DISTRIBUTION INTEGRITY – SAME GOALS, DIFFERENT APPROACH

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Abstract: The Pipeline and Hazardous Material Administration (PHMSA), formerly OPS is currently writing new rules focused on managing the integrity of natural gas distribution networks. While transmission pipeline rules were the initial driver, participants of distribution integrity rulemaking process have identified clear and fundamental differences. Centerpoint Energy's natural gas distribution network includes over 66,000 miles of main and 3.3 million services. CenterPoint Energy (the result of several corporate acquisitions) is regulated by six different state agencies, resulting in a mix of business policies, data formats, and field reporting forms. Objective risk analysis and effective capital investment planning and deployment are currently cumbersome to achieve across the enterprise. Centerpoint is currently pursuing a corporate-wide strategy to consolidate distribution integrity business processes and information from each operating area. In addition to positioning itself to comply with the anticipated new regulations, the company expects to realize significant benefits in operational efficiency, objective risk analysis, planning, and capital investments. This paper will summarize the current state of PHMSA regulatory activities, focusing on the differences between pipeline integrity and distribution integrity. In addition, it will summarize CenterPoint Energy's Distribution Integrity Management Roadmap, and highlight some of the technologies that will be used to fulfill it.

OVERVIEW OF DISTRIBUTION INTEGRITY REGULATION ACTIVITY

Over the past several years, Pipeline Integrity Management regulations have been implemented for pipelines transporting hazardous liquids (Title 49 CFR Part 192) and natural gas (Title 49 CFR –Subpart O). In June 2004, the DOT Inspector General, in testimony before Congress, recommended that the Office of Public Safety within DOT's Pipeline and Hazardous Materials Safety Administration (PHMSA/OPS) require operators of natural gas distribution pipelines to implement an enhanced safety program similar to those used by hazardous liquids and natural gas transmission line operators. As a result, a multi-phase action plan was initiated to proactively gather industry and stakeholder input about any potential safety programs.

The first phase of the action plan was completed in 2005 by four multi-stakeholder work/study groups, and resulted in a report on Distribution Integrity for Gas Distribution Pipelines (PHMSA, December 2005). The report concludes that it would be appropriate to modify existing pipeline safety regulations to convey the concept of a risk-based distribution integrity management process (PHMSA, December 2005). It also recommends a "high-level, flexible federal regulation, in conjunction with implementation guidance, a nationwide education program, and continuing research and development."

The report also concludes that significant differences between transmission and distribution pipeline systems, as well as diversity among gas distribution pipeline operators, make it impractical to establish prescriptive requirements. Rather, operators may be required to maintain their own tailored integrity management programs that address seven key elements:

1. Establish a Written Integrity Management Plan
2. Pipe Infrastructure Knowledge
3. Threat Identification
4. Risk Assessment and Prioritization
5. Risk Mitigation
6. Performance Measurement and Adjustment
7. Regulatory Reporting

The second phase began in January 2006 and involves development of appropriate requirements by PHMSA, and preparation of guidance and standards by appropriate industry and government organizations (including the American Gas Association's Gas Piping Technology Committee). PHMSA is expected to take up possible rule development in late 2006 or 2007, with operator planning and implementation expected in 2008 and 2009.

DISTRIBUTION INTEGRITY AT CENTERPOINT ENERGY

CenterPoint Energy's natural gas distribution network includes over 66,000 miles of main and 3.3 million services. CenterPoint Energy(the result of several corporate acquisitions) is regulated by six different state agencies, resulting in a mix of business policies, data formats, and field reporting forms. Objective risk analysis and effective capital investment planning and deployment are currently cumbersome to achieve across the enterprise.

In the past, individual divisions and organizations had developed unique risk assessment techniques that required intense manual labor and were nearly impossible to maintain in an effective manner. Additionally, failure investigation has been inconsistent across the territories. These policies or procedures were never applied consistently across the corporation as a whole.

CenterPoint is currently pursuing a corporate-wide strategy to consolidate distribution integrity business processes and information from each operating area. In addition to positioning itself to comply with the anticipated new regulations, the company expects to realize significant benefits in operational efficiency, objective risk analysis, planning, and capital investments.

Distribution Integrity Management Roadmap

As the first part of the corporate initiative, CenterPoint Energy's Gas LDC Operations Council engaged a leading distribution integrity consultant and system vendor (Opvantek, Inc.) to assist in the development of a Distribution Integrity Management Roadmap. The roadmap (completed in May, 2006) sets forth objectives, goals, and tasks to position the company to comply with anticipated new federal distribution integrity management regulations (as they evolve), and to achieve additional strategic asset management objectives. The roadmap will likely evolve into the company's formal Distribution Integrity Management Plan.

The roadmap is aimed at accomplishing or fitting into the following envisioned business situation:

- A single organizational entity responsible for distribution integrity management, with localized monitoring and tactical execution tied to corporate goals and strategic objectives;
- New federal and/or state distribution integrity regulations enacted by 2007, with implementation required by the end of 2008;
- A written distribution integrity management plan that complies and can evolve with all applicable regulations, is transparent and accessible to all stakeholders, and can be tuned based on results and evolving business conditions;
- A consistent, objective approach to monitoring threats and assessing risk and economic replacement opportunities across the entire distribution system;
- An information technology environment that provides efficient access to all relevant data in a format that can be used to support decisions related to distribution integrity management, while leveraging existing IT systems and investments.

DISTRIBUTION INTEGRITY MANAGEMENT PROGRAM

Written Distribution Integrity Management Plan

It is almost certain that the new distribution integrity rules or regulations will require any company operating a gas distribution network to ***establish a written Distribution Integrity Management Plan***. The plan will document CenterPoint's approach to meeting distribution integrity regulations and related asset management objectives. Although no model Distribution Integrity Management Plans have been developed at this time, it is expected to cover at least the following topics:

- Consideration of existing company-wide policies or guidance, as well as established regulatory agreements;

- Identification of sources of information and business processes related to distribution integrity management;
- Communication about the existence and benefits of the plan to employees, business partners and the public in general;
- Document how CenterPoint addresses each element of an effective Distribution Integrity Management Program.

Know the Infrastructure

Evaluating an entire distribution network is an arduous task without the benefits of an enterprise GIS and automated risk analysis systems.

GIS Integration and Benefits

An enterprise GIS provides a number of benefits in support of a Distribution Integrity Management Program:

1. Spatial context forms a very pertinent and useful part of overall knowledge about the distribution system;
2. Factors influencing the likelihood and consequences of pipe failure can often be derived through analysis nearby objects in the GIS;
3. The ability to quickly view a high risk pipe on the map, in the context of leak records, pipe condition reports, nearby buildings, services, and streets can facilitate decision-making and risk mitigation planning;
4. Many of the data sources necessary to perform system-wide risk assessment may already be incorporated or integrated into the GIS;
5. Visualization of the entire system can help identify geographic trends, communicate the location of high risk pipes, and coordinate risk mitigation activities across the organization;
6. Visibility of and alignment with third-party initiated street improvement and/or construction projects can have economic benefits and improve public relations by diminishing supply disruptions and avoiding unnecessary street disturbances.

Monitor Threats

A number of issues make distribution systems significantly different from transmission pipelines.

In *Developing A System-Wide Approach to Distribution Integrity Management* (Nimmagadda, Benedict 2006), the authors provide an interesting matrix of common threats to the integrity of a natural gas distribution system (reproduced below for reference).

Distribution Integrity Threat Matrix

Threat Class	Threat Mechanism	Pipe Class Affected	Business Processes	Analytical Processes
Corrosion	Natural Corrosion / Deterioration	Bare Steel	- Leak Surveys - Leak Management Programs	Failure-mode analysis and Failure Forecasting by pipe type
		Copper		
		Protected Steel		
	Graphitization	Cast Iron		
	Joint Leakage	Cast Iron		
	Embrittlement	Plastic		
Natural Forces	Freeze - Thaw Cycles Ground Settlement	Cast Iron	- Leak Surveys - Leak Management Programs	Customer / Location specific failure-mode analysis and forecasting
		Plastic		
Excavation	Immediate Pipe Damage	All	- Locate Programs - Damage Prevent Programs - Area/Contractor Monitoring - Enforcement	Statistical Analysis: - Locates to Direct - Locates to Delayed - Area Risk Flagging Forecasting: - by Locate Request
	Immediate Coating Damage	Protected Steel		
	Delayed - Mechanical	Cast Iron		
		Plastic		
	Delayed - Corrosion	All Steel		
	Delayed - Disturbance	Cast Iron		
Other Outside Forces	Traffic Loads	All	- Traffic Area Monitoring	Failure-mode analysis to identify areas affected
Materials/ welds/ construction	Construction and/or material defects	All Steel	Legacy Materials: - "Vintage" and Lot Monitoring - Procedures Reviews New Construction: - Materials Management - Training/Qualification	Failure analysis by material/vintage. Material/vintage flagging.
		Plastic		
Equipment	Customer specific equipment threats as identified			
Operations	Customer specific Operations issues/threats as identified			
Other	Other customer specific threats as identified			

The threat matrix recognizes several unique aspects of distribution piping systems:

1. Distribution systems are typically a mix of pipe classes, installed over time based on prevailing construction practices.
2. Each threat affects each of the different pipe classes differently.
3. Different business processes and programs are needed to monitor and manage each class of threat.
4. A Distribution Integrity Management program must be able to treat each threat/pipe combination using appropriate risk assessment and mitigation techniques.

The following provides a “short-list” of some of the typical factors that can be used to monitor and assess the threats to a distribution system (“failure factors”):

- Prior Leaks/breaks
- Pipe material/size
- Leak Cause
- Corrosion extent (internal/external) - pitting
- CP reads
- Coating type/condition
- Pipe depth
- Soil type/conditions

Assess Risk

The classic definition of risk is:

Risk = Probability of Failure * Consequence of Failure

Various commercially available and custom developed information systems have been developed to measure risk in a natural gas distribution system. Detailed discussions of the mechanics behind this type of calculation can be found in *Developing A System-Wide Approach to Distribution Integrity Management* (Nimmagadda, Benedict 2006) and *Pipeline Risk Management Manual, Third Edition* (Muhlbacher, 2004).

The following table prioritizes some of the typical factors that can be used to assess the consequences of failure in a distribution system ("risk profile factors"):

Factor	**Priority (H/M/L)**	**Comments**
Base Material	H	See Escaping Gas
Base Size	H	See Escaping Gas
Main Pressure	H	See Escaping Gas
Population Density	H	Usually derived from other factors (Zip Code, Total Customers, Services Total, etc)
Service Length Or Building Proximity	H	Length of services connected to a main or spatial scan main to building
Escaping Gas	H	Volume and density of gas likely to escape, derived from material/size/pressure & failure mode.
Cover Type	H	The type of cover material, which can allow gas to accumulate or migrate greater distances
Building Type	M	The type or usage of nearby buildings
Depth Max	M	Maximum depth of pipe, which can allow gas to migrate greater distances
Other Conduit	M	Presence of nearby conduits that provide pathways for gas migration
Service Efv	M	Presence of an existing excess flow valve (reduces consequences)
Total Customers	M	Total number of nearby or connected customers
Traffic Conditions	M	What type and how much traffic is there?
Emer Network	L	Pipe supplies critical care or other emergency facility
Class Loc	L	DOT class location value

Managing Risk and Mitigation Alternatives

Once you can assess risk for individual pipes, you have a comprehensive way of analyzing risk across the entire system, and defining risk mitigation programs based on threat class, pipe type and failure mode. The next challenge is deciding what risk mitigation actions are appropriate. This decision-making process is normally based on many competing criteria, including:

- Capital available for discretionary investment
- Regulatory agreements
- Business risk tolerance
- Coordinated excavation opportunities
- Availability of alternate risk mitigation options

In order to provide a consistent, rational, and controllable decision-making environment, a Distribution Integrity Management Program should establish policies for addressing risk. These policies may provide only guidance, or they may establish firm rules, on topics like:

- when a pipe must be replaced based on risk
- when increased surveillance is a viable alternative
- when a pipe can be effectively rehabilitated
- how a replacement project can be justified economically
- when to replace a pipe if other excavation activities are occurring
- when an excess flow valve should be installed

Measure Performance

Distribution Integrity rules are expected to suggest the use of performance measures as a means of evaluating the effectiveness of Distribution Integrity Management processes. All metrics should be ***transparent, reliable, and objective***. The measurement system must be ***simple to understand and maintain***, and should not be subject to frequent changes (in order to provide useful trend data).

Candidate metrics include:

- **Total System Risk** – The concept of a relative pipe risk score comprised of probability and consequence components enables the concept of total system risk. Each "risk point" from one pipe is comparable to each "risk point" of another pipe (allowing for length normalization). The sum of all risk scores across the network represents the total risk for the system. Risk scores can also be used to compare and rank pipes by geographic area, material type, etc.
- **Risk Mitigation Cost** – approximating the expenses associated with various risk mitigation options for each project enables the concept of $ spent per point of risk reduction. This can help identify the most cost effective method of risk mitigation. For example, increased leak surveillance or targeted refurbishment may reduce risk to an acceptable level more cost effectively than full pipe replacement. This also leads to recognition that each next point of risk reduction across the system becomes more costly, and the potential development of policy target levels. Example cost metrics include:
    - Average $/risk point reduction for the facilities currently targeted for risk mitigation
    - Average $/risk point reduction for the next level of facilities targeted (i.e., the "Marginal Cost" per point)
- **Failure Rates** – While actual failure rates for certain types of threats may vary from year-to-year (e.g., CI Breaks or corrosion, based on weather or other factors), risk mitigation activities should eventually reduce the rates of the most likely (or most consequential) types of failure. The accuracy and reliability of the risk assessment mechanism can be monitored and tuned by comparing actual failure rates to the previously forecasted expected failure rates.
- **Failure Trends** – All pipe failures should be periodically analyzed in order to identify emerging new trends. It should be possible to trend failures along several dimensions, such as pipe material, yr installed, size, coating type, protection type, geographic region, or leak cause.

CONCLUSION AND NEXT STEPS

Through integration of its existing enterprise GIS and an automated software solution that performs system-wide risk assessment and prioritization of pipeline segments, CenterPoint Energy is preparing to comply with any future Distribution Integrity Management rules or requirements. The company also expects to realize significant business benefits from this system regardless of the nature of any final regulations. During development of the Distribution Integrity Management Roadmap, CenterPoint identified sources within existing information systems for many of the typical failure and risk profile factors, including:

- 10 of 10 high priority failure factors
- 11 of 13 medium priority failure factors
- 7 of 9 high priority risk profile factors

The following matrix summarizes the changes recommended by the Roadmap in terms of relative cost and benefit to CenterPoint Energy.

Distribution Integrity Management Change Matrix				
Change	**Cost**	**Cost Description**	**Benefit**	**Benefit Description**
On-going Leak Geocoding	Low	Data entry time and associated process changes	High	Expose most significant source of information about pipe integrity to GIS users and GIS enabled applications
Enhance Field Data Collection	Low	Modify forms, train field crews, extend data repository	High	Monitor various threats and risks by extending existing processes and data collection activties
Implement Distribution Integrity Metrics	Low	Natural result of other recommended changes	High	Provide visibility of meeting policy objectives; Enable objective system-wide decision-making; Position for anticipated reporting/monitoring requirements
Written DIMP Plan	Low	Consensus building and corporate policy-making effort; align perceptions with actual results of comprehensive statistical analyses	Medium	Consistent documentation of threat/risk analyses; Align corporate-wide decision processes; meet expected regulatory mandate
Distribution Integrity Management Decision Tree	Low	Consensus building and corporate policy-making effort	Medium	De-centralize routine decision-making, align local behavior with corporate objectives
Define Continuous Improvement Plan	Low	Periodic assessment and tuning	Medium	Position for anticipated monitor/adjust regulations; evolve with business/regulatory conditions
Implement Distribution Integrity Management System	Medium	Software, system integration, training	High	Enable objective system-wide assessment, monitor all threats & risks, position to comply with anticipated regulations
Make CP Test Point Reads and Fault Repairs Available to DIM System	Medium	System integration	High	Monitor threats to protected pipe
Geocode Legacy Leaks	Medium	Data processing, minor software development	Medium	Enable threat assessment based on actual operating history in each region
Electronic Collection of 3rd Party Paving Plans	Medium	Data modeling, establish data collection processes	Medium	Identify cost savings and avoid penalties by aligning replacement plans with 3rd party construction activity
Make Locate Request Information Available to DIM System	Medium	Data modeling, establish data collection processes, perform analysis of immediate vs. delayed impacts	Medium	Enhance Damage Prevention and Assessment of 3rd party threats and damage to underground facilities
Populate All CP Areas and Test Point Locations in GIS	Medium	Data entry and on-going maintenance	Medium	Understand CP infrastructure; enable future mobile work alignment
Load service pipes and attributes into GIS	High	Data entry and on-going maintenance	Medium	Document infrastructure in a single system; avoid system integration expense

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BIOGRAPHICAL INFORMATION

Steve Greenley
Manager, Technical Field Operations (Houston)
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Specific Responsibilities

As Manager of Technical Field Operations, Steve manages the corrosion control, leak detection, and measurement activites in the state of Texas for CenterPoint Energy.

Past Experience

Steve began his career with CenterPoint Energy in 1999 in Gas Distribution Engineering as a design engineer. He has also worked in Gas Engineering Standards developing engineering and operational policies for CenterPoint Energy LDCs. His operational experience includes being Gas Integrity Group Manager to begin development and management of Transmission Pipeline Integrity activities. Steve recently became the Manager-Technical Field Operations.

Educational Information

Bachelor of Science in Mechanical Engineering from the University of Texas - Austin

Professional Memberships

American Society of Mechanical Engineers
National Association of Corrosion Engineers
American Gas Association Corrosion Control Committee

BIOGRAPHICAL INFORMATION

Tony Sileo
Product Manager
Opvantek, Inc.

Specific Responsibilities

As a Product Manager at Opvantek, Inc., Tony is responsible for establishing product roadmaps based on customer input and market research, directing product development and support activities, managing customer delivery projects, and participating in consultative sales efforts. Recently, he has been working with Opvantek's LDC customers to expand the capability and coverage of the Company's Optimain DS product to meet all aspects of pending Distribution Integrity regulations.

Past Experience

Tony's background includes over 20 years of software product development experience, including over 10 years developing and delivering software solutions to the utility industry. Prior to joining Opvantek, he held various leadership roles in the GIS software industry with GeoData Solutions, Navigant Consulting, Smallworld, and GE Energy. While with GeoData Solutions, Tony conceived, built, and sold one of the first commercial GIS-based electric outage management systems, which eventually became the basis of the Smallworld PowerOn product. His most recent role at GE was Global Product Development Manager, directing the activities of over 200 staff in 5 countries, and managing over $25 million in annual software development and support investments.

Educational Information

M.S. Electrical & Computer Engineering, 1997, University of Colorado – Boulder
B.S. Computer Engineering, 1990, Rochester Institute of Technology

Professional Memberships
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