Pigging in the Arctic Circle
Challenging operational variables

Richard Sharvin – ILI Sales Manager
Prepared for: PPSA Virtual Seminar, 18 November 2020
Introduction

➢ Variable Operator Challenges

- Safety
- Cost Effective Compliance
- Maximum Output

Key Operator Drivers

➢ Role of Inline Inspection (ILI)

- Inspect and analyze pipelines
- Reliable & Accurate data to assess + predict potential issues
- Enhanced Profitability via effective Pipeline Integrity Management

Baker Hughes – Process & Pipeline Services (PPS)

- De-commissioning
- Integrity Engineering
- Pre-commissioning
- Pipeline Inspection
- Maintenance

➢ Delivering actionable insights to enable decisions that promote environmental and public safety
Pigging in the Arctic Circle

Introduction

1. Project background
2. Planning & Preparatory work – 2017 ILI Program
3. 2017 Operation review & collaboration
4. Feasibility Study & Testing
5. Operations Execution – 2019 ILI Program
6. Minimum ID identification

Conclusions
Project background – Goliat Field 2017

- IKM Testing ITT for ILI survey – 10”x7km Gas Injection Line
  - SOW initially scheduled to be performed in Aug/Sept 2017

  - Temporary subsea trap (PLR) to main deck onboard the Goliat FPSO:
    - Assess the internal pipeline geometry
    - Create a pipeline tally
    - Detect metal loss defects
    - Map the pipeline route (3D)

- IKM was the EPC and
- Var Energi the Operator

- Competitive tender process
Goliath Field & 10” x 7km Gas Injection Flowline

- Goliath Field located in Barents Sea
- ±50 nautical miles NW of Hammerfest, Norway
- Water Depth of 430m

- Eight templates in total:
  - 4 x production templates
  - 3 x water injection templates
  - 1 x gas injection template

- Operational since 2016
- Max. Pressure: 170 barg
- Seabed ambient / 5°C
- Nominal WT – 14.5mm
- Velocity 0.3 – 0.5 m/s
- Pipe type: Seamless
Pigging in the Arctic Circle

Introduction

1. Project background

2. Planning & Preparatory work – 2017 ILI Program

3. 2017 Operation review & collaboration

4. Feasibility Study & Testing

5. Operations Execution – 2019 ILI Program

6. Minimum ID restriction

Conclusions
2017 Inspection preparation – Tool build

IKM tool build 10” MFL4 Inspection Train

- MV (69 KG) Magnetizer Vehicle
- CV = 19 KG Caliper Vehicle
- IV = 22 KG Instrumentation Vehicle
- EBV = 21 KG Extra Battery Vehicle
- IMU = 20 KG Inertial Mapping Unit

Copyright 2019 Baker Hughes Company LLC. All rights reserved.
Execution of ILI Operations

➢ Delivery of ILI tool and support equipment
  ▪ To IKM Testing onshore facility at Hammerfest
  ▪ ILI loaded onto Deep Ocean vessel Edda Fauna
  ▪ Receive equipment mobilized to Goliat FPSO

➢ Launch and receiver co-ordination (MFL)
  ▪ Subsea PLR pre-loaded with MFL inspection vehicle
  ▪ PLR lowered and connected to subsea manifold

➢ Key Challenges
  ▪ Logistics
  ▪ Support vessels
  ▪ Operations window
  ▪ Parallel operations
  ▪ Two inspection vehicles
  ▪ Weather
2017 Gauge Run

- Critical analysis of gauge plate results – 2017
  - 215mm diameter aluminium – 4mm thick (segmented)
  - Minimum diameter measured at 211.18mm
  - 211.18mm = 24.5% bore restriction
  - Operations suspended
  - Baker Hughes, IKM & Vår Energi review results
Pigging in the Arctic Circle

Introduction
1. Project background
2. Planning & Preparatory work – 2017 ILI Program
3. 2017 Operation review & collaboration
4. Feasibility Study & Testing
5. Operations Execution– 2019 ILI Program
6. Minimum ID identification

Conclusions
2017 Operational review & collaboration

➢ **Root cause analysis**
  - Review piggability table
  - Consider IDs of each pipeline segment
  - Risk review of progressing into unknown
  - Demob to consider alternative solution

➢ **Collaboration**
  - Baker Hughes & IKM Testing
  - Objective to locate, identify and pass the restriction
  - Full line inspection data
  - Feasibility Study
  - Target inspection date August 2019
Pigging in the Arctic Circle

Introduction
1. Project background
2. Planning & Preparatory work – 2017 ILI Program
3. 2017 Operation review & collaboration
4. Feasibility Study & Testing
5. Operations Execution– 2019 ILI Program
6. Minimum ID identification
Conclusions
Feasibility Study

- CAD modelling
- Applications Engineering
- Reduced bore assembly
- 5D bend of 210mm
- 205mm straight pipe
- Derived Caliper Solution
- Project Management
Testing – objectives

The objectives of the testing phase were two-fold:

1. To utilise the pull-in equipment to replicate the loading of the PLR (Pig Launcher / Receiver) onboard the dive support vessel

2. Demonstrate a variety of bore passing capabilities restrictions.
Test Rig Configuration

TEST CONFIGURATION #1

LAUNCHER SECTION

HEATER SECTION

REGENERATION PORT

TEST CONFIGURATION #2

LAUNCHER SECTION

HEATER SECTION

REGENERATION PORT

TEST CONFIGURATION #3

LAUNCHER SECTION

HEATER SECTION

REGENERATION PORT

TEST RIG DRAWING PLM100049
Technical sketch modified MFL train

- EXTRA DRIVE UNIT (EDU)
- MAPPING UNIT (IMU)
- EXTRA RANGE BATTERY VEHICLE (EBV)
- SHORT TRAP ASSEMBLY (SHORT TOWBARS)
- 8 MODULES IN TOTAL
Modified MagneScan MFL Inspection Vehicle

- **Minimum Bore Passing:**
  - 210mm 5D, 205mm in straight pipe
  - Modified bristle rings
  - Suspension modifications

- **Improved Sealing**
  - Guarantee drive in low flow
  - Addition of rear cup
  - Extra drive module to front of the tool

- **Output**
  - Modifications successfully negotiated all sections of test rig
  - Analysis of data confirmed FULL tool functionality
Pigging in the Arctic Circle

Introduction

1. Project background
2. Planning & Preparatory work – 2019 ILI Program
3. 2017 Operation review & collaboration
4. Feasibility study & Testing
5. Operations Execution – 2019 ILI Program
6. Minimum ID identification

Conclusions
2019 Inspection Program

➢ Planning and Preparation as per 2017

  ▪ Mobilisation ILI equipment
  ▪ Client cleaning + NEW gauge inspection
  ▪ Standalone Caliper (optional)
  ▪ 10” MFL Inspection
  ▪ Fast Track Infield Analysis
2019 Gauge Run

209.96mm

209.63mm
2019 MFL Inspection

- Tool launched 11.09.2019
- Run time: 8 hours 7 minutes
- Velocity: 0.2 m/s
- Swift infield data analysis confirmed 100% data captured
- Analysis uploaded to Cramlington, UK
- Final inspection report and presentation held at Vår Energi office
Pigging in the Arctic Circle

Introduction
1. Project background
2. Planning & Preparatory work – 2019 ILI Program
3. 2017 Operation review & collaboration
4. Feasibility study & Testing
5. Operations Execution – 2019 ILI Program
6. Minimum ID identification

Conclusions
Where was “the bore restriction”?

- **Benefits of integrated data set**
- **The minimum ID was measured as 208.2mm**
- **Located in the receive area of the pipeline, at absolute distance 6988m**
- **High Resolution**

**MFL Inspection Data – Trace**
- Distance from upstream weld to min ID: 0.18m
- Distance from centre of valve to min ID: 0.78m
- Weldolet Offtakes Absolute distance 6988.82m

**Calliper Inspection Data**
- Minimum ID Absolute distance 6988.232m
- Ball Valve Absolute distance 6989.015m
  - IKM no 18
- Pipe spool – IKM no 22
  - Data spool average ID 254.24mm
  - IKM ID 254.0mm
Pigging in the Arctic Circle

Introduction
1. Project background
2. Planning & Preparatory work – 2019 ILI Program
3. 2017 Operation review & collaboration
4. Feasibility study & Testing
5. Operations Execution – 2019 ILI Program
6. Minimum ID identification

Conclusions
Conclusion

- Stakeholder collaboration
- Technology / engineering
- Benefits of testing
- Management of Change
- Robust & proven technology
- Theory validation
- Pipeline intelligence
- Experience
- Lessons learned

- Select the right tool
- Critical path to effective decision making
- Key stakeholder collaboration
- Overcome RISK of stuck pig
- Operational excellence in challenging environment
Thank You ...

Open to Q&A...