Data Management Practices For Pipeline Integrity

GeoFields, Inc.

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Pipeline Data Management

“From Data to Wisdom”*

• Data
  – Numeric values - pipe attributes, environmental attributes, obtained through inspection, etc

• Information
  – Extracted from data through processing. Contained in descriptions (who, what, where, when, how many)

• Knowledge
  – Familiarity gained through experience. Makes possible the transformation of information into instructions.

• Understanding
  – Knowing the cause and how to correct it

• Wisdom
  – The capability to judiciously apply resources

* Russell Ackoff
Pipeline Data Management

• Objective
  – Provide a framework for a coherent, well managed, easily accessible collection of information regarding the facility, operating environment and the operating history
  – Information Value - Improved with the ability to integrate with other information
"Model Centric" Risk Assessment

Pipeline Facility Data

Data Preparation

Risk Model

Model Output

Integrity Program
“Data Centric” Risk Assessment

- Pipeline Facility Data
- Data Preparation
- Facility Database
- Data "Gateway"
- Risk Model 1
- Model Output
- Risk Model 2 (Validation)
- Model Output
- Integrity Program
Re-engineering the Risk Assessment Process

Objectives

- Stepwise reduction in effort to gather and format information
- Improve analytical environment
- Facilitate decision modeling and scenario building
- Improved documentation of decision rationale
- Flexibility of process to incorporate revision
Acceptance and Confidence
Formulating Decisions from Risk Assessment

• Characteristics of a Risk Assessment Process which lead to acceptance and confidence
  – Feasible
  – Systematic
  – Defensible

• To establish confidence, risk results must be validated
  – models must be “robust” and based on accepted research
  – alternate models should deliver similar results
  – Quality of data must be maintained (garbage in / garbage out)
  – Raw data must be available for diagnostics
Pipeline Data Model

- **Basemap**
  - Vector: Transportation, Hydrography, HCA polygons, etc.
  - Raster: DRG, DOQ, Photography, etc.

- **Pipe Centerline**
  - Station aware

- **Attribute (event) Tables**
  - Relational tables linked to centerline by line identifier and stationing
  - Point (valves, meters, pig anomalies, etc.)
  - Linear (casings, coating, pipe spec, hydrotest, etc.)

- **“String” or “Series” data**
  - Efficient management of survey data (CIS, PIG, DOC, etc.)
### Linear Referencing (Dynamic Segmentation)

#### Station Measure

- **Line Identifier**
- **0+00**
- **9+76**
- **15+35**

#### “Station Aware” Pipe Centerline

#### Pipe Attribute “Event” Tables

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<tr>
<th>LINE_ID</th>
<th>BEG_STATION</th>
<th>END_STATION</th>
<th>PIPE_OD</th>
<th>DESCRIPTION</th>
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Risk Modeling
Data Related Issues

- **Pipe Centerline Definition**
  - Establishing a geographic pipe centerline allows
    - Full confidence in determination of impact on HCA
    - Determination of interaction between pipeline and off line features (residential development, roads, rail, etc.)
    - Submission to NPMS
  - Establishing a “stationed” geographic centerline allows
    - Integration of data sets utilizing station as a common location
    - Integration of “stationed” data sets with geographic data sets
Risk Modeling
Data Related Issues

• Pipeline Attributes – Stationing vs GPS Location
  – Maintaining station provides a location wrt pipe centerline
  – GPS location provides an absolute location (wrt Earth)
  – GPS located points will only fall on pipe centerline if both GPS location and pipe centerline have high accuracy
  – Maintaining stationing allows “enhancement” of centerline position
    • stationed points will always fall on centerline.
    • Integration of data sets can be performed without a “perfect” pipe centerline.
Evolutionary Centerline Development

Calibration Points

Calibration Points

Calibration Points
Risk Modeling
Data Related Issues

• Model / Data Dependencies
  – User should understand impact of a data set on model
    • Not a “black box”
    • Model must be defensible
  – 20% of factors have 80% of influence on model output
    • Model should operate with any number of data inputs
    • Allows “iterative modeling” & model refinement on as needed basis
Risk Modeling
Data Related Issues

• Data Preparation
  – A suite of processing data processing functions that “prepare” data for loading to Pipeline Database

• Attribute Validation
  – Checking of attribute values to ensure validity
    • Valid range of values
    • Valid station values
Risk Modeling
Data Related Issues

• Data Preparation

• Data “Alignment”
  – Sometimes referred to as “Data Integration”
  – Refers to the process of insuring that data from different sources are “aligned” such that features (valves, vents, welds, etc.) from each data set have the same “station” value.
    • Facilities database, CIS, PIG, Hydraulic models, etc.
Risk Modeling
Data Related Issues

• Data Preparation
  – A sequence of data preparation functions may be required

• Data “Derivation”
  – Extracting data from externally maintained sources
    • CPDM, HCA, corporate databases

• Data Alignment may need to be performed on derived data sets
Risk Modeling
Data Related Issues

- **Data Error**
  - Positional accuracy error (GPS, Data Source)
  - Human (Interpretive) error
  - Missing data
  - Rarely given adequate consideration
  - Error has a significant impact when integrating data sets from multiple sources
Data Management for Pipeline Integrity Implementation

- Identify the process & stakeholders
- Build the Team
- Set & Understand Objectives
- Develop Feasible Scope
- Set Milestones & Define Deliverables
- Manage Expectation & Scope
- Project Management
- Work Hard & Manage Issues
- Plan Early
  - Identify follow-on activities – how is the process kept evergreen