

PROJECT PLANNING SUMMARY

Date: March 2005

AUTHORS: Steven Gower, BP
Clive Ward, Advantica

SPONSORS: GERG, Transmission & Storage PC
PRCI Corrosion and Inspection Committee

1. **PROJECT TITLE:** ILI Tool Performance Guidelines for Pipeline Operators
New: Y
Continuing: N **Prior Project(s):**
Other affected Technical Committees: None
Est. Years to Achieve: 3 **Est. Cost** **Phase 1 Stages 1,2** \$80K
Phase 1 Stages 3 – 5 \$250K - \$500K
Phase 2 not costed

2. **BUSINESS DRIVER(S) AND ISSUE ADDRESSED:**

Drivers:

Improved pipeline integrity, reducing the likelihood of a leak or rupture.
Improved safety and minimizing environmental risks
Achieving regulatory compliance
Optimizing integrity assessments – only inspect as often as necessary
Reduce operators' risks and costs of conducting integrity assessments using ILI

Issue:

To gain a better understanding of the true capabilities of ILI tools, and the factors that influence performance, so that ILI programs can be designed to better meet operators' integrity needs.

3. **PRACTICAL PROBLEM FOUND IN CURRENT PRACTICE:**

A brief description and rationale of the problem to be addressed (about 150 words).

ILI tools offer a range of inspection capabilities addressing different integrity threats. Performance varies according to the technologies being used and the system design, influencing parameters such as defect sensitivity, accuracy and spatial resolution. ILI vendors routinely provide performance specifications such as the types of defects that can be detected, their minimum dimensions and the expected sizing accuracy. Practical experience reported by operators is that discrepancies often exist between quoted and achieved performance. This may be due to inadequacies of the ILI tool or poor measurement practice on site.

Understanding the true behavior of ILI, and what affects it, is fundamental to integrity management planning and has a direct impact on repair strategies and inspection frequencies. Operators require better guidance, based on actual performance data, to ensure ILI programs meet their ongoing integrity needs.

API1163 [1] provides a process-oriented approach for measuring pig performance. Having a common standard will help operators to compare the data provided by different vendors. While API1163 cites typical accuracies for some of the different technologies, this is insufficient to compare specific devices or vendors.

The aim of this proposal is to accelerate the assembly of ILI performance information to meet the requirements of operators. Sharing and analyzing information on the historical performance of ILI tools, to support modeling and measurement of pig performance would enable operators running tools, particularly when a line is being pigged for the first time, to address the above issues and plan more reliable and effective ILI programs.

Proposals have been developed previously for collaborating on the topic outlined here but as far as the authors are aware, none has so far been successful due to reluctance from industry as well as the vendor community.

4. SOLUTION DESIRED:

Discussion of desired solution, end products and deliverables (about 200 words).

1. Practical guidance on ILI tool selection written from a pipeline operator's perspective (a 'Pipeline Defect Assessment Manual' for ILI)
2. A better understanding of the operational circumstances (such as inadequate cleaning and over-speed conditions) that impact the inspection quality
3. Guidance on when inspection run findings need to be qualified using direct examinations rather than relying on qualification tests such as pull-throughs.
4. Guidance on suitable methods for the measurement of defects examined in the ditch.
5. Concise, independent guidance on the impact of inspection tool performance on the outcomes of inspection, the repair strategy, and the ongoing integrity assessment schedule (interval).
6. Actual performance capabilities and success rates of different types of ILI tool and of ILI vendors, operating in different pipeline geometries and matched to the relevant integrity threats.
7. A proposed structure and mechanism for sharing similar information into the future.
8. A solution that complements rather than duplicates API1163 and other relevant codes and standards.

5. POTENTIAL BENEFITS AND TIMELINESS ONCE ACHIEVED:

Anticipated benefits of R&D efforts necessary to address issue, with relationship to business drivers quantified as much as possible, and timeline necessary to achieve benefits (about 200 words).

*****Note: Template to be used for January 2005 submissions. PRCI staff will complete relationship to Business Drivers for contractors/members who will be submitting this document.**

6. DESCRIPTION OF STATE OF THE ART:

Review of relevant research performed and significant results achieved (about 400 words).

Over the last 30 years ILI has become established as the preferred method of integrity assessment for pipeline operators. Different types of ILI tools have proven capabilities for detecting and sizing defects caused by most time-dependent integrity threats, including corrosion (internal and external), cracking (hydrogen blisters, stress corrosion, fatigue), some types of mechanical damage, and others.

During the last 5 years, significant attention has been paid in the US to the development of ILI standards. These documents (either published or soon to be published) should improve awareness and confidence in ILI and help meet the needs of the various parties interested in maintaining safe and reliable pipelines, see for example, refs [1-3].

Internal inspection tools are complex systems designed to gather, process and record information relevant to the integrity threat being addressed. Many performance characteristics are pre-determined by the tool design, and can be simulated using commercial magnetic modeling packages and others developed for PRCI by Queen's University, Kingston. Performance testing is also required. The most common ways to do this are to use pull-through rigs or flow loops although testing in live pipeline conditions is also possible. API1163 provides examples of the type of data to be collected and how the information may be analyzed and presented.

- 'Pull-through' rigs are the least expensive proving method enabling vendors to assess and demonstrate the capabilities of their ILI tools at ambient pressure. Results of this type of test have been published by vendors and are often quoted in tool specifications.
- More realistic conditions are provided by pressurizing a test loop such as the GRI loop in Columbus Ohio and Shell's facility in the Netherlands. These tests have helped establish performance levels for commercial MFL inspection tools (through the Pipeline Operators' Forum) and for the underlying techniques (Battelle, who carried out extensive evaluations using test bed MFL vehicles [4]). Limited information exists in the public domain.
- A limited amount of information relating to actual performance of pigs under live conditions is available as a result of incident inquiries and other publications [5-6].

These sources provide valuable data that help define the capabilities and limitations of the inspection technologies tested. Unfortunately, it has rarely been in the interests of either the vendors or operators to publish their experiences of ILI tool performance when results have been poorer than expected, and consequently the knowledge base literature is lacking.

7. PROPOSED WORK SCOPE (THIS PROJECT):

Description of proposed work scope and discussion of how project advances the state of the art (about 400 words).

Phase 1 of the project will be confined to looking at magnetic flux technologies tools for detecting corrosion. This reflects the importance of metal loss detection and the dominant position of MFL in the market.

Stage 1) Project specification

A methodology for completing subsequent stages will be developed by the contractor based on a detailed literature review, in-house knowledge of MFL technologies derived from tool development and operating experience, and materials and fitness-for-purpose considerations. A structured process to performance evaluation will be developed from API1163 with tools grouped according to appropriate criteria, such as magnetization direction and resolution defined by the vendor. The value of ILI system modeling will be assessed for its potential to reduce the need for full-scale testing. Finally, data access issues will be explored with potential sponsors to help project definition.

The report from this stage will include a plan for the data required in stage 2, for review by sponsors. A review meeting will be held with sponsors to discuss the document.

Stage 2) Contract Development

Potential sponsors have suggested that this project will benefit from a joint-industry approach. The managing contractor will develop the necessary framework and coordinate this contract preparation. This task follows the release of the stage 1 report to ensure that the contract tasks are fully defined and understood by all parties. Contracts need to acknowledge that the data required to perform the study are highly sensitive. Companies will require adequate precautions in place to ensure data remain confidential.

Stage 3) Modeling will be conducted if required, based on the recommendations from stage 1).

Stage 4) Data gathering from pipeline operating companies

Pipeline operators will be required to provide access to information needed for this project. Pull through, flow rig and field testing reports will be required, together with the results of subsequent dig programs. The task will be conducted by experienced analysts and integrity engineers. The contractor may need to talk directly to the ILI vendor and operator personnel to solicit comment on any conclusions drawn. The number of inspections considered and the extent of the review will be necessarily limited but will be targeted to ensure maximum value for the project.

Stage 5) Analysis and Reporting

Different analyses will be required to address the diverse objectives set out in Section 4 - Solution Desired. Recognizing that the data gathered during this type of project will be from multiple sources, covering a diverse range of inspection scenarios, it is unlikely that it will be amenable to a rigorous statistical analysis. Included in the analysis:

- Identifying factors that contributed to success (and failure) of first-time inspections.
- Examples of ideal performance of technologies based on modeling, pull-throughs and loop tests including published data.
- Analysis of data from actual inspections taking into account tool detection sensitivity, classification and sizing accuracies and the impact of these tool performance parameters on integrity management.
- Recommendations for the format and population of a database containing the reference data for the project.

Stage 6) Witnessed ILI system performance tests

While the need for specific evaluations of named vendors' inspection tools would not be part of the initial plan, it is recognized that the relevant information may not be available to the project team from existing sources. Stage 6 is therefore an optional extension to the project should this need arise. The facilities for conducting such testing could be provided by a vendor, a test loop facility, or in the field by a pipeline company.

Phase 2 of the project will address other ILI technologies, commencing with ultrasonic tools for detecting metal loss and cracks. Phase 2 could commence once Phase 1 is underway and the methodology established.

8. EXPECTED RESULTS (THIS PROJECT):

Deliverables:

Discussion of desired solution, end products and deliverables for the proposed project (about 100 words).

The deliverables will be:

- 1) A detailed project specification report resulting from Stage 1
- 2) A contract proposal for subsequent stages of work, following Stage 1.
- 3) A detailed final technical report with sections covering:
 - a. Practical guidance on ILI tool selection
 - b. Description of the operational circumstances that impact inspection quality, and how to recognize and mitigate against adverse effects
 - c. Guidance on when inspection run findings need to be qualified using direct examinations rather than relying on qualification tests such as pull-throughs
 - d. Guidance on defect measurement in the ditch
 - e. Guidance on the impact of tool performance on the outcomes of inspection, the repair strategy, and the ongoing integrity assessment schedule (interval).
- 2) A database of performance capabilities of different types of ILI tool
 - a. Results obtained during this project, comprising a database or spreadsheets containing all reference data used in analysis. These would include specific examples with performance curves relating defect size to the Probability of Detection (POD) and other relevant parameters.
 - b. A proposed structure and mechanism for sharing similar information into the future.

Probability of Success:

Discussion of the probability of success in achieving the stated project deliverables (about 200 words).

Parts of this project can be achieved using existing information, through literature and data review, and rely to a significant degree on the expertise of the contractor. Other parts of the project can only be successfully delivered if sufficient cooperation is provided by pipeline companies. This will require a willingness to share data including access to ILI vendor reports, electronic data such as pipeline and defect listings, and definitions of data formats to allow independent audit of the information. Provisions will be made to ensure that confidentiality is maintained in line with the wishes of the donor companies.

It would be beneficial to the project if vendors were willing to provide certain background information on their tools and cooperated by commenting on the findings.

Any specific performance testing would require participation of one or more ILI vendors.

Given the cooperation just outlined, there is a very high probability that the project will be a success.

9. TECHNOLOGY TRANSFER STRATEGY:

Discussion of suggested strategy for transfer of deliverables to industry (about 100 words).

The technical report would provide the primary means of technology transfer. If required, a training course could be developed based on the material assembled during the project.

10. CONTRACTORS SUGGESTED:

Listing of potential contractors, sub-contractors and teams capable of performing project.

Advantica (lead)

Subcontractors may be required to deliver part of this project e.g. Battelle and specialist R&D organizations

Cooperation with ILI vendors if possible

11. FUTURE WORK NEEDED TO ACHIEVE SOLUTION:

Description of future work necessary to achieve solution (about 100 words).

This project would be conducted in stages and would aim to deliver the complete outcome in accordance with the needs of sponsoring companies.

12. ALTERNATE FUNDING SOURCE:

Listing of alternate funding organizations, co-funders and type of co-funds.

Proposed Joint Industry Project attracting initial funding from BP for a state-of-the-art review, then PRCI and European pipeline companies either individually or via GERG from January 2006.

References

Sequential listing of technical references, as needed.

[1] NACE Standard RP0102-2002 Standard Recommended Practice, In-Line Inspection of Pipelines.

[2]. ASNT – In-Line Inspection Personnel Qualification and Certification Standard No. ILI-PQ-2003.

[3] NACE TR 35100 – In-Line Nondestructive Inspection of Pipelines –Dec. 2000.

[4] Nestleroth, Bubenik (Battelle) various reports 1998 – 2003 from Gas Research Institute contract 5093-260-2605 “3D details of Defect-Induced MFL and Stress in Pipelines”.

[5] Morrison, T, Mangat, N, Desjardins, G and Bhatia, A. Validation of an in-line inspection metal loss tool. ASME International Pipeline Conference IPC2002, Calgary.

[6] Bhatia, A and Westwood S.M, 2003 “Developing a Baseline Inline Inspection Program with Design and Operational Decisions on the use of a High Resolution Magnetic Flux Leakage Tool”, NACE 2003, Paper 03172