CASE STUDY ON THE IMPLEMENTATION OF A PIMS SYSTEM FOR AN OFFSHORE ASSET FROM ENGINEERING TO SOFTWARE

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Abstract

The QP offshore pipeline network is getting mature and several pipelines in operation have reached or exceeded their design life. In order to cater for the present and future production levels from the above fields, QP conducted an initial risk assessment study to rank the criticality of the offshore pipeline network. The study identified those pipelines most critical to QP's operations. The most critical offshore pipelines (51 off) were then subjected to a detailed Pipeline Integrity Review. This paper describes the scope and the main findings of this project.

PII worked together with the client's team – over a 14 month contract period to establish a comprehensive understanding of the integrity of such an ageing asset and to support QP with the required integrity management tools to maintain the pipelines going forward. Comprehensive pipeline integrity management system (PIMS) software was implemented that was integrated with QP's existing pipeline GIS and was aligned with current industry best practice to effectively manage and mitigate the principal pipeline hazards and risks

Introduction

Maydan Mahzam (MM) and Bul Hanine (BH) are the two major offshore oil fields operated by Qatar Petroleum (QP). The QP offshore pipeline network comprises of approximately 160 flowlines and export pipelines. The flowlines transport well fluid produced at the wellheads to offshore platform processing facilities. The export pipelines transport the crude oil, water and associated natural gas produced from the well fluid at the process platforms for various purposes onshore.

The QP offshore pipeline network is getting mature and several pipelines in operation have reached or exceeded their design life. In order to cater for the present and future production levels from the above fields, QP conducted an initial risk assessment study to rank the criticality of the offshore pipeline network. The study identified those pipelines most critical to QP's operations.

These most critical pipelines (51 off) were then subjected to an Engineering Consultancy Study to perform a Pipeline Integrity Review (PIR) of the 51 pipelines in light of the extended future operation. The pipeline integrity review was conducted for QP by PII.

This paper describes the scope of the PIR study conducted and the main findings of the project.

Project Objective

In commissioning the PIR study QP's requirements were to safely extend the operating life of the selected pipelines, to assess the level of risk associated with this life extension and to identify the adequate measures needed to bring operational risks in line with standard industry practice/level. The overall objective of the study was therefore as follows:

- Evaluate the condition of the 51 selected offshore pipelines
- Establish their fitness-for-purpose and need for any remedial work
- Determine the level of risk associated with continuing operating life
- Identify the remedial measures and costs required to bring operation risks in line with standard industry practice levels
- Produce individual pipeline study reports (integrity management plans)
- Establish a GIS based Pipeline Management System (PIMS)
- Provide PIMS document philosophy (Corporate Philosophy and Codes of Practice)

To meet these objectives the PIR study involved the following phases:

Phase 1: Data gathering, review, and data integration,

Phase 2: Engineering evaluation of Fitness For Purpose (FFP),

Phase 3: Probabilistic Assessment of Pipeline Failure (PAPF) and consequence assessment,

Phase 4: The preparation of scope of work for Front End Engineering Design (FEED) based on the conclusions and recommendations of the Pipeline Integrity Review (PIR) Study, and

Phase 5: The development of QP GIS based corporate Pipeline Integrity Management System (PIMS), corporate philosophies and codes of practice documents addressing in particular, abandonment and decommissioning of pipelines, leak detection and methodology for ensuring integrity of pipelines/repair of pipelines including additional measures to assess integrity of “unpiggable“ pipelines.

Subject Pipelines

Figure 1 provides an overview of QP’s pipeline network. The 51 pipelines covered under the project scope are generally located within or connecting from/to one of the following offshore locations described below:

- North Field Alpha (NFA) - PS4,
- Maydan Mahzam Field (MM) PS-2 Production Station (PS2),
- Halul Terminal and Export facilities,
- Bul Hanine Field (BH) PS-3 Production Station (PS3), and
- Idd Elshargi North Dome (PS1)

The pipelines convey a variety of products with varying pressures and product specifications. Four (4) of the pipelines included in the project were onshore transportation lines.

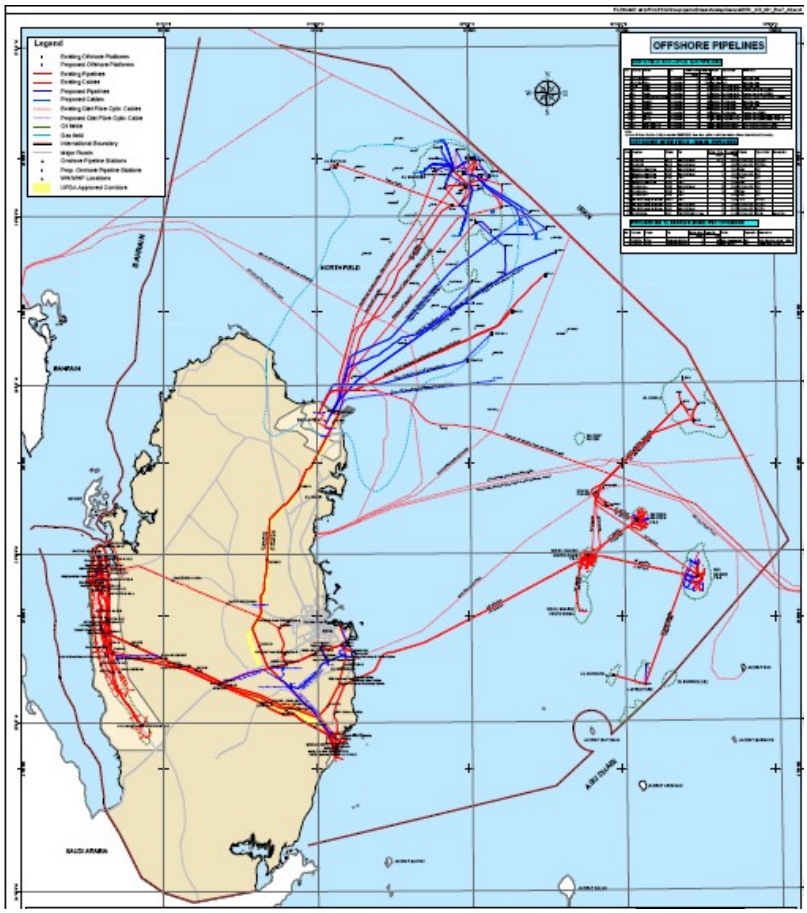

Figure 1 – Overview of the QP Pipeline Network

Phase 1: Data gathering, review, and data integration

As part of Phase 1 of the project a site visit was conducted in order to obtain an overview of QP's pipeline system, its operational and integrity strategies and to start the long process of collecting the data required for the PIR study and the PIMS. The data collection required a joint effort between QP and PII with QP performing most of the data source identification and gathering and PII converting the information into usable data. Overall more than 5 GB of data was gathered, checked and loaded into the GIS database as part of the project, including:

- Alignment sheets for 51 pipelines (total of 965 km)
- Centerlines for each of the pipelines were set up in the GIS
- Condition monitoring data for each of the pipelines. The main techniques for inspecting the condition of pipelines were by means of ROV's, Auto UT surveys/corrosion coupons and Cathodic Protection. In-line inspection (ILI) using intelligent pigging was performed on only a few pipelines.
- The condition monitoring data imported into the GIS database included:
    - 107 ROV reports
    - 85 external UT reports
    - 9 ILI reports
- The product composition, production rate data and corrosion control information was collected for each of the pipelines
- Additional data elements for more than 90 attributes (for use in the risk and FFP assessments) were entered for multiple line segments (~40,000 individual entries)

Early on in the data gathering and review process a Data Gap Analysis Report was produced. The gap analysis report identified the parameters essential for conducting the required scope of work, reviewed the source documents, analysed the types and quality of data collected, identified any gaps in the data for the 51 pipelines and recommended the further course of actions to be undertaken in relation to the data gathering phase of the project. It was agreed that where information regarding specific data elements could not be provided in the foreseeable future (did not exist), QP and PII would agree on appropriate and conservative default values for the data elements.

The last task within Phase 1 was to produce a Study Basis of Design report. The purpose of this document being to clearly set out the following:

- Statement of the Study scope of work, referencing methodology and deliverables
- Basic Data to be used in the Study including assumptions
- Listing of software to be used in the Study
- Listing of industry codes and standards to be used in the Study.

The objective of the Study Basis of Design report was for QP and PII to agree at an early stage in the project these items thus reducing the risk of misunderstandings in the project scope, methodologies applied etc later on in the project that may lead to project delays.

Phase 2: Engineering Evaluation of Fitness For Purpose (FFP)

The Engineering Evaluation of the FFP phase involved performing a condition assessment on each of the 51 pipelines. This assessment involved the following steps:

1. A review of the historical and current IRM activities and records (ILI, Caliper, automated-UT (Auto-UT), corrosion and ROV inspections). Feature and significant event summaries were provided for each pipeline based on the available most recent survey data and accounting for any remedial and intervention work conducted since the last survey.
2. An FFP evaluation of the most recently known condition of the pipeline utilising industry best practice. This required the determination of the current and historical operational parameters associated with each pipeline, the assessment of the severity of any reported pipeline anomalies (corrosion, dents, weld anomalies, mill faults), the determination of the maximum allowed (critical) span length and assessment of any reported spans or other stability anomalies, identification and recommendation of the necessary actions that

should be taken to ensure the current and on-going FFP of the pipeline based on its most recently known condition.

3. An external Corrosion Review to assess of the effectiveness of the pipeline corrosion protection system including a review of the external survey data relating to the Cathodic Protection system and an assessment of sacrificial anode depletion involving the determination of the remaining life for each anode and the estimated time to replacement.
4. An Internal Corrosion Review to review the on-going risk from internal corrosion in the 51 pipelines including an in-depth operational analysis of the transported products, operating conditions (temperature, pressure, flow-rate), inhibition, produced water, solids, bacterial contamination, leak history in order to evaluate the internal corrosion threat to each of the pipelines and to estimate corrosion deterioration rates.
5. An estimate of the costs associated with the proposed rectification/remediation activities recommended.

Phase 3: Probabilistic Assessment of Pipeline Failure (PAPF) and Consequence Assessment

The Probabilistic Assessment of Pipeline Failure and Consequence Assessment on each of the 51 pipelines involved the following steps:

1. The development of the probabilistic assessment models for each applicable threat to the safe operation of the subject pipelines and the evaluation of the probability of pipeline failure by threat and by pipeline segment.
2. The identification of probabilistic industry benchmark levels and comparison against the results for the QP pipelines.
3. Evaluation of the consequences associated with a failure (i.e., a loss of containment event causing either a leak or rupture release).
4. The combination of the probability of failure results and the consequence of failure results to give the overall risk of failure for each pipeline and each pipeline segment.
5. A summary of the recommended remedial activities per pipeline prioritised according to the level of risk and demonstration of the benefits in terms of reduction in risk after the remediation activities are performed.

The threats applicable to the 51 pipelines in the study were concluded to be:

- Internal Corrosion
- External Corrosion
- Mechanical Damage
- Sour Cracking
- Weather and Outside Force and
- Incorrect Operations

The probability of failure (per year) was estimated by threat and by pipeline segment where the pipelines were segmented as follows:

- Start riser
- Safety zone 1
- Main Subsea section
- Safety zone 2 or Shore Approach
- End Riser or Onshore section

Note the onshore sections where appropriate were further segmented to account for changes in the environment, the land use and population density etc.

Phase 4: The preparation of scope of work for Front End Engineering Design (FEED) based on the conclusions and recommendations of the Pipeline Integrity Review (PIR) Study

The purpose of this phase in the project was to draw up the necessary documentation and detailed scopes of services for the required FEED and rectification works as recommended in the Phase 2 and Phase 3 tasks. The scope of services described in this document included:

- Detailed engineering of rectification works;
- Freespan Rectifications;
- Pipeline Stabilisation Rectifications;
- Pipeline Crossing Rectifications;
- Sacrificial Anode Retrofits;
- Anomaly repairs;
- Replacement of a damaged pipeline section.

The document was structured as a stand-alone scope of services suitable for QP's use in any future invitation to tender (ITT).

Phase 5: The development of QP GIS based corporate Pipeline Integrity Management System (PIMS), corporate philosophies and codes of practice documents addressing in particular, abandonment and decommissioning of pipelines, leak detection and methodology for ensuring integrity of pipelines/repair of pipelines including additional measures to assess integrity of "unpiggable" pipelines.

Managing pipeline integrity requires a comprehensive system in place to support it. As a minimum, that system must address process, people, and activities to manage the pipeline. In this Phase of the project PII provided a software solution (referred to as "the PIMS software" hereafter) that ties the three elements (process, people, and activities) together in a seamless and integrated system. The PIMS software takes the user step by step through the pipeline integrity management cycle (Figure 2).

This Phase of the project involved the following steps:

1) The supply of PII's PIMS software including upgrading / modification of the existing QP ArcSDE Geodatabase structure to an industry standard APDM data model. The following applications from PII's suite of standard software products were delivered:
    - PipeView Facility for ArcGIS (PVAG)
    - PipeView Access
    - PipeView Integrity (PVi)
        - Risk assessment module
        - Data alignment module
        - Feature assessment module
2) Data migration from the existing QP ArcSDE Geodatabase and conversion of data identified from other sources to the APDM geodatabase.
3) Implementation of the PIMS software in QP's offices, on-site acceptance testing and training of QP's personnel in the use of the software.
4) Development of QP corporate policies, philosophy, codes of practice & procedures to address the following in accordance with International Codes and standards and best Industry Practice:
    - Abandonment / decommissioning of pipelines
    - Leak detection, accepted leak rates/frequencies, corrosion monitoring
    - Pipeline integrity methodologies, pipeline repair, integrity of unpiggable lines

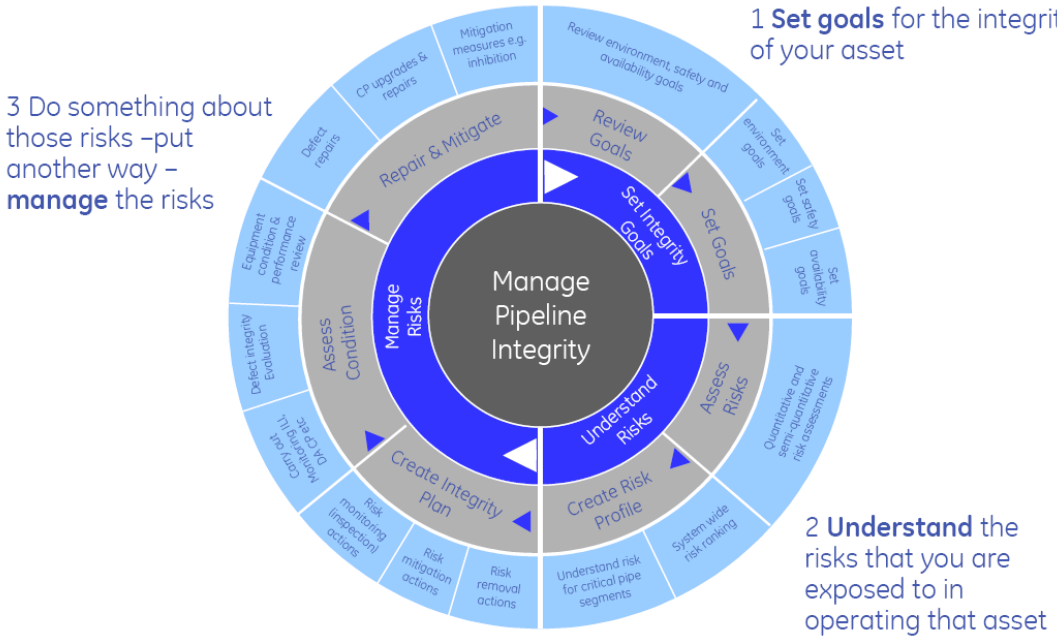

Figure 2 – Pipeline Integrity Management Cycle

Project Findings and Conclusions

Over a 14 month contract period, PII worked together with QP's team to establish a comprehensive understanding of the integrity of such an ageing asset and to implement the required integrity management tools and technology transfer to facilitate the safe operation and maintaining the pipelines going forward.
Overall the PIR study of the 51 pipelines involved the evaluation of the severity of more than:

- 600,000 ILI anomalies
- 4,600 pipeline spans
- 500 crossings
- 100 stabilizations
- 600 anodes

The project delivered more than:

- 350 written reports
- 250 risk profiles (before and after remediation)
- 51 integrity management plans

As a result of the PIR study over 800 remediation activities were identified (and cost estimated) in order to safeguard the immediate on-going integrity of the 51 subject pipelines, including:

- Rectification of critical freespans, pipeline crossings and ineffective stabilisations
- Anode retrofits / replacement
- ROV surveys
- ILI surveys
- Auto UT surveys

The project was successfully completed with QP's objectives being met:

- The condition and fitness-for-purpose of the 51 subject pipelines was established
- The level of risk associated with current and the on-going operation was determined
- The remediation activities and costs required to bring operation risks in line with standard industry practice levels were identified

- Pipeline study reports and pipeline integrity management plans were produced for all 51 pipelines
- PIMS GIS based software was implemented and data from QP's existing Geodatabase was migrated and other relevant data sources converted
- A PIMS philosophy and guidance document describing industry current practices and highlighting industry best practices.

Finally, it is worth noting that although QP had many up to date processes and systems in place for managing the integrity of their pipeline network, the PIR study was able to fill in the process and technology gaps in support of QP's goal of being a best practice Pipeline Integrity Management Operator in the gulf region and globally in the pipeline industry.