Help Is Here To Improve Pipeline Integrity Management

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Pipeline operators can realize many benefits by implementing a data integration approach that enables integrity managers, risk-assessment specialists and pigging engineers to view and analyze combined information from disparate surveys and to increase the value of data by sharing it across the entire corporation.

This article discusses the concept and importance of integrating and aligning inspection data from a variety of sources. It looks at the value of making data comparisons among lists of pipe sections intersecting high-consequence areas (HCAs), the results of risk analyses and reports from field inspections. The real value of integrating multiple surveys is that integration not only supports analysis of surveys against each other, it also helps foster cross-departmental cooperation for prioritizing pipeline maintenance.

Real Value

Discovering and tracking metal loss and geometry anomalies form the basis of most preventive pipeline maintenance activities. However, recent OPS rules require operators to assign priorities to maintenance and repair and determine whether a specific anomaly should be repaired immediately, or within 60 or 180 days.

Operators are also expected to have their own set of criteria to supplement those that are mandated. This prioritization requires not only the analysis of a single survey or external map data, but also the comparison of multiple survey types to each other and integration with various risk analyses.

The key to prioritizing maintenance and repair is, therefore, to integrate survey data with other important information. By doing this, an operator can begin answering key business, regulatory and risk-related questions such as:

- Which anomalies fall under immediate repair vs. 60-day or 180-day?
- Where do we have predicted metal loss greater than 50 percent at foreign line crossings?
- Which dents on the top of the pipe are in areas that could affect a high-consequence area?
- Which dents lie on the bottom of a pipe exhibiting metal loss?

Inline inspections will continue to be important for locating and performing digs at features of concern. While ILI devices continue to produce more and more accurate location information through the use of secondary GPS surveys and sophisticated inertial navigation systems, several necessary requirements are left unanswered.

A thorough analysis of the data requires the integration of other operator data, such as facilities, casings, valves, compressor stations, external data and HCA locations. If survey data is not integrated and aligned with the vast array of operator data, precise risk assessment is almost impossible. Effective inspection data integration can support operations in a variety of ways. Operators can:

- Compare a single survey to all other data sets along the pipeline;
- Compare inline surveys to each other at a weld-to-weld level;
- Integrate inline and aboveground surveys so that an analyst can establish the recorded CIS readings for each anomaly observed in an inline inspection; and
- Monitor advancing corrosion by comparing surveys from different years.

When it comes to integrity management plans, data integration allows an operator to identify significant events of concern without having to align multiple datasets to the survey each and every time. It brings surveys into context with the rest of the information held about the pipeline and facilitates further analysis. This analysis might be as simple as filtering data and locating features of concern, or one could integrate the survey into a comprehensive risk-modeling process.

Integration also promotes information sharing among different departments. For example, the department in charge of inline inspections and the department in charge of integrity management can now work in tandem since data can be combined and understood on a variety of levels, using a common frame of reference. The integrity manager does not have to become a data integrator, and the pig engineer can focus on analysis needs, rather than those of other groups. Information gets to the right people at the right time and is accessible by all.

Mechanics Of Data Integration

There are five levels to data integration. The first level is when data remains unaligned — in a stand-alone file or tool-specific database, which is not a preferred option, given today's OPS rules. The second level is reconfiguring odometer readings to provide approximate pipeline stationing. This is commonly approximated by the pig vendor or calculated manually by the pipeline operator. The third level is aligning data relative to aerial photography or another base map, perhaps making use of GPS field surveys of markers.

Moving onto more advanced alignment options, level four is alignment relative to an enterprise facility database where comparisons with other data can be performed. Finally, level five is when alignment is done relative to other inline surveys.

Level 1:	Data remains unaligned
Level 2:	Reconfigured odometer readings to provide approximate pipeline stationing.
Level 3:	Aligning data relative to aerial photography/basemap
Level 4:	Alignment relative to an enterprise facility database

Build precise risk assessment program

Level 5:	Alignment relative to other in-line surveys

Figure 1: Precise risk assessment is possible with level five alignment.
Source: *GeoFields Inc.*

Operators should choose a level of alignment that helps them meet their business objectives and regulatory requirements. While levels one through three may assist a pig engineer in identifying groups or clusters of anomalous readings, or in performing predictive growth modeling and 3D visualizations, it does not provide the rest of the organization with the basis for the analyses they need. We'll look at how level four and five alignment supports more precise risk assessment.

First, report data from pig devices is synchronized in two stages. Known points within the survey — features that the pig can detect, such as valves and markers — are referenced to corresponding pipeline features in the facility database. Once the known points are synchronized to the centerline, correct pipeline stationing is established for all records in the pig run, including all anomalies. The facility database provides the means to translate stationing to coordinate values as necessary, depending on the needs of field engineers.

Following the stationing of each pig run, the runs can be aligned to each other by matching the weld spacing (joint lengths) within the pig data sets. Robust algorithms are needed to account for runs being performed in different directions, or replaced sections of pipe causing breaks in joint length sequence. Once weld-to-weld matches are established, it can be determined which individual joint lengths are afflicted with multiple feature types. Comparisons of each joint length can be made, locating dents or scours in one survey that coincide with corrosion found by another — a key element of current rules.

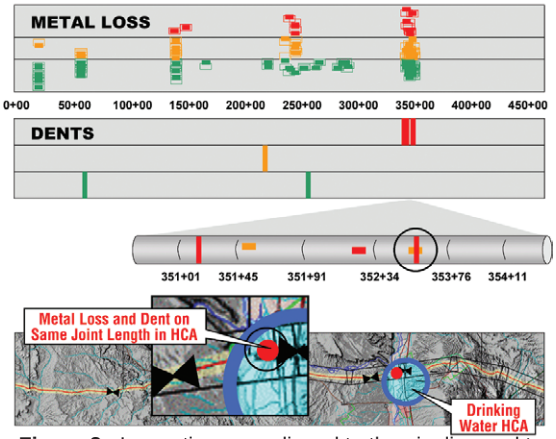

Figure 2: Inspections are aligned to the pipeline and to each other, supporting required analysis.

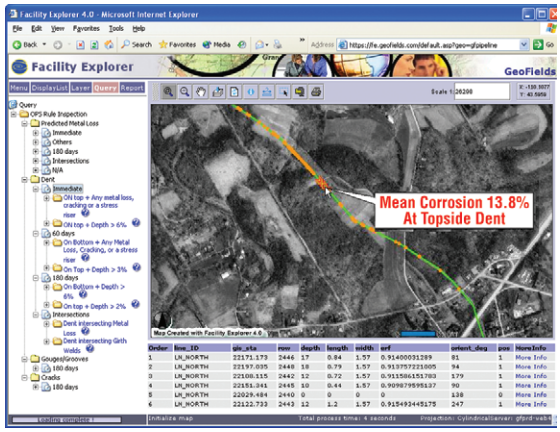

Figure 3: With robust querying tools, an operator can pinpoint problem areas and perform risk analysis.

Level five alignment brings multiple pig runs into precise alignment with both the pipeline centerline and more importantly, with each other at the weld-to-weld level. The alignment of records from different runs and vendors can now be established.

In effect, alignment is happening on two levels: Macro alignment (level four) focuses on aligning surveys to features on the pipeline and the rest of the facility database and micro alignment (level five) matches joint lengths within pig runs and aligns them to each other.

By aligning inline pig runs at a high level of accuracy, an operator can determine where problem areas coincide, especially when they are on pipeline segments that could affect an HCA. Once location has been determined and the coincidence of events in different surveys is established, data is made available for querying and analysis across the organization.

These same techniques are also used to synchronize Close Interval Survey (CIS) data to the pipeline centerline and produce stationing for each survey reading, allowing surveys to be related to data held in the GIS, including smart pig surveys, HCAs and other areas of interest.

Storing And Querying Data

Aligning data is a key step in the risk assessment process, but the ability to query data is critical for analyzing anomalies. Storage in local files across desktop computers or departmental servers might work when dealing with the analysis of separate runs in isolation, but with the use of data integration, the information should be available in a more accessible manner.

With an "enterprise" storage system, an operator can retrieve and query data without having to integrate every time. In effect, the data can still be stored in its native format, but with an additional alignment layer, data can be accessed and analyzed in combination with other data sets.

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In the enterprise system, operators move beyond just filtering one survey on its own or comparing a survey to a few pipeline features imported into the system. Now, an operator can query multiple surveys against information held in any part of the organization and in any available database - from cathodic protection and work order management to SCADA and even the accounting system.

This would allow an operator to home in on a part of the pipeline that has a combination of anomalies that require action and understand the consequences of both responding and not responding to an anomaly. For example, a dent with indicated metal loss on a pipeline that could affect a high-population HCA would be flagged and the location given. With this information in hand, an operator can assign priority for repair and maintenance and have substantive evidence to warrant action and remediation.

Common Frame Of Reference

Operators routinely use level five integration to enhance risk assessment and prioritize repairs. One way is to assess which anomalies should be the focus of immediate inspections. Once comparisons are made among surveys, it quickly becomes clear, for example, which of the dent anomalies on the top of the pipeline, as recorded by a geometry tool, lie on corroded pipe, as recorded by a magnetic flux leakage (MFL) tool.

Additional criteria searches can readily take place between tools to establish other "immediate" anomalies, as determined by the OPS. According to OPS rules, these anomalies must be inspected within five days.

Further, operators can determine which anomalies fall into the 60-day and 180-day categories for scheduled inspection and maintenance. In this way, some of the time and cost pressures are relieved, having exact information about anomalies and as a result, being able to prioritize them.

The additional benefit of using an enterprise-wide approach to data integration is the immediate availability of data to risk assessment teams. Data can be plotted on risk assessment maps, made available through the corporate Web-based mapping and reporting software for team members and is easily incorporated into the risk model within the integrity management plan — all leading to a better understanding of pipeline threats.

Simply put, data alignment is all about bringing disconnected, fragmented sets of information into a common frame of reference. Through integration, operators can begin to more easily mine information from surveys that they never knew existed and begin to share information across the entire enterprise. ***P&GJ***

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