Internal Robotic Inspection Tool for Unpiggable Pipe Inspections

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A self-propelled in-line inspection tool tested at Electric Power Research Institute and utilized in Europe can traverse a complex piping configuration and discriminate areas of metal loss. This tool is becoming available to inspect traditionally unpiggable piping such as: buried piping at nuclear plants, oil and gas terminals, refineries, industrial sites, cased pipeline crossings and distribution pipelines. In the past, these facilities have often deferred their inspections due to the cost to modify facilities for traditional flow driven in-line inspection tools or the cost to excavate to complete direct examination. A new line of tools being introduced by GE Energy's Industrial Solutions business, is becoming available with *Single Point Access* capabilities. This technology allows the tools to be inserted into the pipe at a single location, e.g. a removed block valve, and retrieved from the same location. In many cases, facility modifications and limited excavations are not required or necessary to complete the inspections.

Figure 1. Tool inserted at removed valve.

The first of this new line of robotic tools is capable of running in pipes that are filled with liquid, partially filled with liquid, or dry. This tool was recently included in blind testing at Electric Power Research Institute (EPRI). The test mockup consisted of three sections of 24-inch pipe. Two sections were 40 feet long and the third was 60 feet long with a 90-degree 1.5D elbow. In order to simulate field conditions, the entire test pipe was covered so that all of the testing was completed blind.

EPRI's research on buried pipe nondestructive evaluation (NDE) has five objectives:

1. Benchmark buried pipe NDE capabilities
2. Support technology implementation
3. Provide resources for vendors to improve technologies and procedures
4. Support vendors in understanding nuclear industry needs
5. Facilitate construction mockups to assess technology. Piping mockups containing actual or simulated corrosion technology are necessary to accomplish tasks two and three. Because only limited field-removed corroded piping has become available from the industry, EPRI has constructed the 24-inch diameter pipe mockup containing discontinuities of different shapes, depths and extents.[1]

Figure 2. 24-inch Robot Tool w/Slofec insp. tech. tested at EPRI for Buried Pipe Inspection. Photo courtesy of GE

The specific 24-inch self-propelled tool used during the testing utilized SLOFEC™ (saturated low frequency eddy current) sensors. The tool is electromagnetic and has a rotating head capable of inspecting the entire pipe including the heat affected zone associated with the girth welds. It transverses down the pipe and collects 360 degree corrosion mapping data while discriminating between ID and OD reflectors. The unique design allows the tool to pass through multiple bends while inspecting the pipe. Powered via an umbilical, it feeds live data including video of the interior of the pipe. This enables a technician located at a nearby work station to interpret the data and identify areas of metal loss. The tool has the ability to inspect the pipe and interpret data while traveling up to 1,000 feet into the pipe. It can effectively inspect the pipe twice with a single launch, allowing the technician the ability to take a second look at areas of concern as the tool backs out of the pipe. Additionally, the tool can inspect a pipe with a sensor lift-off of up to 0.4 inches, which could be associated with internal pipe lining or debris.

Preliminary results from the testing in the three 24-inch pipe sections at EPRI showed the following:

1. The tool is capable of propelling itself through 1.5D radius bends.
2. The tool is consistent in recording the data from the pipe defects.
3. 90 percent of all internal and external defects were detected.
4. Defect sizing data is being calculated and plotted by EPRI, however, the preliminary results indicate an average accuracy of greater than 80 percent of actual depth.

Additional robotic tools from six to 30 inches are slated to be manufactured in 2012 by GE. The tool designs have been proven through actual field applications in Europe. Ultrasonic inspection technology will be available from six-inch to 12-inch diameters and SLOFEC inspection technology will be available from 12-inch to 30-inch diameters. The ultrasonic tools are designed to inspect dry pipe while navigating vertically and horizontally within the pipe. The larger tools, 12 inches and above, will be equipped with an oxygen sensor to detect explosive vapors. As a safety feature, if explosive vapors exist the tool will automatically shut down. All of the tools will be suited to pass multiple 1.5D 90 degree bends, inspect pipes (filled with liquids, partially filled with liquids, or dry), and will be equipped with an umbilical to provide power to the tool and provide live corrosion mapping data streaming to a technician for analysis. The umbilical can also be used to retrieve the tool if it requires a shut down due to the oxygen sensor or if it somehow becomes lodged. This provides the customer with added assurance of being able to retrieve the inspection tool without the risk of a costly excavation up to 1,000 feet.

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Clay Goudy is a Sales Manager for GE Industrial Solutions focused on Non Destructive Testing provided by GE Energy Inspection Services. Clay is the applications specialist for this project. Clay has worked with Pipeline Intelligent In-Line Inspections with PII, a joint venture between GE Oil & Gas and Al Shaheen. Prior to working for PII he worked for Conoco Specialty Products and Conoco Pipe Line Company, providing pipeline solutions around the world. Clay earned both his Mechanical Engineering and Industrial Engineering degrees from Georgia Tech.

References

1. Inspectioneering Journal, Vol. 17, Issue 6, Nov./Dec. 2011, p. 16. "Internal Ultrasonic System Shows Promise for Buried Pipe Inspection"
2. SLOFEC is a TMT trademark.