WHOSE DOING WHAT?

• GOVERNMENTS

• INDUSTRY CODES AND STANDARDS

• OWNER/OPERATING COMPANIES

• MANUFACTURERS

• CONTRACTORS

SOME CURRENT INFO

• GOVERNMENT REGULATORS
  – NO REQUIREMENTS BY THE PROVINCIAL REGULATORS OF PIPELINES(?)

– FOR PIPING IN PLANTS UNDER PROVINCIAL REGULATORS (e.g. ABSA, SPSB)
  • an approved QC System is mandatory for the Construction, Repair and Alteration of Pressure Piping (by all that do it)

– SOME REQUIREMENTS BY THE NEB Onshore Pipeline Regulations
  • Materials Control 'A company shall develop a quality assurance program for the purpose of ensuring that the pipe and components to be used in the pipeline meet the specifications referred to in section 14'

SOME CURRENT INFO

• INDUSTRY CODES/STANDARDS
  – CSA STANDARDS for 'equipment' (pipe, fittings, flanges, valves) in the Z245 series call for the manufacturer to have a ‘documented quality program in accordance with’
    • CAN/CSA-ISO 9000,
    • ISO 9000, or
    • API Q1

  – CSA STANDARD Z662, 'Oil and Gas Pipeline Systems' does not require a quality program for the construction, repair or alteration of the pipeline.
SOME CURRENT INFO

- OWNER/USERS
  - Some require contractors to have documented and approved QC Systems but don’t have them for their own owner/user run jobs
  - Some require contractors to have documented and approved QC Systems and require owner/user run jobs to be under the owner/user documented (and audited) QC System
  - Some owner/users use the ABSA approved QC System (for piping) for their pipeline jobs

SOME CURRENT INFO

- CONTRACTORS
  - most have an documented quality control system that is offered to the owner/user for approval
  - the quality control system is not necessarily to a recognized industry standard

SOME CURRENT INFO

- MANUFACTURERS
  - for CSA pipelines, ‘equipment’ manufacturers are required to have a documented quality program under:
    - CSA CAN/CSA-ISO 9000
    - ISO 9000, or
    - API Q1

WHATS HAPPENING NOW?

- What is the experience of those here today?
  - Locally
  - Canada
  - other countries

  - Government Regulations
  - Industry Code/Standards
  - Owner/Users
  - Manufacturers
  - Contractors

  - Producing vs Transmission vs Distribution Companies
WHAT DOES (SHOULD) THE FUTURE HOLD?

• What do you think needs to be done in the future?

  • Government Regulations
  • Industry Code/Standards
  • Owner/Users
  • Manufacturers
  • Contractors

• Producing vs Transmission vs Distribution Companies
NEB Pipeline Integrity Management Program Guidelines

Topics of Discussion

- Background and Objectives
- Content of Guidelines
- Status and Future Guidelines
- Conclusions

Role of the NEB

- Independent regulatory tribunal reporting to Parliament through the Minister of Natural Resources... NEB Act/Onshore Pipeline Regulations
- Ensure safe design, construction, operation and abandonment of international and interprovincial pipelines
- Jurisdiction over 40,000 km pipelines currently 48 gas/29 oil

Background

- 22 pipeline failures since 1991
- Stress Corrosion Cracking Inquiry in 1996 recommended extensive SCC management program
- Board also concerned with broader aspects of pipeline integrity
- Dialogue with 13 regulated companies

Revised Onshore Pipeline Regulations

- Move from prescriptive to performance-based, goal-oriented regulations
- Increased emphasis on pipeline maintenance
- Requires companies to be more proactive in managing risks
- Guidelines accompany revised regulations

Guidelines Vs Regulations

- Guidelines are not regulations but...
  - Are advisory in nature and represent "best practices"
  - Allow degree of flexibility not possible with regulations
  - Enforcement of regulations will be based on the "intent" of the guidelines through audits
Objective of Guidelines

- ensure companies have comprehensive integrity management plan in place and provide the NEB with audit baseline
- ultimate goal...pipeline systems that are “suitable for continuous safe, reliable and environmentally responsible service”

Content of Guidelines

- Four components
  - Management System
  - Working Records Management System
  - Condition Monitoring
  - Mitigation
- CSA Z662 and OPR references
- Continuous process

Management System

- Scope (facilities, objectives)
- Lines of responsibility and reporting requirements to senior management
- training requirements
- change management procedures
- measure of effectiveness (audits)

Working Records Management System

- access to data within 24 hours (pipe specs, mapping data, repair and inspection history)
- documentation of procedures to track, analyze and trend condition of pipeline
- documentation and records of pipeline condition (maintenance procedures, safety audits, system changes, historical records)

Condition Monitoring

- In-line inspection within 6 months of construction
- Engineering Assessment of pipeline integrity
  - 10 year intervals or less
  - addressed in revised CSA Z662
  - ILI, hydrostatic test, dig data, metallurgical analysis
- Risk Assessment to rank segments
  - thought process invaluable
  - qualitative Vs quantitative

Condition Monitoring (continued)

- identification and prioritization of failure causes (corrosion, manufacturing defects)
- methods used to evaluate pipeline integrity (ILI, hydrostatic test, digs, CP surveys)
- incident reporting procedures/failure cause analysis
- monitoring and surveillance programs (line patrols, slope movement)
Mitigation

- criteria and procedures for evaluation of imperfections/repair
- consequence analysis to establish repair priorities
- mitigative measures (cutout, sleeving, hot taps, hydrostatic retesting, pressure reduction)
- plans and priorities (short/long term)

Guideline Status and Future Plans

- OPR and guidelines issued for comment in January...industry comments pending
- NEB changing approach to audits and inspections
- Facility Guidelines (e.g. stations, tanks) target late 1999
- Gas Plant Guidelines target year: 2000

Conclusions

- The “intent” of the Integrity Management Program Guidelines
  - proactive, comprehensive, continuous process
  - encourage technology and analytical methods (ILI, RA, EA)
  - common language in one document
  - Senior Management support is key

Conclusions (continued)

- Measures of guideline effectiveness
  - companies proactive
  - companies sharing information
  - increased industry research activity
  - direct CSA Z662 involvement
  - ultimately, a reduction in pipeline failures

NEB Pipeline Integrity Management Program Guidelines
PETROSLEEVE STEEL REINFORCEMENT SYSTEM

- Permanent Repair for Pipeline Defects
- Designed to be installed without interrupting Pipeline Service
- Designed to be installed without Welding to the Pipe

DEFECT TYPES

- Corrosion
- Stress Corrosion Cracking (SCC)
- Mechanical Damage
- Pipe Body Cracks
- Arc Burns
- Dents
- Weld Defect
PETROSLLEEVE ADVANTAGES

- Easy to Install
- No interruption to Pipeline Service
- 100% Support of the Pipe
- Repairs Cracks & Corrosion
- Repairs Dents

PETROSLLEEVE ADVANTAGES cont...

- No Welding to the Pipeline
- Can be Installed in Severe Working Environments
- Serviceable for all Operating Pressures
- Steel on Steel
PRE-INSTALLATION ASSESSMENT

- Carrier Pipe Information
  - Diameter
  - Wall Thickness
  - Grade
  - Seam Type
- Pipeline Operating Conditions
  - Operating Pressure & MOP
  - Operating Temperature
  - Product Type
  - Flow Rate

INSTALLATION PROCESS

- Clean Pipe and Sleeve
- Apply Thin Epoxy Interface
INSTALLATION PROCESS cont....

- Assemble Sleeves
- Apply Compression Devices

INSTALLATION PROCESS cont....

- Raise Temperature to EiP Requirement
- Complete Welding
INSTALLATION PROCESS cont...

- Apply Coating and Backfill

STRAIN ANALYSIS - DURING INSTALL

Strain Readings of Pipe Under Sleeve During Sleeve Installation Process

Prior to Installation -
Vessel Press: 200 psi

Prior to Installation -
Vessel Press: 400 psi

After Sleeve Installation -
Vessel Press: 400 psi

After Sleeve Installation -
Vessel Press: 0 psi

Time Line for Sleeve Installation Process:
- Strain in Pipe Under Sleeve
STRAIN ANALYSIS - DURING CYCLING

Strains in Pipe Under Sleeve During Pressure Cycling

DENT PROFILE ANALYSIS

Superimposed Puncture Dent Profiles (After Cycling)
### PETROSLEEVE INSTALLATION HISTORY

<table>
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<th>PIPE DIAMETER (NPS)</th>
<th>NUMBER OF SLEEVES INSTALLED</th>
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<th>DENTS</th>
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### ECONOMIC ADVANTAGES

- Easy to Install
- Very Economical
- No pipeline interruption Required
- No Welding to the Carrier Pipe
- Permanently Repairs Defects
- Can be Coated immediately after Installation
<table>
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<tr>
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<th>Affiliation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Denis Trudeau</td>
<td>Corrigo</td>
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<tr>
<td>Don McNabb</td>
<td>Apache Pipeline Projects</td>
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<tr>
<td>Bryan Scott</td>
<td>Enbridge Pipelines Inc.</td>
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<tr>
<td>Cyril Karvonien</td>
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<td>George Chelkwanow</td>
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<tr>
<td>Bernie Frost</td>
<td>A.C.U.B</td>
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<td>Bert Johnson</td>
<td>Gulf Canada Resources Limited</td>
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<tr>
<td>Bob Kliciak</td>
<td>Husky Oil Operations Limited</td>
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<tr>
<td>Rudy Steiner</td>
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<td>Emmy Nielsen</td>
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<tr>
<td>Robert Smith</td>
<td>Minerals Management Service</td>
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<tr>
<td>David Taplin</td>
<td>Komet International Inc.</td>
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<td>N W Murray</td>
<td>Mining of Alaska Canada</td>
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<td>Jim Bronson A</td>
<td>Canusa</td>
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<td>Steve Cooper</td>
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<tr>
<td>H. Parekh</td>
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<td></td>
<td>Pipelines Division, New Delhi, India</td>
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<tr>
<td>Jim Steeves</td>
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<td>Mark Kuppe</td>
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<td>I Kam Wu</td>
<td>3M Canada</td>
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<tr>
<td>David Kuruczak</td>
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<td>Greg Hill</td>
<td>Corridor Pipeline (Trans Mountain)</td>
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<tr>
<td>Dale Dye</td>
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<tr>
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<td>Ellipse Spool Ltd.</td>
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## WORKING GROUP #1

**Tuesday 1/10**

<table>
<thead>
<tr>
<th>Name</th>
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<tr>
<td>Glen Scott</td>
<td>B.C. GAS</td>
</tr>
<tr>
<td>Lyne Gerlitz</td>
<td>J.L.G. ENGINEERING LTD.</td>
</tr>
<tr>
<td>Steve Lemon</td>
<td>GREE N PIPE</td>
</tr>
<tr>
<td>Bruce Fowler</td>
<td>NO. TERR M'nan Consulting</td>
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<td>Brian Nelson</td>
<td>NATIONAL ENERGY BOARD</td>
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<td>Ed McCauchy</td>
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NAME

Terry Klatt
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NRM Thomasen
Darius Boucher
Kam Wu
Barry Nesbit
RM Goodfellow
Dale Pay
Reena Soinney
Mike Bell
Bob Kliciak
Rudy Steiner
William Iaros
Bill Tyson
Ken Danylick
Jim Steves
David W. Murray
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Dan Sinclair

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3M Canada
National Energy Board
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Husky Oil Operations Limited
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Canmet
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Proactive Technologies Intl.
Union of Keepers
Westcoast Energy Inc
Westcoast Energy Inc
Working Group 2A - Stress Corrosion Cracking
Tuesday, April 13, 1999 1:15 p.m.

Evaluation of SCC Defects

Co-Chairs: L. Blair Carroll, Enbridge Pipelines Inc.
Dr. Martyn Wilmott, Brodoro Price Coaters (Absent)

Objectives:
- Familiarization with SCC assessment models
- Identify applicability and limitations of models
- Identify future work if required

Presentation - Evaluation of SCC Defects: How do we determine pipeline integrity
Dr. Carl Jaske, CC Technologies Inc.
(Refer to presentation slides)

Open Discussion Period 1:44 pm

- **Bill Tyson** (CANMET). Work is being done in collaboration with the industry on the approximation of crack failures using finite element analysis. Many current models are based on empirical results rather than FEA.

- **Carl Jaske** (CC Technologies): advances in crack failure mode predictions will include ductile tearing of cracks.

- **Blair Carroll** (Enbridge Pipelines), Question: For SCC inside corrosion, how accurate are the current models for estimating failure pressure? Group, Answer: general agreement that models are applicable provided that the total defect depth used is depth of corrosion plus depth of cracking.

- **Valentino Pistone** (SNAM), Question: Has the Canadian industry found bacteria to be associated with SCC? How about corrosion pitting? **Barry Martin** (Rainbow Pipeline), Answer: No bacteria has been found and from Rainbow’s experience, very little pitting corrosion is associated with SCC occurrences.

- **Barry Martin** (Rainbow Pipelines): In dry soils we have found SCC and it has been noted that little corrosion has been associated with it.

- **Peter Merreck** (Rainbow Pipelines): SCC is proportional to tape application. If tape is in good condition, it is likely that SCC will not be found. The morphology of SCC appears to be linked with soil conditions.

- **Jim Marr** (Marr & Associates): What actions are being taken by individual pipeline companies to address the issue of coatings? How do we document what we're looking at? Rainbow program included new parameters - look at tape overlaps. Must be careful not to destroy evidence when doing digs. SCC without corrosion has been seen. At the end of the day, this all boils down to integrity concerns. Documentation is critical. Measuring amount of disbondment is becoming an issue for companies.

- **Blair Carroll** (Enbridge Pipelines). Question: What are the current capabilities of in-line inspection for detecting coating disbondment? **Martin Phillips** (Pipeline Integrity International), Answer: Efforts through the
Elastic Wave User’s Group are looking into detection capabilities of disbonded coating but, cannot comment current capabilities of the EW Tool to direct minor disbondment. We could use the help of pipeline companies in collecting field data of disbonded coatings to compare to the data gathered by the ILL tools.

- **Mimoun Elboujdaini** (CANMET), Question: What role does hydrogen play on the SCC and how does it affect the life prediction? **Carl Jaske** (CC Technologies), Answer: We know hydrogen plays a role and is considered one of the mechanisms in crack growth. The experimental data that has been used in modeling crack growth does incorporate the effects of hydrogen.

- **Mimoun Elboujdaini** (CANMET), Question: Are the effects of hydrogen more evident in clean steel? What about the heat affected zone? **John Beavers** (CC Technology), Answer: Not identified as a real issue.

- **Blair Carroll** (Enbridge Pipelines), Question: Current assessment models are based on evaluating defects in the pipe body. Are these models also applicable to defects located in the weld region? **John Beavers** (CC Technologies), Answer: There are small changes that need to be considered due the weld profile as well as toughness and HAZ near the weld region.

- **John Beavers** (CC Technologies), There does not appear to be any work done in comparing differences between SCC in liquid and gas lines.

- **Blair Carroll** (Enbridge Pipelines): Should the industry be looking into differences in morphology in the SCC found on liquid vs. gas pipelines?

- **Susan Miller** (Enbridge Pipelines): Enforced Blair Carroll question – the industry should compare the experience of SCC occurrences between liquid lines and gas lines. We should promote better investigation efforts into differences of SCC found on liquid lines vs. gas lines.

- **Herbert Willems** (Pipetronix): There have been some notable differences in SCC found between gas and liquids lines. SCC in gas lines is found mostly near weld seams. With the oil lines, SCC has been found mostly the pipe body and there has been no notable correlation with SCC found on the weld seams.

- **Tom Morrison** (Morrison Scientific), Question: Is the information regarding differences between SCC on liquids vs. gas lines readily available from sources like the SCC CEPA database? Group consensus identified that this information is not readily available and helpful information such as the Rainbow data is not included in the CEPA database.

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**Session Summary 2:40 pm**

**Blair Carroll** – Summary of Relevant Action Points

1. Projects investigating the differences in defect morphology, initiation and growth between liquids and gas pipelines might assist in refining assessment and susceptibility models

2. Careful characterization of coating condition is needed to identify the minimum extent of disbondment necessary for SCC initiation and the information should be shared throughout the industry
Banff 99
SCC Session

SCC Colony Assessment
J.E. Marr Associates

Scope

- To assist with the characterization, documentation and assessment of SCC
Presentation Overview

- theory of MPI
- inspection techniques
- classical and non classical SCC
- SCC characteristics
- colony interpretation
- colony documentation
- colony assessment

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Magnetic Particle Inspection (MPI)

Fig. 1 represents a longitudinal cross section through a piece of magnetized material.

![Diagram of Magnetic Field]

Crack

![Diagram of Surface Defects]

Jim Marr, J.E. Marr Associates
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Magnetic Particle Inspection (MPI)

Fig. 3 represents how a discontinuity oriented parallel to the magnetic field in the object will have far less effect on the field than a discontinuity perpendicular to the field.

Orientation of Discontinuities

Figure 3

Source: Magnetic Particle Testing
Mechanical Trades & Technologies Department
Southern Alberta Institute of Technology
Vol 3

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Magnetic Particle Inspection (MPI)

- Wet fluorescent (WFMPI)
- Black on contrast white (BWMPI)
- Dry powder
Wet Fluorescent MPI

- Advantages
  - Generally less expensive than BWMPI method
  - Inspection rate quicker than BWMPI method on longer investigative sites
  - Higher sensitivity
  - Weld indications more easily identified

- Disadvantages
  - Longer set up time
  - Requires more inspection equipment and personnel
  - Difficult to document SCC
  - Difficult to photograph

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Black on Contrast White MPI

- Advantages
  - Less set up time
  - Requires less inspection time
  - Easier to document SCC
  - Easier to photograph SCC
  - Easier to present SCC
  - Can be completed by a single person

- Disadvantages
  - Can be expensive
  - Pre-mixed solutions requires larger supply on hand
  - Mis-interpretation of SCC like indications
Pipe Preparation Requirements

- Requires a system that adequately removes coatings, primers and hard corrosion product deposits
- A surface preparation that promotes MPI inspection

Classical vs Non-Classical SCC

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Classical</th>
<th>Non-Classical</th>
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<tbody>
<tr>
<td>Other Name(s)</td>
<td>* High pH</td>
<td>* Low pH, near neutral</td>
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<tr>
<td>Location</td>
<td>* Typically within 2 miles (3 km) downstream from a compressor station</td>
<td>* Samples detected immediately from compressor to 35 miles downstream, more significant SCC within first valve section from a compressor station (i.e. first 10 miles)</td>
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<tr>
<td>Electrolyte pH</td>
<td>* High pH (electrolyte pH between 8.5 and 11)</td>
<td>* Low pH (electrolyte pH between 6.0 and 8.5)</td>
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<tr>
<td>Concentration</td>
<td>* Concentrated carbonate - bicarbonate solution</td>
<td>* Dilute bicarbonate electrolyte solution</td>
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<tr>
<td>Temperature</td>
<td>* Growth rate decreases exponentially with temperature decreases</td>
<td>* No apparent correlation with temperature of pipe</td>
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<td>Electrochemical Potential</td>
<td>* Near C.P. range in the presence of a carbonate environment, ranging from -600 to -900 mV, use &quot;off&quot; potentials to determine C.P. level</td>
<td>* Far from corrosion potential (-600 to -700 mV) for asphalt, no factor for tape coatings - use &quot;off&quot; potentials to determine C.P. level for asphalt coated lines</td>
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<tr>
<td>Terrain Condition</td>
<td>* Soils generally dry, well drained, cannot achieve C.P. levels (C.P. &gt;550 mV, &quot;off potential&quot;)</td>
<td>* Variable depending on coating, i.e. tape and asphalt</td>
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<td>Crack Location</td>
<td>* Generally in pipe body, beneath sized bonded coating</td>
<td>* Generally associated with weld areas - long seam andirth welds, essential to have sized bonded coating</td>
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<td>Crack Morphology</td>
<td>* Intergranular, narrow tight cracks with no evidence of secondary corrosion along crack walls</td>
<td>* Intergranular, mix mode at crack tip, wider cracks with evidence of corrosion along crack walls</td>
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Classical vs Non-Classical SCC

- Classical SCC
- Classical SCC distribution pattern

Classical vs Non-Classical SCC

- Non-classical SCC (magnified)
SCC Conditions

Three conditions necessary for SCC

- Patent environment
  - coating disbondment
  - moisture and CO₂
  - cathodic protection levels
  - soil conditions
  - temperature

- Tensile stress
  - fabrication stress
  - service stress
  - operating pressure
  - cyclic loading
  - strain rate
  - secondary loading

- Susceptible pipe material
  - surface condition
  - steel microstructure

Source: NEB 1996.

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Colony Identification

- All colonies require an unique identifier
- document position on pipe - location
- orientation of colony - shape
- identify severity or significance of colony
Location of SCC

- Body
- Longseam
- Girthweld

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Location of SCC

- SCC along longseam (beneath disbanded coating)
- SCC across girthweld
Location of SCC

- SCC near long seam on spiral weld
- SCC along long seam

Location of SCC

- SCC within pipe body
Location of SCC

- SCC in channel corrosion
- SCC in pitted channel corrosion

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Location of SCC

- SCC in pitted corrosion
- SCC in combination corrosion (general and pitting)
Location of SCC

- Toe crack before buffing
- Toe crack associated with SCC (after buffing)

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Location of SCC

- Toe crack after removing weld cap

![Image of SCC Colony Shape](image_url)

SCC Colony Shapes

- Linear
- Axial
- Circumferential
- Diagonal
SCC Colony Shape

- Linear SCC colony shape

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SCC Colony Shapes

- Axial SCC colony shape

- Circumferential colony shape

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SCC Indications

- Longitudinal
- Circumferential (transverse)
- 45 degree
**SCC Indications**

- SCC at a 45 degree orientation
- Transverse cracking

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**SCC Indications**

- Short deep cracks
- Shallow SCC in linear corrosion

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SCC Documentation

- Identify joint and colony
- Colony dimension
- Longitudinal reference
- Circumferential reference
- Average crack length
- Maximum crack length
- Horizontal distance between cracks
- Colony location
- Interlinking
- Maximum interlinked length
- Crack depth
- Associations
- UT wall thickness measurement
- Photographs

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SCC Documentation

- Splitting up SCC colonies
- ERW longseam - interlinked cracking

Jim Marr, J.E. Marr Associates
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Colony Characterization

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<td>Distance from Reference Girth Weld</td>
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<td>Distance from Reference Girth weld</td>
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<tr>
<td>LONGSEAM</td>
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<tr>
<td>Individual Cracks Interspersed</td>
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<tr>
<td>Maximum</td>
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<td>Crack Length</td>
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<td>Linear Indication of Toe of weld</td>
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<td>Distance to Longseam</td>
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<td>Either Clockwise or Counterclockwise Direction</td>
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<tr>
<td>Maximum length of interlinked crack</td>
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<td>Longitudinal Spacing</td>
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<tr>
<td>Overall colony width</td>
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<tr>
<td>Circumferential Distance Between Cracks</td>
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<tr>
<td>Overall Colony Length (along pipe axis)</td>
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<tr>
<td>Stress Corrosion Crack</td>
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SCC Colony Assessment - Depth Evaluation

- At present, there are two common field methods to quantify the depth of a crack.
  - Advanced ultrasonics (non-destructive)
  - Buffing (destructive)
Significant SCC

• An SCC colony is assessed to be significant if the deepest crack in a series of interacting cracks, is greater than 10% of the wall thickness and the total interacting length of the crack is equal to or greater than 75% of the critical crack length of a 50% throughwall crack at a stress level of 110% of SMYS - source CEPA

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Significant SCC Assessment

• Determine the critical length for rupture of a 50% throughwall defect at 110% SMYS
• determine the cumulative interacting length of the cracks - dependent on circumferential and axial separation
• if one of the cracks within the cumulative, interacting length has a depth greater than 10% of the wall thickness - compare the interacting length of the colony to the critical length
• if the interacting length exceeds 75% of the critical length, the colony is considered significant
• source - CEPA
SCC Colony Assessment - Evaluation

- To properly evaluate the potential impact of a SCC colony, the depth and length of a colony should be accurately determined.
- The determination of critical crack sizes is dependant on the individual company.
- Fracture mechanics based calculations can be used to determine the critical crack size of a given pipeline for a known set of metallurgical and operational parameters.

Managing Pipeline Integrity: Technologies for the New Millennium
Weld Indications

- Manufacturing defects
- Lack of Fusion (ERW & SAW)
- Undercut (SAW)
- Roll over (SAW)
- Slag (SAW)
- Hook cracks (ERW)
- In-service defects
- SCC cracking (environmentally assisted)
- Fatigue cracks (cyclic)

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Non-SCC Indications

- Laminations
- Surface blisters
- Corrosion
- Inclusions and stringers
- Mill scale
Reporting

- Future reference
- Creating/maintaining pipeline profile databases
- Monitoring programs

Photography

- Future reference
- Aiding in engineering assessments
- Monitoring programs
Banff 99
SCC Session A

EVALUATION OF SCC DEFECTS: HOW DO WE DETERMINE PIPELINE INTEGRITY

by Carl E. Jaske and John A. Beavers
CC Technologies

Topics to Be Addressed

• Definition of Integrity Assessment
• Why Is It Needed?
• Uses of Integrity Assessment
• Information Needed for Assessment
• Overall Methodology
• Prediction of SCC Life
Definition of Integrity Assessment

- An Analytical Procedure to Determine If Pipeline Can Operate Without Risk of Failure

Why Integrity Assessment Is Needed

- Maintain Safety
- Avoid Environmental Impact
- Maintain Reliable Operation
- Optimize Maintenance Programs
Uses of Integrity Assessment

- Establish In-Line Inspection (ILI) Intervals
- Prioritize ILI Results for Field Inspection
- Establish Hydrostatic Testing Intervals
- Determine If Pressure Must Be Reduced
- Decide to Repair or Cut Out Defect
- Prioritize Inspection, Re-Coating, or Repair
- Estimate Remaining Life

Information Needed

- Dimensions: OD and WT
- Material Properties: YS, UTS, and TSN
- Pressure: MAOP and Actual Operating
- Defect Size, Shape, and Orientation
- Defect Location: Welds, Bends, Dents, etc.
- Optional: Flaw-Depth Profile, Fracture Toughness, Stress-Strain Curve
Overall Methodology

- Two Failure Criteria for Crack-like Flaw
  - Flow Strength
  - Fracture Toughness
- Stress Reaches Flow Strength Locally
- Use a Model to Calculate the Failure Stress for Locally Thinned Area (LTA)
  - Effective Area Method: Rstreng or CorLAS™
  - \( \sigma_{\text{fail}} = \sigma_{\text{flow}} \left(\frac{1-A/A_0}{1-A/(MA_0)}\right) \)

Overall Methodology

- Fracture Toughness (\( K_c, J_c, \) or \( CTOD_c \))
- Failure When Applied \( K, J, \) or \( CTOD \) Reaches a Critical Value
- Estimate Fracture Toughness from CVN Measure Using Test Specimens
- Current Approach Conservative for Very Long Crack-Like Flaws
Overall Methodology

- Models Developed for Single Axial Defects
- Some Address Linking of Co-Linear Flaws
- Conservative for Non-Co-Linear Flaws
- May Be Inaccurate for Complicated Shapes
- Generally Provide Conservative Results for SCC Colonies Where Cracks in a Colony Are Assumed to Be Inter-Linked

Typical Applications

- Remaining Life Calculation
  - Prioritize ILI Results for Field Inspection
  - Prioritize Inspection, Re-Coating or Repair
  - Establish Hydrostatic Testing Intervals
  - Establish ILI Intervals
- Burst Pressure Calculation
  - Assess Whether to Repair or Cut Out Defect
  - Determine Whether Temporary Pressure Reduction Is Required
Prediction of SCC Life

- Establish Existing Dimensions of Flaw
  - ILI Inspection
  - Hydrostatic Testing and Calculations Using Integrity Assessment Models
  - Statistical Estimates Based on Field Digs
- Estimate Critical Flaw Size at MAOP
- Estimate Flaw Growth Rate
- Calculate Remaining Life

Summary

- Evaluation of SCC Defects Is a Critical Component of Integrity Management
- It Helps the Pipeline Operator Prioritize System for Inspection and Repair
- It Provides Valuable Information Needed for Long-Range Planning
# Working Group 2A: Stress Corrosion Cracking
**Tuesday April 13, 1999 - 1:15 pm**

<table>
<thead>
<tr>
<th>Company</th>
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<td>Thomas J. Cook</td>
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## Working Group 2A: Stress Corrosion Cracking

**Tuesday April 13, 1999 - 1:15 pm**

<table>
<thead>
<tr>
<th>Company</th>
<th>Name</th>
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## Working Group 2A: Stress Corrosion Cracking

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### Attendance Sheet

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WORKING GROUP 3
COATINGS WORKSHOP
WEDNESDAY APRIL 14, 1999
1315 TO 1700 HRS
ROOM 251 - MAX BELL BUILDING

Co-Chairs: John Baron – Shell Canada
Matt Cetiner – Anteris Corrosion

Background – John Baron
- CSA Z 662-96 definition of coatings does not specify how to ensure the quality and integrity of the coating
- CSA Z 662 Materials subcommittee formed a group to address NEB SCC inquiry from 1996 report
- Offshore in east coast Canada pipe line installation in environmentally sensitive areas
- Challenge for the next Millennium – “Objectives”
- “To select and apply pipeline coatings in a manner which significantly lowers the probability of external corrosion occurring over the life of the pipeline”

Workshop objectives
- Increase awareness – coatings design criteria and life assessment (Influence CSA activity)
- Consistency in-service coating assessment methodology, fit for service evaluations
- Improve field joint coatings
- Improve field repair coatings
- Identify future areas of research, test method development

PAPER # 1 – PIPELINE DYNAMICS; IMPACT ON COATINGS DESIGN
Graeme King – Greenpipe Industries Ltd.

- Solutions for long term reliability are to be implemented at the design stage
- The CSA code identifies the minimum requirements and at times additional requirements must also be implemented
- Movement at Bends can be calculated for Longitudinal Compressive Force and Lateral Bearing Load
- CSA Z 662 requires additional wall thickness to keep hoop & longitudinal stress below 90% SMYS
- (Appendix C offers an alternative to Subsection 4.6.2.1)
- The extra wall increases axial force & hence lateral load
- Longitudinal movement can apply large longitudinal shear stresses on the coating
- In summary damage to pipe coatings due to movements between the pipe and the soil can be prevented by a combination of:
  - Reducing forces:
    - Use long radius bends to reduce bearing loads at bends
    - Specify good backfill compaction to prevent settlement
- Reduce wall thickness, operating temperature & pressure
- Good pipelining procedures to reduce locked-in stresses
- Avoid unstable slopes

How many companies carry out stress tests?
Not too many to Graeme’s knowledge. Shear tests are not specifically specified anywhere whether it is in a code of practice or standard

What are if any effects on coating are cyclic temperatures?
Assumptions made – temperature & pressure cycling is on-going Graeme believes this to be natural and not to be a problem. The coating takes max. shear stresses and is able to take abrasion of pipe moving back & forth.

Super compaction with fine materials like sands can cause abrasion in a vibrating service.
- Super compaction also increases shear stress.
- Slick surface coatings, i.e.: FBE coatings will reduce shear stress-also depends on internal angle of friction
- Backfill is important in that it must be filled in under the pipe and proper compaction obtained

Line with Tape coating has sagging at 5 and 7o’clock positions. Line is low temp. What could the cause be?
- Most likely cause is voids around the bottom of pipe backfill and as the soil moves the mastic also for creep and the movement and sagging of the tape

What is required for design for stress?
- Relatively all the normal information, use of industry standards for backfill, and the fact that stress on the pipe coating is calculated and the resistance of the coating to this stress.

PAPER # 2 CONSISTENCY IN ASSESSMENT OF IN-SERVICE COATINGS
Dale Temple – Anthers Corrosion
- CSA does not give a methodology for how coatings behave in a lifetime
- References to NACE RP 0169-69 Clause 5-3-34 External Coating System Qualification
- Inconsistency lies in :
  - Lack of understanding of failure mechanisms to design realistic testing
  - Incorrect use of testing standards and acceptance criteria
  - Inconsistent standards for specific coating types (i.e.: CSA addresses FBE and not Liquid applied epoxies
  - Definitions of what are failures and their mechanisms
  - Inconsistent reporting
  - Sampling & Test methods, testing of coatings not always conducted in applicable operating environment

Testing is very important for testing to be conducted in appropriate field operating environments. Mechanisms in lab should display this.
- Standards require some flexibility (i.e.: FBE has rigid requirements for bend flexibility which applies to the bends and needs not to be applied to straight sections of pipe)
PAPER # 3 INCREASING DESIGN LIFE OF PIPELINES
Peter Singh – Shaw Pipe Protection Limited

- Designing a coating and not just selecting one off the shelf!
- Consideration to Operating conditions, Construction and installation practices and others (i.e.: abrasion & UV stability)
- Arrhenius Equation can be used to determine Lifetime Extrapolation for insulated coated systems
- Stresses affect the shear strength (Pipeline Weight, Thermal, Hydraulic and Soil)
- What standard shear tests are conducted?
- No specifications for stand alone coatings, and there is the Alyeska Shear test for insulated-coated systems. Peter indicated this might not be considered a true shear test as it puts a load on and time is recorded when there is a shift.
- What is CP capability with the coating mean?
- No real answer discussion on conductive coatings being developed.
- Coating life needs to match pipeline design life; i.e. 7 years vs. 50, 60, 80 need same requirements?
- What is the status of external corrosion in marine environments with regard to shielding?

PAPER # 4 FIELD JOINT COATINGS
John Baron – Shell Canada Limited

- Field joint coatings usually applied by the contractor
- Currently no standards on system capability and performance on interface
- Issue with personal training and material qualification
- European countries have specialized contractors for joint application, good quality and not left with mainline contractor. North America behind.
- Field coatings should have the same quality as the shop-applied coatings. Challenge for material supplies and contractors.

PAPER # 5 REPAIR COATINGS
Aida Lopez – Trans Canada Pipelines Limited

- Coating selection was start of the art during initial construction and has been subjected to aging due to increased operating temperatures, soil stresses and increase CP
- Recoating program direct costs about 60% of replacement cost
- Have done extensive lab testing to qualify 5 liquid epoxies and their application
- Urethane girth weld coating failures have occurred and putting together a field investigation and repair program
- Challenge of overcoating existing polyethylene systems with liquid epoxies. Testing is required for the overlap area for tape, asphalt and coal tar systems
- Very good success with brush applied liquid epoxies on girth welds and discrete digs
- Identified in-house training for coating inspectors, 3 day course with exam
- All coating applicators shall be pre-approved
Understanding Pipeline Dynamics and its Impact on Coating Design

by Graeme King
V.P. Engineering
Greenspipe Industries Ltd

Introduction

- We see a number of pipelines with coatings damaged by relative movements between the pipe and the soil.
- The problem is worse near bends and areas with poor backfill compaction.
- Solutions, which are best implemented during design & construction, are limited to:
  - reducing the magnitude of the movements & forces, and/or
  - increasing the toughness and adhesion of coatings.

CSA Z662 Requirements

- The relevant minimum requirements specified by CSA Z662 for coatings are:
  - Designers must make sure that coatings have sufficient strength and adhesion to resist soil shear stresses at service conditions (including maximum temperature) for the life of the pipeline (CSA Z662 §6.2.4.2 and §6.2.6.1(66))
  - And for the soil backfill are:
    - The pipeline must fit the contour of the ditch, and it must be backfilled to prevent damage to the pipe or coating, and to prevent subsidence of backfill and support material (CSA Z662 §6.2.6.4, §6.2.7.2 and §6.2.7.4)

Pipe-Soil Interaction

- Although CSA Z662 Appendix C §8.9 talks about pipe-soil interaction forces and 3-D soil spring models, the code doesn't specify how to evaluate soil shear forces.
- Basically, any movement between the soil and the pipe can cause shear forces.
- The shear forces can act either across the pipe (lateral shear) or in the direction of the pipe (longitudinal shear).

Back-Filling Practice

- Customary backfill procedures aim to prevent damage to the coating during backfilling rather than to get good backfill compaction under and around the sides of the pipe.
- Poor compaction contributes to:
  - unnecessary lateral movement at bends that can abrade the coating and tend to pull it off the pipe.
  - soil settlement that can pull coating off hot pipes if coatings have mastics that soften at high operating temperatures.

Movement at Bends

\[
\text{Internal pressure and thermal expansion forces:} \quad F_T = F_B = F_R \theta = I_P R \theta
\]
Calculation of Soil Bearing

- What is the soil bearing load at a 40° bend in NPS12 pipe with an 8.4 mm wall, operating at 10 MPa & at 60°C above tie-in temperature?
- Longitudinal Compressive Force:
  \[ F_c = (1 - 3V) \pi r^4 / 4 \times \text{E} \times \Delta \text{E/O} \]
  \[ 330 \times 1.280 = 1,510 \text{ kN} = 154 \text{ tonnes} \]
- Lateral Bearing Load:
  \[ L = F_c / R \]
  \[ 124 \text{ kN/m run} = 12.7 \text{ tonnes/m run} (= 96 \text{ psi}) \]

Lateral Load at Bends

- Backfill cannot handle lateral bearing loads of this magnitude & pipes move laterally at bends, damaging pipe as well as coatings.
- The problem is made worse by CSA Z662 §4.6.2.1 which requires extra wall thickness to keep combined hoop & longitudinal stress below 90% SMYS. The extra wall increases axial force & hence lateral load.
- (Appendix C offers an alternative to §4.6.2.1.)

Lateral Movement

- Sometimes the coating fractures across weld bead
- Relative backfill movement
- Pot coating within
- Coating "bagg" in voids and loss effectiveness

Longitudinal Shear

- Lateral movement at bends also causes longitudinal movements in the straight pipe near the bends.
- The longitudinal movement can apply large longitudinal shear stresses on the coating.
- High operating temperatures make the problem worse. Mastics soften and the pipe can move longitudinally inside the coating.

Equilibrium at Bends

- Longitudinal soil shear forces \( F_{\text{LSS}} \)
- Low strength bending
- Internal pressure and thermal expansion forces \( F_{\text{PTE}} \)
- Static Equilibrium:
  \[ F_x = F_y \]
- Longitudinal soil shear forces \( F_{\text{LSS}} \)
- Internal pressure and thermal expansion forces \( F_{\text{PTE}} \)

Calculation of Soil Shear

- What is the shear stress on the pipe coating if the angle of friction between the coating and the soil is 30°, the soil density is 2,000 kg/m³, and depth to pipe centerline is 2.0 m?
  \[ \tau = \gamma h \sin \theta = 2000 \times 0.82 \times 0.50 \times 0.20 = 20 \text{ kPa} (= 2.9 \text{ psi}) \]
- This is a low estimate because it ignores cohesion, the bulking of soil in shear, and the presence of rocks in the backfill.
- An \( F_g \) of 3 would be appropriate for design.
Other Causes of Shear

- Other causes of shear between the pipe and the backfill include:
  - A tendency to lock stresses into the pipe during construction.
  - Soil movement on unstable slopes.
- These and the other situations already discussed can all cause both lateral and longitudinal shear forces between the pipe and the soil at localized points along the line and consequently cause coating damage.

Summary

- Damage to pipe coatings due to movements between the pipe and the soil can be prevented by a combination of:
  - Reducing forces:
    - Use long radius bends to reduce bearing loads at bends.
    - Specify good backfill compaction to prevent settlement.
    - Reduce wall thickness, operating temperature & pressure.
    - Good pipeline procedures to reduce locked-in stresses.
    - Avoid unstable slopes.
  - Increasing toughness and adhesion of coatings.
Consistency In Assessing In Service Coatings

- NACE RP0169-96, Clause 5.3.3.1 External Coating System Qualification
  - laboratory tests
  - application under recommended practices
  - installation under recommended practices
  - in-service field performance tests

Consistency In Assessing In Service Coatings

Laboratory testing for coating selection
- lack of understanding of failure mechanisms to design realistic testing
- incorrect use of testing standards and acceptance criteria

Consistency in Assessing In Service Coatings

- For epoxy, at a given temperature, the rate of water absorption is proportional to the inverse of the square of the thickness (Dennis Neal)
  - 14 mil coating, 0.005
  - 28 mil coating, 0.0012
  - Twice as thick, 4 times longer for H2O (0.005/0.0012)

M. Centiar & D. Temple
Consistency In Assessing In Service Coatings

- Test Methods CSA Z245.20-98
  - 28 day, 1.5 volts, 65 °C cathodic disbondment test and adhesion

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Consistency In Assessing In Service Coatings

- FBE powder coatings have to meet CSA Z245.20-98 requirements
  - Change in location of manufacture or formulation, coating has to be qualified again (Table 1 and Table 2-16 tests)
  - Incoming powder must pass QC check before application (Table 3-5 tests)
  - Test ring cut to verify coating application (Table 4-7 tests)

Consistency In Assessing In Service Coatings

- Liquid coating systems
  - Manufacturers may tweak formulation
  - QC testing done on materials before application?
  - Testing of coating is usually thickness and holiday detection
  - Critical parameters usually not addressed such as mixed material temperature and cure testing
Consistency In Assessing In Service Coatings

- FBE typically exhibits cathodic disbondment, blistering and loss of bond
- Kendig confirmed chemical breakdown of the oxide layer at high pH is the predominant mechanism for disbonding.
- Industry indicating blistering is not a concern
  - passage of CP
  - no corrosion

Consistency In Assessing In Service Coating

- Coating type identification
  - FBE coatings made by same manufacturer are difficult to distinguish
  - Asphalt
  - Primer, tape backing and adhesive combinations
  - Liquids
  - Shrink sleeves

Consistency In Assessing In Service Coatings

- Information collected at coating sites
  - Thickness
  - Samples
    - coating, liquids, soil
  - Adhesion testing
  - Parameters such as:
    - Soil type and constituents
    - Pipe surface pH
    - On-off pipe to soil potential
    - Operating temperature
Consistency In Assessing In Service Coatings

Challenges
- Develop consistent sampling and test methods.
  For example a pull off or knife adhesion test.
- Compensation for temperature. Use ASTM standards for describing size and blister density
- Definition of what is a coating failure
- Consistent reporting
- Test new coatings in worst case operating environment, not where easy to install
# Coatings Design and Selection - Predicting Coating Performance at Elevated Temperatures

P. Singh  
Shaw Pipe Protection Limited

## Design Conditions

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TEMPERATURE

- Significant effect on all other properties of polymeric coatings
  - degradation, creep, adhesion, chemical resistance

- Continuous service temperature rating
  - provide acceptable long term behavior

Determined by following methods:
- Safety factor below critical temperatures
  - Tm for thermoplastics
  - Tg for thermosets
- Studies of property vs aging time at temperature
- Accelerated aging studies
  - Increasing temperature speeds up degradation
  - based on Arrhenius equation $A = k E \exp(-E/RT)$
  - measure critical property

LIFETIME EXTRAPOLATION

<table>
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<tr>
<th>Aging Temperature, C</th>
<th>Time for property to fall below acceptable value, days (Shear &lt; .08N/mm²)</th>
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STRESSES

- Weight
  - pipe, content, soil
  - resolved into compressive and shear stress on coating
- Thermal
  - operating vs burial temperature
  - depends on pipeline design, delta T, pipe, etc.
- Hydraulic
- Soil
Pipeline Stress Analysis
20"OD 9.52mm wt, Burial 2m, crude

Horizontal Distance (inches)

Vertical Stress (psi)

EFFECT OF TEMPERATURE ON PEEL/SHEAR

Temperature (C)

Peel N/cm

Shear N/mm²
ENVIRONMENT

■ Chemical (moisture)
  ➤ Absorption - effect on bulk properties
     – compressive, shear
  ➤ Transmission - effect on interfaces
     – adhesion to pipe surface

■ Electro-chemical
  ➤ Effect of generated species on:
     – adhesion to pipe surface
     – chemical degradation
**FIELD-JOINT COATINGS (FJC'S)**

Banff/99 Pipeline Workshop
Managing Pipeline Integrity Technologies for the New Millennium

**FJC's - BACKGROUND**
- Field-applied, primarily to girth welds
- Covers the shop-applied coatings cut-back length plus weld.
- Usually applied by the construction contractor
- Coating materials normally specified by the end-user, based on experience, etc.

**FJC'S - OBSERVATIONS**
- External corrosion at girth welds is a significant problem
- Problem due to design and application quality
- CP compatibility problem exists with some FJC products

**FJC'S - DESIGN**
- Design criteria specified by inference only within current codes
- Shop-cbg + FJC = Cob System
- No industry standards on systems compatibility, performance of interface
- FJC's often evaluated independently

**FJC'S - APPLICATION**
- Application standards generally based on "manufacturer's recommendations"
- Most pipeline companies have in-house standards for application
- Personnel training & material qualification limited (but improving)
- No code requirements for application quality verification

**Minimum FJC Installation Specification**
- Steel preparation cleaning, drying, preheat, weld splatter grinding, weld bead condition
- Materials and application equipment
- Application procedure
- Qualification of materials and personnel
- Quality verification

J. Baron, Skill Canada
FJC's - What's Needed??

- Industry Design standards to address FJC's
- Specifically:
  - alignment with shop-applied coatings
design performance criteria
  - shop-applied coatings/interface
performance
  - CP compatibility
  - application quality - personnel, QA tests

FJC's - "The future?"

- FJC materials will further evolve to
  match shop-applied coatings evolution.
- Increased specialist vendors to supply
  and apply FJC's.
- FJC quality will match or be very close
to shop-applied coating quality.
- Codes will require materials qualification
  and applied quality performance.

J. Baron, Shell Canada
TransCanada PipeLines
Coating Systems

Aida Lopez, P. Eng. - TransCanada PipeLines
Pipeline System Infrastructure

- 14,500 km of Transmission Pipelines
  - 6 Parallel Lines in West (looping line 7)
  - 4 Parallel Lines in Central
  - 2 & 3 Parallel Lines in East
- 56 Compressor Stations
- 182 Meter Stations
System Construction Details

- Line 100-1 Completed in 1958
  - 34” Coated with Asphalt and Coal Tar
- Line 100-2 Completed in 1969
  - 36” Coated with Asphalt, CoalTar and some Tape
- Line 100-3 Completed in 1971
  - 36” Coated with Asphalt (FBE in Central and East)
System Construction Details

- Line 100-4 Completed in 1977
  - 42” Coated with Tape and some Asphalt
- Line 100-5 Completed in 1982
  - 48” Coated with Fusion Bonded Epoxy and some Tape
- Line 100-6 Completed in 1986
  - 48” Coated with Fusion Bonded Epoxy
Coating Selection

Criteria
- Increase in current required to maintain CP
- Ageing due to soil stresses
  - 35°C versus 60°C
- Ageing due to increased temperatures
  State-of-Art During Initial Construction
Cathodic Protection Requirements

- Increasing beyond system capabilities
  - Technically feasible but not cost effective
  - Damage to coatings on newer well coated lines (FBE)
    - Blistering
    - Disbondment
Coating Initiatives

- Knowledge of degradation lead to
  - 1982 - All new construction used FBE
    - 1996 a 70°C FBE approved
  - 1995 - A 55°C Tape repair system instituted
  - 1995 - Liquid Epoxy developed for 65°C
    - Field welds, valves and fittings
Coating Initiatives

- 1996 - Liquid Epoxy with 95°C temperature rating approved
  - Station piping, Mainline recoating, field welds, valves and fittings
Remedial Actions

- Mainline Recoating Program
- Station Recoating Program
- PMP and SCC digs
- FBE digs
Mainline Recoating Program

- Carried out since 1996
- Line travel equipment
- Spray applied epoxies
- Feasible for large scale pipeline recoating (distance > 5km)
- 1998 Mainline recoating trial test
Mainline Recoating Program

• Direct cost of recoating estimated to be 60% of the cost of replacing the pipe
• Future programs are based on pig data results, CP data and soil aggressiveness
Station Recoating Program

- Program started 1997
- Recoating with liquid epoxy rated for high temperature service (up to 95°C)
- Factors considered to select stations for recoating:
  - CP data
  - Discharge temperatures
Station Recoating Program

- Field observations of coating degradation
- Age of piping
- Soil corrosivity

• Results:
  - Coating disbondment was significant (100%)
PMP and SCC Digs

- 25 to 75 metres long digs
- Based on pig runs and SCC program
- Coating repairs - Liquid Epoxies
- Tie-ins repair varies with previous coating
FBE Digs

- Confirm that FBE in the presence of other coatings is holding on
- Investigate that there is no corrosion or SCC
  - To date no corrosion/SCC problems
FBE Digs

- To establish long term degradation modes for FBE coatings
  - Blistering/Disbondment
  - CP limits (-1100mV)
- Verify the joint coating (urethane)
  - Girth weld problems
**Working Group 3 - Cooling 3:30 Session**

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Steve Cooper, Canspec Group Inc.
Siu Tsai, TCPL
Ray Goodfellow, Chalrism
Barry Harlow, Rainbow Pipe Line
David Park, Gulf Midstream Services
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Glenn MacIntosh, Denso North America Inc.
P.K. Deb, Indian Oil Company Ltd.
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Kyle Gerlitz, JLG Engineering Ltd
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Dave Harpaz, "
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Kan Wu, 3M Canada
Anton Kazmier, Enbridge Consumers Gas
Kevin Garrity, CC Technologies Canada Ltd
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Linda Graf, Alberta Research Council
Graeme King, Greenpipe Industries
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RISK ASSESSMENT / RISK MANAGEMENT – General Session

Session Objectives

To provide an interactive forum to identify and prioritise general risk management issues.

Key Issues Brought Forward

General Comment

Many of the issues advanced during this session have been identified and advanced at previous Banff Workshops. Their reoccurrence at this workshop underscores that these issues are still revenant and should continue to be advanced.

Qualitative versus Quantitative Methods

The approach applied to estimating and assessing risk needs to be consistent with the objectives of the analysis.

It was emphasised that a progressive or staged approach is required to address the broad range of risk management issues within the pipeline industry. Tools and processes are required covering the range from qualitative through to quantitative analysis.

Currently, different companies are using a wide variety of methods and approaches for assessing different types of risks (e.g., life safety, environmental, and financial). While industry sees advantages in moving toward common approaches as a longer term goal, it was felt that it is too early to attempt to standardize these processes.

In support of the use of more quantitative methods it was recognised that more specific guidance on establishing acceptable risk levels should be developed, however this is also seen as a longer term goal. It is suggested that in the interim, quantitative assessments should key on relative as opposed to absolute measures of risk.

Data for Frequency Analysis

There is ongoing concern regarding the quality, availability and relevance of the data currently being used for risk analysis.

This emphasises the importance of current industry initiatives in the area of database development and data collection. It is recommended that guidelines should be developed for screening and validating the incident data used in the context of failure frequency estimation. In addition, given the ongoing development of failure prediction models based on line condition data collected in the course of monitoring, maintenance and repair, it is recommended that the current data sets be expanded to include this other data.
Performance Measures
There is a need for meaningful near-term performance measures to help industry and regulators evaluate the effectiveness of ongoing risk management programs.

The current focus on failure incidents as the sole performance measure does not necessarily promote proactive pipeline integrity management. In the near-term, these measures (i.e., failures) can be misleading due to the rarity of pipeline failures. It is recommended that additional consideration be given to measures related to practices involving monitoring, inspection and preventative maintenance (e.g., efforts at finding and eliminating defects or reducing the frequency of mechanical interference events).

Knowledge Sharing
Within the industry there is a need to promote understanding and share information on the use and benefits of pipeline integrity and risk management programs.

As most companies are on a learning path, thought should be given to developing an ongoing process for the sharing of information and ideas. This process must include the smaller companies who may not currently be involved due to resource constraints.

Corporate Commitment
It was emphasised that the development and success of risk management programs within individual organisations is highly dependent upon the degree of corporate commitment to and belief in the merits of risk-based methods for managing pipeline integrity.
Session: Agenda

- WHY WE’RE HERE
  - Objectives of the Session
  - The Jargon of Risk
  - Where we’ve been
  - What’s Working / Issues

- PATH FORWARD
  - Prioritization of Actions & Issues
  - Recommendations
Attend. Sheet I
Risk - General Session

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PYXIS CONSULTANTS
KONEX INTERNATIONAL 71-297-0200, 520-755-1126

INDIAN Oil Corp., India 91-11-7555076
Centra Gas Manitoba (204)985-3333 (Fax)
COLT ENSE
TRANS Gas Ltd
Western Facilities (403)705-7010 702-200
Gorron Gas 617-652-6354 617-652-6025 604-664-1403
UNIN EN SE
BCGAS Utility 604-576-7004 604-576-7005
Willisow Industries 604-713-1212

Trans Mountain Pipe Line
Enbridge Pipelines
ENBRIDGE PIPELINES (Sask)
Concord Pipeline Co.
CENOVUS Energy
CENOVUS CANADA, INC.
CAMEL WRC
Federated Pipe Lines LTD
Talisman Energy Inc.
SNHR SPA
Pipelines Western Memoireal Ltd
BG TECHNOLOGY

TRANSPORTATION SAFETY BOARD
TPE
C.RIPPI

RISK - GNL SESSION
ATTENDANCE SHEET 1

Joanna Makowaski
Tom Cool
Tim Harston
Sankara Papavinasam
Alistar Walker

Enbridge Consumer Gas
The Cool Group
PREMIX
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Suncor

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West Coast Energy
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CANMET/WRC
Enbridge Pipelines
Energy Mix (sask)
Hunter McCormick
Conoco Pipeline Co.
Gascoigne Gas
Union Oil
BC Gas
Williams Gas Industries
Trans Mountain Pipeline
Canda Gas Maritime
COLT ENG’G.
WESTERN FACILITIES
PYXIS GEOMETRICS
NATIONAL ENERGY BOARD
PYXIS GEOMETRICS LTD.
KPMEX INTERNATIONAL
Indian Oil Corporation Ltd.
India
Working Group 4B
Risk Management/Internal Corrosion Producers

Review of Issues
Directions for the New Millennium

14 April 1999

1993-06 Materials Working Group
Six Priorities Identified

- Correlation of laboratory testing with the real world (inhibitors & coatings)
- Internal protection of high water cut pipelines
- Failure assessment of corroded pipe (ECA)
- Predictive capability for HIC
- External SCC - mechanisms of and laboratory tests for
- Elastomers resistant to explosive decompression

14 April 1999
1994-06 Materials Working Group
Highest Priority Issues Identified

- Environmental cracking (SCC & HIC)
- Failure assessment of corroded & cracked pipe
- Corrosion mitigation in high water cut pipelines and under disbonded coatings
- Assessment of alternative materials such as:
  - polymer liners
  - high-strength steel pipe
  - fibre-glass pipe
  - composite wrapped pipe
  - materials properties database development to enable modelling of SCC & HIC

14 April 1999

1995-10 Internal Corrosion Mechanisms Working Group
Important Issues at this Time

- Controlling internal corrosion (454 or 60% of failures in 1994)
- Ineffective inhibition at localized areas
- Verification of threshold levels of inhibitors determined in the laboratory by field monitoring
- Preliminary selection of inhibitors so data is applicable to field conditions and not based on specific test methodologies
- Quality management of pipeline maintenance systems (eg. Inhibition, training, staffing, pigging)
- Definition of critical parameters, such as:
  - fluid composition
  - levels of chlorides
  - elemental sulphur
  - flow regimes
  - CO₂/H₂S ratios

14 April 1999
1997-04 Risk Management/Internal Corrosion
Issues Identified

- We cannot predict internal corrosion well enough
- We do not have coordinated industry action with respect to internal corrosion

14 April 1999

Are We There?

1993
- 713 pipeline failures
- 419 due to internal corrosion

1997
- 750 pipeline failures
- 455 due to internal corrosion

14 April 1999
## Producers Issues 1993-1997

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<td>• Preliminary selection</td>
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<td>• Correlation of lab with field</td>
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<td><strong>Internal Corrosion Prediction</strong></td>
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<td>• Definition of critical parameters</td>
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<td><strong>Assessment of Alternative Materials</strong></td>
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<td>• Polymer liners</td>
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<td><strong>HIC &amp; SCC</strong></td>
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<td>• Materials properties database</td>
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<td>• Mechanisms of &amp; lab tests for</td>
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<td>• Prediction of HIC &amp; SCC</td>
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CAPP guidelines

is it possible
 Rule of thumb
 Focusing on internal corrosion

Involve regulators

Bob, Tailisman
 Different treatment in different districts

Focus on global monitoring rather than one site monitoring

Bert, Gulf
 Monitoring crew does not know technical details
 Educate them

Reg
 Identify significant issues
 For company
 For regulators
 For public

Dave
 With increase spending the failure rates can be reduced

Consequence of spill long term effects, problems
 Wrap them now

Alberta Pipeline Environment Steering Committee (APESC)

Industry, public and government

Make this committee aware

Bob
 Make EUB to give public input, announcement, that spill volume is going down

Other issues

INTERNAL CP

MONITORING
4B - Risk Management/Internal Corrosion - Producers

Direction for the New Millennium

Issues from Previous Workshops:

1993: Internal protection of water-cut pipelines
      Failure assessment of corroding pipelines
      Prediction of HIC/SSC

1994: SSC/HIC
      Failure assessment
      Corrosion of high water-cut pipelines
      Polymer lines

1995: Internal corrosion mechanism
      Predictive modeling of internal corrosion

1997: Risk management/Internal corrosion
      Coordinated industry action
      We can’t predict

Actions taken:

Methodologies for inhibitor evaluation CANTMET
Internal corrosion models CANTMET/Suppliers
Polymer lines Shell/JIP

High-strength steels Not an issue

1999 Workshop

Objectives

- Decide key issues
- Recommendation for future direction

Discussions

Ray, Chevron: Newer technologies available for monitoring, e.g., noise.
      Local expertise not available
      Not many companies to set up electrochemical monitoring
      Expertise comes from other countries, e.g., Scotland, U.S.
How to use new techniques

Dave
Low cost equipments available
Suppliers not using them

Recommendation
Producers tell suppliers how to select inhibitors

Reg
Historically use higher concentration of inhibitors in the field

Ray, Chevron
Higher inhibitor cost – shutting down well
Noise – good, instantaneous response

Dave
Monitoring at one point not representative of the pipe

Ion, CAPP
Statistics has not changed over the years
When regulators is going to step in?

Dave
Regulators already stepping in

Reg
We do not inhibit marginally producing lines
Economically robust

Reg:
Do inhibitors work in the presence of slug
Lots of lines.. Should not paint the same conclusion for all lines

Dave:
spill number or volume to be considered for consequence
Industry wide/provincial wide guidelines

Consequence side of the risk should be considered
What is acceptable risk

Bert Johnson, Gulf
Natural gas lines.. Internal corrosion big issue

Dave
No complaints from residents
Landowner/company good relationship

Reg
untreated lines
Semi-log plot...cumulative vs. time...number of failures decreasing
Success story or not ...

Rapporteur – S. Papavinasam, NRC
Dave

Failure can't be zero
Focus on detection
Minimizes failures
Consequence in risk assessment

New board members Educate them
EUB data do not tell full story

Don Currie, ACR
What is the consequence to the producers

$ 5000 to 2,000,000

Regulators do not see the financial side

Reg
EUB information ladder
See if there is a common industry process (approach) that can involve the regulators

Predictive Models

Bob, Talisman Use both qualitative and quantitative approach

Dave
Concentrate on the consequence of risk

Producers/CAPP/ group sit with regulators

Gain support
Address their concerns
Is not too late

EUB Database

Better version being made
Role into PRASC database

Role of CAPP

How to present data, e.g., failure, volume of spill etc.

New techniques
Have potential
Location of placement of monitoring device is important
Concept of risk

How to get board involved

CAPP form task force

Model that everybody can use

Form Task Forces

CAPP producing 4 years of oil pipeline performance including

Industry/Regulator meeting

Additional R&D Work

Flow regime CANMET Model considers flow as well

Industry should be aware of other work, e.g., Ohio university

Reg Not everybody is using all the available techniques

Flow line models good for gas lines
Not for multi phase lines

Field monitoring important

Not the corrosion rate, but the probability important... say from B to C

Ray: Mitigation type to be modelled
Some lines are better than others ... inspect

Tune your models

Pan Canadian No of failures/year decreasing
Does regulators aware of this

Gulf Canada No. of failures/year increasing

Forum to share information

Rapporteur – S. Papavinasam, NRC
<table>
<thead>
<tr>
<th>Name</th>
<th>Affiliation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Winston Revie</td>
<td>CANMET</td>
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<tr>
<td>Ian Scott</td>
<td>CAPP</td>
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<tr>
<td>BERT JOHNSON</td>
<td>Gulf Canada Resources Ltd.</td>
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<tr>
<td>Grahame Serafini</td>
<td>CANMET</td>
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<td>Ray Goodman</td>
<td>CHINROM</td>
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<tr>
<td>A. Demoz</td>
<td>CANMET/WRC</td>
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<td>D. Currie</td>
<td>ARC</td>
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<td>Bob Shepka</td>
<td>Tolisman Energy</td>
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<td>Reg MacDonald</td>
<td>Mobil Oil Canada</td>
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<tr>
<td>Dave Patterson</td>
<td>PEnCA</td>
</tr>
</tbody>
</table>
Working Group 4C: Risk Assessment/Risk Management – Transmission

Co-Chairs:  Kevin Cicansky (TCPL)
            Glenn Yuen (Dynamic Risk Assessment)

SESSION E: Tools and Techniques

INTRODUCTION
- Reviewed summary of three principal recommendations from last workshop (1997)
- Items have been addressed by individual organizations but minor progress from industry
groups (ie PRASC)
- SCC was a big issue and since then some companies are looking at more issues such as
general corrosion

SESSION OBJECTIVES:  To review new developments and applications of tools and
techniques for risk analysis of transmission pipelines.

PRESENTATION 1:  Pipesafe Risk Assessment Package for Gas Transmission Pipelines
Tim Baldwin, British Gas Technology

SUMMARY:  Attached

DISCUSSION:
- What is the range of diameters for validation of Pipesafe in large scale tests – full scale – 6 in
to 36 in + up to 12,000 KPa
- Focus on human casualties – do you look at property damage cost – much less concern
- Is there a prescribed value for acceptable risk level – No – ALARP principle – what is the
value of human life – ¼ to 1.5 million pounds, but higher values are implied
- Pipesafe only used for sweet natural gas – the future may look at sour gas
- How long does it take to carry out a risk analysis – normally most of time is spent with input
parameters – perhaps a day – normally look at specific ‘hot spots’ not the complete line
- Can you change input data (for application say to N America) – yes
- Exposure is dependent principally on distance to pipeline
- If there was a house within the ‘hazard’ zone, have BG ever bought it out – no
- Proximity distance is not necessarily a ‘safe’ distance
- HSE have advised against building at some distance at times where a company may not –
HSE have different laws compared to planning commissions
- Who pays for analysis and mitigation – HSE/BP/Developer combination
PRESENTATION 2: Risk Based Decision Management (RBDM) Applied to Large Scale Assets
Rob Bruce, RMRI

SUMMARY: Attached

DISCUSSION:

- Expected utility – presentation mentioned that share activity can be used to determine utility curve for company – use expected utility for large losses relative to corporate assets (or returns) only
- Theory of utility – have to separate shareholder risk vs management risk – management will be more risk adverse because they have fewer alternatives – have used series of paired questions – have looked at such techniques – concluded they are not too useful – questions are highly hypothetical (hard for person answering to envision) – personal bias comes in – better to put in all the costs and this will ‘incorporate’ risk aversion

SESSION F: Company Experiences with Risk Assessment

SESSION OBJECTIVES: To use case histories for demonstrating the successful application of risk assessment techniques

PRESENTATION 1: Visions and Issues for Pipeline Risk Management at TransCanada
Bob Sutherby, TCPL

SUMMARY: Attached

DISCUSSION:

- Customization – what is the opportunity to integrate risk management program into ISO 9000 – few ISO discussion held at this time but quality assurance is an important issue
- ISO 9000 has monitoring component – how does such a large program incorporate some sort of validation step of models – problem is recognized – hope to use historical information – will implement what we have now and validate as we go
- How do we measure the success of such a program
- Defect Management (eg external corrosion) – how does this mesh with risk management
- What is acceptable for risk measurements – no number on what is acceptable – will continue to address
- Who is driving this program – initiated with Pipeline Integrity Dept – Designed by IT (&Business) Dept. – Pipeline Integrity Groups – 1) Long range plan 2) 1 year program 3) Long term strategy, facilitate risk management 4) Data management
- Need to be concerned with scope creep from other internal department
- Will program determine level of spending or prioritize spending within a level – doing both right now but need to develop a strategy
- The more quantitative the model the more useful it is? – depends on the stakeholders
- Model will consider business consequences – considers multiple regulator? require constituency of philosophy across the board – many issues with different regulators

PRESENTATION 2: The Northwest Risk Management Program
Sean. Black, Northwest Pipelines (Williams Energy)

SUMMARY: Attached

DISCUSSION:

- You can address the risk but still be out of compliance with code – they enter into an agreement with regulator – like a waiver – they have been trying for a couple of years to get into the demonstration program
- Example applications for risk were associated with sections out of code (Eg class locations)
- What is the confidence level of using risk vs regulations – what makes pipeline less safe if one additional house means a class change – this was a cultural change within the company
- In the segments where risk was used, was there any impact on operations of other segments? Yes, the experience was useful for consideration of other segment – learning process
- General view from Europe that US regulators want zero risk – if legal system says you knew there was a risk but didn’t eliminate it, how do you respond? We are making our pipeline safer and are trying not to let such concerns derail system – lawyers have looked at program
- How are you identifying the highest risks and convincing the regulator – use past history – last 5 years of William’s system – 25,000 km – e.g. 3-4 rupture from earth movement and monitoring shows concern
- Legal criteria may be based on what the common man might due – benchmarking to industry is important – common industry approach provides due diligence
- Trying to find the best way of mitigating risk from a large segment (not a specific small segment) – what is public perception – not in my backyard syndrome – to date acceptance has been good – in some areas, open discussion with public has helped – would not be surprised if future problems
- What happens after 4 year demo concludes – grandfathered, risk work applicable for future operations
SESSION CONCLUSIONS AND RECOMMENDATIONS

- Measurement – how can we keep track of all the data and keep it up to date
- Incorporate models/programs into quality assurance system
- Need system for tracking how data is used
- Tend to have focussed on public safety and should include reliability in the future
- May not need to discuss database management and risk management together – separate (but both important)
- Requirement for top management buy in – value in something like best practice documentation, further meetings
- Should consider what are the uncertainties associated with all the risk models – tradition has been to err on the conservative side – end result is we do not know how conservative – a lot of work has been done in other applications e.g. environmental risk assessments
- Many engineering applications add safety factors to design and then we use this conservative information for risk – combined approaches introduce problems
- Need to look at what kind of data you need for risk models – separate session for this group, not the database group
- What are the objectives for carrying out a risk assessment – there can be many but need to be documented – determines the data requirements and management process
- Can use Baysian methods to handle rare incident data
Risk Assessment of Onshore Gas Transmission Pipelines and the PIPESAFE Package

Tim Baldwin - BG Technology

Introduction

Background
- Risk - likelihood of an undesired event, e.g. casualty
- Individual Risk - frequency of an individual at a specified location being a casualty
- Societal Risk - relationship between the frequency of an incident and the number of casualties

Introduction

TRANSPiRE
- Developed by BG (formerly British Gas)
- Software Package
- DOS application
- Validated mathematical models
- Individual and societal risk
- Used extensively by BG and other operators under licence

Introduction

PIPESAFE Collaboration
- International Collaboration
  - BG (UK)
  - DONG (Denmark)
  - ENAGAS (Spain)
  - Gasunie (Netherlands)
  - Statoil (Norway)
  - TransCanada Pipelines (Canada)

Introduction

PIPESAFE Collaboration
- Phase 1 (1994 - 96)
  - 1st version of PIPESAFE, based on TRANSPiRE
  - New models for corrosion, fatigue, fireball
  - Pipeline damage database
- Phase 2 (1996 - 98)
  - PIPESAFE validation and improvement
  - Phase 3 (1999 - 2001)
  - To address issues raised in Phase 2
Elements of a Pipeline Risk Assessment

Failure
- Failure Causes
  - External interference
  - Corrosion
  - Fatigue
  - Ground movement
  - Material or construction defects
- Failure Modes
  - Leaks (punctures)
  - Breaks (ruptures)

Elements of a Pipeline Risk Assessment

Gas Outflow
- Rapid depressurisation
- Crater formation
- Pipeline alignment
- Jet release (or releases)
- Initial transient release (mushroom shaped cap)
- Quasi steady plume
- Gas outflow initially balanced
- Decay rates determined by system

Elements of a Pipeline Risk Assessment

Ignition
- Immediate ignition
- Transient "fireball" phase
- Up to ca. 30 seconds duration
- Followed by quasi-steady fire
- Delayed ignition
- Quasi-steady fire only

Elements of a Pipeline Risk Assessment

Thermal Radiation
- Varies with time
- Varies with distance
- Varies with shape, nature and extent of fire
- Determined by source and atmospheric conditions
- Varies with atmospheric transmissivity
- Determined by humidity

Elements of a Pipeline Risk Assessment

Thermal Radiation Effects
- People
  - Affected by high thermal radiation doses
- Buildings
  - Ignited by high thermal radiation doses or secondary fires
Failure Frequency Models

Third Party Interference

- Third Party Interference
- Predictive model
- Models pipeline diameter, wall thickness, design factor, grade, and toughness
- Depth of cover, sleeving, stabilizing, surveillance
- Corrosion
  - Validated by comparison with on-line inspection
- Fatigue
  - Probabilistic crack growth model

Consequence Models

Gas Outflow

- Standard Model
- Dynamic simulation model
- Pressure, pipeline internal diameter, friction effects, position of failure, boundary conditions
- Gasunie Model
- Designed to model networks

Consequence Models

Initial Fireball

- 11 large scale tests
- 6" (150mm) diameter pipeline
- Initial pressures 20, 50, 120 bar
- Sandy, clay and no soil
- Flames ca. 100m high

Consequence Models

Quasi Steady-state Fire - Ruptures

- Physically based model
- Source, flame structure, combustion and radiation sub-models
- Validated against large scale tests with range of release conditions
- Empirical model
- Based on many large scale steady-state fire tests
Consequence Models

**Thermal Effects**
- Transient event
- Fire models run at ten times
- Thermal effects model sums dose:
  - Stationary targets (buildings)
  - Moving targets (people)
- Calculates
  - Burning distance (buildings)
  - Escape distance (people)
- Mitigating effect of shelter

Risk Calculation Routines
- Failure position unknown
- Effects considered over "interaction length"
- First routine
  - Individual risk
  - Generic societal risk
- Second routine
  - Societal risk for specified site
  - FN curve
  - Expectation value

PIPESAFE Validation

**Software Testing**
- Comprehensive Programme in 3 Phases
  - "Quicktest"
  - "Test of Data Flow Cycle"
  - "Module Test"

PIPESAFE Validation

**Incident Comparison**
- PIPESAFE predictions of burnt areas compared with documented incidents
- Predicted values slightly conservative
- Some incidents had features not modelled
- Flame jetting
- Two fire plumes
- Correctly predicted response of people (e.g. Edison, New Jersey)

PIPESAFE Validation

**Sensitivity and Uncertainty Analysis**
- Sensitivity Analysis
  - High sensitivity of failure frequency models, but inputs well known
  - High sensitivity to fire source conditions
- Uncertainty Analysis
  - Wind conditions
  - Pipeline failure orientation

Future Developments
- Phase 3
  - Probabilistic treatments
    - Weather
    - Fire source
  - Refined failure frequency models
  - Improved thermal response model
  - Increased flexibility in risk calculations
**TRANSCO'S HIGH PRESSURE NETWORK**

- 18,000 km operates between 7 bar and 75 bar
- 270,000 km pipelines in total
- HP network operates to IGE/TF/1

**PIPESAFE APPLICATIONS**

- Encroachments
- Code infringements
- Upgrading
- Routing
- Emergency Planning

**Encroachment**

- Proximity infringements
- Population density infringements

**Encroachments picked up by**

- Pipeline Surveys
- Land Use Planning Regime

**Survey essential for uprating**

**PIPESAFE used to calculate**

- Individual risk
- Societal risk
Several risk reduction measures considered:

- Relay in thick wall
- Diver
- Concrete slab
- Increased surveillance

Decision based on ALARP

Summary

**PIPSAFE**

- Integrated hazard and risk assessment package
- Extensive validation:
  - Large scale testing
  - Incident comparison
  - Software testing
  - Uncertainty and sensitivity analysis
- It is a tool that
  - has evolved over a long period
  - is in constant use
  - is flexible
  - is beneficial in decision making
Risk Based Decision Management (RBDM)

Outline
- Introduction
- Axioms of RBDM
- Application to Pipeline Management
- Examples
- Summary

Management/Decision Making
- Rational, consistent decision-making ⇒ improved asset/organisation performance
- Improved performance ⇒ improved return on investment
- Quality of decision depends on quality of data

Axioms of RBDM
1. Decision making = management
2. Risk - capital staked under conditions of uncertainty
3. Balance - risk, returns and uncertainty
4. All associated capital - voluntary/involuntary
5. Risk aversion
6. Optimum decision maximises 'expected' return

Pipeline Hazards (1)
- Corrosion/Material Defects
- Settlement of Foundations/Support Structures
- Landslides
- Ice/Frost Damage
- Vehicle Impact
- Storm Damage/Scour
- Maintenance Errors

Pipeline Hazards (2)
- Process (Overpressure/Pressure Transients)
- Sabotage
- Earthquake
- Wave/Current Action (offshore)
- Dropped Objects (offshore)
- Anchor Damage (offshore)
Gas Pipeline Event Tree

Decision Criterion

\[ E[\text{cost}] = \sum_{i=1}^{N} f_i C_i \]

= sum over all scenarios of 'frequency' x 'cost'

Repair Decision

- Scour damage identified
- Decision: repair now or wait?
  - Wait for better weather?
  - Wait for scheduled shutdown?

If $E[\text{cost}]_{\text{Immediate Repair}} < E[\text{cost}]_{\text{Deferred Repair}}$

Bayesian Analysis

The definition of the relationship between inspection strategy and the chance of detecting damage can be progressively refined using a statistical technique known as Bayesian Analysis.

High Frequency Inspections

- High Frequency Inspections:
  - High Inspection Cost
  - High Chance of Detecting Damage
  - Low Probability of Loss of Containment
  - Low Expected Damage

Low Frequency Inspections

- Low Frequency Inspections:
  - Low Inspection Cost
  - Low Chance of Detecting Damage
  - High Probability of Loss of Containment
  - High Expected Damage
Summary

- RBDM provides a Rational Framework for Decision Support
- Identify Alternatives
- Produce Risk Profile for each Alternative
- Include all Capital
- Compare Expected Loss/Return of each
- Allow for Risk Aversion (if appropriate)
- Manage data in an auditable manner (DDMT)

CAMD
Vision and Issues for Pipeline Risk Management at TransCanada

R. Sutherby
D. Diakow
B. Nolan

OUTLINE

- Pre-Merger Integrity Approaches
- Concepts for Future Integrated Integrity Program
- Risk Management Approach
- Issues: Data collection, Database management, Assessment Tools

Pre-Merger TCPL

- Zero Rupture Tolerance
- Two Main Integrity Challenges:
  - SCC
  - Corrosion
- Mainline System
- Linear System & Loops
- Mitigation Mode

Pre-Merger TCPL

- TRAPRAM: TransCanada Pipelines Risk Assessment Model
- Susceptibility & consequence models applied along mainline.
- Applied to Prioritize Mitigative Actions (e.g. Hydro, Proximity, digs, etc.)
Pre-Merger NGTL
- Failure risk reduction
  - Failure frequency & consequences
- Integrity management program considered:
  - SCC, Corrosion, Geotech
- Considered consequence for SCC and Corrosion prioritization.
- Considered hazards individually

Merged TCPL Pipeline System
- 38,000 km of natural gas transmission pipelines
  - NPS 2 to 48
- Geographic diversity:
  - Population densities
  - Terrain differences
  - Regional System Complexities
  - Regulatory differences
  - 5 provinces

Merged Integrity Program
- Consistent Philosophy
- Risk-Based Approach System Wide
- Reflects Geographic Diversity
- Address All Known Hazards
- Data Reusability
- Integrity Program Optimization

Consistent Philosophy
- Integrity Targets:
  - Zero Rupture
    - >NPS XX
    - Class > X
  - Business Consequence
    - <$xxx,xxx
  - Emissions Targets
Risk Management - A Common Approach

- Public Safety
- Reliability
- Competition
- System Scale
- Geographic Diversity
- Time-Dependent Failure Causes

Program Development Challenges

- Consistent Data Models
- Consistent Hazard Models
- PIRAMID
- Integration:
  - Mixed mechanisms
  - Annual program optimization
- Macro versus Micro Assessment
- Regional Business Consequence Model
- Communication & Consultation

Pipeline Risk Information Management - Concept

- Database
- Work Order
- Rainfall
- Soil Strength
- Alignment Data
- Pipeline Data
- Risk Models
- Queries
- GIS
- Levels I, II, III

Hazard Initiation and Growth Models

- External Corrosion
- Environmentally-Assisted Cracking:
  - SCC, HIC
- External interference
- Geotechnical
- Mixed Mechanisms:
  - Cracks in Corrosion
  - Geotechnical with Corrosion or Cracks
PIRAMID

- Off-the-Shelf Modules:
  - External Interference
  - Corrosion
- Customization of Hazard Models
- Customization of Consequence Models
- Integration with Integrity Data

Program Optimization Concepts

- Obtain Greatest Risk Reduction for Resources Expended:
  - Selecting Appropriate hazard to mitigate
  - Prioritizing segments
  - Mitigation against Multiple Hazards
- Cost Effectiveness
- Enhanced Reliability

Macro Versus Micro Risk Assessment

- Data Scale Dependency
- Hazard Model Dependency
- Analytical “Horsepower”
- Spatial versus Relational
- GIS Interface

Regional Issues

- Upstream Customer Impacts
- Downstream Delivery Impacts
- Competition
- Linear versus Highly Networked System
- Populated versus Remote
- Gathering versus Mainline Operation
Current State

- Developing PRIM & PRIME
  - Populating databases
  - Refining models
  - GIS Customisation
- Implementation in 2000-01
- Stay Tuned
Name: Brian Griffin
Name: Tim Baldwin
Name: John Henderson
Name: Mark Otten
Name: Bob Eiber
Name: Doug Casey
Name: Clive Ward
Name: Joshua Johnson
Name: Max Buck
Name: Marie-Cantel Laterre
Name: Ted Hamre
Name: Paul Trudel
Name: Mike Glover
Name: Don Powell
Name: Bruce Dupuis
Name: Carlo Spinelli
Name: Mark Yeomans
Name: Darren Hill
Name: William Jarvis
Name: Doel Billette
Name: Dick Graham
Name: Dick Cash
Name: Don McNabb
Name: Denis Trudeau
Organization: Golden Associates
Organization: ACR Technology
Organization: NEB
Organization: Trans Mountain Pipe Line
Organization: Consultant
Organization: CNRL Midstream Services Limited
Organization: BG Technology
Organization: CC Technologies
Organization: Conoco Pipeline Co.
Organization: NEB
Organization: Conspec
Organization: BTS - A Collpro Company
Organization: Amoco Canada Petroleum
Organization: Integrated Integrity Inc.
Organization: SHAM SPA
Organization: TCPL
Organization: Hultech Consultants Ltd.
Organization: Williamson Industries
Organization: Natural Resources Canada
Organization: TransGas
Organization: Apache Pipeline Products
Organization: Corepro
CARYL KARVONEN
ERROL BATEBLO
Guy Hervieux
WES Macleod

Fred Barnes
Norm Trusler
Frank Gareau
Garry Sommer
Rob Brue
Kevin Cicansky
Glenn Yuen
Sean Black
Rick Watten

Andrew Francis
Paul Meaden
Janna Makomashi
Marc Spencer

George Dow
A.H. Parekh
Brian Nesbitt
Leo Dawson
Stephan Giese

Jane Dawson
Geri Wengreniuk

Minh Ho
Carl JABIE
Terry Chaney

TRANS CANADA MIDSREAM
WESTCOAST ENERGY INC.
A+Co Pipelines
KOMEX INTERNATIONAL LTD.

BC GAS
BC GAS
NATIONAL ENERGY BOARD
CORPRO CANADA, INC.
Risk Management Research Ltd
TCPL
Dynamic Risk Assessment
Williams
AER Pipelines

B9 Technology
UNION CRI LTD
Energy Consumers Gas
M&I INTEGRITY ENG.

N.E.B.
INDIAN OIL CORPORATION LTD

National Energy Board
NED

WESTCOAST ENERGY

P.I.I.
BASELINE TECHNOLOGIES INC

NEB
CC Technologies
Enbridge Pipelines
AC: BANFF PIPELINE INTEGRITY WORKSHOP
3:30 - 5:00 PM
3:45 PM
SESSION 4C RISK ASSESSMENT
COMPANY / ORGANIZATION

NAME

A. Frank
Brian Griffin
Bob Eiber
Mark Gilmour
Paul Minamugi
John Nendelnhot
Gordon Davis
Clive Ward
Marc Spencer
Joanna Makomaski
Brian Neubert
Max Buck
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Joshua Johnson
Paul Trudel
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Ted Hamre
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Carl Spinelli
Jane Dono
Patrick Vieth
Darren Hill
Shepillar Crasse
Harry Hunt

BG Technology
Golden Associates

Consultant
Trans Mountain Pipe Line
MWA Gas Limited
NEB
NBB
BG Technology
HSC INTEGRITY Inc.
Enbridge Consumers Gas
NATIONAL ENERGY BOARD
Conoco Pipeline Co
Thomassen Energy Consultants Ltd
CC Technologies
NEB
NEB ONE
NEB
Canspec
Williamson Industries
NEB
Amoco Canada Petroleum Co.
SPAENT
PILI
PILI
Hiltech Consulting Ltd.
Westcoast Energy
WESTCOAST ENERGY
DOEL BILLETTE
Carl Laske
Dick Graham
Terry Chong
Aaron Dinovitzer
Rick Wattens
Cyril Karvonen
Brad Watson
Errol Stewar<br>er
Guy Hervieux
Bert Johnson
Denis Trudeau
Gerry Sommers
Wenwu Cheng
Ian Scott
FRANK GAREAU
Good Weishenik
SEAN BLACK
Rick Greco
Mike Gledhill

Natural Resources Canada
CC Technologies
TransGas
Enbridge Pipelines
Fleet Technology Ltd.

AEC Pipelines
TransCanada Midstream
TransCanada Pipeline
Westcoast Energy Inc.
Ateo Pipelines
Gulf Canada Resources
Corpro
Corpro Canada, Inc.
Canmet
Capp
National Energy Board
Baseline Technologies Inc.
Williams
Union Gas
BTS - Corpro
Risk Assessment and Risk Management - Communications and Public Consultation

Facilitator: Mr. Anton Walker, Suncor Energy Oil Sands, Calgary, Alberta
Co-chairs:  Mr. David De Gagne, Alberta Energy and Utilities Board, Calgary, Alberta
Mr. Terry Gibson, Gecko Management Consultants, Calgary, Alberta (not available)

Objectives
The objectives of this program was broken down into four steps

1. The first was how risk communication fits into risk management framework and its importance within the overall success of the project in becoming a reality. This was presented by Mr. James Wright of Risk Management Associates.
2. The second step was to highlight as an example the CAPP public involvement guidelines for which operators could use in developing their own specific communication programs. This was presented by Ms. Bev Denis of Gulf Canada.
3. The third step demonstrated a specific case study using the Caroline interrogatory process as an example of how an effective communications and public involvement program can re-establish trust and credibility levels within a community.
4. The last step was to use the principles of fundamentals learned in the first three steps and apply those to an extreme situation (e.g., eco-terrorism) and identify the direction the industry and regulators need to take in order to reduce the likelihood of extreme situations.

Background
A video that had been put together by CBC newsmagazine and W5 portrays the deep unrest with a few isolated individuals near a Northern Alberta community. As expected the newscast was not well balanced and certainly was geared towards sensationalising the situation. Notwithstanding this, for the individuals involved the risk are real in their perception.

Because of the media involvement, the seriousness of the allegations and the environment in which the community must exist, some response from the government and industry seems necessary and inevitable.

Regardless of how well the regulators and industry are able to respond, they will not be able to completely repair the damage that has been afflicted on their reputations. The object then is to ensure that a similar situation does not recur. As such, the industry through various associations, such as CEPA, CAPP, CGA, and regulators, such as NEB, EUB, TSB, etc., must develop mechanisms that ensure that the principles of risk communication are adopted and used accordingly.

Rapporteur – S. Kandaswamy, Univ. of Calgary
Observations and Challenges

After the presentations, the floor was opened for discussion during which several observations were made that pose challenges to the industry and regulators in addressing risk communication effectively.

Regulators

It was observed that regulators should establish their credibility independent of the industry in order to be objective and provide effective mediation. The challenge for the regulators is to ensure that there is a level playing field with regard to public involvement and community relations programs by establishing clear expectations so that there is no doubt about the level of commitment required by the industry.

Media

It was observed that the media has a critical role in shaping reactions among the public and interest groups. Media often does not portray the complete information and may be biased towards issues that are controversial. It is found that the industry is generally reactive rather than proactive. It is, therefore, a challenge for the industry to ensure that a balanced picture about its activities is presented all the time.

Industry

Part of the problem that the industry faces with the public is its piece-meal approach to development. In addition, part of the public animosity faced by the industry is due to an increase in new projects, media hype and the numerous players involved. Another significant problem is the increased pace of the industry. Many decisions are made to meet approvals in the short term. The challenge for the industry is to include the public in the overall industry development plans for a particular area. It is also important to build trust through effective relationships, admit to a mistake when it occurs and make a commitment to ensure effective public involvement.

Information and Training

While there is a comprehensive manual on public involvement prepared by CAPP, there is inadequate information on risk communication and its process. It is, therefore, necessary to develop a risk communication handbook that should be a companion to the CAPP public involvement manual. For this purpose, a committee should be established under PRASC to develop the handbook, promote risk communication and train personnel in the industry.
CAPP Public Consultation Guidelines

Presented by
Bev Dennis, Community Relations Coordinator
Gulf Canada Resources
This Presentation Will Provide:

- an historical overview of consultation processes
- a review of public involvement principles and practices
- a description of how these principles can be effectively applied to work with the public in the oil and gas industry
- available resources
- issues
A History of Public Consultation

- Canadian oil and gas industry produced public consultation guidelines in 1989.
- A formal review of these guidelines took place in 1992.
  - Multi-stakeholder, multi-sector committee.
  - Resource collection housed at Mount Royal College
  - One day training course.

The Canadian oil and gas industry commits significant resources to developing positive relationships with the public as a means of improving the overall business environment. However, public cynicism an changing regulatory requirements are causing our industry members to address a broad range of public interests more consistently and proactively than in the past.

For the Canadian oil and gas industry, formal development of processes to assist public involvement began in 1986 with the Canadian Petroleum Association’s Environmental Code of Practice. It was followed in 1989 by the CPA’s Public Consultation Guidelines.

In 1992, the CPA and the Independent Petroleum Association of Canada merged to form CAPP. In that year, a multi-stakeholder and multi-sectoral process was initiated to improve and expand the guidelines. The result was a comprehensive guide for public involvement and a collection of resource materials available to CAPP member companies which is housed at Mount Royal College’s city centre location.
Why Consult the Public?

- It's the LAW...
- More Informed Public
- Less Tolerant Public

Public consultation has taken on a new significance in the last couple of years. The reasons are many and the benefits even greater. One of the most important reasons, however -- it's the LAW. Consultation is legislated and minimum requirements have been mandated.

Secondly, the public is more informed, better educated, and therefore more concerned about what is happening in their community. And if there's going to be development, there had better be some direct benefit back to that community.

And lastly, the community is far less tolerant and more demanding that companies be accountable for their activities, their impacts and their errors, as well as the actions of their employees and contractors.
What do We Call IT?

Public Consultation

Public Involvement

Public Engagement

Stakeholder Participation

PEOPLE - COMMUNICATION

GAPP
What is Public Involvement?

Public involvement goes beyond informing people to involving them in decisions that may affect their lives.

• Process through which relationship building occurs.

• Needs to be integrated into your project planning and decision making processes (early and throughout).

• Must address both the specific nature of the company and the unique characteristics of the interested and affected stakeholders.

• “Fit for purpose” - not a cookie cutter approach.
Why Consult?

It’s the “right way” to do business

It’s the “smart way” to do business

Involving the public is the “right way” to do business:

Effective public involvement can help build cooperative working relationships with local communities, interest groups and governments at all levels in areas where your company operates or hopes to operate. It can achieve balanced decisions and results that are effective, fair and enduring, and that respect the knowledge, values and rights of all affected parties.

Involving the public is also the “smart way” to do business:

• Establish good relations with residents, representatives and stakeholders
• Develop positive attitudes toward your company’s activities
• Provide accurate information to the public about your activities.
Benefits of Public Involvement

- Local partnership rather than a "critical eye"
- Minimize regulatory intervention
- Identifies and resolves issues/conflicts
- Provides early warnings about issues before they escalate
- Foundation for resolution of problems & incidents
- Industry makes better decisions
- Competitive advantage
  - Prevents delays
  - Intervener support
- Saves Money
  - Reduces liabilities
  - Hearing, staff, intervener costs
Costs of **NOT** Involving the Public

1. Do not under estimate the power of the public.
   1. Increased difficulty gaining approvals and licenses from regulators.
   1. Escalation of issues, requiring more costly mitigation, enhancement and compensation measures.
   1. Delays, lengthy and costly public hearings, project cancellations, and long term opposition to your company.
   1. Bad publicity, damaged reputation and time required for the associated damage control.
   1. Formation of polarized groups that fight any kind of development
   1. Devalued standing with shareholders and customers.

You may have one of the greatest engineered projects in the world, but if the public doesn’t understand it, or want it, it likely won’t get off the drawing board.

*Examples:*
The EUB recently pulled a company’s approved application for an $11 million pipeline, with surveying and construction underway, in the Rimbey area because a local farmer felt he had been excluded from intervening in the project because he didn’t have information.
Mission Statement:

To achieve balanced decisions and results that respect the knowledge, values and rights of all affected interests.
Shared Process:

- scope and terms of reference that identify decisions that ARE and ARE NOT open to input
- expectations and objectives
- benefits and losses
- constraints and boundaries
- roles, responsibilities and protocols
- timeliness
- control and enforcement
- ways and means to share resources
- monitoring and evaluation
- ways of handling disagreements
Public Involvement Guidelines

1 Respect

Demonstrate respect for the participants and the process.

Respect:
• honoring diverse cultures, perspectives, values, approaches and interests
• declaring one’s own interests, values and perspectives to other participants
• recognizing the legitimate rights of stakeholders participate in decisions affecting them
• interacting honestly, openly and ethically
• bridging differences with integrity and courtesy
• acknowledging participants’ professional codes of practice
• adhering to objectives, expectations, commitments and protocols agreed upon for the process.
Commitment:

- engaging affected interests in defining problems, expectations and objectives
- building trust and relationships from the outset, with a long-term orientation
- following through on commitments made during the process
- incorporating input from all participants
- fostering collaborative and voluntary agreements
- maintaining a constructive, problem-solving focus.
Public Involvement Guidelines

I Timeliness

Demonstrate that time is an important resource

Timeliness:
• sharing information early and often to assist all interests to prepare and to act knowledgeably
• providing early and adequate notice of opportunities for involvement
• negotiating timelines among participants
• establishing and adhering to realistic deadlines
• responding in a timely manner to questions and requests.
Public Involvement Guidelines

1 Relationships

Establish, maintain and enhance relationships.

Relationships:
• fostering trust and respect through performance
• facilitating the voluntary building of ongoing, constructive relationships
• improving the quality of existing relationships among participants
Public Involvement Guidelines

I Communication

Communicate effectively to develop mutual understanding.

Communication
• listening carefully
• being honest and open
• using plain language
• providing opportunities for information exchange and mutual education regarding interests, objectives and values
Public Involvement Guidelines

1 Responsiveness

Demonstrate flexibility and responsiveness.

Responsiveness
• recognizing that public involvement is a dynamic, ongoing process
• building flexibility into the process
• balancing participants’ and process needs
• moving towards objectives and using resources effectively
• including and using feedback mechanisms
• continually evaluating and modifying the process in an ongoing manner
Public Involvement Guidelines

1 Accountability

Demonstrate accountability to affected interests and process participants.

Accountability

- encouraging participants to solicit input from their constituents and to maintain communications with them
- expecting participants to commit to and follow through on the negotiated process and its results
- becoming familiar with the rules and regulations affecting the issues under discussion
Unless you are willing to consider the answer -- don't ask the question.

A company needs to be clear about how much influence (and over what aspects of decision making) it is prepared to share.
Levels of Public Involvement

- Self - Determinism
- Delegated Authority
- Joint Planning
- Consultation
- Information - Feedback
- Education
- Persuasion
Costs of Public Involvement

"Why can’t we find the time and resources to do it right the first time, when we find the time and resources to do it over?"

Anonymous

Public involvement is an investment, with benefits, risks and costs. But like contingency planning in a safety program where it can be difficult to assess the cost savings attributable to accident prevention, it is not always possible to comprehensively estimate the benefits, or quantify costs and savings of an effective public involvement program.

One easily identifiable cost is personnel. Some companies hire community relations or public affairs staff who can act as internal consultants on public involvement for a broad range of company plans, projects and operations. Others contract external public involvement consultants to assist with a particular project or problem. Still other companies train existing staff in conflict resolution, public involvement and communications.

Hiring staff and training or engaging experienced consultants may appear to be costly in the short term. However, these costs for public involvement can be relatively small compared to the potential costs of failed communication. A poorly conceived, inappropriate public involvement process for a development or operation can result in concern and conflict related to both the development and the communication process.
Five Steps of Public Involvement

“If you don’t have a plan for where you’re going, you may end up somewhere else.”

1. Establish a preliminary plan.
2. Make initial community contacts.
3. Prepare a detailed plan.
4. Implement public involvement plan.
5. Monitor, evaluate, and follow through.
Step 1
Establish a Preliminary Plan

Objectives

1. To identify issues that might be raised by a particular project proposal or activity.

2. To determine the public groups that will probably be interested in reviewing or influencing your company’s preliminary plans.

✓ What publics (e.g., residents, landowners, aboriginal organizations, community associations and others) should be contacted about the project?

✓ Which formal or informal leaders and organizations should be consulted?

✓ Which government and regulatory authorities (e.g., local, regional, provincial, national or First Nations, as appropriate) should be contacted and in what order?

✓ What types of issues or concerns do you expect these publics to raise about the proposed activity?

✓ What information will these various publics need (e.g., maps, project descriptions or reports) and how can this information be prepared in a form that is understandable and useful to them?

✓ What groups or departments within the company should be aware of plans to initiate a public involvement program?

✓ How and when will the public involvement program be integrated with the company’s project planning and decision making processes?

✓ What budget and other resources might you need?
Step 2
Make Initial Community Contacts

Objectives

- To start the public involvement process
- To obtain information from initial contacts to prepare a more detailed public involvement plan

✓ List government agencies, formal groups, informal groups, individuals, and formal and informal community leaders likely to be interested in company plans
✓ Describe the major issues likely to emerge during the involvement process
✓ Estimate the level of public interest in and significance of these issues.
Step 3
Prepare a Detailed Plan

Objectives

1. To allow your company to think its way clearly through the entire public involvement process.

1. To integrate public involvement activities with decision-making processes.

Your public involvement plan should be appropriate to the type of project or activity your company is involved in. The level of detail will vary depending on the scale and sensitivity of the project and the nature of public interests. The plan should include

✓ The objectives of the plan
✓ A description of the major issues
✓ A list of key publics
✓ An estimate of the level of concern these publics will have for each of the major issues
✓ A description of the decision making process
✓ A list and schedule of activities including assigned responsibility for their completion
✓ Identification of intervals at which the plan will be reviewed
✓ Methods that can be used to evaluate the success of the plan after it is completed
Step 4
Implement Public Involvement Plan

Objectives

1. To assess information about issues you have received from the public
2. To generate options or project modifications to resolve public issues
3. To reach mutually agreeable solutions through negotiations and co-operative problem solving

Use a variety of approaches and adjust your program as you go to reflect the needs of your publics and the feedback received. Developing and implementing a detailed public involvement plan will help you to:

✓ Develop relationships based on trust and credibility
✓ Document, analyze, assess and categorize the information you obtain
✓ Clarify issues, and identify options for resolution
✓ Build consensus and implement mutually acceptable resolutions
✓ Improve planning and decision making
Step 5
Monitor, Evaluate & Follow Through

Objectives

I To ensure you have built a public involvement program that's right for your company and your publics

I To evaluate your program to make sure it's working

I To find opportunities to improve your program

I To create lasting positive relationships with your publics

Monitoring, Evaluating and Following through are essential in public involvement. They close the management loop. Reviewing and evaluating your company’s activities, following through and following up on the public’s concerns will:

✓ Enhance your company's ability to operate in a particular area
✓ Help your company in developing a sound management approach to public involvement throughout its areas of operation
✓ Improve your ongoing public involvement programs
In the Guide:

- Toolbox:
  1. Glossary of terms and techniques.
     - Advisory Committees
     - Displays
     - Newsletters
     - Public Hearings
     - Questionnaires
     - Surveys
     - Mediation

GAPP
Tool Box

How to:

- Set up advisory committee or task force
- Run an effective “public meeting”
- Host a successful “open house”
**In the Guide**

- **Backgrounders** to help you better understand the benefits, challenges and processes of public involvement.
  - Trust and Credibility
  - Common Problems
  - Communication
  - Communities and Culture
  - Conflict and Consensus
  - Planning
  - Financial & People Resources
  - Regulatory Requirements
  - Strategic Consideration

**Trust and Credibility**
- building positive relationships
- building personal trust
- building corporate trust
- building an open and credible process

**Common Problems**
- conflicting company messages
- different companies working at cross purposes
- false expectations by participants
- puzzling recommendations from the public
- losing contact with the wider public
- participants who seem determined to cause trouble
- public rejection of your public involvement program
- problems caused by corporate deadlines

**Communication**
- listening and talking effectively
- feedback - getting and giving
- nonverbal communication
- probing and being a good listener
- risk communication

**Communities and Culture**
- differences in types of communities
- differences in density, history and culture
- identifying formal and informal community leaders
- public involvement with aboriginal communities and First Nations
- legal and regulatory background to aboriginal communities
- petroleum industry relations with First Nations

**Conflict and Consensus**
- levels of conflict
- degrees of resolution
- developing a shared evaluation of options

**Planning**
- planning matrices to help you develop and record your plans
- guidelines for documentation to ensure you keep accurate and useful records of your public involvement plans and activities
- guidelines for ensuring your emergency response planning includes meaningful public involvement

**Financial and People Resources**
- estimating a realistic budget
- picking the right people - clarifying your needs
- developing your corporate training program

**Regulatory Requirements**

**Strategic Considerations**
- demystifying decision making
- determining the scale, sensitivity and nature of publics
- extending public involvement from cradle to grave
- timing - start early
- addressing management responsibilities
In the Guide

I Examples and Exercises
  I to learn or teach others about effective public involvement

I Resources
  I description of other reference material
  I bibliography of documents and other guidelines
"The need to build trust and communicate does not go away when an event is over, a crisis has passed or the financial results are out. It's an integral part of the day-to-day management and leadership of a company. And that is the same regardless of its size."

Rick George
President and CEO, Suncor
WORKING GROUP 5 COMPANY UNIFICATION
Wednesday April 13, 1999, 8:15 a.m.
Co Chairs – Bruce Dupuis, (Integrated Integrity Inc.) / Keith Leewis (GRI)

Name of Speaker – Wanda Alison, TransCanada Pipeline, IT Department
Topic – Pipeline Integrity’s Common Data Management Approach
Summary: Discussion of the decision process to move to a unified data model after the merger and a highlight of the hurdles faced. Benefits of integration were identified as:
   Increased efficiency in data collection and management
   Increase efficiency for management of TCPL’s assets
   Improved business and customer service through the use of integrated, consistent and timely data
   Improved understanding and capability of data sharing by integrating maintenance activities.

Key elements of a successful integration are:
   Program sponsorship
   Multi-disciplined team – build partnership
   Communication
   Organization Structure that supports Decision Making
   Documented benefits & cost savings
   Balance Integration & Implementation Decisions

Speaker Name: Sean Black, Williams Northwest Pipeline
TOPI¢: 5 into 1
Summary: Discussion of the issues addressed and the problems faced in moving the five companies in the Williams family to a unified risk assessment and management process.

Overall:
The discussion focussed on the applications used to facilitate a unified data structure (i.e. GIS). Although this technology was identified as not necessarily required, it was seen as a common platform to share to data within an organization. It was suggested that a protocol for evolving from the spreadsheet to database to GIS would be of benefit for companies facing this issue. Sean with Williams emphasized the value of an enterprise data management tool in maintaining knowledge within a company given the mobility of people.

The cost associated with unifying data within a company was difficult to capture when all aspects are considered. The importance of a corporate champion and a multi-discipline coordination group was emphasized, with communication in general bring the key to success.

The potential value of open structure vs. third party owned GIS systems was introduced.

WORKING GROUP 5 INDUSTRY UNIFICATION
Wednesday April 13, 1999, 10:15 a.m. Session

Speaker: Mel Hutzi/ Mary Kai Manson
Topic: Pipeline Industry Unification: Data Management Standards, Leveraging The PPDM Experience
Summary: Presentation of the evolution and scope of the Public Petroleum Data Model. Model managed by a self funded independent governing organization. Since it’s formation in 1991 it has grown to a world standard for the upstream industry.
**Speaker:** Wayne Feil, Imperial Oil  
**Topic:** PRASC  
**Summary:** Emphasized the necessity of the industry providing input into the direction of the PRASC incident database and its harmonization with other databases. It was suggested that a common data dictionary would be a prudent place to start, rather than going directly into data consolidation.

**Speaker:** Glenn Yuen, (Dynamic Risk)  
**Topic:** ISAT 2.0 Pipeline Open Database Standard (PODS)  
**Summary:** PODS is a proposed unified data model for the pipeline industry to facilitate sharing and analysis of data, and reduce costs associated with application customization. The scope of PODS includes all assets associated with the pipeline including compression facilities. Unlike the original ISAT, PODS is designed to support GIS technology with its structure. PODS has evolved with significant input and support from software and application vendors.

**Discussion:**  
PODS was clarified as a data model (it facilitates functionality, but does not directly provide any). There was broad support for industry harmonization in terms of data dictionaries and data models. The “go forward” for industry harmonization requires a structured process and direct participation from the owner/operators with broad representation. However, a process to continue was not agreed upon.

**Key Points of the Information Management**  
- Compatibility  
- Benefits: Quantify  
- Incremental - Cross Fertilization / Use  
- Small Successes – “KISS”  
- Scaling Protocols - Small / Middle / Large enterprises  
- Simple to Multiple Coordinates Systems  
- Structured Data Across Industry  
- Tie Common Data Together  
- Standardization  
- Feed Regulatory Compliance  
- Buy In – Formal Structure
Pipeline Industry Unification: Data Management Standards
Leveraging the PPDM Experience

If so...
then
**Industry Data Management Standards**
are an essential component of your company's business strategy.

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Data Management Standards

- Impact
  - how data is described & stored
  - what data is stored
- Require Consensus and Scalability across:
  - Projects
  - Functional Groups
  - Intra-company
  - Inter-company

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Elements of Data Management Standards

- Data Definitions
  - data dictionary
- Data Model
  - describes relationships between data
  - logical description
  - physical implementation
- Reference Data
  - standardized data content eg. fluid names, units of measure, facility codes, etc.

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Are you interested in ...

Adding Value and Enhancing Productivity through:
- Enabling quick deployment of solutions
- Benefiting from new technology
- Supporting process re-engineering
- Reducing dependence on any single vendor
- Increasing your data value; managing data as an asset
- Attaining "plug" & "play" interoperability
The PPDM Experience

- Public Petroleum Data Model Association
- www.ppdm.org
- (403) 660-7817

Mission Statement

"PPDM Association is a non-profit organization through which members worldwide cooperate to develop an open standard data model as the foundation for managing data as an essential asset in the global business of oil and gas exploration and production."

PPDM Association - Startup Triggers

- Business problem - reduce data management costs
- Required multi-company solution & perspective
- New technology available: client server
- Perceived exponential increase in value realization through broad industry adoption
- Neutral forum required to support industry co-operation
- PPDM - a non-profit organization was formed in 1993

PPDM Profile

- Neutral, open environment
- One member, one vote
- Business driven sustained growth in:
  - deliverables, membership, funding
- Governance - International Board, CEO
- Current Funding - membership fees, project funding
- Resources - contract staff, member volunteers

Membership Distribution

- Approx. 100 members

Membership fees '98-'99

Based on revenue in US dollars

- Bar chart showing distribution of membership fees based on company size and revenue.
Growth of the PPDM Association

Model growth: business areas
Life cycle of a property asset

Subject Distribution in PPDM 3.4

PPDM - the Invisible Defacto Standard

PPDM Evolution - Key Events

PPDM Deliverables

- 1991 PPDM Association initiated
- PPDM / POSA merger initiatives
- Project Discovery collaborative effort
- PPDM v3.4 comprehensive integrated release - December '97
- PPDM v3.5 alpha testing in progress
  - Stratigraphy, Land Surface Rights, Business Associates, Facilities, Named Areas
- New initiatives - Compliance, Spatial, Populated reference tables, Sample implementation

- Data Model - DDLs in Oracle
  - Tables, columns, keys, constraints, indexes
- Documentation
  - Entity-relationship diagrams
  - Business requirements
  - Architectural Principles
- Future
  - Populated reference tables
  - User guides
Architectural Principles

- A set of guidelines for model design
  - Table and column names
  - Field types and lengths
  - Constraints
  - Units of measure
  - Geographic references
  - Extending or sub-setting PPDM
- Consistency and ease of use
- Facilitate new module development

Wells

- Covers well reporting requirements
  - General, scouting, licenses and permits
  - Positional, directional survey
  - Drilling & completion events
  - Cores, pressure tests, logs, fluid analysis
  - Tops, interpretations, velocities

Production Information

- Production data supported for
  - Well
  - Production string
  - Production well formation
  - Commingled production
  - Facility
  - Field / pool / county
  - Lease unit (Land right)
  - Business unit

Production Information

- Allocation
- Forecasts
- Volumetric data
  - Allocated / Measured
  - By substance
  - Monthly / daily
- Fluid / gas analysis
- Allowable production

Production Information

- Cross reference to corporate entities such as wells, facilities, lease units etc.
  - Track multiple versions of the data
- Future support for reserves data

Seismic

- Field acquisition
- Processing
- Time picks
- Restricted coverage
  - marine, 3-D,
  - interpreted features
Seismic Geodetic

- Geodetic transformations
  - Geodetic datums
  - Map projection
- World-wide applicability
- Seismic survey point reference to
  - monuments
  - facility
  - well node

Information Management

- Manage data not actually stored in the database
  - paper files and boxes of data
  - maps, sections, paper logs...
  - digital data (disk, tape, optical disk, flat files...)
- Physical products linked to seismic line etc.
- Indexing, circulation, maintenance

Land Mineral Right & Contracts

- Mineral Rights
  - Surface & sub-surface description
  - Analysis & maintenance
    - pre-acquisition, acquisition, obligations, relinquishment
- In Progress
  - Contracts, surface rights

Integration in PPDM 3.4

- Model integration (Wells, Land Mineral Rights, Production)
- Preliminary
  - Explicit connections
  - Spatial

PPDM Release Strategy

- Not more than every 2 years
- Major release (v3.x, v4.x ...)
  - New Architectural Principles
- Subject release (v3.4, v3.5 ...)
  - Increase depth and breadth of model
- Correction release (v3.41, v3.42 ...)
  - Critical corrections to subject release
- Test versions
  - Alpha (v3.4a), Beta (v3.4b), Pre-production

Options for Pipeline Standards

- Go it alone:
  - Create a new Pipeline Data Management Standards Association
- Partner with other industry data management standards initiatives (eg. PPDM)
  - a formal or informal arrangement
- Wait for integrated commercial solution or partnership alliances
  - may not become a standard
HA³ GIC Standards Organization Checklist cont'd

- Standards Clarity
  - Architectural Principles
  - Sample Implementation
  - Populated Reference Tables
  - Compliance Measurement

PPDM Strengths

- Neutrality - balanced input & removal of biases
- Necessary core competencies - proven processes
- Model foundation: primed for take-up, based on proven relational technology
- Measurable success - international track record
- Demonstrated industry support
- Solid organization - worldwide membership

HA³ GIC Perspective

- History has shown that data management standards are difficult and expensive to develop. They require a sustained broad base of industry support.
- Ultimately only good standards will be adopted. They don’t need to be perfect.
- Standards add extensive business value. Your commitment can make it happen.

Thankyou

- Huszti Associates Ltd
- Mel Huszti
- (403) 239-6912
- husztim@cyedi.com
- Extensive PPDM experience: founding member ’90, member Board of Directors ’90-’95; Executive Director ’95-’99.

Discussion

- Leveraging from the PPDM Experience
ISAT 2.0 (PODS)

Pipeline Open Database Standard

Presenter: Glenn Yuen, P.Eng.
Dynamic Risk Assessment Systems

PODS Pipeline Open Database Standard
- Overview & New Features
- Benefits
- Compatibility
- Who's Using ISAT
- PODS for Total Data Management
- PODS in Integrity Management
- Example

Overview
- Extensive Upgrade of GRI ISAT (1995)
- Standard definition for data storage
- Enterprise database
- Not vendor dependent
- Starting point which can be customized for each operator

Overview
- All pipelines (Producer, Transmission, and Distribution)
- All pipeline assets and integrity related data
- Directly supports trending, failure models, risk assessments

New Features
- Optimized for modern GIS software and databases
- Optional implementation of certain features
- Historical tracking
- Improved network model
- Pipeline coordinate warehouse
- Multiple pipeline geometries including schematics
- Multiple linear coordinate systems

New Features - Integrity
- Inline Inspections
- Excavation Data
- Surface Measurements
- Corrosion Facilities
- Repairs
- Risk Assessment
PODS Benefits

- Reduce Costs
  - Most of the Work is Done
  - One Source For All Data
  - Eliminate Duplication of Effort
  - Standard Formats For Data Vendors
  - Encourage Application’s Developers
- Corporate Wide Data Sharing
- Enables Industry Collaboration

Compatibility

- ESRI, Intergraph, and Smallworld GIS
- Oracle, Sybase and MS SQL Server
- CEPA SCC Database
- National Pipeline Mapping Standard
- PPDM (Public Petroleum Data Model)
- ILI Specs from Pipeline Operator Forum
- MFL Data Formats
- Excavation Data Collection and Corrosion Mapping Techniques

Who’s Using ISAT? Operating Companies

- Williams Companies
- Duke Energy
- TransCanada/Nova
- KN Energy
- Dynegy
- Enron
- Marathon
- CMS Energy (Panhandle)
- Conoco

Who’s Using ISAT? Application Developers

- Bass-Trigon
- Dynamic Risk Assessment Systems
- Eagle Information Mapping
- ESRI

- Geofields
- Intergraph
- MJ Harden
- New Century Software
- Smallworld

Available Third Party Applications

- GIS
- Facilities and Database Manager
- As-built Generators
- Risk Assessment & Integrity Assessment
- Inline Inspection Data Analysis
- Query & Correlation Tools

PODS for Total Data Management

- All Physical Pipeline Facilities
- Interface with SCADA, Data Collectors
- Coordinate Data From All Sources
- Network Hierarchy, Staboning and Equations
- Operating Information
- Regulatory Compliance and Information
- Crossings
- Population
PODS In
Integrity Management

- Inline Inspections
- Hydrostatic Tests
- Excavations and Defect Measurements
- Soil, Corrosion Deposits, Electrolyte Samples
- Repair History, Pipe and Coating Condition
- Surface Measurements
- Soil and Environment
- Risk Assessment Results

Possible Applications/Analyses

- Unlimited Ways to Correlate Datasets
- Advanced Trending Studies
- Data Mining
- Pit Matching
- Corrosion Growth Models
- Soils Models
- Excavation - ILI defect correlation
- Excavation Planning

Possible Applications/Analyses

- Advanced Failure Models
- Risk Assessment
- Simulations
- Maintenance Planning
- Code Compliance Audits
- Effective Visualization of Problems
- Emergency Response
- Insurance/Financial Loss

More Information

- Sponsor
- Design Team
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Kyle Keith
Stephen Jacobson

Dynamic Risk Assessment
Integrated Integrity Inc.
Foothills Pipe Lines Ltd.
Foothills Pipe Lines Ltd.
In-Line Inspection Working Group
Co Chairs: Bruce Lawson: WestCoast Energy, Arti Bhatia: Enbridge Pipelines
Rapporteur: Bryan Scott: Enbridge Pipelines

Summary Of Presentations

Segment #1
ILI Tools for Corrosion, Mechanical Damage and Other Inspection.

Presentations:

David Hektner/Jeff Sutherland
BJ Pipeline Inspection Services

Topic: Vectra MFL Tool

Summary: The Presentation will cover the operation of the Vectra MFL tool and the related software technology. The following describes the areas to be covered:

Vectra System Applications

- Speed Control for High Velocity Gas Pipelines,
- Inertial Measurement System for:
  GPS Location of Features and Anomalies,
  and Pipeline Mapping for GIS Integration,
- Tri-Axial Sensor Technology for High
  Resolution Defect Sizing,
- ‘Near Virtual Reality’ VECTRA VIEW
  data analysis software.

Benefits

- High Capacity Gas By-Pass Speed Control,
- Tri-Axial, High Resolution Sensor Technology,
- Inertial Mapping;
- ‘Near Virtual Reality’ VECTRA VIEW Software;
- Pre-Packaged Inspection Database for GIS.

Rapporteur – Bryan Scott, Enbridge Pipelines Inc.
Keith Grimes, Pipe Integrity International

Topic: ILI Tools for Corrosion

Summary: Handling large data volumes, LAPA, Corrosion Growth, Girth Weld Inspection, Hard Spots, Blisters, Dual Diameters, Variable Bypass, Spatial Analysis.

Tim Marston, Pipetronix Limited

In-line Inspection Data Management

Integrating ILI results together with other inspection survey results, combined with all available pipeline system related information as the basis of pipeline data management.

Bryce Brown, Rosen Pipeline Inspection

Topic: Latest Developments – In-Line Inspection

Summary:
This presentation is meant to give the audience a general impression of the technologies available to date and into the near future. This includes the following topics:

1. Maintenance/Pre-Inspection Pigging,
2. Geometry Inspection,
3. Metal Loss Inspection,
4. Speed Control,
5. XYZ Mapping,
6. and Reporting

The representatives from the ILI companies will describe the latest technologies in corrosion inspection, mechanical damage, high-resolution caliper and inertial tools.

Discussion:

Risk Analysis using MFL.

A question was raised as to the accuracy of defining pitting corrosion. Is the old data valid given the fact that the technology has improved?
Vendor's Response:

The same tool technology is used but the software component has changed so that their data can be updated and a valid comparison can be made. All vendors agree with this philosophy. If corrosion growth analysis is to be done, it may be better to utilize the same vendor however not always necessary. By accessing the raw data, as computer systems have become “more friendly” we are in a better situation to perform this analysis. Raw data from the past can be reprocessed and configured to better be compared with more recent inspection data.

Reliability and Confidence in the Tools

Vendor Statement: Even the best tools cannot achieve 100 percent reliability because you have to make allowances for defect differences, normalizing data sets based on girth weld signal matching.

In order to improve reliability there also has to be feedback from the operating companies regarding the effectiveness of the inspections and validation in the field with respect to tool performance.

Definitions

Operator Input:

Discussion of the term “high resolution” was initiated. Most operator’s felt that the words are used to better advertise the tool and may not necessarily related to tool performance.

Vendor’s Response: The vendor’s were in agreement that the tool performance was the defining factor not the tool title.

Automation of Data Analysis

Operator Question: The operator’s requested an explanation of the degree to which automation (“non-human factors” – computer based analysis).

Vendor’s response: The vendor’s responded that with MFL analysis a combination of manual and automated procedures is used. The manual checks are used to evaluate the more significant or serious defects. Less serious defects are run through computer based algorithms to be sized. The amount of automated analysis is a function of the number of defects detected by the ILI tool.
ILI contracts:

The operator's were questioned about their views on a two tiered/staged contract execution and payment schedule. The first stage would outline the requirements for performance in the field and attach a certain cost to this work. The second stage would outline the requirements for reporting and data validation and attach a value to this work. Most operators felt this was a good approach to ensure some integrity and performance from the tools.

Confidence Levels:

The vendor's were asked about the level of confidence with their tools. The vendor's state that the level of confidence is related to how much information they have about the nature of defects on the line being inspected. The contracts are usually reported to an eighty percent Confidence Interval Performance Specification. If more information is given to the vendor's prior to the inspection, and post inspection with validation, this confidence will be bettered.

Accuracy - Improving tool capabilities.

It was emphasized by the vendors as a result of the last statement better confidence can be achieved by better information on the line however improved accuracy has a higher cost component. The vendors did caution the operators that the limitations of accuracy limits are a direct function of the physics of the MFL technology and that improvements over the commercially stated +/- 10 percent is unlikely.

Summary Of Presentations

Segment #2
ILI tools for Crack Detection

Presentations:

Keith Grimes, Pipeline Integrity International

Topic: ILI for Cracking – TFI

Summary:
The shortcomings of "standard" MFL, TFI Methodology, Data Comparison, Result, Future Plans.
Neb Uzelac, Pipetronix Limited

Topic: Sensitivity and repeatability of detection.

The UltraScan CD tool was discussed and it's capabilities for detection of SCC. The results of a recent inspection were demonstrated and reinforced the high level of issue of reliability and repeatability of the tool.

Patrick Porter, Tuboscope Vetco Pipeline Services

Topic: Electromagnetic Acoustic Transducer (EMAT)

Summary:

Tuboscope Vetco Pipeline Services (TVPS) is testing EMAT technology for the detection of Stress Corrosion Cracking (SCC) using an In-Line Inspection tool. Gas Research Institute (GRI) and T. D. Williamson (TDW) developed this technology over the last 12 years. It was originally developed to detect and quantify corrosion defects in operating pipelines and was recently modified to the SCC detection application. TVPS is working with GRI to commercialize the system developed. A prototype tool has been built and tested. The first tests were conducted in the Pipeline Simulation Facility using crack defects designed by GRI. The tool has also been tested in several operating pipelines. This paper will review the novel aspects of the technology; the results of the field trials and speculate on the commercial potential and schedule for the inspection service.

Martin Phillips, Pipeline Integrity International

Topic: PII Elastic Wave Crack Technology

Summary:

INSPECTION MISSION
- STRESS CORROSION CRACKING - FULL PIPE
- LONG SEAM FATIGUE CRACKING - LONG SEAM
- LACK OF FUSION - LONG SEAM
- HOOK CRACKS - LONG SEAM
- SHRINKAGE CRACKS - LONG SEAM

OPERATING PERFORMANCE
- GAS AND LIQUIDS
- UP TO 1000 PSIG
- UP TO 50 ° C
- UP TO 4 M/S IN LIQUID
- UP TO 9 M/S IN GAS WITH BYPASS
- Up to 150 km range in one pass

**Inspection Performance**
- Detection of cracks > 50mm
- Detection of cracks > 20%
- Pipebody or seam weld
- Length ± 10mm
- Depth ± 25%
- Location accuracy as per MFL
- Dents are detected

**Achievements**
- Operational since 1992
- 3000 km of inspection
- Over 140 cracks & weld defects
- 418 km successfully hydrotested
- Hydrotest waivers for two USA operators
- $5.3M GRI, CEPA, PII development

**Future Developments**
- Increase number of tool sizes
- Coating condition
- Discrimination
- Reduce operational costs

The representatives from the ILI companies will describe recent successes and future advancements in crack detection tool technologies.

**Discussion:**

**Tool Development Strategies**

A question was raised about potential incentives that would be offered by vendor’s if operator’s supported development of ILI crack tools. The vendor’s responded that they would welcome support and entertain profit sharing proposals although the payback may be over an extended period of time.

**Definition of “False Call”**

The vendors were asked about their definition of a “false call”. The operator’s as to the ability to differentiate between inclusions and cracks further clarified the statement.

With respect to the Pipetronix CD tool: Inclusions and cracks are confused only on small scaled defects. Any significant defects would not be confused.
Elastic Wave Tool Response: Although it is recognized as an issue, it is seen as a concern for defects that would fail 100 percent SMYS.

The consensus in the workshop was that the issue of false call sets up an unrealistic expectation of the vendors. The vendors felt that the operator had to better define their need as to what they require from a crack tool and thereby the operator could set a better definition for “false call”.

The vendor’s requested that the operator define a range of what they viewed acceptable. The operator’s felt that the minimum standard from a crack tool was discrimination of defects that would fail a hydrotest at 100% SMYS. Ideally the higher standard would result in 100 percent detection, discrimination and sizing of all crack features greater than 10 percent wall thickness.

Feedback

It was restated that feedback from the operator’s is still required to increase the level of confidence in the tools by the vendors.

Level of analysis

The onus is on the operators to better define their needs with respect to reportable crack sizes i.e. Where You Set Your Cut Off Levels. The operators have to be prepared that with more detailed analysis comes a higher cost for inspection.

Other Technologies

A question was asked about how to relate ILI data collected to assist in the assessment of unpiggable pipelines. Research from other organizations is underway and may assist in addressing these issues.

Circumferential MFL Inspection Technology

Research issues are still being addressed as to the capabilities and limitations of circumferential MFL technology. One of the key advantages of this technology is its ability to be miniaturized.

User’s Groups

It was suggested that the ILI Crack Tool vendors develop a “User’s Group” with their historical and current clients. This was suggested to be expanded to incorporate all technologies.
FORWARD ACTIONS:

- Initiating "User’s Groups" to assist in the advancement of all ILI tool technologies

- Feedback of field data to the ILI Vendors to improve confidence and proper technology selection.

- Industry standards are required for reporting tool specifications, accuracy, confidence levels and terminology.
Banff 99
In-line Inspection Session

Latest Developments - Inline Inspection

R. Stelmachuk & B. Brown
**Maintenance/Pre-Inspection Pigging**

Managing Pipeline Integrity - Technologies for the New Millennium

**Geometry Inspection**

Managing Pipeline Integrity - Technologies for the New Millennium

**PURPOSE:**
- Verify Pipeline Construction Specs.
- Detect Any Hidden Third Party Damage.
- Ensure Safe Passage of Inspection Pigs.

- Dents in % of nom. ID
- ID changes
- Bend radii, degree and direction
- Installations: - valves
  - tees
  - flanges
  - taps
  - welds
- Ovality in % of nom. ID
Topics

- MAINTENANCE/PRE-INSPECTION PIGGING
- GEOMETRY INSPECTION
- METAL LOSS INSPECTION
- SPEED CONTROL
- XYZ MAPPING
- REPORTING

Maintenance/Pre-Inspection Pigging

- FULL RANGE OF HIGHLY EFFICIENT CLEANING PIGS
- HIGH WEAR RESISTANT POLYURETHANE DISKS PROVIDING UNSURPASSED PERFORMANCE
- EXCELLENT BATCHING CAPABILITY
- COST EFFECTIVE
- EASY HANDLING
- ALL SIZES CAN BE EQUIPPED WITH PIG LOCATORS, BRUSHES, MAGNETS, ETC.
- ALL CLEANING PIGS AND ASSECORIES ARE MANUFACTURED BY ROSEN
**Geometry Inspection**

**ELECTRONIC GEOMETRY PIG (6" - 56")**

**SYSTEM DESCRIPTION:**
- EDDY CURRENT BASED TECHNOLOGY
- UP TO 32 CHANNELS (SENSORS)
- BEND DETECTION AND MEASUREMENT
- TEMPERATURE AND PRESSURE RECORDING

**Metal Loss Inspection**

**CORROSION DETECTION PIG (4" - 56")**

Managing Pipeline Integrity - Technologies for the New Millennium
Metal Loss Inspection

- SOPHISTICATED ELECTRONICS
- SENSOR TYPE AND DESIGN
- REFINEMENT OF SIZING ALGORITHMS
- NEURAL NETWORKS

Speed Control

- Recently Tested Successfully.
- Initial Range of Service: 24” - 36”.

Managing Pipeline Integrity - Technologies for the New Millennium
XYZ Mapping (GPS)

- Recently Tested in Client Pipeline.
- Available in 16" and up.

Reporting

The Inspection Survey Report includes the following:
- written report detailing all activities, parameters and results,
- feature, installation and marker lists,
- graphical output,
- pipe tally,
- survey logs,
- client software (Y2K compliant).
Reporting

ROSOFT - Client Software Package
- Windows Based (WIN95, 98 and NT4)
- Database Format (*.dbf)
- View and Access all 'Raw' Survey Data
- Feature, Installation and Marker Management
- Generate Client Specific Lists (set filters)
- Various Graphical Output
  (Distributions, Pressure Based)

Managing Pipeline Integrity - Technologies for the New Millennium
Reporting

- Reporting format tailored to the field application.
- Direct access to data during field excavation.
- On-call support provided.
Banff 99
In-line Inspection Session
Crack Detection
UltraScan CD
Sensitivity and repeatability of detection
N. Uzelac
Pipetronix

DEPLOYMENT OF SENSORS
- 480 - 540 crack detection sensors
- circumferential spacing - 10 mm (4 couples)
- uniform wall coverage
- redundant data

N. Uzelac
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Working Group 7  External Corrosion

Co-Chair:  Susan Miller (Enbridge Pipelines)
Co-Chair:  Robert Worthingham (TransCanada Pipelines Ltd.)

Banff 1997 External Corrosion Summary

This working group focused on monitoring, assessing and predicting external corrosion. The participants agreed on the great value of determining corrosion rates, specifically the growth rates of pits and any correlation with environments and operating conditions. It would be helpful to agree on a methodology and on common data to be collected, for comparison purposes, and to include the data in a database, such as the CEPA database. Updates on activities to evaluate corrosion rates and state-of-the-art developments should be included in future Workshops.

Producers Group to develop an internal corrosion model based on failure mechanisms. The model must be cost-effective for upstream pipelines, be reasonably accurate, properly assess three phase flow, be user friendly, be readily accessible by field operators, and should have an output that can be used with a risk matrix.

There is a need for improved inhibitor batch pig technology. In addition, any changes in an inhibited system must be monitored so that, for example, there is a record of when the becomes water-wet.

Presentation

Working Group 7C - Remaining Strength Assessment

Objectives
1. Determine if more comprehensive language should be included in CSA
2. Review criteria for use of RSTRENG
3. Determine if more training is required in industry on conducting assessments

CSA – Jake Abes (Pipeline Safety Inc.)

Summary: attached

Questions and Discussion
1. Carl Jaske (CC Technologies) – better to have regulations more general than too specific so future development can be implemented
2. Jake Abes (Pipeline Safety Inc.) - people are using programs, such as RSTRENG, with little or no experience
3. Mike Reed (Trans Mountain Pipeline Company) – Is this going to become a design standard as oppose to a guideline?
4. Jake Abes (Pipeline Safety Inc.) - we have a responsibility as an industry to set the minimum standard but ultimately it will a responsibility of the design engineer
5. Marc Spencer (M&C Integrity) – Commentaries may apply to these clauses to give more depth to the clauses. The specifics would be better as commentaries as oppose to embedding them into the code.

6. Jake Abes (Pipeline Safety Inc.) - CSA is inconsistent between being prescriptive and flexible

7. Bob Eiber (Consultant) – If you become too prescriptive, the document becomes difficult to maintain. Do not rule out future development by making the code too prescriptive. Specifics may be address through CSA training programs.

8. Don Marr (Corpro Canada Inc.) – Have there been a number of cases of failures due to inadequate training? The professional engineering practices need to play a role.

9. Jake Abes (Pipeline Safety Inc.) - Need to decide if we want to stay with B31G or modified B31G


11. Aaron Dinovitzer (Fleet Technology Ltd.) – uses in-house document

12. Marc Spencer (M&C Integrity) – uses plastic collapse

13. Bin Fu (BG Technology) – uses a British standard that is currently being used throughout the UK

14. Bob Worthingham (TransCanada Pipelines) – uses RSTRENG and B31G. How many are using RSTRENG? ~34

15. Barry Martens (Rainbow Pipelines) – What do people use for acceptable burst pressure? RSTRENG does not include a safety factor.

16. Pat Vieth (Pipeline Integrity International) - there is no safety tolerance in the code. Currently, CSA allows the company to do an engineering assessment which this could be a part of. B31G and RSTRENG are explicit in using a safety factor.

17. Susan Miller (Enbridge Pipelines Inc.) – Nothing in CSA mandates a factor for safety for acceptable burst pressure.

18. Pat Vieth (Pipeline Integrity International) – safety factor needs to be addressed in an assessment. If your design factor is 0.72, that implicitly means that you should maintain this factor for the life of the pipeline.

19. Tom Morrison (Morrison Scientific) – There are errors in everything. Include and consider error levels in engineering assessments of defects. This may include field measurements, ILI measurements and RSTRENG.

20. Arti Bhatia (Enbridge Pipelines Inc.) - this would also apply to field measurement – use best tools to obtain the most accurate measurements.

21. Aaron Dinovitzer (Fleet Technology Ltd.) – From the history of the line, need to know how much you may fluctuate from the MOP.
R-Streng – Pat Vieth (Pipeline Integrity International)

Summary: attached

Questions and Discussion
1. Susan Miller (Enbridge Pipelines Inc.) – Who has training in RSTRENG? ~5% If there was a 1-day course, how many would be interested in attending? ~80%
2. Keith Grimes (Pipeline Integrity International) - There should be some kind of research or consensus on interaction of corrosion. What to use for interaction rules?
3. Pat Vieth (Pipeline Integrity International) – interaction is defined as how far apart (axially or radial) do areas of corrosion have to be before they are considered separate defects? There are different rules of thumb.
4. Bob Worthingham (TransCanada Pipelines) – Need to understand the limits
5. Carl Jaske (CC Technologies) – used the average – RSTRENG or effective area method for interaction corrosion is a useful tool but should be validated
6. Application of RSTRENG and B31G can also apply to cracks
7. Jake Abes (Pipeline Safety Inc.) – Is training necessary? What sort of problems come out of the training sessions?
8. Pat Vieth (Pipeline Integrity International) – A good example of this is burst pressure vs. MOP. If you have some understanding then the results have more meaning.
9. Corrosion data must be used in conjunction with statistical frequency analysis methods.
10. More data is required to apply RSTRENG to high strength steel (above X65)
11. Bin Fu (BG Technology) – B31G is conservative around flow stress and shape. From experience, finds many people ignore the flow stress.
12. Pat Vieth (Pipeline Integrity International) – compared to flow stress and geometry, the Foliarc factor plays a big role in causing a problem for pipeline operators
13. B31G was based on 37 data points; RSTRENG based on a lot more
14. Marc Spencer (M&C Integrity) – The design factor applies to infinite length of pipeline but if you apply this factor to a single joint, the result is very conservative. Does not think it is a safe assumption to apply a single design factor. Other items need to be taken into consideration
15. Pat Vieth (Pipeline Integrity International) – by applying statistics, you can overcome
16. Bruce Lawson (Westcoast Energy Inc.) – there are many points outside the band – how come?
17. Pat Vieth (Pipeline Integrity International) – many points go back to the 1960s that add to the variability to the data. Instead of using flow stress, Pat will use the UTS. By applying a safety factor, will eliminate the effects of scattered data.
18. Bruce Lawson (Westcoast Energy Inc.) – Do you feel the ILI data is accurate in determining accurate features?
19. Pat Vieth (Pipeline Integrity International) – Validate the data by doing excavations
20. John Beavers (CC Technologies) – What are the effects of end caps on the burst pressure?
21. Pat Vieth (Pipeline Integrity International) – very little end effects (~10%) due to the loading
22. Failure criteria, based on predicted failure stress, is less than SYMS. Predicted failure stress from RSTRENG is greater than SMYS.
23. Barry Martens (Rainbow Pipelines) – Can the defect be ground out?
24. Pat Vieth (Pipeline Integrity International) – yes, but then you have a blunt notch defect – B31G would then apply
25. Jake Abes (Pipeline Safety Inc.) – CSA has special provisions for determining how to assess a ground out area.

Conclusions and Recommendations for 7C
1. There are different methodologies being developed.
2. There are errors in measurement no matter how careful the measurement is taken. The goal is to reduce the error as much as possible.
3. Allow latitude to take advantage of new findings.
4. Engineering critical assessment training should be made available.

Working Group 7D – Corrosion Growth Estimation

Objectives
1. Explore advances indirect and direct monitoring methods
2. Use of represented ILI data
3. Use of soil coupons
4. Identify other methods used and their success in application to pipeline integrity programs

Modelling Corrosion Growth – Guy Desjardins (Morrison Scientific)

Summary: attached

Questions and Discussion
1. Bob Eiber (Consultant) – How variable is the corrosion rate along the pipeline from year to year?
2. Guy Desjardins (Morrison Scientific) – Tends to vary when something changes such as, no CP or with seasons.
3. Bob Eiber (Consultant) - Have you been able to tie the corrosion rate to the inspection method? Will you get various corrosion rates from two vendors or will the rate be the same?
4. Guy Desjardins (Morrison Scientific) – It may vary a bit especially in length due to the different tools. This averages out over time.
5. Bob Worthingham (TransCanada Pipelines) – double logarithmic graph vs. mm/yr. (depth) Gumble graphs like this are used to predict the inspection frequency and shows distribution of corrosion rates. Rates vary from zero to 0.85 mm/yr.
6. Carl Jaske (CC Technologies) – Does the step reflect a +/- 1 variability in the distribution?
7. Bob Worthingham (TransCanada Pipelines) – This may be an artefact. First inspection data points are grown to predict future inspections.
8. Bob Worthingham (TransCanada Pipelines) – currently were are working on asphalt lines but plan to expand.
9. Scott Oliphant (Chevron Canada Resources) – What success have people had with inspection of coatings other than ILI?
10. Susan Miller (Enbridge Pipelines Inc.) – ILI can be a limitation, if for example, pigging of tape coated lines is not feasible. For some lines have found a correlation to drainage points. Where there was a drainage point the severity and frequency of corrosion was higher.
11. Jane Dawson (Pipeline Integrity International) – in addition to the inspections, one needs to continue to complete CP surveys, coating surveys, etc.
12. Bob Worthingham (TransCanada Pipelines) – agrees; however, this assists with finding the problems and assist with the priority.
13. Tom Cook (The Cook Group) – What is the confidence level?
14. Tom Morrison (Morrison Scientific) – upper limits 50% of the wall, 80% of the time – more seriously, have examined the errors on the ILI tools. The confidence limit on the prediction is slightly higher than the tool.
15. Bob Worthingham (TransCanada Pipelines) – takes into account the variability of the tool to aid in a better confidence of the prediction.
16. Guy Desjardins (Morrison Scientific) – accuracy of the data plays a large part in the accuracy of the prediction.
17. George Cherrington (Pembina Pipeline) – the internal corrosion needs to be considered.
18. Bob Worthingham (TransCanada Pipelines) – internal corrosion is not of concern with the sweet gas lines.
19. Don Marr (Corpro Canada Inc.) – has had success in finding corrosion with over the line surveys. If you are confident why complete future ILI; why not complete periodic digs?
20. Bob Worthingham (TransCanada Pipelines) – new features could show up – the frequency of ILI has been reduced.
21. John Beavers (CC Technologies) – Could you identify if the rates were as high as the graph showed? Do you have models that show high rates on other parts of the system?
22. Bob Worthingham (TransCanada Pipelines) – we are working on this. Field observations have confirmed these rates.
23. Arti Bhatia (Enbridge Pipelines Inc.) – there is some cross correlation with geographical data. Also the data from ILI may transfer to other lines if the geographic characteristics are similar.
24. Bob Simmons (RTD Quality Services Inc.) – Is the excavation data consistent? Or does it vary from company to company? 1” grid vs. 1/2” grid?
25. Growth rate is not a single number but a reflection of a probability.
Use of CP Coupons – Greg VanBoven (NOVA Research and Technology Corporation)

Summary: attached

Questions and Discussion
1. Grant Firth (Corpro Canada Inc.) – In October there was a step-up with some probes and a step-down with other probes. What was the cause?
2. Greg VanBoven (NOVA Research and Technology Corporation) – not sure but will assume there was an interference problem
3. Bob Worthingham (TransCanada Pipelines) – there are about 100 coupons throughout the system.
4. Bob Worthingham (TransCanada Pipelines) – some correlation work in progress to understand various soil parameters. This will help understand the risk to the pipeline.
5. Carl Jaske (CC Technologies) – is the coupon maintained at the same temperature as the pipe?
6. Greg VanBoven (NOVA Research and Technology Corporation) – temperatures are similar therefore both the pipe and the coupon will need to be measured
7. Barry Martens (Rainbow Pipelines) – found quite a few problems with the MFL tool so Rainbow is now using the UT tool
8. Susan Miller (Enbridge Pipelines Inc.) – similar experience to Rainbow. With tape lines, tending occurs around the weld yielding narrow axial external corrosion (NAEC). Other techniques may also include circumferencial examination. With any method, you need to take into account the errors.
9. John Baron (Shell Canada Limited) – Shell runs ILI tools to look for anomalies. They have tried to correlate soil data to external corrosion. They have seen rates as high as 1.5 mm/yr. – this lead to a failure. Are you looking for anything else such as pH in soil analysis?
10. Tom Jack (NOVA Research and Technology Corporation) – NRTC is researching redox potentials, at depth soil parameters, deposition of the soil, surface parameters and soil texture.
11. Marc Spencer (M&C Integrity) – Why do these parameters trigger some locations but not others?
12. Bruce Lawson (Westcoast Energy Inc.) – the CEPA database has space for additional information. Has anyone considered building a database for external corrosion.
13. A working database should be considered for the next workshop.
14. Bob Worthingham (TransCanada Pipelines) – Review of objectives: Continuing to use ILI data; coupons are used to obtain estimations on the pipe; other method are being used

Conclusions and Recommendations 7D
1. The industry should develop a standard approach to measuring corrosion in the field
2. Identify guidance for soil analysis.
3. A shared database of soil conditions and corrosion rates should be develeoped, perhaps CEPA.
Managing Pipeline Integrity:
Technologies for the New Millennium

Working Group 7c: External Corrosion
Remaining Strength Assessments

OBJECTIVES
1) Determine if more comprehensive language should be included in CSA
2) Review the criteria for use of RSTRENG
3) Determine if more training is required in industry on conducting assessments

SPEAKERS
Jake Abes - CSA
Pat Vieth - RSTRENG

CSA Z662-99
Oil and Gas Pipeline Systems

CLAUSE 10.8.1.6
Where piping is not suitable for continued service at the established operating pressure due to the presence of defects, either the piping shall be operated at pressures that are determined by engineering assessment to be acceptable, or the affected piping shall be repaired in accordance with the applicable requirements of Clauses 10.8.2 to 10.8.6 inclusive.

CLAUSE 10.8.2.5
Corroded areas that exceed the depth or length limits specified in Clauses 10.8.2.3 and 10.8.2.4 shall be considered to be defects, unless determined by an engineering assessment to be acceptable. The engineering assessment shall include consideration of service history and loading, anticipated service conditions, the mechanism of imperfection formation, imperfection dimension, failure modes, and material properties (including fracture toughness properties).
RSTRENG

- Remaining Strength of Corroded Pipe
- Tool for predicting the remaining strength of corroded pipe
- PRC International sponsored research (1989)
  - addressed inherent conservatism in B31G
  - developed analysis methods
  - validated against database of corroded pipe
  - continued validation against expanded database

RSTRENG Effective Area Iterative Calculation

- RSTRENG provides accurate assessment and analysis of the corrosion
- Addresses difficult in the definition of length via the iterative calculation
- Software provides the means for conducting the calculation
- Training and understanding of corrosion measurement and assessment is encouraged
Managing Pipeline Integrity: Technologies for the New Millenium

Robert Worthingham
TransCanada Pipe Lines
Calgary, AB

OBJECTIVES
1) Explore advances in direct and indirect monitoring methods
2) Use of repeated ILI Data
3) Use of soil coupons
4) Identify other methods used and their success in application to pipeline integrity programs

The Problem ...
When do we inspect next?

- How do we optimize the reinspection frequency?
- When will the remaining flaws deteriorate sufficiently to be in danger of rupture?
- How do we spend the ILI resources wisely to inspect as many lines as possible, and then only when needed?

The Dream ...

- High resolution ILI data could be used to identify where corrosion pits were growing and how fast they were growing!
- Allow for just in time inspection and repair
- Allow for coating repair of sites that are growing before they need reinforcement or removal

Site Specific Approach

- Match individual corrosion pits reliably by correcting for ILI tool variability with PHOENIX
- Determine individual corrosion pitting rates and project the expected size of each pit into the future
PHOENIX

- Monte Carlo analysis of each feature used to determine probability of failure in a given year. Takes into account tool repeatability and variability.
- Critical sub-feature analysis used on all ILI data collected since 1994 (Rstreng, Lapa)
- Validate ILI vendor analysis

Matches from Phoenix

Increasing Depth with Time

Failure Pressure Decline

Growth in Penetration Through Wall—Example 1
Growth in Penetration Through Wall—Example 2

Critical Feature Sizes

Growth in FPR (Failure Pressure Ratio)—Example 1

Growth in FPR (Failure Pressure Ratio)—Example 2

Frequency of Failure Dates

Where is Corrosion Occurring?
- By viewing the growth data in a GIS, it is possible to help answer WHY? and WHERE?
- Correlations with environmental, geographic and construction related factors can be made.
- Where will the first failures occur?
- Where are the fast growing pits?
Why is Corrosion Here?

Why is Corrosion Here?

Why is Corrosion Here?

Why is Corrosion Here?
Corrosion Modeling with Coupons

1999 Banff Pipeline Workshop
Working Group 7D
G. Van Boven
NOVA Research & Technology Corp.

OBJECTIVE

To understand the corrosion state of a 40 year old asphalt coated pipeline in seasonally dry soils where an apparent seasonal lack of protective CP as measured against conventional guidelines is observed.

Close Interval Survey

How Can the CP Issues of This Line Be Dealt With?

- Add anode beds to increase line polarization
- Perform close interval surveys only in the winter or early spring
- Initiate a research program aimed at understanding and demonstrating pipe protection.

Research!

A seasonal study using buried coupons, environmental probes and electrochemical corrosion rate measurements aimed at:
- Understanding the Relation of CP to Environmental Changes
- Evaluating the Impact of the Environment on Corrosion
- Demonstrating Pipeline Protection with Alternate CP Criteria

Seasonal “On” Potentials

G. VanBoven, NOVA Research & Technology
Two Mechanisms

1) MOISTURE DEPENDENCE: Unprotected coupon corrosion rates less than 0.05 mm/year
   - Soil resistance is greater than 10 Kohm.cm
   - Native coupon potentials are more positive than -500 mV
   - Oxidation-reduction potentials more positive than -250mV (Au vs CSE)

2) O₂ Dependence
   - Soil moisture is not limiting corrosion & O₂ dependent corrosion may be present.
   - These areas can be a concern if inadequate CP and/or defective coating is present.
Finally

- General CP guidelines are often difficult to meet and in some cases may be misleading as to the degree of polarization on the pipe.

- Adequate polarization may have to be demonstrated with alternate criteria.
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2nd Session
WED, 14

W.E. 7

EXTERNAL CORROSION
16:30

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Ricardo Abdalla

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Issues

- need for a "cooperative" industry approach to public involvement
- greater respect for people's time
- more lead time required - resident's understanding of the "system"
- residents wanting larger set backs from pipelines
- residents wanting larger emergency response planning zones
- residents demanding better compensation for disturbance (neighbours too)
- community relations audits as important as environmental audits
- bad attitudes
Presented by:
David DeGagne, EUB
Terry Gibson, Gecko Management

We will review our experience related to public
engagement and consultation related to
the Sundre-Caroline area
Background to the Caroline Interrogatory
process
Discuss the current situation
- Terry
  - Community Affairs Coordinator - construction and start-up 1991-1994
  - Consultant 1994-1999
  - Caroline B Pool Advisory 1998 -

Gas and oil exploration from the 1950's
more than 25 operating oil and gas companies
4000 oil and gas wells, and related facilities
System - major transmission point
Caroline - Beaverhill Lake - deep, sour gas
Commission commenced 1985 (3 years after the
Deepole Blowout)
Catherine Field - east of the Town of
Catherine - stretches to the Village of
Catherine
Catherine - population 2,000
Catherine - population 400
Many farms and ranches; many cottages
and camping areas

The public is nervous about sour gas
- Lodgepole blowout #1
- Lodgepole blowout #2
- Major EUB Public Inquiry
- Public continued to be worried about sour
gas and very distrustful of industry
First find in Alberta in 20 years
$100 million capital - 15 producing wells - reservoir
50 square miles (over 30 wells drilled to define field)
Major compressor stations (50,000 hp)
Plant
our Forming and load-out facility
construction jobs
Operating jobs
billion cash flow over 20 years

1985 - first contact of community
December 1987 - first public meetings
January 1988 - Caroline Gas Field
Advisory Board established
1988-1989 - Community Offices
Established
out/Sky/Shell competition to develop the
1989 - Sundre Parade
May 1990 - ERCB Hearing
November 1990 - construction commencement
1992 - construction work force peaks at
- Oct. 1992 - Community Offices closed
November 1992 - February 1993 - start up

Opportunities
- Public Health (emissions)
- Water - pollution - volumes used
- Road
- History of mistrust; lack of openness
THE VALLEY INCIDENT

WHAT HAPPENED?

Gas from service rig - small release of sour gas - August 1987
and the neighbourhood - they were angry
Local meeting - company told them "you were not at the meeting there really was not a problem!"
Company didn't listen!
Company was close minded
Company didn't admit it when they didn't know the situation
Company didn't apologize

Listen and to keep an open mind
Apologize
Have empathy and sensitivity
Be prepared to deal with anger and lose trust - and do not take things personally
Look for solutions jointly with stakeholders - e.g. work together on ERP
In Expectations
Community Consultation Program

Economic Opportunities

Roads and Traffic

Information and Education Vehicles

Strawberries

Mercury

Community Advisory Board

Emergency Planning Committee

Eco-Economic

Environmental Monitoring and Studies

Water, Water and Soils

Livestock

Wildlife
or issue

individual coordinators - Shell, Dilcon, Babtech-Lavalin

actory

contracts broken into smaller pieces

information/educational meetings

ons and contractors

itored progress

ificant impact on the community

actively monitored roads

struction traffic schedules

king for workers

uses used to transport workers to

odore and Caroline at night
Major outside company was hired to supply fly-mix concrete

LESSONS LEARNED:
- The team must be supportive
- "Walking the talk"
- If you receive approvals, you are accountable
- A mistake erodes support - admit your mistakes - and you can recover!

Mercury potentially detected in the Caroline gas field
- Perceived health risk
- Prior to start-up - Company - nervous
- Opposition to be open
- Believed employees
- Interested stakeholders
- Company had few answers
- Mercury eventually confirmed Mercury was not a problem
Shareholders appreciated openness

Credibility increased

Neighbourhood trust of Shell increased

Having early paid off
to face resident contacts most effective (but
expensive)

Gnugness to make changes - a key element of
effectiveness

Do not always need to have all of the answers
Community helped

First to understand and then to be
understood"
Persistent messengers

Communication - quality Vs. quantity

Send types of public forums - know the audience

Local media - a key audience

Not all of the public will support the company

Strategy development and planning for communication events

OK to say no

The number of community affairs personnel went from 11 to 1 (1994)

Company significantly reduced/stopped providing information to the community

Resources related to community affairs dropped drastically (analogous to moving from dating to marriage - lots of resources to keeping operating expenses low)

Patience in the post-approval/post construction stage
Complacency - under sensitive to community needs

Over sensitive to community needs

Missed start-up problems

Missed start-up problems and rumors

Delta Cattle Commission Report

Gas leak - January 1994
- Concerns raised by the community
- Public Health
- Animal Health (Cattle Commission Report)
- Complaints
- Decline in Public Trust & Credibility
- Hearing (October 1996)
  - Pre-hearing Meeting (June 1996)
  - Limit scope, no human/animal health evidence
  - Government promise to initiate separate process
  - Application Approved, Appeal Denied (deep anger)
Credible Facilitator (Dr. George Kupfer)

1. Identify Most Affected Parties
2. Meet with Affected Parties (issues, concerns & personal experiences)
3. Document in a Formal Report
IDENTIFICATION AND
AGGREGATION OF ISSUES

- Categorize Issues & Concerns
- Operator or Government Agency
- Region
- Provincially
- Firm & Validate with Community
- Identifying Possible Approaches to Issue Resolution
- Forward List to Shell, SPOG, CAPP, AEP
- EUB.

RESPONSE BY INDUSTRY & GOVERNMENT

Shell, SPOG, AEP, & EUB Prepared
- Written Response to Identified Issues and Concerns Including:
  - Acknowledgement of the issue
  - Reasoning why the issue existed
  - Steps taken to address issue in past
  - Future action to resolve issue appropriately

Provided Written Responses to CIP Participants
PUBLIC FORUM AND FOLLOW-UP ACTION

- Oral Presentation of Responses by H. SPOG, AEP & EUB to the Community and Answer Questions
- Establishment of SPOG as the Focal Point for Issue Resolution
- Deal with issues regionally
- Include Public members in Committees and decision making processes

FREE PETROLEUM OPERATORS' GROUP

Producers in area strongly encouraged to actively participate.

Scheduled Workshops on:
- Establishing working relationship with the community
- Communicating effectively (7 Habits, Impact Newsletter, Open House, BBQ)

Structured to accommodate public participation.
Tolled concerns for residents & EUB
needed for coordinated, consistent approach by operators for new E & P.
Advisory sub-committee formed including
EUB OG representative
community members (responsible to constituents)
BIL “B” Pool mineral holders
EUB (Head & Field Office Reps)

("B" POOL DEVELOPMENT

...)

Observation: “A long term relationship based on mutual trust, honesty and respect, by way of sharing pertinent information & resolving issues to benefit all stakeholders.”
Establishment of Community performance pressures and development expectations
Emergency response planning
Communications/egress routes
Impact minimization (W/PL/ ProdFac/ProcPlt)
Emission reduction (flaring/testing/producing)
Operator Development Plan reflected contract with the Public

kept & involve the public early as a 

imate partner (better solutions & win).

en carefully to public concerns and 
ond to them in an open, honest &

k manner.
continuously evaluate your efforts and make improvements when needed.

- Work collaboratively (e.g. SPOG), but avoid painting all stakeholders with the same brush.
Northwest Risk Management Program

Banff/99 Pipeline Workshop
Risk Management Presentation

Why Are We Developing a RM Program?

- Potential to use RM in Everyday Operations
- Miss-Match between Where We Are Spending Dollars and Where We Need to Spend Dollars
- US DOT is offering a risk based approach to regulations
- Makes common sense

Project Goals

- Address and Understand the Needs of System
- Demonstrate RM is Superior to "One Size Fits All" regulation
- Increase Reliability and Safety of the System
- Make Regulation Work Through Partnership

Overall Description of the Program

Phased Approach
- Phase I - Development and Test RM Principles on Specific Segments
- Phase II - Implement Program System Wide 2000-2002
- Implement Risk Program on all Williams Gas Pipeline Systems.
Phase I - Lessons Learned

• Existing risk control programs created excellent starts
• Company missing comprehensive approach focused on alternatives
• RM is a culture change
• Initial fear of having a formal quantification of risks available to outside sources
• Upper management support and understanding is essential

Realized Benefits

Realized Regulatory Benefits

• Project in Western Washington
• Regulations would have mandated 6 miles of replacement and 3 miles of strength test to maintain MAOP
• Risk assessment model and process gave background and documentation to demonstrate that this money spent on 9 miles was not addressing our highest risks

Realized Regulatory Benefits

• Alternatives were tested in RA models to show activities such as:
  - Internal Inspection of 73 miles
  - Additional SCC testing
  - Additional geologic hazard mitigation
  - Increased public awareness in populated areas
  - Installation of remotely operated valves
• Provided superior safety to the public

Realized Regulatory Benefits

• Completing alternative projects rather than prescriptive projects provided approximately 3.5 Million additional dollars which we then able to apply to other areas on the system
• Many operational benefits such as:
  - Removal of liquids
  - The ability to internally inspect in future at low cost
  - Increase knowledge of segment for future considerations

Weighing the Alternatives

Northwest Risk Management Program
**Realized Operational Benefits**

- 2 mile segment. CIS. Depolarization testing, annual pipe to soil tests, and bellhoming indicated a corrosion problem.
- Project was submitted to replace 2 miles of pipeline.

**Realized Operational Benefits**

- Comprehensive RA performed on this segment.
- RA results:
  - 2 mile area was high risk due to corrosion as well as other areas outside of the 2 mile area.
  - Within much larger CS to CS segment numerous geologic hazards exist.
  - Potential for Internal Corrosion exist.
  - Potential exist for liquids within segment.

**Realized Operational Benefits**

- Risk assessment results and comparison of the alternative competing projects indicated the internally inspecting the much larger area addressed the highest risks to 80 miles of pipeline.
- Project cost equal to the original plan to replace 2 miles of pipeline.

**Long Term Benefits**

- Experience and Knowledge walks out the door everyday.
- RM focuses on capturing knowledge for future utilization.
- Formal RM gives decision makers better information to make decisions.
- RM helps to reduce subjectivity and emotional decisions.

**Risk Management Program Development**

- Get upper management support.
- Start out slow, don't try to institute formal RM all at once.
- Determine what your risk profile before you go after data.
- Communicate RM as nothing more than putting common sense into a process.
- Involve field throughout the process.

**Questions?**
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Andrew Francis  BG Technology
Paul Meanwell  Union Gas Limited
Ian Dowsett  Conoco Pacific Environment

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Fred Bangs  B.C. G.C.S.E.
Terri's Charlie  Enbridge Pipelines
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Garret Den

N.E.B.