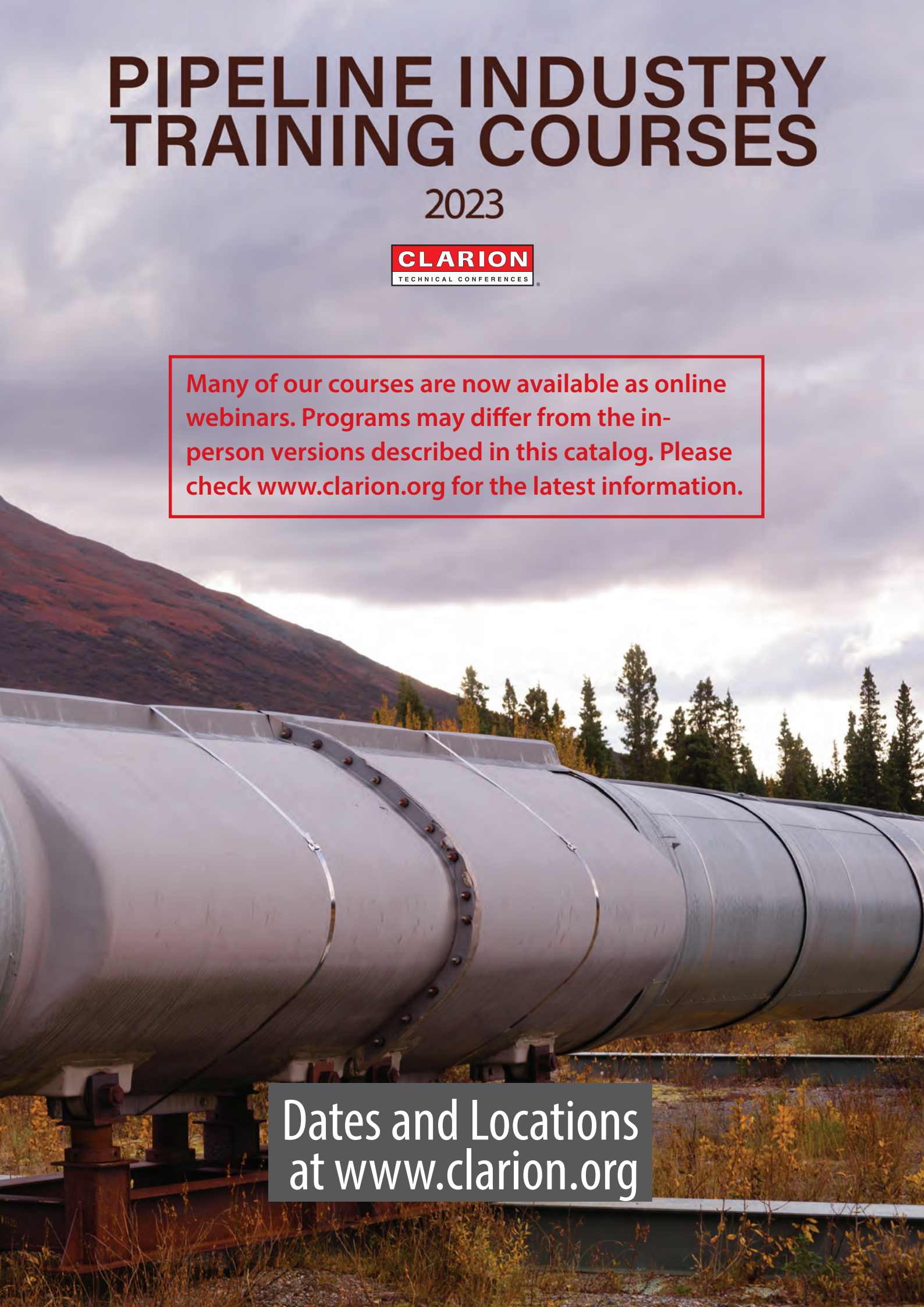
PIPELINE INDUSTRY TRAINING COURSES

2023

CLARION
TECHNICAL CONFERENCES

Many of our courses are now available as online webinars. Programs may differ from the in-person versions described in this catalog. Please check www.clarion.org for the latest information.



Dates and Locations at www.clarion.org

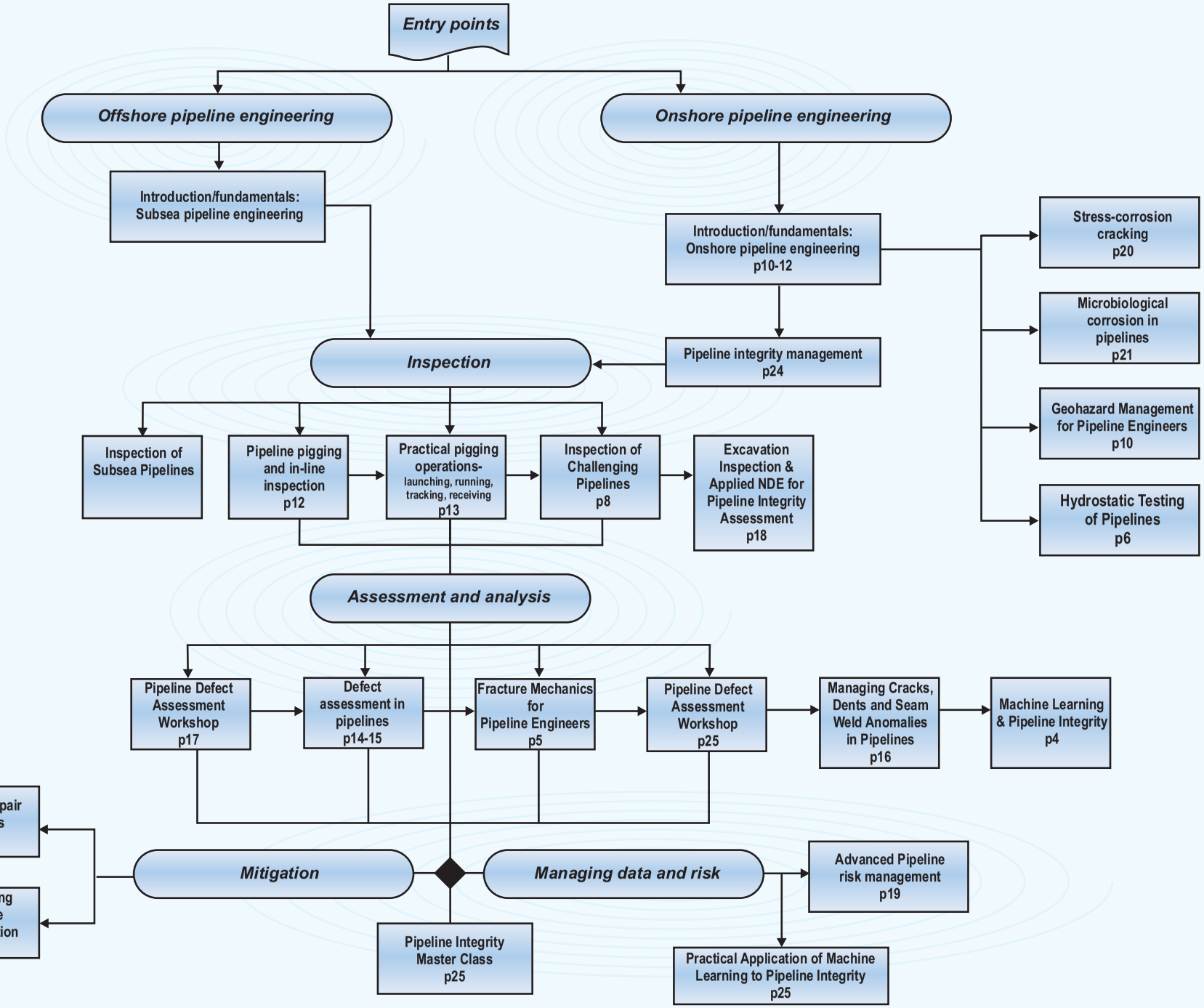
THE COURSES DESCRIBED in this brochure continue to represent some of the best-available industry-based technical training courses for those working in the oil and gas pipeline industry, both onshore and offshore. Ranging in length from one to five days, all are designed to be both informative and intensive; some are well known and have been presented to thousands of participants world-wide (the pipeline defect assessment course and the subsea pipeline engineering course are examples of these), while some are still relatively new to our program. All, however, are presented by recognized industry experts, and all undergo continuous development and improvement, based both on industry advances and participants' feedback.

While each course can be considered as 'stand-alone', they all have been planned to fit into the schematic shown opposite, with the intention of providing engineers and technical specialists in this industry with a defined route for training and continuous professional development. By following one or other of the various routes shown, an individual can be sure to receive an intensive and complete overview of the different subjects involved, starting at the basic level and progressing to an advanced understanding.

Clarion Technical Conferences® is committed continuously to update, revise, and augment this course programme, and for the latest information on what is planned, readers are referred to www.clarion.org and www.pipeconferences.com.

BJ Lowe, Director, Clarion Technical Conferences

Contents Please see the website for dates and locations: www.clarion.org


Entry points
Offshore pipeline engineering
Onshore pipeline engineering
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NEW! Practical Application of Machine Learning to Pipeline Integrity

Attendees will learn how to apply inferential statistical and machine learning methods to common pipeline integrity and risk management use cases. In this interactive hands-on course, participants will be presented the technical basis of machine learning fundamentals and will use their own data with open source software to experience its practical application.

Course objectives

This is a practical hands-on course structured as a "teach and do," where attendees will be presented the technical concepts of machine learning which they will then apply to their data. The objective of the course is for the attendee to learn how machine learning methods can support the following use cases:

- Learn & validate data driven algorithms
- Validate existing rule-based algorithms
- Measure the influence and importance of underlying threat data
- Infer missing or unknown data
- Establish optimal assessment intervals
- Support the assessment of un-piggable pipelines
- Support monetized risk-based decision-making

Who should attend

- Integrity managers & engineers
- Risk managers & engineers
- Data analysts

Preparation to attend

- Install machine learning desktop software on PC (a download link and installation instructions will be provided prior to the course)
- Prepare example data set (template will be provided)
- Watch software instructional videos (<2 hrs)

Lecturer

Michael Gloven, P.E. is Managing Partner of EIS (www.expertinfrasolutions.com) a Denver-based engineering consultancy focused on machine learning and risk management practices for the natural gas, hazardous liquids and water industries. He started his career with Conoco Pipeline holding various operational, engineering and management positions throughout the US. He then went on to co-found Bass-Trigon, a software and engineering company, and as president helped build the organization as a leading provider of risk and cathodic protection data management software. After acquisition of Bass-Trigon, he became an advisor to several international energy and technology companies, and soon afterwards started a new company focused on API 1173 process management for the pipeline industry which was then acquired in 2015. For the last several years, Mike has merged his software, engineering and domain expertise with machine learning practices to advance problem solving in the pipeline industry.

Course notes

- Presentation slides and related documentation will be printed in full color in spiral-bound book form as well as PDF download
- Machine learning configuration file (example machine learning processes)

Technical Content

- Fundamental Elements of Machine Learning as a Strategic Process
- Requirements for Data Preparation & Quality Assurance
- Inferential Statistics, Hypothesis Testing, Confidence Intervals
- Cognitive vs. Machine Learning Bias
- Math Fundamentals (Role of Linear Algebra, Statistics and Calculus)
- Feature Analysis (Information Gain, Correlation, Mutual Information, Deviation)
- Feature Engineering (Principal Component Analysis)
- Feature Selection (Forward and Back Propagation, Genetic Algorithms)
- Outlier Detection Methods
- Sampling Techniques, Cross-Validation
- Regression (Linear, Generalized, GBT, SVM, Polynomial, Deep Learning)
- Classification (CART, Bayes, KNN, Logistic Regression, GBT, Random Forest, DL)
- Clustering (X-Means, K-Means)
- Bias-Variance Trade-Off, Validation & Performance, Model Comparison
- Confusion Matrices, ROC Curves, Learning Curves
- Model Simulation and Sensitivity Analysis
- Model Application to Support Decision-Making
- Extending Methods to Support Monetized Risk Analysis
- Overview of Machine Learning Technology Options (R, Python, TensorFlow)
- Popular Learning Resources

Continuing Education Units: 1.4

Fracture Mechanics for Pipeline Engineers

This two-day course is ideal for engineers who work in the pipeline industry and are faced with the technical and regulatory challenges associated with the seam weld crack threat. The instructor is Dr. Ted Anderson, who is a well-known expert in fracture mechanics with many years of experience in the oil & gas industry. The attendees will receive a grounding in fundamental concepts of fracture mechanics, but with a focus on practical applications of this technology to the pipeline crack threat. A laptop is required for this course.

Who should attend?

- Pipeline engineers
- Designers and service professionals who are involved with the maintenance, inspection, and repair of pipelines.

Documentation

PDF files containing all presentation slides.
Textbook: Fracture Mechanics: Fundamentals and Applications, 4th Edition (2017), by T.L. Anderson.
An Excel-VBA application that performs burst pressure calculations, rainflow analysis, and pressure cycle fatigue analysis.

Lecturer

Dr. Ted Anderson is the author of a best-selling book on fracture mechanics, which has been adopted as a required text in over 150 universities. He recently returned to independent consulting after serving as Senior VP of Technology Development for Team Inc. and the Chief Technology Officer for Quest Integrity. He founded a consulting and software company in 1995, which was acquired by Quest Integrity in 2007. He holds a Ph.D. in Metallurgy from the Colorado School of Mines.

Syllabus

Introduction and Overview
- Cracks, notches and metal loss.
- Driving force versus resistance (toughness).

Linear Elastic Fracture Mechanics (LEFM)
- Stress intensity factor (K)
- Limitations of LEFM

Elastic-Plastic Fracture Mechanics
- Crack tip opening displacement (CTOD)
- J-Integral
- Fracture toughness testing.
- Relationship between Charpy energy and fracture toughness.

Pipeline Fracture Models
- Log-Secant
- CorLAS
- API 579 failure assessment diagram (FAD)
- PRCI MAT-8
- Strengths and weaknesses of various models.

Pressure Cycle Fatigue Analysis
- The Paris equation.
- Rainflow cycle counting
- Equivalent cycles and the Cyclic Index
- Computing re-assessment intervals based on hydrotest results or ILI data.

Special Topics
- Probabilistic analysis.
- Optimizing hydrostatic test pressures.

In-Class Exercises with Excel VBA Application
- Burst pressure calculations
- Rainflow analysis
- Pressure cycle fatigue analysis

"All material was well distributed … covered a great amount of material in a short time."
—Daniel Gutierrez, IMP Technical Leader, Dow Chemical

"Very well arranged and well presented."
—Thomas Windt-Jensen, Maersk Oil

"Very enlightening! The presentation contained very detailed information. The software is great … Good balance."
—Steven Axtell, Senior Metallurgist, Northern Natural Gas

Continuing Education Units: 1.4

Hydrostatic Testing of Pipelines

This course is designed for pipeline personnel in engineering, integrity management, operations, and regulatory compliance roles. This course will cover a wide range of topics related to hydrostatic testing of pipelines for gas and hazardous liquid service for both in-service and new construction according to CFR 49 Parts 192 and 195.

"Hands on. Real-world examples. Interactive. This course improved my understanding of the elements involved in the hydrostatic testing of pipelines."
—Ehren Koelsch

"Great presentation on several aspects of hydrotesting" Covered real-life examples. Great explanations on the physics behind fluids."
—Vera Idemudia, Integrity Engineer, DowDupont

Course Objectives

To provide attendees with necessary information for planning and conducting a successful hydrostatic test, whether it's for initial service or retesting existing lines. Planning will cover review of integrity prior to testing through evaluation of test results. The course will focus on testing with water but testing with other medium will be discussed.

Instructor

Gary Zunkel, PE, is the Senior Engineer of Pipeline Integrity with BlueFin in New Iberia, LA. He has been involved in the oil and gas industry for over 30 years with the last 10 years focusing on pipeline integrity management. He has been involved with over 200 pipeline tests; planning, managing, executing, and reviewing. In recent years, he has planned and conducted multiple, simultaneous tests on large diameter in-service pipelines for integrity verification.

Continuing Education Units: 1.4

Who Should Attend

The course is intended to cover the technical aspects of planning and conducting a hydrotest. It is designed for engineers, project managers, integrity management, and operations personnel to prepare for testing. The following topics will be covered:

- Pipeline integrity review
- Water source identification, disposal, and permitting
- Leak detection
- Risk assessment and contingency planning
- Calculations for test pressures according to 49 CFR 195
- Assessment of test results, including methods of analyzing pressure discrepancies
- Test scheduling
- Documentation for regulatory review

Course Outline

1. Establishing Test Requirements
   - Purpose of the test
     - ◊ Evaluate integrity of the pipeline
     - ◊ Confirm integrity program
   - Establishing pressure requirements
     - ◊ Federal regulatory requirements
       - Liquid – 49 CFR 195
       - Gas – 49 – CFR 192
     - ◊ Pressure parameters based upon MOP/MAOP requirements
     - ◊ Strength Test
     - ◊ Leak Test
     - ◊ Spike Test
   - Segment Isolation
     - ◊ Headers & End Caps
     - ◊ Valves
       - Gel Isolation
2. Conducting a Safe Test
   - Risks of potential energy
     - ◊ Compressed gas
     - ◊ Compressed liquid
   - Protecting the public
   - Managing test safety
     - ◊ Immediate area
     - ◊ Equipment
   - Communication prior to and during a test
3. Preliminary planning
   - Pipeline evaluation
     - ◊ Historical records evaluation
       - Repairs
       - Previous test records
       - Integrity records
   - Equipment pressure ratings
   - Elevation profile
   - Water sources
   - Water crossings
   - Exposed pipe
4. Test Schedule
   - Preliminary Scheduling
     - ◊ Water source & landing
     - ◊ Outage
     - ◊ Permitting
     - ◊ Pipeline rehabilitation
     - ◊ Notifications
   - Test Setup
     - ◊ Site preparation
     - ◊ Line Isolation
     - ◊ Line fill
   - Test Sequence
     - ◊ Stabilization
     - ◊ Pressurization
     - ◊ Test time
     - ◊ Depressurization
   - Water movement & discharge
   - Restoring a line to service
5. Water as a test medium
   - Source
     - ◊ Permits
     - ◊ Volumes
     - ◊ setup
   - Discharge
     - ◊ Permits
     - ◊ Treatment
   - Volume requirements and calculations
6. Other test medium
   - Liquid hydrocarbon
   - Natural gas
   - Nitrogen
   - Air
   - Applications
     - ◊ Requirements
     - ◊ Changes in test planning
     - ◊ Instrumentation
7. Leak Detection
   - Dye
   - Gas
   - Acoustic pressure
   - Section isolation
     - ◊ Valves
     - ◊ Freeze plugs
     - ◊ Test headers/caps
8. Test Documentation
   - Graphs
   - Calibration certificates
   - Drawings
   - Elevation profile
   - Test procedure
   - Summary of results
   - Explanation/calculations of pressure changes
     - ◊ Test pressure interpretation
     - ◊ Temperature effects on pressure
     - ◊ Air entrapment
     - ◊ Examples of test results and interpretation
   - Pressure Volume (PV) Plot
     - ◊ Creation of a PV Plot
     - ◊ Offset Line
     - ◊ Interpretation of a PV Plot
   - Test log
   - OQ documentation
     - ◊ Historical records evaluation
       - Repairs
       - Previous test records
9. Managing water movement
   - Fill rate
   - Purging prior to line fill
   - Dewatering
     - ◊ Product
     - ◊ Air
   - Drying
     - ◊ Explanation of terminology
       - Penetration depth
       - Dew point and temperature
   - Air lock
   - Contamination
   - Contingency
     - ◊ Drain up calculations
     - ◊ Refill/Retest planning
   - Discharge
     - ◊ Rates
     - ◊ Discharge structure
     - ◊ Treatment of contaminated product
   - Pigging
     - ◊ Types
     - ◊ Multiple pigs in the line
     - ◊ Launching receiving
     - ◊ Bypassing a station
     - ◊ Tracking
10. Instrumentation
    - Types – Pressure & Temperature
      - ◊ Bourdon Tube (Pressure & Temperature)
      - ◊ Bi-metallic (Temperature)
      - ◊ Resistance Temperature Detector (RTD)
      - ◊ Quartz electronic
    - Accuracy vs. Repeatability
    - Calibration
    - Pressure measurement
      - ◊ Deadweight – Mechanical/ Electronic
      - ◊ Gauges
      - ◊ Recorders
    - Temperature
      - ◊ Thermometer
      - ◊ Recorders
        - Quantity
        - Placement
        - Type
    - Volume measurement
      - ◊ Stroke counter
      - ◊ Flow meter
11. Data Interpretation & calculations
    - Pipeline evaluation
      - ◊ Historical records evaluation
        - Repairs
        - Previous test records
12. Test Failure
    - Rupture
    - Leak
    - Pressure reversal
    - Equipment failure
    - Location of failure
    - Repairs
    - Retesting
13. Contingency Planning
    - Repair materials
      - ◊ Sleeves
      - ◊ Replacement Pipe
      - ◊ Stopples
    - Emergency Response
      - ◊ Public relations
      - ◊ Notifications
      - ◊ Cleanup and remediation
    - Retesting
      - ◊ Venting & refill

Inspection of Challenging & Difficult-to-Inspect Pipelines

The course will provide an in-depth introduction into the inspection of challenging pipelines, i.e. pipelines that cannot be inspected in a straightforward manner using traditional free- swimming in-line inspection tools. The course will introduce typical flaws and anomalies found in challenging assets, including a wide range of metal-loss and crack features. Assets covered in the course include difficult-to-inspect onshore and offshore pipelines in the up-, mid- and downstream sector, including gathering and distribution lines, loading lines, storage lines, risers, flexible pipe and risers, laterals. The course includes an introduction of all relevant inspection technologies and related non-destructive testing principles as well as operational procedures, data analysis and reporting.

"Very competent lecturers, good overview of possibilities for challenging inspections."
—Ole N. Mortensen, Business Manager, FORCE Technology

"Great course, packed full of good material. Very knowledgeable presenters."
—Greg Knopinski, Enbridge Gas Distribution

"Very good class on all inspection techniques, not just challenging-to-inspect lines."
—Chuck Bartunek, Andeavor Logisitcs

Who should attend?

Pipeline Engineers, Integrity Engineers, Corrosion Specialists, Engineering Consultants in the field of pipeline inspection and integrity, personnel from regulators or certifiers involved with pipeline inspection and assessment.

Course Objectives

Approximately 40% of all pipelines installed globally are considered "un-piggable," which means they cannot be inspected with traditional free-swimming in-line inspection tools.

However these other lines also have to be inspected to investigate whether there are geometric, metal-loss or crack-related issues that would affect their mechanical integrity. Many of these challenging lines can be inspected from within, i.e. using specially designed or modified tools. Some, however, will have to be inspected from the outside because internal inspection is not possible at all.

The important questions relating to the inspection of Challenging Pipelines are:

- Accessibility:how can the line be accessed and how can an inspection device be introduced into the line?
- Negotiability:this relates to either operational challenges such as high flow and high pressure or low flow and low pressure during the inspection. It also relates to issues such as bends, diameter variations and other issues relating to the design or the operation of the pipeline.
- Propulsion:How is the tool moved through the line? Can it be pumped, is a cable or tether needed or maybe even a robotic approach?

All this will be covered in order for the partcipants to fully understand the difference between "piggable" and "unpiggable" pipelines. The objective of the course is to build this understanding and provide an awareness of a wide range of solutions available on the market.

Continuing Education Units: 1.4

Lecturers

Dr. Michael Beller has more than 28 years' experience in the pipeline inspection industry. Having served in both technical and management positions with Preussag Pipeline Services, Pipetronix, PII and NDT Systems & Services, he is currently Director of Corporate Strategy - Pipelines with Rosen Technology & Research Center in Karlsruhe, Germany. Michael holds a master's degree in mechanical engineering, and obtained his PhD in fracture mechanics. He has been involved with a large number of inspection projects all around the world, including on- and offshore inspection work. Michael has considerable experience as a presenter and trainer, and in lecturing. He has authored more than 75 papers on the subject of pipeline inspection and intelligent pigging, and is also co-author of a German reference book on pigging technology. Currently, Michael serves on a number of Technical Committees and is also a member of the editorial board of The Journal of Pipeline Integrity. He is a former president of the Pipeline Products and Services Association.

Dr. Konrad Reber studied physics and material science at the University of Mainz and Erlangen. For his Ph.D. thesis he worked on stray flux methods for the testing of magnetic materials. At Pipetronix he was responsible for the development of data analysis algorithms and the design of MFL-pigs. After moving to NDT Systems & Services AG in 2000, his focus changed to defect assessment and integrity management. Between 2006 and 2008 Konrad was with TÜV Rheinland as an expert within the Pipeline Technology Group. Since 2008 he has been head of research and development for the Innospection Group. His department is responsible for designing new inspection equipment for the oil and gas industry. His focus is on the development and refinement of testing technologies with applications for underwater and otherwise difficult-to-inspect structures.

Geohazard Management for Pipeline Engineers

The course is an introduction to Geohazard Management for non-geotechnical pipeline managers and regulators within the Canadian context. It focuses on the key issues in Pipeline Geohazard Management, including:

- Leading concepts and practices for the entire pipeline life cycle
- Identification of Geohazards and their effects on pipelines
- Risk reduction strategies during design, construction and operations

The course covers the management of related data, risk assessment, monitoring and mitigation technologies. It also reviews the range of risk assessment methods with examples from the pipeline industry.

In recent years, the pipeline engineering and construction community has gained valuable experience associated with routing, design and construction of new major pipeline projects in challenging environments, and in meeting the heightened expectations of ensuring the integrity of aging operating systems. World-wide, regulatory agencies are raising their expectations of the pipeline industry to deal more rigorously with Geohazards including landslides, erosion and seismicity.

The topics addressed in this course have recently seen significant advances that have redefined the state-of-practice in how to design, construct and ensure the integrity of operating pipelines in areas prone to Geohazards.

An important guiding philosophy for practically managing these hazards in a responsible yet cost-effective manner is to consider Geohazard effects from the pipeline out, as opposed to a purely geotechnical treatment of Geohazard occurrence independent of the pipeline.

Lecturers

Moness Rizkalla is president of Visitless Integrity Assessment Ltd. in Calgary. Prior to forming VIA he held positions with WorleyParsons, TransCanada / NOVA, and PRCI. Mr. Rizkalla is a recognized specialist in pipeline design and integrity management. His experience includes several management and senior technical roles in pipeline design, project management, pipeline risk assessment and integrity management planning, operations support, and associated technology development and applications. His professional experience has been gained in both Canadian and international settings. Within the pipeline integrity management area, Mr. Rizkalla has specialized in the management of external load hazards – geotechnical and mechanical damage. He has been involved in a wide range of pipeline geotechnics with an extensive list of associated publications. In 2000 he founded Visitless Integrity Management, a company that delivers commercial proactive prevention solutions to the pipeline industry's mechanical damage challenges. Mr. Rizkalla holds a BS in Civil Engineering and an MS in Civil Engineering (Geotechnical).

Dr. Rodney S. Read is a practicing consulting engineer specializing in applied rock mechanics and geotechnical engineering. He is president of RSRead Consulting, Inc., based in Okotoks, Alberta. Dr. Read has been involved in projects ranging from concepts for nuclear waste disposal to geohazard assessments for pipelines in challenging physiographic environments. He was geotechnical lead on the Turtle Mountain monitoring project at the historic Frank Slide in southern Alberta, the site of Canada's deadliest landslide. His current interests involve geotechnical risk assessment of linear systems in difficult terrain. Dr. Read holds a BS in Geological Engineering and a Ph.D. in Civil & Geological Engineering.

Continuing Education Units: 1.4

Who should attend?

Supervisors, engineers and technicians responsible for ensuring the adequate protection of pipeline assets; regulators.

Course notes

All delegates will receive a detailed set of lecture notes on cd providing an invaluable reference document. The course documentation also includes the reference book *Pipeline Geo-Environmental Design and Geohazard Management* edited by Moness Rizkalla (2008) as well as the 2009 PRCI study *Guidelines for Constructing Natural Gas and Liquid Hydrocarbon Pipelines Through Areas Prone to Landslides and Subsidence Hazards*, a combined $225 value.

Syllabus

DAY 1

1. Introduction
2. An overview of regional Geohazards – focusing on the more commonly encountered hazards such as landslides, seismic, subsidence and water course related integrity issues
3. Data Management Requirements and Utilization
4. Hazard Assessment Methodologies – Prioritizing and Addressing risk
5. Hands-on Exercise

DAY 2

6. Monitoring – An overview of options
7. Design and Operational Mitigation - an overview of options
8. Hazard Reduction strategies during design and construction
9. The Geohazard Management Planning Process – Integration of components
10. Hands-on Exercise
11. Conclusion

Onshore Pipeline Engineering

THERE ARE MILLIONS of kilometers of onshore oil and gas pipelines around the world. As the industry expands and new staff are introduced into it, there is an increasing need for full appreciation of the engineering design of pipelines. Additionally, many staff in the pipeline industry have not received basic pipeline engineering training, and some staff are only exposed to specialized areas. This course is a formal introduction to pipeline engineering.

"I really liked the information, pictures and illustrations of actual execution of pipeline construction and operational activities - a lot of this is not taught in school."
—Samantha Choi, ConocoPhillips

Who should attend?

- Engineers who are new to the pipeline business and those who wish to update their knowledge, including:
- Pipeline engineers, pipeline construction engineers, project managers, maintenance engineers, contractors, supervisors, inspectors, operators, equipment suppliers, inspection and quality engineers, pipeline design engineers.
- Engineers who need a wider appreciation of onshore pipeline engineering.

Documentation

Included with the course fee is a detailed set of lecture notes (700 pages, COLOR) and a CD containing an additional 300 pages of text reference material.

Continuing Education Units: 3.0

"Good experience and lots of knowledge for someone new to pipeline engineering like me. All topics covered were very informative and thoroughly explained, regardless of time constraints. Dr. King and Prof. Hopkins did an excellent job. Thanks to Clarion and GPM for this great course."

"The instructors' knowledge and experience are first rate."

Lecturers

Dr Phil Hopkins is a consulting engineer with more than 35 years' experience in pipeline engineering. Phil formed his consultancy company in 2015, after being Technical Director with Penspen Ltd in the UK, and previously Managing Director of Andrew Palmer and Associates, in the UK. He has worked with most of the major oil and gas companies and pipeline companies around the world, providing consultancy on management, business, design, maintenance, inspection, risk analysis and safety, and failure investigations. He is the past-chairman of the ASME Pipeline Systems Division, and is a Fellow of ASME. More than 15,000 engineers and technical personnel around the world have attended his courses. He also teaches extensively on masters' programmes at Newcastle and Northumbria Universities in the UK.

Dr Roger King has over 30 years' experience of corrosion in the oil, gas, civil, and nuclear industries. He has specialist knowledge of sweet and sour corrosion and its prevention by chemical inhibition, monitoring of corrosion, microbiological corrosion, and the design of efficient cathodic-protection systems for flowlines, structures, and seabed installations. He has been an independent consultant since September, 1989, and prior to this was a founder member of the Corrosion and Protection Centre Industrial Service (CAPCIS) at the University of Manchester Institute of Science and Technology (UMIST).

Tom Miesner spent 25+ years at Conoco Pipeline, retiring as President in 2003. Over those 25+ years Tom held many industry positions and served on a variety of boards and management committees. In 2004, Tom became a pipeline consultant, and in 2008 he founded Pipeline Knowledge & Development. Since 2008, Tom has taught over 150 classes to over 2,500 students. Tom is currently producing video based training materials and working on the second edition of *Oil and Gas Pipelines in NonTechncal Language*. Tom is also an angle investor and works with a variety of midstream stakeholders to improve the safety, reliability, efficiency and environmental performance of the industry.

"The course is great ... knowledgeable and experienced lecturers. What I liked most was the information from the presentation slides ... very useful to me."





Course Program

Day 1

Pipeline Engineering Basics (HOPKINS)
- Basics of Oil and Gas
- The Petroleum Industry
- Introduction to Pipelines
- Basic pipeline and material parameters
- Pipeline Safety
- History of Pipelines

Pipeline Materials Selection (KING)
- Steels used for Line pipe
- Compositional Limitations, Mechanical Properties, Grades
- Fabrication of Line pipe – Seamless, Longitudinal Welded, ERW, Spiral
- Toughness and Weldability
- Improving Corrosion Resistance
- Solid Corrosion Resistant Alloy Pipe
- Internally Clad Pipe
- New Materials

Pipeline Design (HOPKINS)
- Legislation and regulations
- Development of pipeline design codes
- Design Process
- Detailed design:
- Pipeline Crossings
- Pipeline Valves

Day 2

Other Pipeline Design Considerations (HOPKINS)
- Surges/overpressures
- Bends
- Pipe protection
- Fracture control
- Fluids and Hydraulics

Pipeline Welding (KING)
- Basics of Welding
- Types of Welding Processes
- Effects on Line pipe of the Welding Process
- Welding Procedures
- Inspection of Welds

Design Exercise Part 1

Pipeline Routing and Construction (HOPKINS)
- Basics of routeing
- Classification schemes
- Easements and rights of way
- Legislation and permits
- Routeing methodologies
- Pipeline construction

Internal Pipeline Corrosion (KING)
- Why Pipes Corrode
- Sweet Corrosion, Sour Corrosion, Microbiological Corrosion
- Cracking Mechanisms
- Calculating Corrosion Rates
- Effect of Flow on Corrosion
- Water Injection Pipelines

Day 3

Monitoring of Internal Pipeline Corrosion (KING)
- Inhibition of Corrosion
- Biocide Treatment of Pipelines
- Monitoring Internal Corrosion
- Supplementary Inspection Techniques

Pipeline Testing, Operation, Inspection (Hopkins)
- Pressure Testing
- Batching
- Incorrect operation
- Control Systems, Leak Detection
- Inspection and monitoring of operational pipelines

Pipeline Project Control (HOPKINS)
- Management
- Scheduling and resource planning
- Execution
- Contracting strategies

External Pipeline Corrosion and its Prevention (KING)
- External Corrosion in Soils
- Coatings and their Application
- Field Joints
- Interaction of Coatings and Cathodic Protection

Design Exercise Part 2

Day 4

Cathodic Protection (KING)
- How Cathodic Protection Works
- Monitoring of CP at Test Points
- Full Line Surveys with CIPS and Instant Off Surveys
- Coating Surveys using Pearson and DCVG Techniques
- Interference from Third Party Lines and DC/AC systems

Utility and Intelligent (Smart) Pig Inspection (HOPKINS)
- The History of Internal Inspection
- Why 'Pig'?
- Types of Pig
- The History of Internal Inspection
- Why 'Pig'?
- Types of Pig
- Intelligent (Smart) Pigs:
- What do they find and how accurate are they?
- Pigs versus Hydrotest

Pipeline Equipment and Systems – (Miesner)
- Hydraulic tools
- Equipment – pumps, compressors, motors, pressure control devices
- SCADA
- Leak detection

Day 5

Pipeline Engineers (HOPKINS)
- Responsibilities, duties and ethical behavior

Pipeline Repair (HOPKINS)
- Pipeline Defects
- Pressure reductions prior to repair
- Repair methods

Pipeline Integrity Management (HOPKINS)
- Risk and risk analysis
- Integrity management methods:
- Class tutorial – risk analysis of 3 pipelines

Close with Question and Answer Session (HOPKINS & KING)

"A great course...I'm glad to have had the opportunity to attend"

Pipeline Pigging and ILI

THE USE OF in-line tools for inspection and cleaning is accepted as essential for the safe and profitable operation of all pipelines. internal inspection is required for detecting changes in circumference, anomalies, or wall loss due to corrosion. Pipeline operators offshore wage a constant battle for flow assurance against paraffin, hydrate, and asphaltene formation in deepwater lines, and pigging, combined with chemical treatment, is their primary weapon. The course is designed to provide a comprehensive introduction to all aspects of utility and in-line inspection pigging.

"Time well spent!! Very comprehensive and detailed. Don't change a thing!"
— J. Ryman, BP

"I came with very high expectations and was not disappointed. I have been presenting adult education for 10 yrs. Very professional from introduction to closing"
—D. Hennerbichler, ESSO

"Good speakers who know their stuff."
—I. King, ConocoPhillips

"A solid overview of ILI tools and processes. The speakers were exceptionally knowledgeable in their subject areas."
—Erin Wishart, Union Gas Ltd.

"Good knowledge of ILI tools and excellent explanations"
—Osaze Uwagboe, ExxonMobil

Lecturers

Dr. Tom Bubenik is Vice President of Integrity Services at CC Technologies Services, Inc. He has more than 30 years of experience in pipeline integrity assessments, in-line inspection tools and their capabilities, direct assessment techniques and methodologies, field data collection, and the impact of defects and inspection on pipeline operations and maintenance. Dr. Bubenik's research experience covers inspection technologies for pipelines, analysis tools for corroded and damaged pipelines, and repair techniques for pipelines.

Pam Moreno has more than 30 years experience assisting clients in getting the most from their pipeline integrity efforts, including Inline Inspection programs. She specializes in conducting risk and threat assessments of pipeline facilities. She is involved in all aspects of Asset Risk Management of Pipelines and Facilities, evaluating risk of pipeline segments based on multiple integrity threats and data sets, assisting clients in developing their Integrity Management Programs and more specifically their Inline Inspection programs.

Gary Smith is president of Inline Services, a Houston-based company specializing in pigging equipment and services. He has more than 30 years experience in the pipeline pigging industry, working in services such as commissioning and maintenance of pipelines as well as with designing and manufacturing pigging equipment.

George Williamson is currently Segment Engineering Technical Authority – Inspection, for the Upstream Global Projects group within BP. He has more than 25 years of Operations, Maintenance and Integrity Management experience. He is a registered professional engineer, NACE certified corrosion and a cathodic protection specialist. He has managed compliance and integrity programs for production facilities, gathering systems, liquid and gas transmission pipelines.

Chris Yoxall is Vice President of the ROSEN Group. He commenced his career in South Africa and thereafter relocated to Perth, Australia and now also resides in Houston, USA. Chris remains globally active with industry memberships and committees as is involved in development and oversight of standards and practices related to pipeline inspection and integrity assessment, including PRCI, ASME, NACE, and APIA. Chris is on the APIA RSC executive committee and has a passion for supporting and mentoring newly inducted professional engineers into our industry. Chris, with a mechanical and metallurgical engineering background, has more than 20 years of industry experience and has worked throughout Africa, Asia, Europe and North America.

Who should attend?

The course is specially designed for project managers, engineers, maintenance, and technical personnel responsible for pipeline integrity assurance, flow assurance, corrosion control, and safety.

Course Program

DAY 1

Pipeline safety and regulations
- Brief history of pipeline failures
- Impact of recent legislation and regulations
- Review of inspection and maintenance compliance
- What to expect in pending regulations

Pigging for operation and maintenance
- Pigging during construction
- Pigging during operation

Utility pigs
- Cleaning pigs, Sealing pigs, Gauging pigs
- Dual diameter pigs, Magnetic cleaning pigs
- Designing a pipeline for pigging
- Pig traps, pigging stations, Location, tracking devices

In-line inspection (ILI) tools
- Line pipe integrity threats
- ILI tools available to the operator
- Metal loss inspection, Deformation tools, Crack detection, Movement and pipeline mapping

DAY 2

Designing and implementing an ILI program
- Selecting an ILI tool
- Specific design considerations for running ILI tools
- Launch and receive trap design
- Bends, tees, and valves, Issuing an enquiry
- Schedule requirements, Preparation for ILI
- Controlling operational parameters
- Strategy for contract development and negotiations
- Developing a good specification
- Contingency planning for a stuck pig
- Offshore risers, Onshore flowlines

Post in-line inspection issues
- The inspection report, Responding to the report
- Response prioritization
- Validation of the inspection report
- Acceptance of the report
- Re-assessment intervals - risk and probabilities

Documentation

Included with the course fee is a detailed set of lecture notes and the reference handbook *Pipeline Pigging & Integrity Technology, 4th Edition (2013).*

Continuing Education Units: 1.4

Practical Pigging Operations

THIS NEW TRAINING COURSE is being developed to provide a wide-ranging overview of all aspects of pigging operations. The course will be held at several different pressurized pipeline test loop facilities around the world.

Who should attend?

Engineers and technical personnel involved in field pigging operations.

Course Notes

The classroom portions of the course will be fully documented with all slides and related documents printed in a durable 3-ring binder for reference during and after the course.

Syllabus

The syllabus will include both hands-on exercises using the test loop(s), and classroom instruction, and include full documentation. The content of the course is being developed jointly by Penspen, Rosen Engineering, and Clarion/Scientific Surveys Ltd. Rosen Engineering, through its Rio de Janeiro office, has agreed to provide cleaning-, geometry-, and intelligent tools for use during the course, along with its expert technicians. Among subjects that the syllabus will cover are:

- Pig trap doors: design, operation
- Types of utility tool
- Types of intelligent tool
- Launch/receive trap design
- Launching and receiving utility and intelligent tools
- How to assess a tool's performance
- Signaling and pig location
- Locating and reporting sample defects
- Site safety: procedures and performance

The syllabus will include both hands-on exercises using the test loop(s), and classroom instruction, and include full documentation.

Lecturers and Operators

The course faculty and test loop operators vary with location. Please contact us for details.

Continuing Education Units 3.0

"A great course with lots of useful information and practical advice. I would recommend it to anyone interested in the subject."

"I learned a lot more than I expected."

"Wonderful - it is a complete basic course. Nice simulations and a marvelous staff."

Defect Assessment in Pipelines

MANY TRANSMISSION PIPELINES are now over 50 years old. This is "middle aged" in pipeline terms, and even the best-designed and -maintained pipeline will become defective as it progresses through its design life. Therefore, operators need to be aware of the effect these defects will have on their pipeline, and — more importantly — be able to assess their significance in terms of the continuing integrity of the pipeline. The increasing use of high-technology maintenance (for example, intelligent pigs) is helping pipeline owners to assess the condition of their lines, and if these modern maintenance methods are combined with modern defect-assessment methods, they can provide a very powerful, and cost-effective, tool.

This course will present the latest defect-assessment methods to pipeline engineers and managers. These methods will range from simple, quick, assessment methods, to the more-detailed —fitness for purpose— analysis. The course is highly interactive and takes the form of lectures, workshops, and case studies. The course will cover methods available to assess the significance of defects detected in onshore and offshore pipelines. It will introduce simple analytical methods used to assess internal and external corrosion, dents and gouges, cracks (e.g. SCC), weld defects, and fatigue. The course is unique as it is a holistic approach to defect assessment, and it ensures the student appreciates all aspects of the subject, including repair and risk management.

"Surpassed my best expectations"

"I found the course to be extremely educational and well presented."

"Dr. Hopkins is very knowledgeable, and he communicates the course content well... makes it easy to understand."
—Ricardo Montes, Southern California Gas Co.

"The broad subject matter approach filled a lot of knowledge gaps"
—Charles Bartunek, Tesoro SoCal Pipeline Company

"Good lecturer, attentive to students' queries and knowledgeable of the pipeline business."
—Preston Smith, Engineer in Materials/Corrosion/Inspection/Structural [*company name withheld by request*]

Who should attend?

Pipeline engineers, designers and service professionals who are involved with the maintenance, inspection, and repair of pipelines.

Documentation

All participants will receive a detailed set of lecture notes (700 pages in COLOR) plus a CD containing 500 pages of documents for further reference.

Lecturer

Dr. Phil Hopkins is a consulting engineer with more than 35 years' experience in pipeline engineering. Phil formed his consultancy company in 2015, after being Technical Director with Penspen Ltd in the UK, and previously Managing Director of Andrew Palmer and Associates, in the UK. He has worked with most of the major oil and gas companies and pipeline companies around the world, providing consultancy on management, business, design, maintenance, inspection, risk analysis and safety, and failure investigations. He is the past-chairman of the ASME Pipeline Systems Division, and is a Fellow of ASME. More than 15,000 engineers and technical personnel around the world have attended his courses. He also teaches extensively on masters' programmes at Newcastle and Northumbria Universities in the UK.

Continuing Education Units: 1.7
(1.4 for the 2-day version)

"Great presenter. Good at keeping the class's attention and making the information interesting."
—Alexander Woll

Course Program

DAY 1

Introduction to basic pipeline engineering principles
- Basic pipeline design principles
- Stresses in pipelines
- Routing of pipelines
- Basic pipeline operating and maintenance parameters
- Maintenance and inspection methods

Introduction to pipeline defects – why pipelines fail
- How safe are pipelines?
- How often do they fail?
- What causes pipelines to fail?
- Pipeline risks
- History of pipeline defect assessment

Introduction to fracture mechanics (handouts and notes only, no lecture)
- Basic theory
- Brittle and ductile fracture
- K, J, and CTOD

Fundamental pipeline defect failure relationships
- Why pipeline defects fail
- Fundamental failure relationships
- Explanation of key parameters

DAY 2

How to assess corrosion defects
- Introduction to basic theory
- Background, strengths and weaknesses
- Methods to assess corrosion
- ASME B31.G and RSTRENG methods
- DNV, BG, etc., methods
- Interacting defects
- Universal curves for assessing corrosion defects.

Workshop: corrosion assessment using fitness for purpose

How to assess gouges
- Introduction to basic theory
- Methods to assess gouges
- Additional problems and concerns with gouges

How to assess dents
- Introduction to basic theory
- Methods to assess dents
- Methods to assess dents containing gouges
- Rock dents
- Problems with fatigue loadings

How to assess cracks
- Basic theory
- The problems with cracks in pipelines
- Stress corrosion cracking (low and high ph)

How to assess weld defects
- Welds in pipelines
- Assessing defects in pipeline girth welds
- Assessing non planar defects in welds
- The EPRG girth weld defect guidelines
- Fatigue design of girth welds

Setting intelligent pig inspection levels
- Pigs — where they came from and what they can do
- Basic theory
- Magnetic, ultrasonic pigs – their accuracy and limitations.
- What pigs can detect
- What operators want to detect
- Setting intelligent pig inspection levels

Workshop: setting intelligent pig inspection levels

How to assess fatigue (handouts and notes only, no lecture)
- Why do pipelines fatigue?
- Basic fatigue theory
- Fatigue assessment – design
- Fatigue assessment – service

Fracture propagation and arrest
- Why fractures propagate
- Brittle and ductile propagation
- Fracture arrest
- Calculating toughness requirements

DAY 3

Pipeline repair and rehabilitation
- Repair and rehabilitation strategy
- Response to discovering defects
- What are the cost implications?
- Repair methods: grinding, weld deposition, sleeves, clamps, hot tapping, composite wraps
- Time to repair

Risk and integrity management and analysis
- What is risk and risk analysis?
- Risk management around the world
- Risk management in the USA
- Risk management methods – API 1160 and ASME B31.8
- Baseline and direct assessment – discussion item
- Integrity management programs
- Prioritization schemes

Workshop: setting priorities

"I appreciated the instructor's ability to answer technical, metallurgical questions..it's critical that the person teaching the course is able to do this, to expand on the concepts discussed beyond the information presented in the slides. Phil did a great job of this."

"I thoroughly enjoyed the content and the presentation. Hats off to Prof. Hopkins"
—A. Ellison
Pipeline Integrity Coordinator
Centurion Pipeline L.P.

"Great Course... teacher Phil Hopkins very patient and knowledgeable-explained difficult concepts very well."

"Excellent class, good blend of teaching and student participation"
—M. Odigie
Elf Petroleum
Nigeria Limited

Managing Cracks, Dents and Seam Weld Anomalies in Pipelines

"Very good course and well taught; numerous takeaways to review and use to be a better operator."
– Erick Hallett

"Very knowledgeable instructor; great use of examples and experiences to complement the material."
– McKenzie Kissel

"If the operator has reason to believe any pipeline segment contains or may be susceptible to cracks or crack-like defects … the operator must perform fracture mechanics modeling for failure stress pressure and crack growth analysis to determine the remaining life of the pipeline…."
PHMSA Notice of Proposed Rulemaking

Various forms of cracks or crack-like indications are known to be present in pipelines, which could become a safety concern to their safe operation. The most common forms of cracking are manufacturing related, environmentally induced, and mechanically driven, such as Stress Corrosion Cracking, Corrosion Fatigue Cracking, Hydrogen-Induced Cracking, Hook Cracks, and anomalies associated with the Seam Weld (as those found in vintage ERW/flash-welded pipe).

This course will provide an integrated, data-driven approach for addressing these forms of cracking and seam-weld anomalies. It covers in greater depth the formation of these types of features and the conditions that drive their growth until they become unstable, leading to leaks or ruptures. The appropriate assessment methods such as ILI crack tools, pressure testing and direct assessments will be presented as well as traditional and current engineering approaches for establishing crack severity and determining future integrity. Case studies will be reviewed and discussed throughout course instruction. Appropriate repairs options for cracks will also be covered.

What Will Be Learned

On completion of the course, the student will understand what factors contribute to the formation and growth of crack-like features and seam-weld anomalies in pipelines. In addition, the participant will be able to gather and analyze the type and extent of cracking found, key operational parameters, pipe material properties, full-scale testing data, and ILI crack tool data, and to apply industry-recognized engineering methods for developing and recommending appropriate remedial actions.

Who should attend?

- Pipeline engineers and maintenance personnel who are involved or responsible for the maintenance, inspection, assessments and repair of pipeline systems
- Non-Destructive Inspection personnel who wish to acquire or increase their knowledge of crack formation and growth in pipelines
- Analysts who review ILI Crack tool data and issue inspection reports

Documentation and Materials

Participants will receive a full set of course slides and notes in paper and electronic form, in color throughout.

Continuing Education Units: 1.6
(1.4 for the 2-day version)

Lecturer

Sergio Limon has worked in the oil & gas pipeline industry for more than 15 years with emphasis on pipeline integrity threat analysis and response. He was employed for 10 years with a large owner and operator of natural gas gathering, processing and transportation services. He led for six years the Asset Integrity group for the western division responsible for the analysis, response and remediation of integrity threats as well as the implementation of the Gas Integrity Management Program. Sergio holds B Sc. and M Sc. degrees in Mechanical Engineering with emphasis in fracture mechanics and materials from the University of Utah. He is the founder of Elevara Partners.

Topics covered

1. Formation and Growth of Cracks, Crack-like Features and Dents in Pipelines
2. Foundations of Engineering Fracture Mechanics
3. Performing Engineering Evaluation of Cracks and Seam Weld Anomalies
4. Performing Engineering Evaluation of Dents
5. Integrity Assessments for Addressing Cracks and Dents
6. In-Ditch Non-Destructive Evaluation (NDE) and Repair Methods

The Pipeline Defects Clinic

including corrosion mechanisms and control

This course examines how the manufacturing and corrosion defects identified by intelligent pigging may arise, and how they may develop. With a solid understanding of the ways in which these defects originate, course participants will be better equipped to characterize and prioritize them in review and analysis of inspection reports, and to minimize defects in the fabrication process. The course is a "linking" course between the Pigging & ILI course and the Pipeline Defect Assessment course.

Who should attend?

- Engineers, designers, service professionals and pipe manufacturers who are involved with pipeline fabrication, inspection, and fitness-for-service assessments.
- ILI data specialists.
- Corrosion and materials specialists.

Documentation

All participants will receive a detailed set of lecture notes (400pp approx.) in ring binder format.

Lecturers

Dr Michael Beller has more than 28 years' experience in the pipeline inspection industry. Having served in both technical and management positions with Preussag Pipeline Services, Pipetronix, PII and NDT Systems & Services, he is currently Director of Corporate Strategy - Pipelines with Rosen Technology & Research Center in Karlsruhe, Germany. Michael holds a master's degree in mechanical engineering, and obtained his PhD in fracture mechanics. He has been involved with a large number of inspection projects all around the world, including on- and offshore inspection work. Michael has considerable experience as a presenter and trainer, and in lecturing. He has authored more than 75 papers on the subject of pipeline inspection and intelligent pigging, and is also co-author of a German reference book on pigging technology. Currently, Michael serves on a number of Technical Committees and is also a member of the editorial board of The Journal of Pipeline Integrity. He is a former president of the Pipeline Products and Services Association.

Dr Roger King has over 30 years experience of corrosion in the oil and gas, civil, and nuclear industries. He has specialist knowledge of sweet and sour corrosion and its prevention by chemical inhibition, monitoring of corrosion, microbiological corrosion and the design of efficient cathodic protection systems for flowlines, structures and seabed installations. He has been an independent consultant since September 1989, prior to which he was a founder member of the Corrosion and Protection Centre Industrial Service (CAPCIS) at the University of Manchester Institute of Science and Technology (UMIST).

Continuing Education Units: 3.0

Course Program

Day 1

- Creating a "virtual" pipeline
- Manufacturing defects in pipeline materials
- Testing for defects in the steel and pipe mill
- Construction defects
- NDT methods utilized during pipeline construction and commissioning; creation of the "virtual" pipeline

Day 2

- Internal corrosion in water injection pipelines
- Overview of pipeline inspection techniques
- Identification and sizing of metal loss defects in liquid pipelines
- Corrosion Risk Assessment
- Corrosion Risk Assessment of water pipelines
- Internal corrosion in oil production pipelines

Day 3

- Identification and sizing of metal loss defects: resolution, accuracy and Special Issues
- Corrosion Risk Assessment
- Internal corrosion in gas production pipelines
- Identification of metal loss defects in gas pipelines

Day 4

- Crack Detection in High Pressure Pipelines
- Introducing Combo and Multi-Technology Inspection Tools
- Corrosion Risk Assessment
- External corrosion of onshore and offshore pipelines
- Identification of defects in onshore and offshore pipelines
- Verification of Inspection Results, Measurement Errors and Input for Integrity Assessment

Day 5

- Corrosion risk assessment of onshore pipelines
- Corrosion risk assessment of offshore pipelines
- Integrating defects into the "virtual" pipeline
- Inspection of Non-Piggable Pipelines

Introduction to Excavation Inspection

and Applied NDE for Pipeline Integrity Assessment

On completion of the course, participants will have a solid understanding of the minimum requirements to ensure maximum correlation with ILI and Direct Assessment results during an excavation program. In addition, each participant will receive a general understanding of the available technology and procedures to implant contracts, increase quality, and reduce overall project costs.

The course had been designed around the critical step of excavation inspection and documentation or, more recently termed by DA, as the 'third step. Focus will be on the validation and correlation of both ILI results and/or Direct Assessment techniques through non-destructive testing in the excavation. Comprehensive course notes as well as reference material will be provided, a valuable guide for future applications.

"The pig is wrong" is not often the case: "No anomalies found" is not enough information.

"The course was an excellent overview of the tasks of a pipeline integrity engineer, reinforcing the confidence and intellect behind daily project decisions. It also provided a forum for recent developments in the industry, as well as share thoughts with others."

"Great topics and use of case studies and actual hands on NDE equipment.... Presenters were extremely knowledgeable and took the time to explain things. The hands on was great."
—Brian Bruce

Who should attend?

The course is specifically designed for project managers, engineers and technical personnel responsible for the management, implementation and reporting of pipeline integrity inspection activities.

Syllabus

Importance of data collection and correlation
- What / why information to collect.
- Industry guidelines
- General work flow
- Reporting requirements

Contract considerations for ILI and or DA vendors
- Reporting format
- Delectability tolerances
- Sizing tolerances
- Re-grading of the logs

Contract considerations for NDT vendors
- Qualifications
- Available technology
- Abilities and limitations NDT inspection techniques.
- Procedure demonstration
- Documentation

Optimize NDT results with ILI or DAresults
- Excavation location verification
- Universal naming system for anomalies
- Universal location and sizing system for anomalies
- Reporting format

What do you do if you *don't* find an anomaly in the excavation
- General procedures
- ILI tool-specific procedures (MFL, UT, mechanical)

Advanced NDT techniques and technology
- Corrosion
- SCC
- Mechanical
- ERW and girth welds

Specialized excavations
- Pre 1970 ERW
- SCC soils modeling

Continuing Education Units: 1.4

Lecturers

Jim Marr is President of Marr Associates Pipeline Integrity Ltd. Marr Associates has been in the pipeline integrity business since 1992. For the last eight years he was the SCC Program Planning Manager for TransCanada Pipelines. Jim has worked in pipeline integrity for the past 30 years, focusing on SCC, external corrosion, direct assessment, direct examination, ILI development and correlation, data management and integration and the characterization of the environment around the pipeline. He graduated with a degree in earth sciences in 1986 from the University of Guelph, Ontario. He is a member of NACE and a past vice-chair of the NACE SCCDA committee.

Rick Desaulniers is currently Director, Customer Solutions, with ENTEGRA in Concord, Ontario. He has been involved in the pipeline industry for the past 27 years with the majority of the time spent in the Data Interpretation Department analyzing 1000's of miles of pipelines around the world. He has been involved in past NACE conference as Chairman of the Pipeline Integrity Symposium and presented/ co-write papers on Excavation Data Collection and Data Analyst Qualification Processes. He was on the Standards Development Committee for ANSI/ASNT ILI-PQ-2005 In-Line Inspection Personnel Qualification and Certification Standard. He received his Bachelor of Science in Geology from McMaster University in Hamilton, Ontario.

Advanced Pipeline Risk Management

From the National Transportation Safety Board Safety Study Integrity Management of Gas Transmission Pipelines in High Consequence Areas, January 27, 2015:

"The study did find that IM programs... require expert knowledge and integration of multiple technical disciplines including... probability and statistics, and risk management.... The study found that aspects of the operators' threat identification and risk assessment processes require improvement."

In 2017 PHMSA will implement a wide range of stricter regulations for improving pipeline safety. At the top of the list are these:

- Requirements for conducting risk assessment for integrity management, including seismic risk.
- Expanded mandatory data collection and integration requirements for integrity management, including data validation and seismicity.
- Increased focus on a data- and risk-informed approach to safety by requiring integration of available data, including data on the operating environment, pipeline condition, and known manufacturing and construction defects.
- Required annual evaluation of protective measures in High Consequence Areas, with established deadlines for internal inspections where possible for any new or replaced pipeline that could affect an HCA.

Are you ready for these new rules? The Advanced Risk Management course will get you there.

Who should attend?

Anyone requiring a general knowledge of pipeline risk concepts and how they can be practically integrated into pipeline operations, maintenance, design, or regulation.

Documentation

Participants will receive a detailed set of course notes for reference after the course. Also included is the recently-published third edition of the definitive reference book, *Pipeline Risk Management Manual*, by W. Kent Muhlbauer, as well as a comprehensive course notebook for future reference.

Lecturer

W. Kent Muhlbauer is a principal of WKM Consultancy and is the author of the widely-respected reference book *Pipeline Risk Management Manual*. Since it's inception in 1994, WKM has been an advisor to government regulatory agencies and academia as well as the primary consultant in numerous pipeline technical projects for more than 50 clients, including many major US and international pipeline-operating companies.

Continuing Education Units: 1.4

Course Program

DAY 1

Introduction

- Methodology quickview
- Objectives of risk management
- Gathering and effectively utilizing information
- Using model results in decision-making

Definitions

- Risk assessment concepts
- Tools
- Methodology choices
- Choosing the optimum approach
- Data collection issues
- A proposed methodology— the basic algorithm with assumptions
- Customizing the methodology for specific applications
- Sensitivity analyses
- Databases and software issues
- Tips and learning experiences in practicing risk assessment

DAY 2

Risk management

- Data analysis
- Data-based decision making
- Project prioritization based on risk assessments
- Building a resource allocation model
- Correlating relative risk scales with absolute risk

DAY 3

Administrative processes— ingredients for continued success

- Administrative support structures
- Data maintenance
- Reporting
- Procedures
- Training
- Performance measurements

"A good opportunity to learn and discuss new ways to think about risk."
—Charlie Childs, Kinder Morgan

"Very good presentation and overview of risk."
—Jan VYTRISAL SEPS, a.s.

"Great class, great instructor. Kent did a great job of providing and explaining the formulas."
—Shawnna Poor, Valero Corp.

"The course covered the risk assessment approach in a very comprehensive way."
—Alex Izadpanah

Stress-Corrosion Cracking in Pipelines

ALTHOUGH STRESS-CORROSION CRACKING (SCC) is responsible for a very small percentage of pipeline failures each year, it continues to be a safety concern to pipeline operators, and it must be treated in integrity management plans. This course will provide a detailed description of what is known about its appearance and causes, and it will discuss various approaches to mitigating and managing the problem. Practical information on recognizing and dealing with SCC will be presented, along with descriptions of research results that have led to our current understanding of causes and methods of management.

Who should attend?

- Pipeline engineers, designers, and service professionals who are involved with the maintenance, inspection, and repair of pipelines
- Researchers who want to be aware of the current understanding of SCC in pipelines

Documentation

Participants will receive a full set of the course notes and slides in COLOR, in ring-binder format.

Continuing Education Units: 1.4

"I was very impressed with the depth and quality of the information presented. The presentation was top notch. "
—B.C. Mittelstadt
Senior Engineer
El Paso
Pipeline Services

Lecturers

The course is taught by John Mackenzie based on materials developed by Dr. Raymond Fessler and Mr. Mackenzie.

Dr Raymond R Fessler worked on the Pipeline Research Committee project on SCC since its inception in 1965. He personally conducted most of the early field investigations of SCC, from which he identified the major factors that cause high-pH SCC in pipelines. He also managed the laboratory portion of that program from 1965 to 1982, which added significantly to an understanding of the phenomenon, and explored a number of possible solutions to the problem. For the past several years, he has been the SCC consultant for GRI and PRCI. He recently completed a comprehensive gap analysis on SCC, and he actively participated in drafting the NACE *Recommended Practice on SCC Direct Assessment*.

John Mackenzie is a senior pipeline specialist with Kiefner & Associates, focusing on the areas of Integrity Management Plans and Stress-Corrosion Cracking. John is also President of NorthAm Energy Solutions Ltd, and CEO of Direct Assessment Partners LLP (DAP), both located in Bellingham, WA. DAP provides interactive databases for the capture and integration of pipeline dig-site data as well as training for field technicians. Prior to joining Kiefner & Associates, John was with TransCanada Pipelines for 25 years, where he was responsible for the company's original investigation into SCC (1986-1990). This work led to the discovery of near-neutral pH SCC and identified the conditions under which it occurs. He also served as Chair of the PRCI's SCC Subcommittee for two years.

"Thoroughly enjoyed the course. Was very applicable to my line of work! I felt the course was well balanced between theory and experience. It also left a lot of room for my own conclusions, thoughts, and approaches."
—R. Lee
Pipeline Integrity
EIT
TransCanada
Pipelines Ltd.

Course Program

DAY 1

Description of SCC
- Definition, Causes, Appearance
- Other forms of environmental-assisted cracking

History of SCC in pipelines
- High-pH SCC, Near-neutral-pH SCC, Internal SCC

Stages of SCC
- Pre-initiation, Initiation
- Growth models
- Early growth, Dormancy and re-initiation
- Late growth
- Final fracture

Test techniques to study SCC
- Accelerated testing
- Electrochemical tests
- Cracking tests, Measuring crack growth

Environmental factors
- Field observations
- Liquid composition and concentration
- Electrochemical potential, Temperature

Stress factors
- Field observations
- Importance of strain rate
- Cyclic loading
- Sources of stress

DAY 2

Metallurgical factors
- Pipe grade, Steel composition
- Mechanical properties
- Microstructure, Manufacturer

Mechanisms of SCC
- High-pH SCC, Near-neutral-pH SCC

Likely locations for SCC
- Geographical, Proximity to compressor or pump stations, Proximity to other SCC
- Soil, terrain, moisture level
- Gas versus liquid pipelines
- Coating types and conditions
- Pressure history, Corrosion history
- Pipe manufacturer

SCC detection and integrity assurance
- B31.8S
- Hydrostatic testing
- In-line inspection, Direct assessment

Mitigating SCC
- Operating existing pipelines
- Designing new pipelines, Repair methods

Integrity management plans
- Regulations, Approaches

SCC Direct Assessment technology demonstration

Microbiological Corrosion in Pipelines: Prevention, Detection, Mitigation

MICROBIOLOGICALLY-INFLUENCED CORROSION (MIC) caused by sulfate-reducing bacteria has been found to be a serious threat to pipeline integrity, safety, and reliability. Numerous pipeline failures have been attributed to sustained, localized pitting corrosion. Bacterial colonies that can form in some pipelines will produce combinations of products that pit the metal. Preventing, detecting, and mitigating this type of pitting is often difficult and requires monitoring of the physical, chemical, and biological characteristics of the pipeline. This course will address these issues in detail, with particular emphasis on prediction and monitoring, and testing methods for managing MIC.

Who should attend?

- Pipeline engineers, technicians, and service professionals who are involved with the maintenance, inspection, and repair of liquids, gas and products pipelines, storage tanks, and related components
- Project and facility managers concerned with system integrity assessment
- Researchers who want to be aware of the current understanding of MIC in pipelines

Documentation

Participants will receive a full set of the course notes and slides in ring-binder format.

Lecturer

Dr Roger King (*see page 10*)

Continuing Education Units: 1.4

Course Program

DAY 1

Basics of Corrosion and Microbiology
Sulfate-reducing bacteria (SRB)
- Historical data
- Occurrence
- Mechanism

Ecosystems
Corrosion by SRBs
- Theory
- Reservoir souring by SRB
- Sources of the organisms
- Reservoir cooling
- Sulfide production
- SRB corrosion and growth
- Redox potentials
- Checklist for evaluating sediments and soils

Case histories
- External corrosion and internal corrosion
- Typical corrosion rates experienced
- Operator methods used to prevent continued corrosion.

DAY 2

Predicting internal corrosion of pipelines by SRB
- Pipelines at risk
- Checklist for evaluation of risk of SRB corrosion
- Limitations of growth and activity
- Location of growth of SRB
- Pipeline profile
- Water cut
- Product flow rate and water settlement
- Effect of internal roughness
- Re-population
- Typical pipeline failure mechanisms

Monitoring and testing methods for SRB
Control of SRB
- Chemical treatment to control SRB
- Biocide treatments in water systems
- Biocide treatment of oil systems
- Effectiveness of corrosion inhibitors
- Use of pigging as an adjunct to chemical
- Re-establishment of corrosion inhibitor films

Prevention of external corrosion by SRB
- Impact of SRB on coatings
- Calcareous backfill in the pipeline trench
- Cathodic protection
- Consumption of sacrificial anodes by SRB in sour sediments
- Options for protecting non-piggable pipelines
- UV sterilization

Internal inspection and defect assessment
- Internal inspection methods for detecting MIC damage
- Prioritizing inspection of pipeline networks
- Assessing reported defects

Pipeline Repair Methods, Hot Tapping, & In-Service Welding

THE VARIOUS ASPECTS of pipeline repair using weld and non-weld methods will be covered, as will the concerns for welding onto in-service pipelines and the approaches used to address them.

Who should attend?

Pipeline engineers, operations and maintenance personnel, inspectors, and welders.

Documentation

All delegates will receive a detailed set of lecture notes containing more than 250 pages, providing an invaluable reference document.

Continuing Education Units: 1.7
(1.4 for the 2-day version)

Lecturers

Bill Bruce is director of welding technology with DNV Columbus (formerly CC Technologies). Prior to joining CCT, he was a technology leader at Edison Welding Institute and a senior engineer at Panhandle Eastern Pipeline Co. He is a member of the American Petroleum Institute API 1104 Committee and is the chairman of the Maintenance Welding Subcommittee.

Dr. Chris Alexander is a principal at Stress Engineering Services, Inc. He has been integrally involved in assessing the effects of dents and mechanical damage on the structural integrity of pipelines. Mr. Alexander has also been involved in assessing the use of composites in repairing pipelines and has published numerous papers and made international presentations on this subject.

"Great Course! Bill Bruce did an excellent job. I look forward to future courses"
—P. Kenny
Welding Opeartions Lead National Grid

"Found the information on Procedure Development & Qualification very useful for practical application"
—C. Hartig Sr.
Specialty Engineer
Xcel High Pressure Gas

"Bill Bruce is an obvious expert on in-service welding. Confident delivery of presentation. I enjoyed learning from him."
—D. M. Halferty
Plains All American, Pipeline Integrity Specialist

"Excellent course! This is a must attend for anyone involved in welding on in-service pipelines."
—Jonathan Spronk,
Access Pipeline

Course Program

DAY 1

Defect assessment prior to repair
- Reason for assessment
- Types of pipeline defects
- Pressure reduction requirements
- Corrosion measurement methods
- Corrosion assessment methods

Selecting an appropriate repair method
- Pipeline repair manual
- Detailed selection criteria

Burnthrough and related safety concerns
- Factors affecting burnthrough
- Effect of wall thickness
- Effect of heat input
- Effect of flow rate/pressure
- Avoiding burnthrough

Hydrogen cracking concerns
- Recent significant incidents
- Common factor/recommendation
- Hydrogen cracking requirements
- Welding metallurgy 101
- Prevention of hydrogen cracking

Full encirclement repair sleeves
- Full encirclement sleeve types
- Principle of operation
- Assuring effective reinforcement
- Sleeve design
- Sleeve fabrication

Hot tap branch connections
- Branch connection design
- Reinforcement types
- Integrally reinforced

Pipeline repair by weld deposition
- Physical concept
- History of weld deposition repair
- Burnthrough risk
- Integrity restoration
- Practical application

Day 2

Non welded repairs
- Repair by grinding
- Composite repairs
- Epoxy filled shells
- Visit to testing facility for demonstration of repair methods and testing for qualification of repairs

Code and regulatory requirements
- Recent changes to API 1104
- Code requirements for weld deposition repair

DAY 3

Procedure selection for hot tap and repair sleeve welding
- Burnthrough risk summary
- Prevention of hydrogen cracking
- Welding procedure options
- Welder/procedure qualification
- Predicting required heat input
- Selecting an appropriate procedure

Practical aspects of hot tap and repair sleeve welding
- Proper electrode handling
- Proper fitup
- Proper welding sequence
- Control of heat input levels
- Inspection and testing

Lessons to be learned from past pipeline repair incidents
- Reported incidents
- Previously unreported incidents
- Ten commandments of inservice welding

Performing Pipeline Rehabilitation

This course is centered on the practical aspects of pipeline rehabilitation and covers both internal and external rehabilitation. The course goes into depth on how to safely rehabilitate operating pipelines using manual and automated equipment. Movement of in-service pipelines is analyzed in detail including the application and methodology of recommended practice API 1117. Other industry standards applicable to pipeline rehabilitation are discussed as well as how they should be incorporated into project specifications.

Approximately half of the course is spent in analyzing case studies of field rehabilitation projects from around the world. Over 400 photographs are used to illustrate how the work was performed and the results obtained. The course presents techniques for performing the work with a combination of in-house personnel and outside contractors to minimize costs while maintaining clear lines of responsibility.

Who should attend?

Engineers involved in:

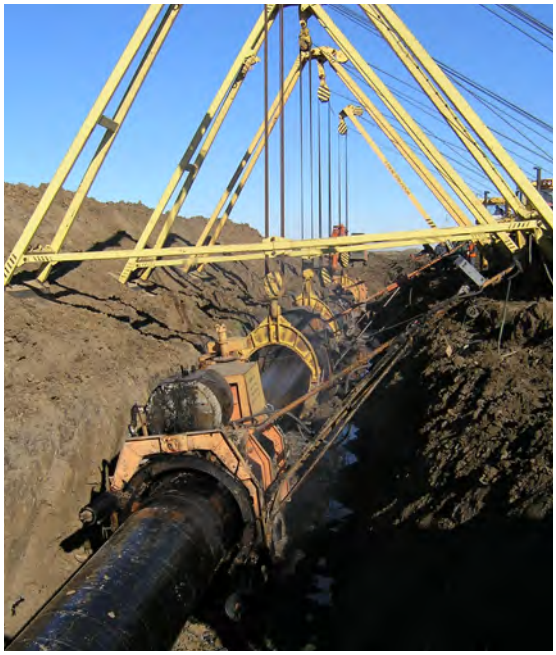
- Determining the best way to rehabilitate a section of pipeline,
- Preparing the project specifications,
- Performing the necessary engineering calculations to insure the project is carried out safely,
- Health and safety issues specific to rehabilitation projects.

Field Operations Personnel and contractors who need to be aware of many alternatives techniques available for pipeline rehabilitation and their cost impact.

Inspection Personnel involved in evaluation of defects and selection of proper repair techniques.

Documentation

All delegates will receive a detailed set of lecture notes providing an invaluable reference document.



Lecturer

Sidney A Taylor is president of Incal Pipeline Rehabilitation, Inc. He has over 30 years' experience in the design and development of automated high-pressure water jet cleaning and coating systems. Prior to Incal, Sid worked with Schlumberger as a designer and manufacturer of well-logging tools and equipment, with MW Kellogg as a senior regulatory attorney, with Weatherford as general manager of water jetting systems, and with CRC-Evans as vice-president, engineering and marketing, where he was responsible for engineering design, manufacturing, and world-wide marketing of pipeline rehabilitation systems.

Continuing Education Units 1.4

Course Program

Day 1

Introduction
Rehabilitation Options
In-Plant Rehabilitation of Pipeline
Out of the Ditch Rehabilitation Projects
In-situ and Short Segment Rehabilitation Projects

Day 2

New Approach to In-Situ Rehabilitation
Internal Pipeline Rehabilitation Projects
Inspection of the pipeline
Making necessary repairs
Environmental Issues
Industry Standards to be incorporated in Job Specifications

Pipeline Integrity Management

The seminar provides a sound review of Pipeline Integrity Management strategies, in compliance with regulatory requirements, including self assessment. It is highly interactive and takes the form of lectures and case studies. On completion of the seminar, participants will have a solid understanding of the procedures, strengths, limitations, and applicability of the main issues that comprise a Pipeline Integrity Management Program.

"The course content is diversified and very beneficial. The instructor is knowledgeable and capable, and he made the course interesting."
—Mohammed Al-Qallaf, Saudi Aramco

"Pleasant, interactive, sincere and extremely knowledgeable are all qualities that help make an instructor good. Dr. Murray was great."
—Travis Hallam

The instructor was excellent. I like that he pushed us hard to maximize value."
—Olin Valby

Course Objectives

To provide attendees with the latest techniques used to develop a comprehensive integrity management program covering both pipelines and their associated facilities. The necessary elements of such a program are described in detail with examples of typical program content including an overarching view of where detailed Risk Analysis and Defect Assessment fits in the Program.

Documentation

The accompanying course notes, in ring-binder format, are written in such a manner as to provide a starting point for a company in either developing its own integrity management plan or updating its current plan. The course documentation also includes the newly published reference book Pipeline Integrity Assurance: A Practical Approach, by Alan Murray, Mo Mohitpour, Michael McManus, and Iain Colquhoun, a $159 value.

Who should attend?

Supervisors, engineers and technicians responsible for ensuring the adequate protection of pipeline assets; maintenance planners, regulators and service-providers to the pipeline industry will also benefit from attending the course.

On completion of this course you will be able to understand:

- Codes used in developing Integrity Management Plans
- The elements of an Integrity Management Plan
- Threat assessment
- Critical aspects of risk assessment.
- Prevention and mitigation measures
- Characteristics and limitations of different inspection methods
- A risk- based approach to maintenance

Continuing Education Units: 1.7
(1.4 for the 2-day version)

Lecturer

Dr. Alan Murray is a consulting engineer with Principia Consulting in Calgary, AB. Prior to forming Principia in 2010, he was Chief Engineer at the Canadian National Energy Board. Dr. Murray's industry experience has included a number of senior management positions with a large pipeline operating company in North America with responsibility for system planning, construction, maintenance and contracting functions. His 42 years of work experience spans research, regulation, third-party assessment, design and development in pipelines and offshore structures. He was the founding chairman of the ASME Pipeline Systems Division and is the co-author of the ASME Press text books *Pipeline Design and Construction – A Practical Approach* and *Pipeline Integrity Assurance* and is a Fellow of the ASME.

Course Program

DAY 1

Introduction
Elements of an Integrity Management Plan (IMP)
Conducting an assessment
Case study

DAY 2

Approaches to Risk Assessment Analysis
Prevention and Mitigation Measures
Inspection Methods: Characteristics and Limitations
Case study

DAY 3

Integrity Management Plans for Facilities

Visit www.clarion.org
for the complete program details

Pipeline Defect Assessment Workshop + API 1163* Compliance Review

* (optional half-day)

This course involves practical application of the principles and methods learned in our Defect Assessment in Pipelines course. It takes those who want to take their defect assessment knowledge to the next level; it goes into greater depth on the various defect assessment methodologies and provides participants with hands-on practical experience performing calculations based on them. Participants will become comfortable performing and reviewing a wide variety of anomaly assessment methodologies and will understand when to best apply them within an Integrity Management Program. Cases and problems worked in class will be based on actual inspections of working pipeline systems. The course addresses both traditional pipeline methodologies as well as recent innovations, including the API 579 Fitness-for-Service Standard.

***ILI SYSTEMS QUALIFICATION – API 1163 (OPTIONAL HALF-DAY)**

API 1163 provide not only provides requirements for qualification of in-line (ILI) systems it also provides a framework for the successful development, implementation, and execution of a successful ILI program. As of January 23, 2017, CFR Part 195 requires compliance with API 1163 for interstate hazardous liquid pipeline operators under PHMSA jurisdiction.

This half-day workshop will provide attendees with a thorough understanding of API 1163 requirements and how to best utilize this standard within an operator's integrity management program before, during and after an inspection. Specific topics include the following:

- How to evaluate and select appropriate ILI technology for specific pipelines,
- How to develop operational procedures to ensure that ILI tools are operated successfully,
- How to report ILI results using a common nomenclature, and
- How to verify that ILI results meet quality and accuracy expectations.
- Compliance with API 1163

Who should attend?

- Pipeline engineers
- Designers and service professionals who are involved with the maintenance, inspection, and repair of pipelines
- Regulatory compliance specialists

Documentation and materials

All presentation material will be documented in an Adobe Acrobat PDF provided by download prior to the class. For this reason it is necessary to bring your laptop or tablet computer. In addition participants will receive macro-enabled Excel spreadsheets that perform various calculations, including effective area metal loss assessment and pressure-cycle fatigue analysis. A laptop is required.

Lecturer

Ian Smith is a consulting engineer with over 20 years in the pipeline industry. He formed his own consulting company, ID Smith Pipeline Engineering, in 2016 after having leadership roles within inline inspection, pipeline operating, and Fitness-for-Service consulting organizations. This has provided Ian with a unique perspective on the complete process of pipeline integrity from data collection to defect Fitness-for-Service assessment through to integrating assessment results into integrity management programs. He is a Professional Engineer and a member of ASME.

Syllabus

1. Introduction to Pipeline Integrity
2. Assessment of Metal Loss
3. Assessment of Cracks
4. Assessment of Plain Dents
5. Combined Anomalies
6. FFS Case Studies
7. API 1163 Compliance Review

Continuing Education Units: 1.4/2.

The Pipeline Integrity Master Class

Over the last 15 years Clarion-Tiratsoo Technical, Penspen and others have educated thousands of pipeline engineers in the essential tools and methods of pipeline integrity assessment. While there continues to be a need for these training courses, more-experienced engineers, who may have risen to senior technical-management positions, need a 'next-level' course that will focus on more complex, sophisticated and nuanced issues - not just in the application of PIM technologies and methods, but in the real management of the asset from a risk and business point of view.

That is the objective of The Pipeline Integrity Master Class to be offered for the first time in 2012 in the UK and the USA.

The five-day syllabus content will be flexible to match the particular needs and interests of each group of class participants, who will receive a questionnaire in advance of the class. Led by a world-class team of instructors, it will be heavy on group problem-solving exercises and case study analysis and will also feature guest lectures from senior operating-company executives and technical specialists.

To facilitate and optimize interaction between participants and instructors, and among the participants themselves, the course will take place at excellent-quality conference centers offering residential accommodation: in the USA,The Woodlands Resort & Conference Center near Houston; in the UK, the Low Wood Bay Hotel on Lake Windermere, near Ambleside in the Lakes District of England. To obtain the full benefits of the class, participants are urged to book in at the class venue for the duration, as discussions and activities will continue into the evenings.

Recommended experience

It is **strongly** recommended that class participants have at least five years' experience in pipeline integrity management and a minimum of 120 hours instruction in relevant professional courses.

Documentation

Included with the course fee is a detailed set of lecture notes (600 pages est., COLOR) and a CD containing an additional reference material.

Who should attend?

The class is recommended for technical team leaders, asset managers, integrity managers, chief engineers, engineering VPs or other experienced personnel who meet the recommended prerequisite criteria above.

Continuing Education Units: 3.0

Faculty

Dr Jane Haswell is a principal consulting engineer with Pipeline Integrity Engineers in the UK, which she joined in 2001. Prior to this, she had over 20 years' experience in pipeline transmission engineering, initially involved in pipework / pipeline stress analysis and 3-D FEA for British Gas. She then became responsible for managing a team of specialist engineers, covering defect assessment, stress analysis, and technical input into developing Codes such as IGE/TD/, TD/12, and BSI PD 6493. Subsequently, she became divisional manager for British Gas' Engineering Sciences group, with responsibility for 55 engineers.

Dr. Phil Hopkins is a consulting engineer with more than 35 years' experience in pipeline engineering. Phil formed his consultancy company in 2015, after being Technical Director with Penspen Ltd in the UK, and previously Managing Director of Andrew Palmer and Associates, in the UK. He has worked with most of the major oil and gas companies and pipeline companies around the world, providing consultancy on management, business, design, maintenance, inspection, risk analysis and safety, and failure investigations. He is the past-chairman of the ASME Pipeline Systems Division, and is a Fellow of ASME. More than 15,000 engineers and technical personnel around the world have attended his courses. He also teaches extensively on masters' programmes at Newcastle and Northumbria Universities in the UK.

Dr. Alan Murray is a consulting engineer with Principia Consulting in Calgary, AB. Prior to forming Principia in 2010, he was Chief Engineer at the Canadian National Energy Board. Dr. Murray's industry experience has included a number of senior management positions with a large pipeline operating company in North America with responsibility for system planning, construction, maintenance and contracting functions. His 42 years of work experience spans research, regulation, third-party assessment, design and development in pipelines and offshore structures. He was the founding chairman of the ASME Pipeline Systems Division and is the co-author of the ASME Press text books *Pipeline Design and Construction – A Practical Approach and Pipeline Integrity Assurance* and is a Fellow of the ASME.

Patrick Vieth is President of Dynamic Risk USA, Inc. Pat has 27 years' experience in management, research, and technical innovation within the pipeline industry. Some of his accomplishments have provided the foundation to modern pipeline integrity, such as his key contributions to validation and implementation of the RSTRENG corrosion assessment method and development of a Transverse Field Inspection (TFI) program to identify longitudinal seam weld defects.

Index of courses by topic

(Note: courses are arranged alphabetically in each category, and numbers refer to page numbers in this catalogue)

Cleaning, Commissioning, & Operations

Corrosion & Materials

Design & Construction

Engineering Assessment

External Inspection

Internal Inspection

Regulations

Repair & Rehabilitation

Risk Assessment/Data Management

Index of courses by title

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