Northeast GAS ASSOCIATION
NYSEARCH

Technology Brief

TIGRE: A Large Diameter Robotic System for the Inspection of Unpiggable Natural Gas Pipelines Using an MFL Sensor

Description: **A robotic platform able to operate in high pressure high diameter gas pipelines in the absence of flow, negotiate commonly encountered features such as mitered bends and plug valves, and carry out wall loss inspection using a magnetic flux leakage sensor.**

Status: **Pre-commercial prototype system is undergoing field testing.**

BENEFITS

The TIGRE robotics system being built under this program will allow pipeline operators to carry out In-Line Inspection (ILI) of 20" - 26" unpiggable gas pipelines using a state of the art Magnetic Flux Leakage (MFL) sensor. The robot is deployed and operated under live conditions using commercial fittings and can operate in pipelines with very low or no flow and with obstacles that render inspection using conventional state-of-the-art pigs impossible. The inspection data from TIGRE can be used to meet the inspection requirements imposed by the 2002 Gas Rule of the Office of Pipeline Safety.

BACKGROUND

In early 2003, NYSEARCH initiated the development of Explorer 6/8, a visual and non-destructive evaluation (NDE) inspection tool for the inspection of both transmission and distribution lines in the 6" - 8" range. That effort was completed in 2010 with the commercial deployment of the tool by Pipetel Technologies Ltd. Based on the same concept and architecture, with cofunding from DOT/PHMSA and OTD NFP, the TIGRE system was designed and built for pipelines in the 20" - 26" range and is adaptable for other pipe sizes; larger and smaller. The two systems share the same architecture as well operational software for operational efficiency and robustness.

TECHNICAL APPROACH

The TIGRE system is based on the same approach used to build the now commercial Explorer 6/8 system, i.e. a modular platform with self powered drives, batteries to provide power, wireless communication to transmit commands and transfer data between operator and robot, and with a non-destructive evaluation on-board sensor. The TIGRE effort was initiated in 2004 with the design, construction and testing of a first generation tool for the inspection of transmission and distribution mains in the 20" to 26" range that was 33 feet long, and over 1,250 lbs. in weight while featuring a state-of-the-art MFL sensor. The system was able to negotiate short radius bends, mitered bends, back-to-back in-plane and out-of-plane bends as well as plug valves, making it an extremely versatile tool for inspecting practically any unpiggable pipeline, including those with no

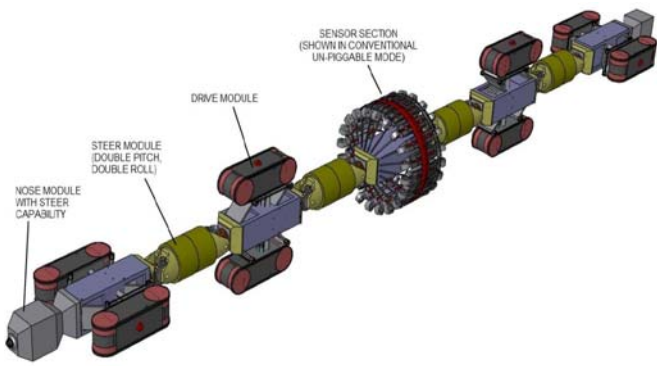

Figure 1: Second Generation of TIGRE System

flow. In 2009, based on the experience gained from operating this system, a second generation tool was designed that has the same capabilities as the first design, but is much shorter, less than 15 feet long, and much lighter at about 800 lbs.

Figure 1 provides a CAD rendering of the final TIGRE design. It consists of two camera modules, one at each end, four drive modules, four battery modules, and one sensor module. Wireless radio communication and rechargeable batteries allow the robot to operate without a tether thus allowing relatively long range operation from a single launching point. Range can be significantly improved if multiple launchers are used for longer inspections. The two camera modules at the two ends of the robot contain the lighting and cameras (with a 190° field of view) for visual data collection as well as the wireless transmitters and receivers. The robot is introduced into the live gas pipeline through a launch chamber, which is attached to a commercial tap-and-drill system, designed for live access to the pipe. The system can operate under pressures up to 750 psig.

The MFL sensor was especially designed for TIGRE, so that is does not limit its ability to operate in unpiggable pipelines. When fully deployed, the sensor looks like any other MFL sensor on a state-of-the-art pig (see Figure 2).

Figure 2: TIGRE MFL Sensor Module

The sensor is specially designed so it can reconfigure itself to negotiate plug valves, mitered bends and other pipeline obstacles. Crucial for such operation is the ability to shunt the magnets on the sensor, which is accomplished through an innovative system of magnets and motors. The sensor has performance specifications similar to those found in state-of-the-art pigs. State of the art software provides sophisticated analysis of the data collected.

PROGRAM STATUS

The original TIGRE was successfully tested in late 2007 and resulted in a wealth of knowledge that was used to redesign it for lower length and weight. The new, second generation tool has completed an extensive laboratory testing program and is undergoing an extensive field testing program in live pipelines in 2011. It is expected to be commercially available in 2012.

Highlights

General metal loss detection capabilities

- Minimum anomaly size: 10% wall loss with a diameter of 3x pipe wall thickness
- Anomaly axial length sizing accuracy: ±0.5 inches with 80% confidence
- Anomaly depth sizing accuracy: ±10% pipe wall thickness with 80% confidence

Driveability

- Locomotes through mitered bends, back-to-back 90s, verticals, plug valves and branch connections
- Inspects long distance with wireless communications

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