PIPELINES & DOWNSTREAM

Robot looks for hidden pipeline damage

Alyeska uses a state-of-the art 'robotic crawler' to inspect buried pipeline at pump station 3 on the trans-Alaska oil pipeline

ALYESKA PIPELINE SERVICE CO.

A robotic crawler device can negotiate a vertical pipeline section by pushing its caterpillar tracks against the pipeline walls, here in one of Alyeska Pipeline Service Co.'s 36-inch lines. The device can adjust its tracks to fit a range of pipeline diameters.

By ALAN BAILEY
Petroleum News

Pipeline operator Alyeska Pipeline Service Co. has successfully used a robotic device to inspect the condition of an underground pipeline at pump station 3 on the trans-Alaska oil pipeline, the company has told Petroleum News.

Developed by pipeline inspection company Diakont and referred to as a "robotic crawler," the device uses miniature caterpillar tracks to drive itself along the inside of a pipeline, while being controlled through an umbilical electrical cord that extends back out of an opening in the pipeline to a portable control unit. Instruments can rotate around the front end of the device, accurately measuring the thickness of the pipeline wall, transmitting video of the pipeline's internal wall or developing detailed maps of the internal surface.

Consent agreement

Alyeska spokeswoman Michelle Egan told Petroleum News that the impetus behind the use of the device dates back to a leak in an underground oil pipeline at pump station 1 on the North Slope in 2011. The leak resulted from corrosion damage in a hidden section of the underground line. In the aftermath of that oil spill, a consent agreement between Alyeska and the federal Pipeline and Hazardous Materials Safety Administration, or PHMSA, requires Alyeska to remove from its pipeline system all piping for transporting liquids that cannot be assessed using in-line inspection tools or some other suitable inspection technique.

Alyeska asked PHMSA to approve the use of the robotic crawler as a means of satisfying the consent decree inspection mandate, Egan said.

Safety reasons

Egan said that, although the pump station 1 spill had raised questions over the safety of Alyeska's use at some locations of difficult-to-inspect underground pipelines, there are safety-related reasons for using underground lines in specific situations.

The underground line that Alyeska has just inspected using the crawler pig connects the main oil line to a relief tank used to absorb excess oil pressure in the line, should some event such as a pump problem cause the pressure to surge, Egan said. With a pressure surge that passes down the main pipeline potentially placing huge forces on the pressure-relief pipeline, the ground around the buried line can absorb those forces, restraining the pipeline from moving and potentially breaking, Dave Roberts, Alyeska technical studies advisor, explained. And having the pipeline at a level below that of the relief tank maintains the oil pressure in the buried line at a high enough level to prevent gas effervescing from the oil, causing vapor pockets, said Dan Williamson, senior project manager.

Alyeska thinks that the use of a robotic crawler will serve the dual purpose of enabling required pipeline safety inspections while also enabling the continued safety benefits of having buried pressure relief lines.

Self-propelled

Steve Lacatena, Alyeska facility corrosion integrity manager, told Petroleum News that the Diakont robotic crawler has three caterpillar tracks, two at the bottom of the device, acting rather like the tracks of a conventional tracked vehicle, and the third on the top of the device. As necessary, that third track can be extended out, to push against the inside of the pipeline wall, holding the crawler rigidly in place in, say, a vertical pipeline section. The device can travel through about 1,000 feet of pipeline, negotiating up to four right-angle elbows. And, given the manner in which that upper track can be extended or contracted, the device can traverse pipelines with a wide range of diameters, including the large 36-inch and 48-inch lines that Alyeska uses.

Access to a pipeline is achieved by cutting a short section from the line and then replacing the section after the inspection has been completed. In the

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PIPELINE CRAWLER

case of the pump station 3 inspection, above-ground sections of the relief line were opened, at either end of the line's underground section, while the relief line was sealed off from the main oil line.

Slow but accurate

Nudging forward a centimeter at a time, and conducting a scan at each "step," the crawler can inspect 80 to 90 feet of pipeline per day, making it an appropriate device for inspecting specialized pipeline sections but rendering it much too slow for inspecting the whole 800-mile trans-Alaska pipeline. But, what the crawler lacks in speed, it makes up for in precision, with measurements and observations made in great detail and with the locations of those observations recorded with high accuracy.

Precision in knowledge of the extent and location of any pipeline damage will lead to precision in the excavation and other actions needed to execute repairs, Egan commented.

Moreover, data from the device can be observed while the device is in operation, Lacatena commented. That ability to identify any pipeline issues almost immediately presents a distinct advantage over the use of in-line inspection devices known as "pigs," conventionally employed for pipeline monitoring. A torpedo shaped pig passes through a pipeline, propelled by the flow of oil in the line and gathering data as it goes. Only after the pig run has been completed and the pig retrieved can the inspection data be obtained and processed, Lacatena explained.

Three instruments

The robotic crawler used at pump station 3 was equipped with three instruments: a device called an electromagnetic acoustic transducer, or EMAT, for measuring the pipeline wall thickness and hence locating corrosion damage; a laser device for making a detailed map of the pipeline's inner surface and hence depicting any surface pitting or other irregularities; and a conventional video camera for photographing the appearance of the pipeline's interior, Lacatena said. Any one of these instruments could have detected the corrosion in the underground pipeline at pump station 1, Roberts commented.

Pipeline cleaning

Unlike other instruments that are used for pipeline wall thickness measurements, the EMAT instrument does not require any physical coupling to the wall itself, Lacatena said. But all three instruments require the inside of the pipeline to be thoroughly clean, a requirement that necessitates a comprehensive pipeline cleaning project prior to inspection, Roberts said. The cleaning operation, conducted by Houston Contracting prior to the pump station 3 inspection, involved removing about 30-years-worth of accumulated wax and other grime, he said. After flushing hot oil from the main pipeline through the relief pipeline, the cleaning crew packed the line with 16,000 gallons of diesel fuel, a material that acted as a solvent for much of the material deposited on the pipeline wall. The diesel flush was followed by a pressure wash with hot water, squirting perhaps 100,000 gallons of water against the internal wall using a special machine. By the end of the cleaning process, the inside of the pipe appeared like new steel, with even some original stenciled lettering visible, Lacatena said.

ALYESKA PIPELINE SERVICE CO.

An operator lays out the umbilical control cable for a robotic crawler after the device has been inserted into a pipeline section.

Testing the device

The two biggest risks in the pump station 3 inspection project were questions over how well it would be possible to clean the pipeline and how long it would take to conduct the inspection, Williamson said. And, rather than going into a live inspection unrehearsed, Alyeska ran some tests of the robotic crawler in 2013, using defunct piping in pump station 10, a pump station that has been out of commission for several years, Roberts said. In those tests Alyeska found that the crawler tool detected known anomalies in disused piping with a high level of accuracy, and that the device could successfully negotiate a pipeline that transitioned from a 36-inch to a 48-inch diameter, he said.

In the end, the live inspection this year in pump station 3 progressed very well, eventually being completed in good time, Williamson said.

And the condition of the pipeline? It was in terrific shape, with two exterior dents and a gouge, known from the pipeline construction, and with two small spots of insignificant corrosion, Lacatena said. ●

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