UNPIGGABLE PIPELINES – WHAT A CHALLENGE FOR IN-LINE INSPECTION!

By Dr. Rainer Schmidt, 3P Services, Lingen, Germany

Introduction

Today, in-line inspection is well on its way to be standard in the maintenance of pipelines - as far as piggable pipelines are concerned. However, next to piggable pipelines there is a large number of un-piggable pipelines which are equally important for the operators, that are equally aging and that equally need inspection.

What is an un-piggable pipeline?

A *piggable* pipeline is a pipeline that is designed to allow a standard inspection tool to negotiate it, which requires basically a more or less constant bore, sufficiently long radius bends and traps to launch and receive the pigs. This way, an *un-piggable* pipeline can be defined as *not* designed like this.

There are plenty individual reasons, why a pipeline can not be negotiated by standard inspection tools. Over- or under-sized valves, repair sections in a different size, short radius or mitred bends (just to name a few factors) can make it impossible for standard inspection tools.

Within the pipeline industry (where large volumes of oil and gas are transported over long distances) the pipeline networks consist mainly of piggable pipelines and may be subject to regular in-line inspection. However, usually these networks have a certain percentage of un-piggable kilometres, that - from a standpoint of "total quality" - need an inspection option.

In other industries (refineries, chemical industries, tanker loading terminals, tank farms, etc.) the percentage of un-piggable pipelines dramatically increases. Finally, any industry that applies tubes is a huge potential for in-line inspection technology, provided this can handle un-piggable pipework.

Is there any way to achieve the benefits of in-line inspection on un-piggable pipelines as well?

First, there is the option to modify the pipeline in a way that it becomes piggable in the end. This option, however, is in most cases not easy. Modifications usually require to interrupt operation and replacement of the un-piggable elements and is, therefore, expensive or even (e.g. if offshore pipelines are concerned) impossible.

Second, the inspection equipment can be tailored to the existing conditions in order to overcome the situation that is considered un-piggable for standard inspection tools.

Third, it may be practical to modify both the pipeline and the in-line inspection tool.

Under any circumstances it is necessary that the pipeline operator and the in-line inspection vendor analyse together such things like technical feasibility, cost and risk factors, schedules, alternative scenarios etc. Only at the end of these considerations there will be a plan that shows whether and to what degree the pipeline, the inspection equipment or both will have to be modified.

Whether a cost-effective solution can finally be developed depends much on the flexibility and versatility of the in-line inspection technology available. The better an inspection tool can be tailored to the individual obstacles of the pipeline, the smaller will be the need to work on the pipeline. In the ideal case, a special tool will be engineered to the requirements of the pipeline and the pipeline will stay as it is.

In this paper, 3P Services from Germany presents three case histories of in-line inspection of pipelines that were considered un-piggable prior to the exercise. 3P Services, originally a niche vendor specialised on small diameter MFL inspections (3” to 12”), has gained rather extensive and versatile experience inspecting un-piggable pipelines over the last decade.

Case History no. 1: Geometric inspection pig detects mitred bends

Pipeline description: Product pipelines, diameters 6” to 12”, 12 km long, connecting refinery and tank farm at the harbour (see Fig. 1). The pipelines pass through a natural reserve. Since adjacent pipelines from another operator had experienced leaks in the natural reserve, the inspection was urgent.

Why is it „un-piggable“? There are mitred bends present in angles up to approx. 50°. Numbers per line and locations were not known.

Target of the inspection: Perform a high resolution MFL inspection.

Concept for a solution: 3P Services proposed first to develop and run a geometry inspection tool, that would document which line actually has mitred bends and the angle, as well as the exact location. Second, 3P Services proposed to check its own MFL tools to what degree mitre bends could be accepted and possibly to optimise the MFL tools in this regard.

Performance: 3P Services developed the GEO pig which is capable to (1) negotiate mitre bends up to 50°, (2) make a continuous measurement of the internal geometry and (3) can distinguish between mitre and radius bends. The concept was approved by the Client following a pump test in 3P Services’ facilities in Germany for the prototype 8” GEO tool. The MFL tools were optimised regarding mitre bends. Finally, all 6” to 12” MFL tools can negotiate 30° mitre bends. Within 2 months 3P Services completed the fleet of GEO tools for the other pipeline sizes, mobilised and performed the inspection.

Result: The GEO inspection lead to the conclusion that mitre bends were present in the lines in a much smaller number than anticipated by the Client. Several of the pipelines did not have mitre bends exceeding 30°, so they could be MFL inspected without any pipeline modification. For the remaining pipelines with high angle mitre bends a minimum modification programme could be set up and executed on a relaxed schedule.

Client: ENGEN Refinery, Durban, South Africa

Case History no. 2: Heavy wall – small diameter flowline inspection

Pipeline description: Offshore flowlines 4“, wall thickness ½“, designed as a hair pin loop starting from the Gannet A platform (Central North Sea), passing by two subsea production templates and back to Gannet A (see Fig. 2). The total length is 11.7 km. There are flexible riser sections at the foot of the platform and bend radius of 5D within the risers.

Why is it „un-piggable“? ½” wall thickness can not be sufficiently magnetised in a 4” pipeline. Therefore an MFL inspection is not feasible. Ultrasonic inspection tools, that could handle the wall thickness, were not available for 4”. Further, the permanent pig traps, having a length of only 1100mm, can not be extended.

Target of the inspection: Perform a high resolution inspection for internal local corrosion. Due to the project circumstances the inspection was to be performed under urgency.

Concept for a solution: When the requirement came up, 3P Services had a new type of sensor technology under development. These “DMR” sensors (*d*irect *m*agnetic *r*esponse) measure the distance between their own location and the next ferritic surface. If properly mounted onto a sensor carrier the DMR sensors are sensitive to internal local metal loss without influence of the wall thickness.

Performance: 3P Services received an order to conclude the development of the sensor, apply it on an in-inspection tools and inspect the flowlines. Two identical units, each carrying 32 DMR sensors were built and tested within only 4 weeks (see Fig. 3). Upon the final testing, the tools were approved by Shell Global Solutions Amsterdam for the Gannet project and mobilised off shore. The tools were propelled by stabilised crude which was available on the platform. The temperature was 70°C at the launch and approx. 40 to 50°C at the receiving end. Both units of the DMR inspection tool were run to achieve a double set of data.

Result: Both tools recovered complete inspection data that allowed an interpretation over the entire length of the pipeline. Internal metal loss like beginning pin holes having a diameter of 5 mm and 1mm deep was clearly identified at excellent repeatability. The operator’s targets were achieved, budget and time schedule were met.

Client: Shell UK EXPRO

Literature: (4)

Case History no. 3: Bi-directional MFL application

Pipeline description: 36“ – 9 km long tanker un-loading pipeline, connecting the offshore pipeline end manifold with the tank farm onshore (see Fig. 4).

Why is it „un-piggable“? Access to the pipeline is only possible at the onshore end of the pipeline

Target of the inspection: Perform a high resolution MFL inspection. As a special issue, study defects in the vicinity of girth welds.

Concept for a solution: Re-design a single module bi-directional MFL-tool for pump-in/pump-out operation.

Performance: The client installed a temporary pig trap at the tank farm. The MFL tool (see Fig. 5) was pumped by sea water towards the pipeline end manifold located on the sea bottom underneath the tanker unloading buoy. The contaminated water was pumped into a tanker moored for this purpose at the pipeline end. The tool returned to shore by reverse flow pumped from the tanker.

Result: The MFL inspection run took less than 8 hours. A particular advantage was the dual coverage of the pipeline, since the measuring system collected data on the way in and out of the pipeline. Therefore, the repeatability of readings could be verified and the grading accuracy improved. Certain sections that were considered critical by the client could be evaluated in detail within 24 hours after the conclusion of the pig run. All project objectives were successfully achieved on time and within the budget.

Client: Refinery on the East Coast of the UK

Literature: (3)

Literature:

(1) DGMK-Frühjahrstagung Fachbereich Aufsuchung und Gewinnung Celle, April 1996; “Zementausgekleidete Rohre – Möglichkeiten und Grenzen für eine intelligente Molchung (Cemet-Lined Pipelines - Opportunities & Limitations for Intelligent Pigs); G. Bogumil and P. van´t Westeinde, BEB Erdgas und Erdöl GmbH, Hannover, Germany, F. Bukman and Dr. R. Schmidt, 3P Services, Lingen, Germany

(2) The Pipeline Pigging Conference, Amsterdam, The Netherlands, June 1997; “In-line inspection of hard-to-pig pipelines”; F. Bukman, BEB Erdgas und Erdöl GmbH, Hannover, Germany; Dr. R. Schmidt, 3P Services, Dalum, Germany

(3) Proceedings of 6th International Conference on Pipeline Rehabilitation & Maintenance, Berlin, Germany, October 2003, “Magnetic Flux Leakage Pigs or Ultrasonic Pigs? The Case for Combined Intelligent Pig Inspections”, Dr. A. Pople, Penspen Integrity, UK

(4) The Pipeline Pigging Conference, Stavanger, Norway, June 1999; “Internal corrosion in small – diameter; heavy-wall; pipelines: a critical phenomenon and how to measure it”, P. A. J. van der Veer and S. F. Jager, Shell Global Solutions, Amsterdam, The Netherlands; Dr. R. Schmidt and F. Bukman, 3P Services, Lingen, Germany

Figures

Fig. 1: (Case history no. 1) Excavation confirms some mitre bends, some radius bends

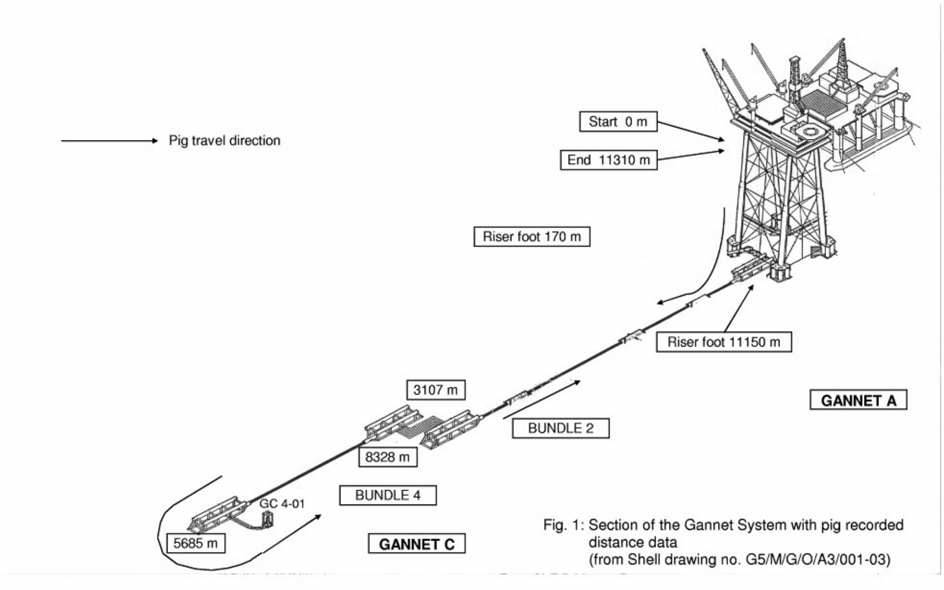

Fig. 2: (Case history no. 2) Schematics of the flowline Gannet A

Fig. 3: (Case history no. 2) DMR inspection tools

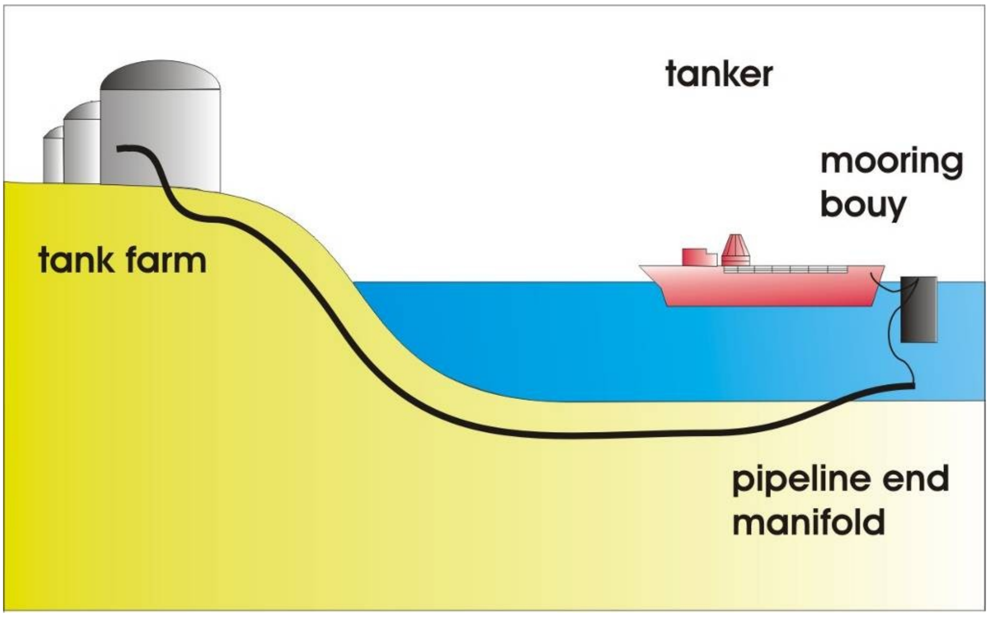

Fig. 4: (Case history no. 3) Schematics of the tanker unloading facilities

Fig. 5: (Case history no. 3) Bi-directional 36” MFL pig