PIPELINE RISK ASSESSMENT
The Definitive Approach and Its Role in Risk Management

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Contents

I.1 ACRONYMS

ACVG AC (alternating current) Voltage Gradient
AGA American Gas Association
ANSI American National Standards Institute
API American Petroleum Institute
APWA American Public Works Association
ASME American Society of Mechanical Engineers
AST Above ground Storage Tank
CGA Common Ground Alliance
CIS Close Interval Survey
CLSM Controlled Low-Strength Material
CoF Consequence of Failure
CPM Computational Pipeline Monitoring
CP Cathodic Protection
CSA Canadian Standards Association
D/t Diameter to wall thickness ratio
DAMQAT Damage Prevention Quality Action Team
DCS Distributed Control Systems
DCVG DC (direct current) Voltage Gradient
DIN Deutsches Institut fur Normung (the German Institute for Standardization)
DIRT Damage Information Reporting Tool
DOT (U.S.) Department of Transportation
DSAW Double Submerged Arc Welding
Dt Ratio Diameter-to-Thickness Ratio
EAC Environmentally Assisted Corrosion
ECDA External Corrosion Direct Assessment
EE Essential Elements
EGIG European Gas Pipeline Incident Group
EL Expected Loss
ERW Electric Resistance Welding
EMAT Electromagnetic Acoustic Transducers
EPA Environmental Protection Agency
EPRG European Pipeline Research Group
ERCB Energy Resources Conservation Board (formerly Alberta Energy and Utilities)
ERW Electric Resistance Weld
ESR Epoxy Sleeve Repair
ERF Estimated Repair Factor
EUB Alberta Energy and Utility Board
FBE Fusion Bonded Epoxy
FFS Fitness For Service
FEA Finite Element Analysis
FMEA Failure Modes and Effects Analysis
FRC Fiber-Reinforced Concrete
GIS Geographic Information System
GMAW Gas Metal Arc Welding
GPR Ground-Penetrating Radar
GPS Global Positioning System
GRI Gas Research Institute
GTAW Gas Tungsten Arc Welding
HAZ Heat Affected Zone
HAZOPS Hazard and Operability Study
HCA High-Consequence Area
HDPE High Density Polyethylene
HF High Frequency
HIC Hydrogen Induced Cracking
HSE Health and Safety Executive (UK)
HUD Housing and Urban Development
HVA High value area
ICS Industrial Control System
ILI In-Line Inspection
IPL Independent Protection Layers
Km Kilometer
LDPE Low Density Polyethylene
Limit states ‘ultimate’ (ULS), ‘leakage’ (LLS), and ‘serviceability’ (SLS)

LOPA Level Of Protection Analysis
LUT Look Up Table
MAOP Maximum Allowable Operating Pressure
MAWP Maximum Allowable Working Pressure
MFL Magnetic Flux Leakage
mi Mile
MOP maximum operating pressure
MPI Magnetic Particle Inspection
MPY mils per year
NAPSR National Association of Pipeline Safety Representatives
NDE Non-Destructive Examination
NDT Non-Destructive Testing
NEB National Energy Board (Canada)
NOP Normal Operating Pressure
NPS Nominal Pipe Size
NRA Nuclear Regulatory Agency
NTSB National Transportation Safety Board
OD Outer/Outside Diameter
OPS Office of Pipeline Safety
OSHA Occupational Safety and Health Administration
PCS Process Control System
PE Polyethylene
PGD Permanent Ground Deformation
PHA Process Hazard Analysis
PHMSA Pipeline and Hazardous Materials Safety Administration
PIPES Pipeline Inspection, Protection, Enforcement, and Safety Act
PLC Programmable Logic Controller
PLRMM *Pipeline Risk Management Manual, 3rd edition*
PoD Probability of Damage
PoF Probability of Failure
PP Polypropylene
PPTS Pipeline Performance Tracking System
PRA Probabilistic Risk Assessment
PRCI Pipeline Research Council International, Inc.
PFD Probability of Failure on Demand
PL Protection Layer
PSA Petroleum Safety Authority (Norway)
psi Pounds Per Square Inch
PVC Poly Vinyl Chloride
PXX abbreviation for conservatism level: P50, P99.9, etc
QA/QC Quality Assurance/Quality Control
QRA Quantitative Risk Assessment
RBD Reliability Based Design
ROV Remotely Operated Vehicle
ROW Right Of Way
RPR Rupture Repair Ratio
SCADA Supervisory Control And Data Acquisition
SCC Stress Corrosion Cracking
SLOD Significant Likelihood Of Death
SIL Safety Integrity Layer
SME Subject Matter Expert
SMYS Specified Minimum Yield Strength
SSC Sulphide Stress Corrosion
TSB Transportation Safety Board of Canada
TTF Time To Failure
UAV Unmanned Airborne Vehicle
UKOPA UK Onshore Pipeline Operators Association
ULCC Utility Location and Coordinating Council
UST Underground Storage Tank
UT Ultrasonic Testing
UTS Ultimate Tensile Strength
Yr Year

CAUTION

This text describes an approach to comprehensive pipeline risk assessment. While the underlying methodology has been proven over years of practice, not every nuance of application is documented here. The user must understand that, as with all technical approaches, a qualified person must oversee its use and accepts sole responsibility for any and all results of applying methodologies described herein and their subsequent uses.

PREFACE

Formal risk management has become an essential part of pipelining. As an engineered structure placed in a constantly changing natural environment, a pipeline can be a complex thing. Good risk assessment is an investigation into that complexity; providing an approachable, understandable, manageable incorporation of the physical processes potentially acting on a pipeline: external forces, corrosion, cracking, human errors, material changes, etc.

Recent work in the field of pipeline risk assessment has resulted in the development of methodologies that overcome limitations of the previous techniques while also reducing the cost of the analyses. Alternative approaches simply no longer compete. This more-defensible, more-efficient, more-useful, i.e., definitive, approach is detailed here.

This text recommends the abandonment of some previous risk assessment methodologies. Our reasons for building and using certain older models are no longer valid. We no longer have to take short-cuts to work around computer processing limitations or to approximate underlying scientific/engineering principles. We don't need extensive component failure histories to produce absolute estimates of risks, as once believed, nor do we have to use data that is so generalized that it does not fairly represent the specific assets being studied. We now have strong, reliable, and easily applied methods to estimate actual risks, and no longer must accept the compromises generated by intermediate scoring schemes or statistics-centric approaches.

A goal of this book is to provide an intuitive, transparent, and robust approach to help a reader put together an efficient risk assessment tool and, with that, optimize the management of pipeline risks.

Therefore, this book is also about risk management—not just risk assessment. Risk is a fuzzy topic, and managing risk involves numerous social and psychological issues. It is by no means a strictly technical endeavor. This book advocates a single, very efficient risk assessment methodology, developed and tuned over years of applications, as the starting point of risk management. The practice of risk assessment can now be fairly standardized.

However, it is a disservice to the reader to imply that there is only one correct risk management approach. Those embarking on a formal pipeline risk management process should realize that, once an improved risk understanding is obtained, they have many options with which to react to that risk. This should not be viewed as negative feature, in my opinion. The choices in technical, business, and social problem-solving surrounding risk management makes the process challenging and exciting.

So, my advice to the reader is simple: arm yourself with this 'next generation' knowledge of how to measure risk, adopt an investigative mind set—good risk management requires sleuthing!—and then, enjoy the journey!