NEW TOOL PROVIDES CLEARER PICTURES OF FLEXIBLE RISERS

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Abstract

Several of the world's oil and gas facilities are experiencing aging production infrastructure. Operators are now applying greater focus to integrity management and more frequent inspections. Internal visual inspection is one method for the inspection of pipeline systems. Challenges exist with this method related to camera tools and receiving a clear image as well as performing swift inspections to keep disruption of production to a minimum.

When a major operator on the Norwegian continental shelf required effective inspection of several flexible production risers, it became apparent that the existing technology did not provide the required image quality and operational effectiveness. This lead to the development of an inspection camera tool that combines existing technology used for inspection of drilling risers and blowout preventers (BOPs) with a commonly used deployment vehicle (pig) design.

The tool enables single inspection runs to acquire digital images in a high-pressure environment. It incorporates high resolution, wide-angle 185/360° images, powerful lighting, and customized software with digital unwrapping and advanced digital filtering.

The tool body has a bidirectional pig design and is launched and controlled using a high-tensile-strength control cable. An effective stripper unit mounted on a regular pig launcher helps ensure a safe launch and control of the tool. The visual inspection tool is normally launched in clear fluid, but other driving media can also be used.

Within pipeline systems, this camera tool enables inspection for abnormalities, corrosion, coating, functions, and other features. Operators can use this technology to improve and expedite the decision-making process, leading to time savings, reduced costs, and increased offshore safety.

Background

Camera technology is ever-evolving and improving in the many industries in which it is used. Within the visual inspection market for internal inspection of pipelines, several challenges and environments usually require specialised and customized solutions. Upgrading this equipment at the same pace as the equipment used within the consumer market is challenging, especially considering the consumer mark is considerably larger by comparison.

Initiators of development are often a set of good questions. In this case, the questions posed related to locating a better camera to provide clearer images, adapting the technology for the specific needs within the industry, and determining whether it can be deployed both swiftly and safely into a pipeline system.

In the case discussed, the operator desired efficient operations and clearer images for visual inspection of abnormalities in flexible production risers. The operator had both a need and willingness to commit to development or a new pipeline visual inspection tool. The goals for tool development were efficiency and quality while reducing both cost and risk.

Figure 1 illustrates the video inspection control station of the tool discussed.

Figure 1: Video inspection control station

Development

Development of such technology should more precisely be called adaption and development of existing technology. A manufacturer had developed a camera solution primarily for application of well services. This camera solution has been used for several visual inspection applications, including the inspection of Drilling BOPs, subsea completions, and plugging and abandonment activities.

The technology behind the camera was developed over a period of three years with the original intention of using it in remote operated vehicle (ROV) operations combined with laser scanning. Because of complications during this process, it was decided to modify a visual inspection system for use in well services, which served as the basis of the camera tool.

Development of the camera tool required redefining the internal electronics of the camera for a smaller fit for use with a pigging solution.

The camera system is based on machine vision camera (MVC) and customized software. The MVC is a camera used in multiple industries (e.g., within the automobile and military industries). All of these cameras are developed and adjusted to meet specific industry needs. Some cameras have a high frame rate, while others have high resolutions.

For the tool development discussed, a high resolution and low frame rate were chosen (five pictures per second) to optimize zooming. The tools are equipped with a camera having 5-mega-pixel resolution, and digital qualities optimized for 185/360° wide-angle visual inspection of pipeline systems. The camera is coupled with a fiber-optic cable, and all processing of pictures is performed from an external workstation. This technology is referred to as "intelligent," which means it uses complex algorithms to perform advanced real-time contrast adjustments. Each contrast adjustment is performed individually within each pixel and then integrated into the other pixels. This creates a unique picture that is detailed and has distinct capabilities that cannot be found in other camera systems.

Figure 2 illustrates the camera system.

Figure 2: Camera system

The camera housing functions as the body of the video pig and is designed to withstand an external pressure of 390 bars. The setup is similar to a standard bidirectional pig with several full-body length bolts that join the different polyurethane discs. The single pig design is based on negotiating 5D bends and the pig encompasses bypass ports to flush the dome in front of the lens.

The control cable is connected at the backside of the pig, and it is the connector that is the weakest link, withstanding a maximum of 1 200 kg pull force. The cable itself is designed for a maximum 1 500 kg pull force.
Actual max pull on the tool is calculated based on the number of bends and restrictions the pig must pass.

Figure 3 illustrates the camera tool pig.

Figure 3: Camera tool pig

Field Results

Video inspection using this technology was employed in fresh water to help ensure clear images. For this reason, the system required decommissioning before introduction of the camera. In this example, it was a gas-producing system and the inspection target was the riser.

The decommissioning pig train was launched using permanent pigging facilities toward closed production. The basis for this operation was to compress hydrocarbon gas while inspecting the riser. Several pigs were launched with batches of mono-ethylene glycol (MEG) to prevent hydrate formation. All pigs were equipped with radioactive isotopes for accurate placement past the subsea isolation (Figure 4).

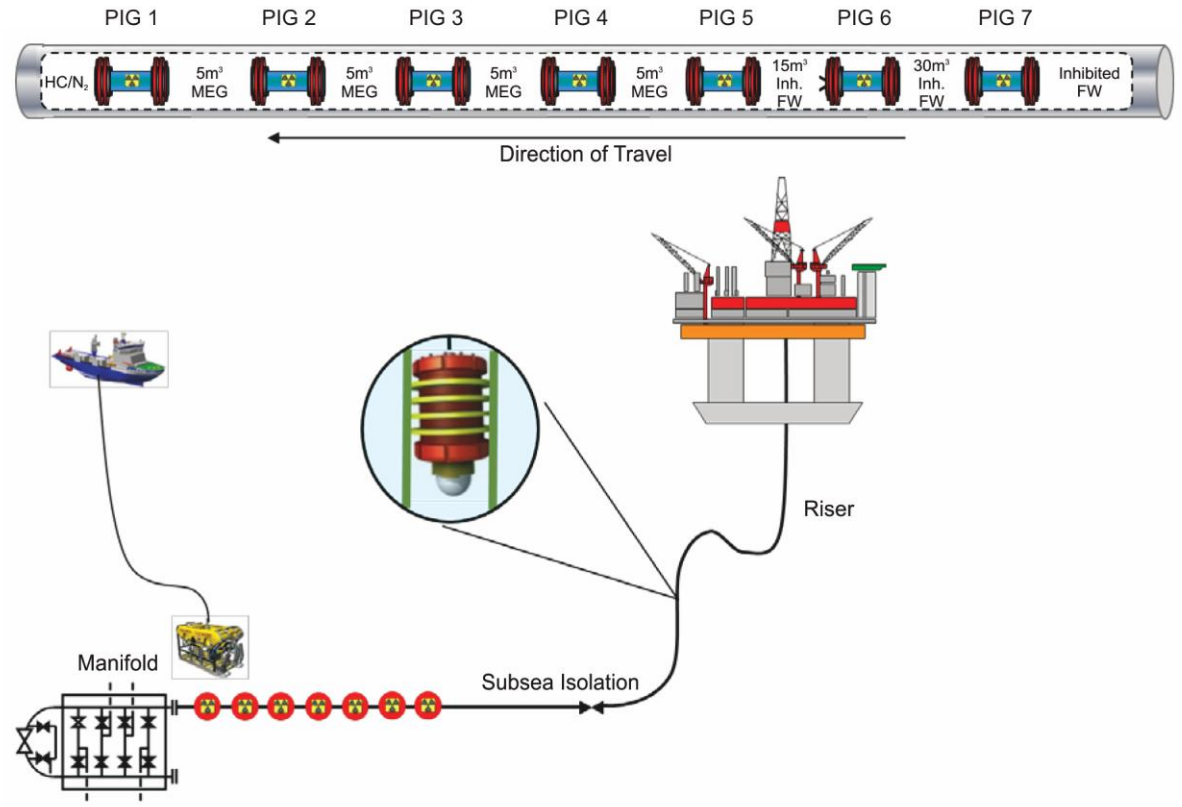

Figure 4: Decommissioning and deployment of camera pig

After verification and testing of the closed subsea isolation valve, the permanent pigging facilities were disconnected and the camera launching facilitates were connected. In this example, the deployment was performed vertically. Horizontal deployments are also possible using an additional sheave.

This system encompassed the following (Figure 5):

- Control container with winch and 1 250-m cable
- Bidirectional video pig
- Isolation valve with stuffing box
- Pig launcher and interface flange

The camera was deployed from the temporary launching facilities with fresh water as the driving media. The cable was fed through the stuffing box while the winch was normally run with 50 kg of constant tension. The tension avoided buckling of the cable while controlling the speed with the water flow. The video was transferred live to help ensure movement of the tool.

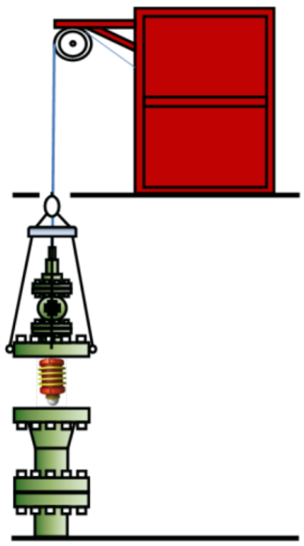

Figure 5: System overview

The riser was inspected and recorded at a steady pace with focus on critical areas. Pipeline specialists can be involved with the live internet feed both on and offshore. The live feed viewer can view the same images as the operator of the camera. As the inspection is conducted, the camera feed is set to perform simultaneous full-frame recording, regardless of view mode. At any time, the recording can be transferred and the line can be reinspected based on the 185/360° wide-angle footage.

Screenshots of the interface are shown in Figures 6 and 7.

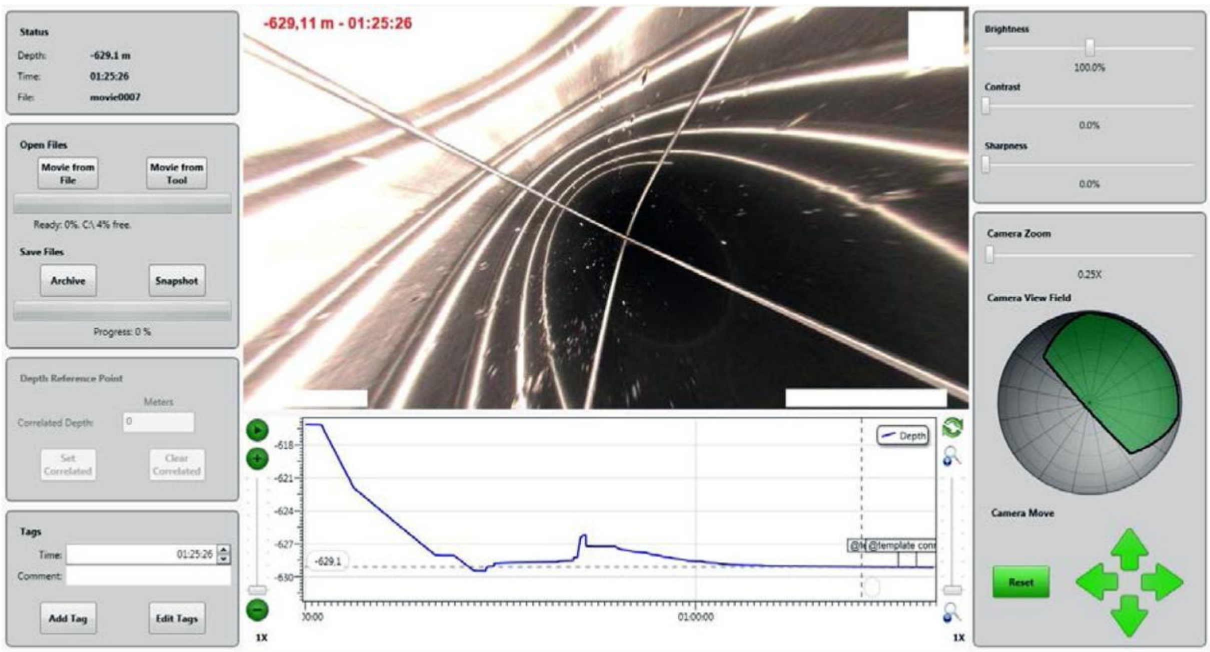

Figure 6: Effect of extreme wide-angle and digital wrapping used as an example

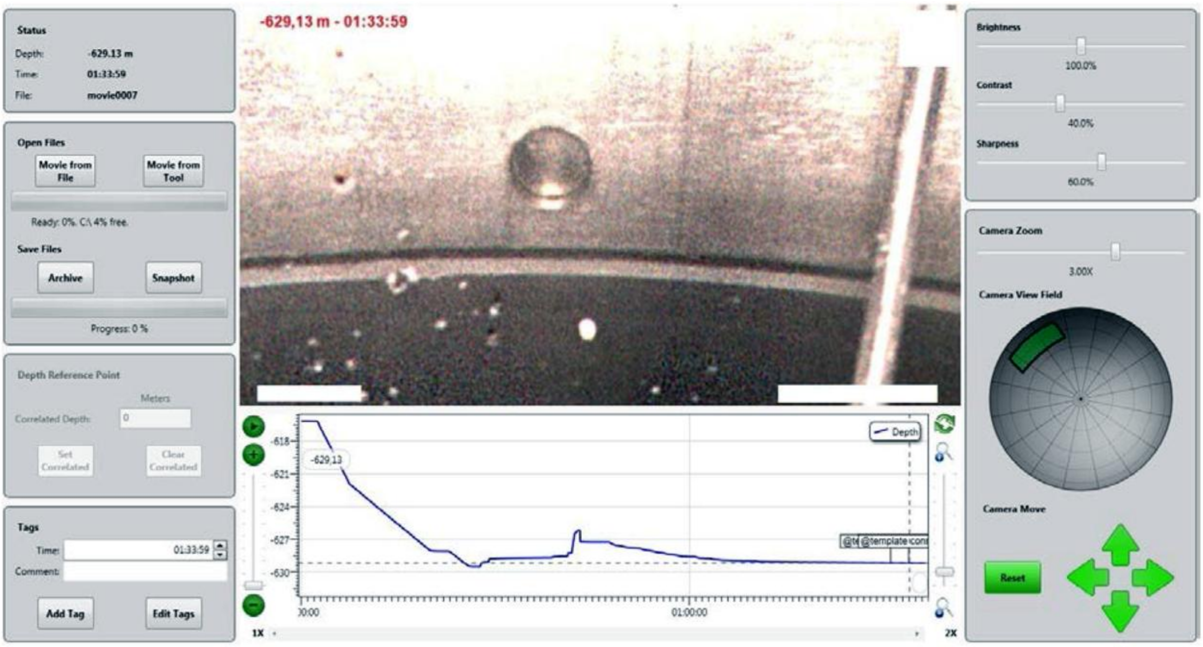

Figure 7: Zoomed in to an area of interest, in this case, a riser end termination

The system can be fully remotely controlled. However, for this application, it was important that the operator offshore coordinate the winch and the water flow for speed control. Partial control is also possible, and will allow anyone to remotely control the view functions for the camera.

Because post-inspection is possible, the inspection can be quickly completed. The tool can be retrieved using expansion of the compressed gas and by recommissioning the pipeline. The winch is normally run with 300 kg constant tension. The tension avoids buckling of the cable while controlling the speed with the water flow discharge. When the tool has been retrieved, the temporary pigging facilities are disconnected and permanent facilities are reinstated. The recommissioning pig train is propelled back to the permanent receiver while dumping water to closed drains and the production separator.

Conclusions

Using the camera system combined with the deployment methodology on the project discussed has saved 11 days of production compared to other systems. Swift deployment under pressurized conditions has enabled compression of the production gas and helped avoid complete decommissioning of the production flowline system. Using this methodology helped the operator avoid several complex subsea operations.

Reducing the number of days required as well as the complexity of the operation also helps reduce many project risks related to health, safety, quality, schedule, and cost. As an example, a common challenge with visual inspection is costly reruns attributed to the quality of pictures or uncovered areas. Because the concept is based on using a live internet broadcast recording combined with wide-angle high-resolution digital video, the inspection operation can be completed with less time spent visually confirming all images. The fullbore footage is available for later offline reinspection with the same original quality and the same advanced filters to enhance visibility.

Nomenclature

BOP—blowout preventer
ROV—remote operated vehicle
MVC—machine vision camera
MEG—mono-ethylene glycol