ADVANCED FLOW ASSURANCE TOOLS TO MINIMIZE PIGGING RISKS IN CHALLENGING LINES

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INTEGRITY SERVICES

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Working across all assets with all the key disciplines covered in-house

- Pipelines, Flowlines, Flexibles & Risers
- Offshore Structures
- Production Facilities
- Upstream Pipelines
- Tank & Terminal Facilities
- Onshore Distribution
- Gas Networks
- Renewables

TECH TALKS


AIMS AND COMPLIANCE SERVICES

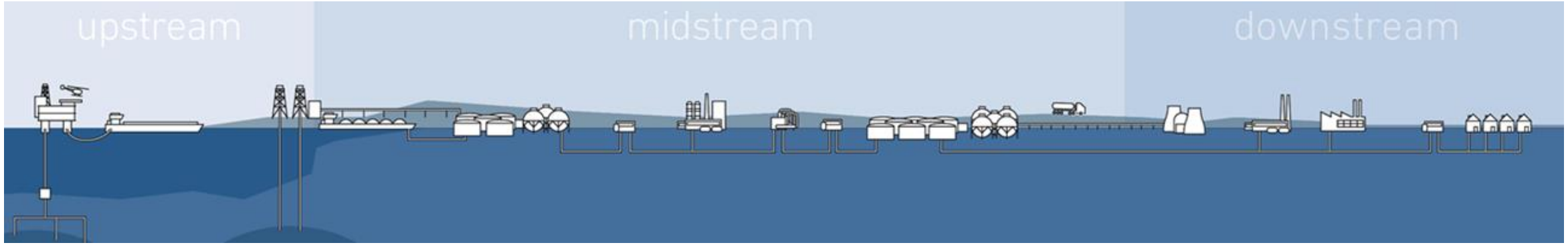

DATA MANAGEMENT SERVICES


ASSET INTEGRITY ASSESSMENT


RISK MANAGEMENT SERVICES


NIMA - ELEVATING SAFETY


CONSULTANCY AND TESTING



INTRODUCTION
INTEGRITY SERVICES

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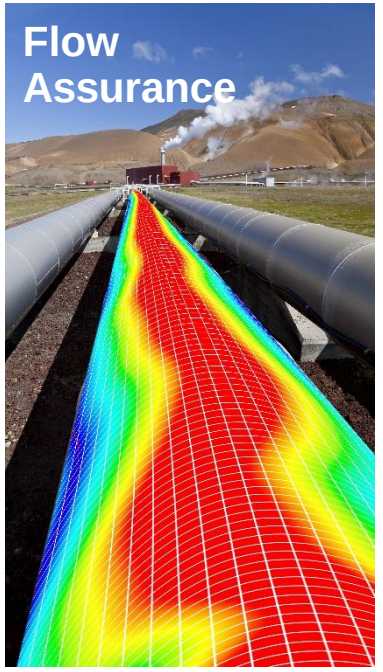

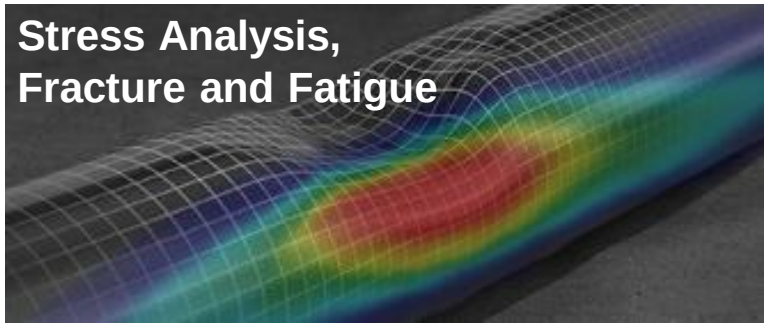

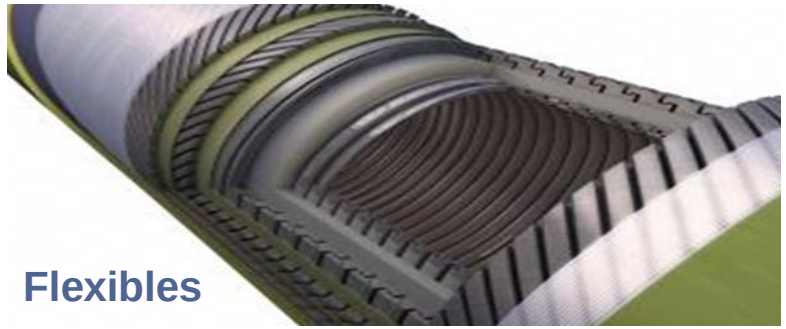

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Pigging Feasibility

PIGGING FEASIBILITY
RISKS

- All pigging operations contain an element of risk:
  - Stuck or stalled pig
  - Blocked pipeline
  - Damaged pig
  - Damaged infrastructure

- Run success is not guaranteed:
  - Sensor lift-off
  - Damaged cleaning / ILI tool
  - Speed excursions

PIGGING FEASIBILITY
CHALLENGES

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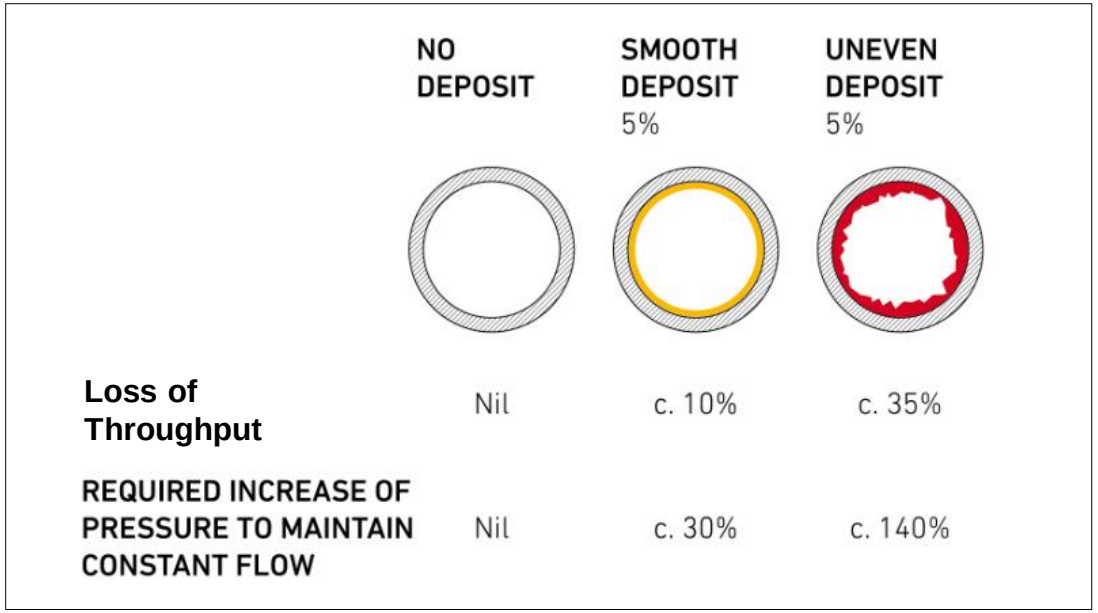
Operational pigging employed for cleaning operations and management of – liquid, hydrates, solid deposits and corrosion

WHY?

- Minimize liquid holdup to reduce ΔP losses
- Clean sand / wax / scales / debris / hydrates
- Reduce corrosion (under deposit, MIC etc.)
- Effective application of chemical treatment
- Pre-inspection cleaning service

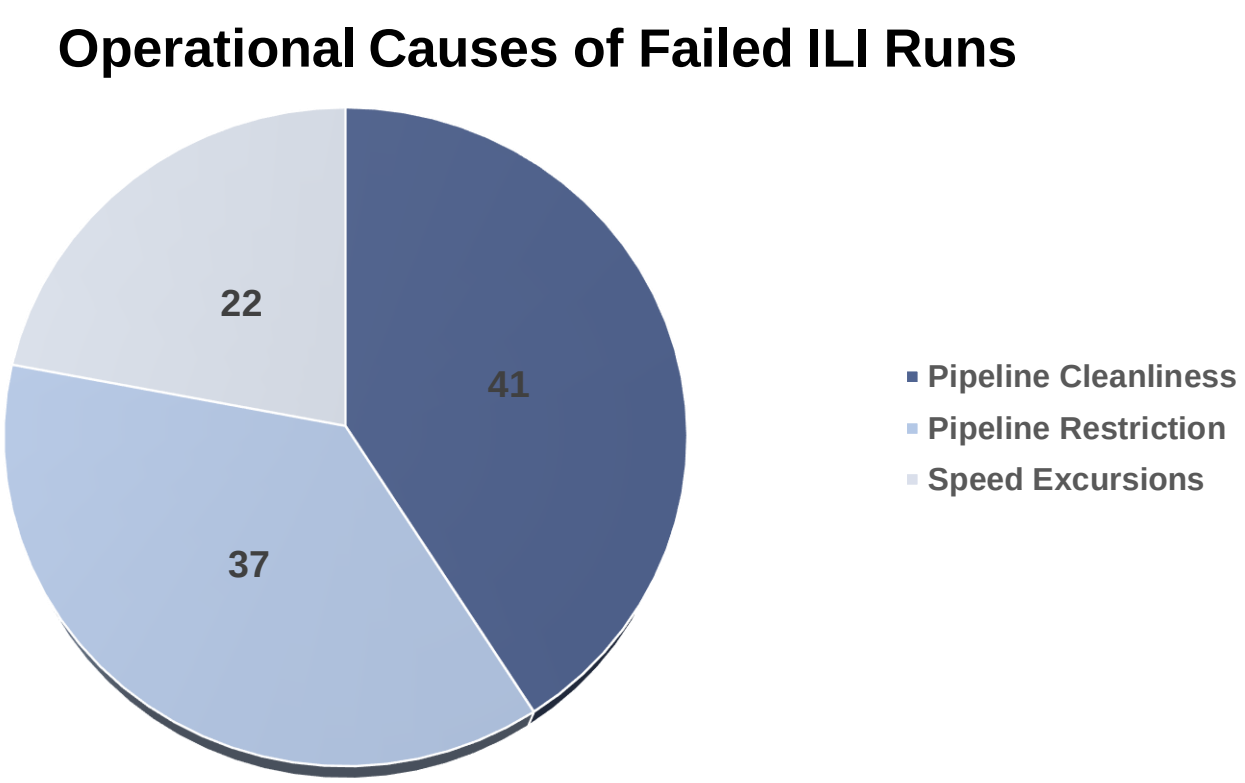
OUTCOMES

- Increase pipeline operational efficiency
- Pipeline integrity – extend life of pipeline
- Minimize production deferment / trips / stoppages
- Minimize sensor lift-off of the ILI tool

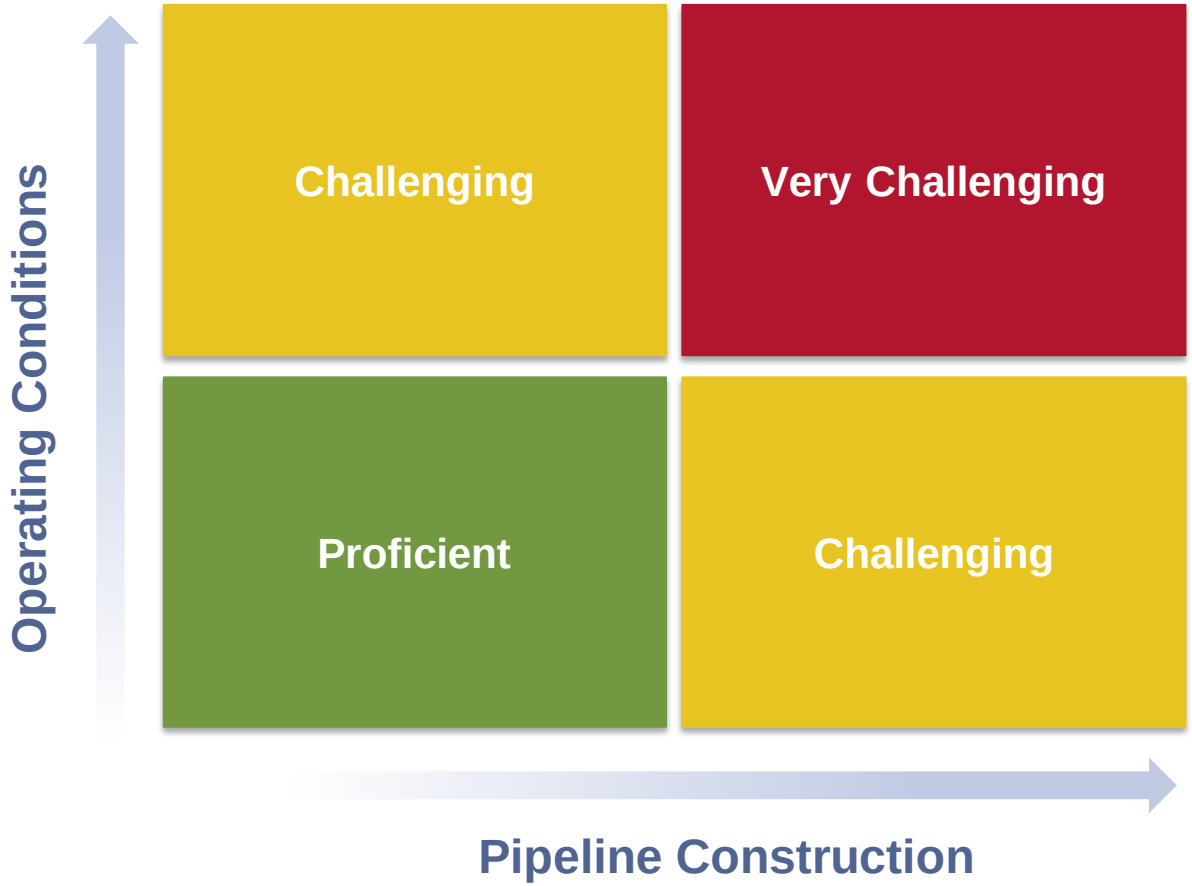


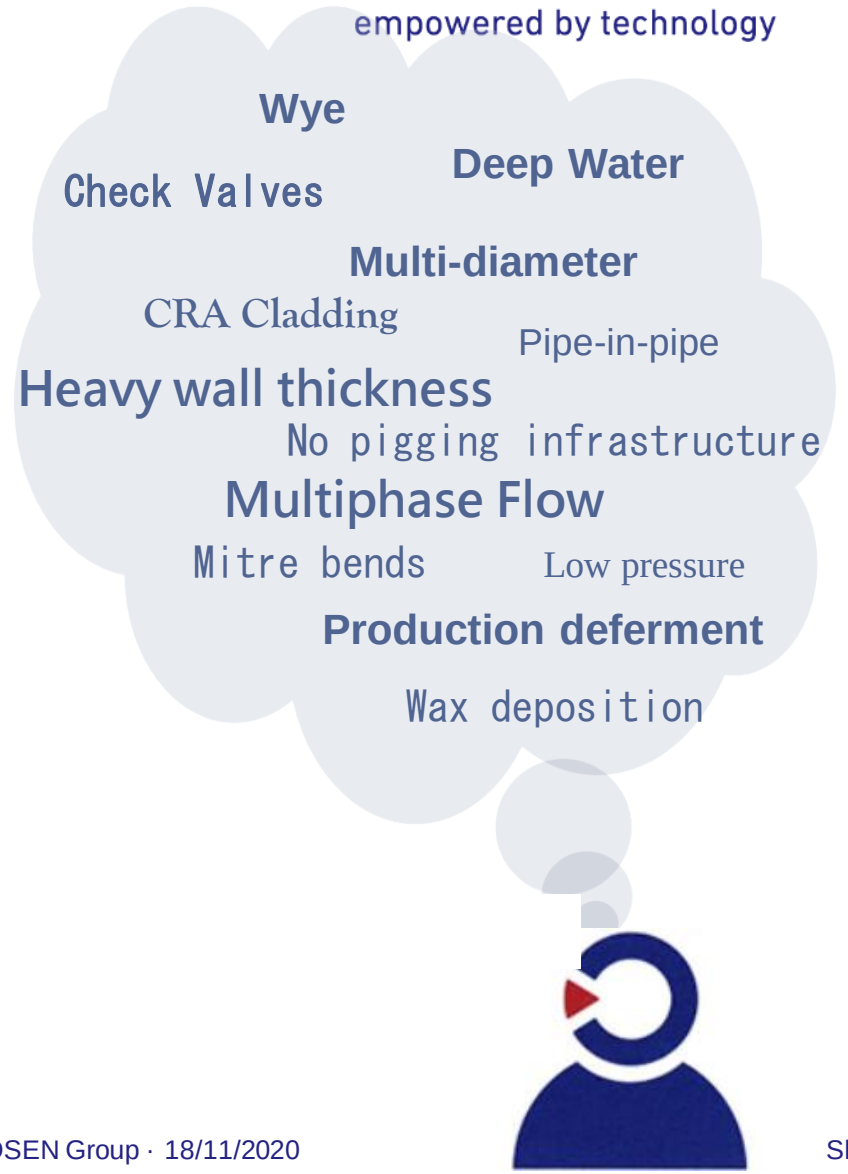
PIGGING FEASBILITY
CHALLENGES

*'Achieving ILI run success requires close collaboration between the Client and Contractor teams, where **adequate planning and preparation** are important factors.'– POF 2018*

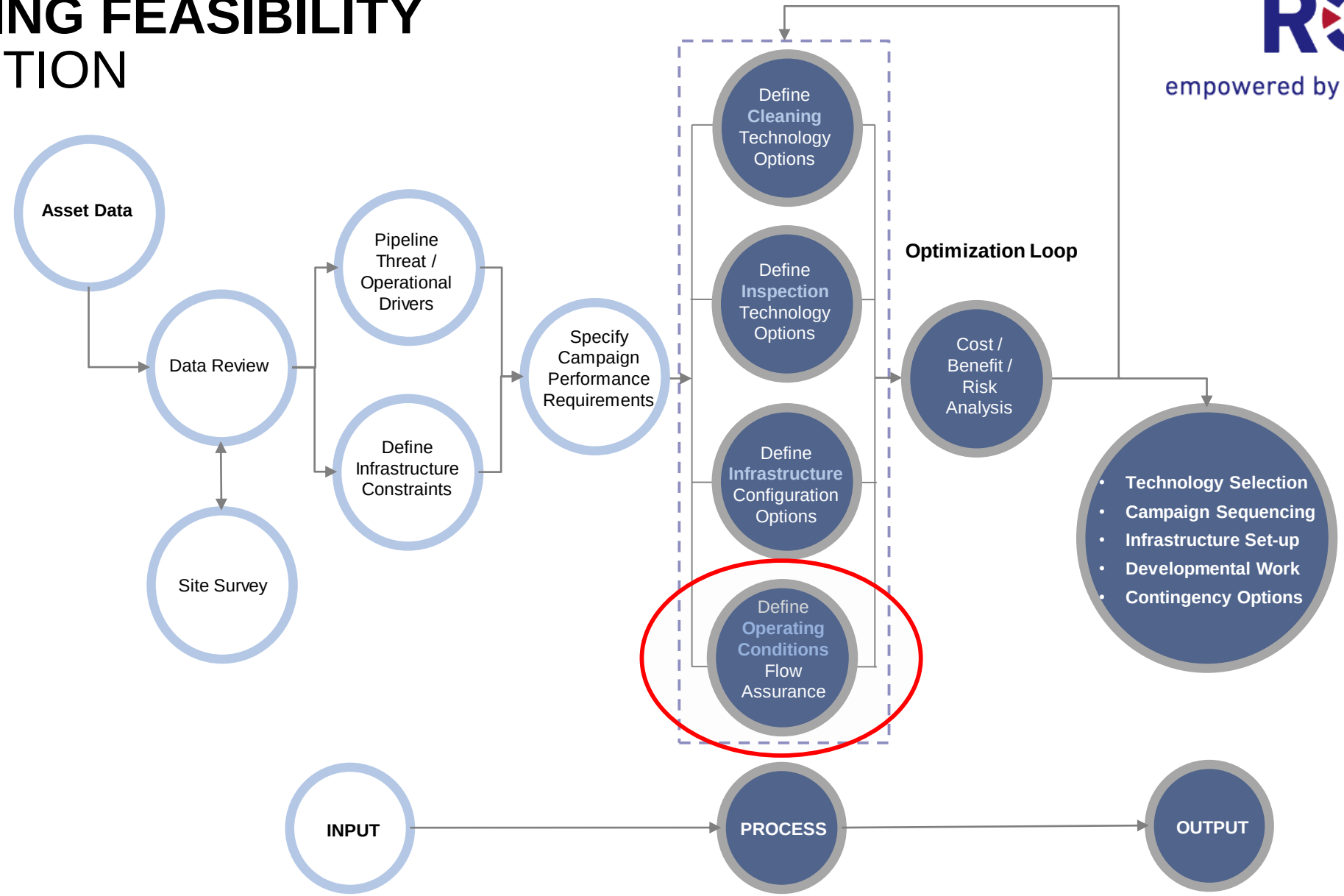


PIGGING FEASIBILITY
CHALLENGES





PIGGING FEASIBILITY SOLUTION



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Operational Feasibility (Flow Assurance)

FLOW ASSURANCE
INTRODUCTION

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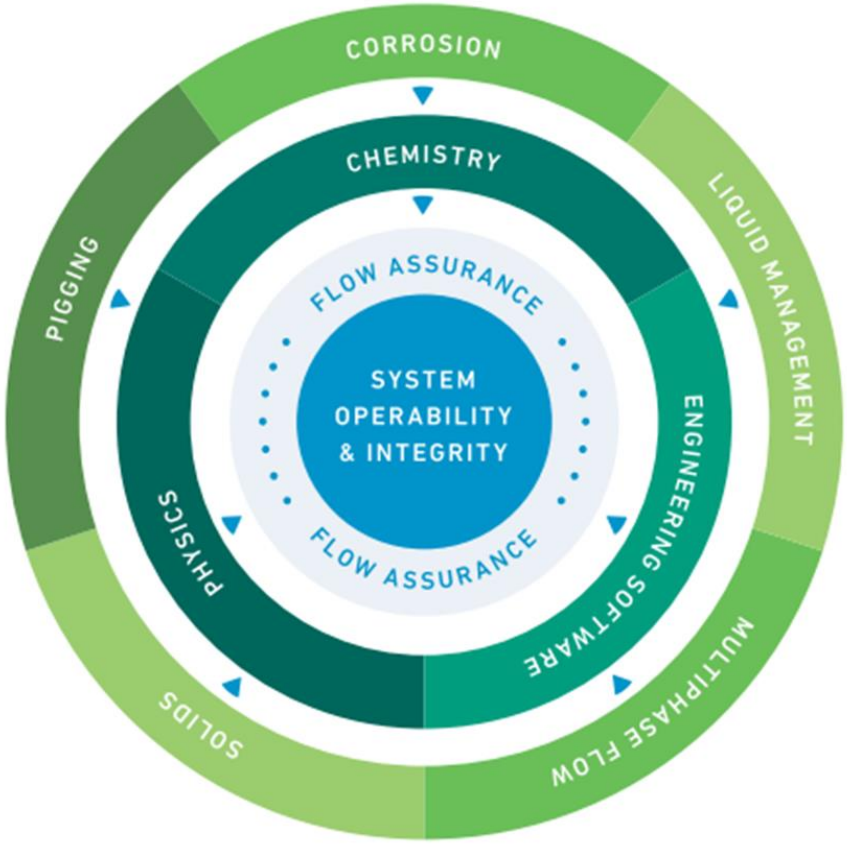
Assure** transportation fluids from **source to facility** in a **safe** and **economical** manner over the **life of the asset

- Process conditions
- Hydraulic calculations
- Corrosion, erosion
- Severe slugging
- Solids: sand, slurry, dust etc.
- Gas hydrates, wax and asphaltenes
- Liquid management during pigging
- Production deliverability
- Pressure surge analysis



FLOW ASSURANCE
CHALLENGES DURING PIGGING

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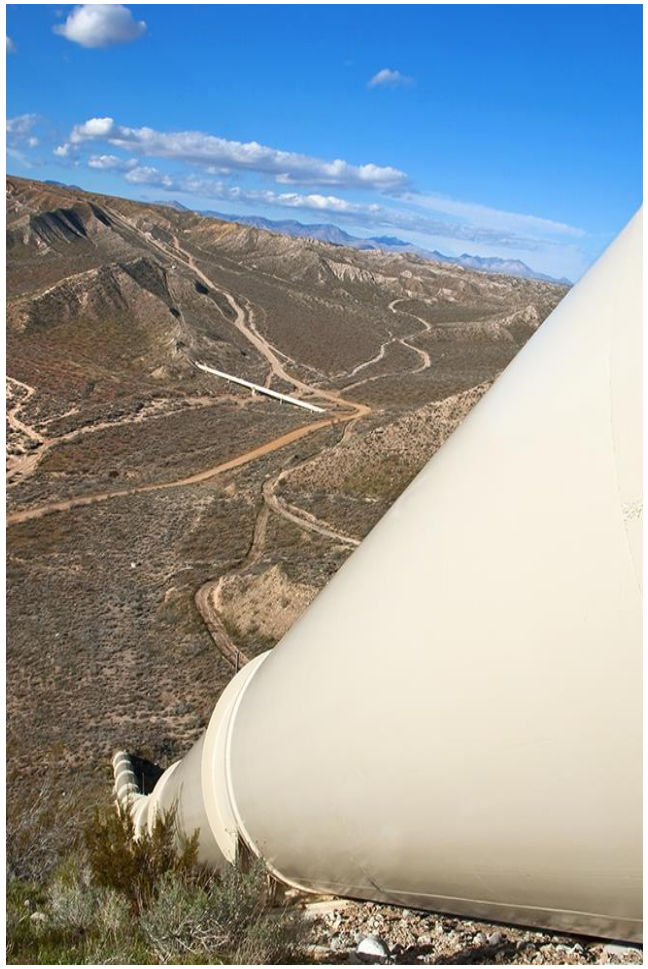
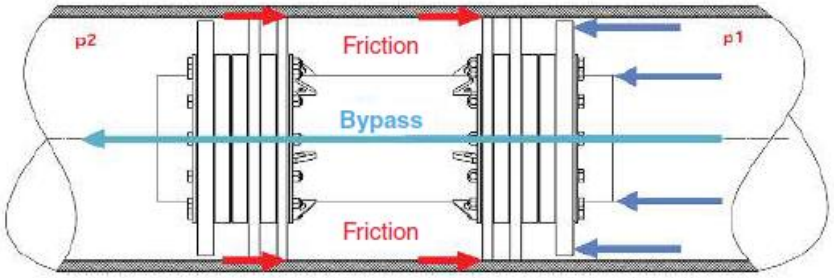
- **Operating conditions**
  - Pressure, temperature, flowrate limits
- **Liquids**
  - Rate of accumulation
  - Pig generated liquid slug could flood the receiving equipment
- **Solids**
  - Rate of accumulation and location
  - Avoid “stuck pig” scenario
- **Maintaining production**
  - Minimize deferment
  - Maximize throughput
- **First pass success**
  - Pig velocity control within recommended limits



FLOW MODELLING
APPLICATION IN PIGGING OPERATIONS

- Estimate solids / liquid inventory
  - **Blockages** due to deposit build-up
  - **Motive pressure** for propulsion
- Tool behaviour due to hydraulics
  - **Pig wall frictional factors** to simulate pig behavior
  - **Bypass port sizing** to maximize production flow without flooding the slugcatcher
- Pigging optimization
  - Process conditions for **optimum tool velocity**
  - **Pigging frequency**
- Pigging diagnostics for flow model validation
  - **Data, data and more data!**



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Need to Combine Pigging Feasibility and Flow Modelling

FLOW ASSURANCE & PIPELINE PIGGABILITY
OPERATING LIMITS

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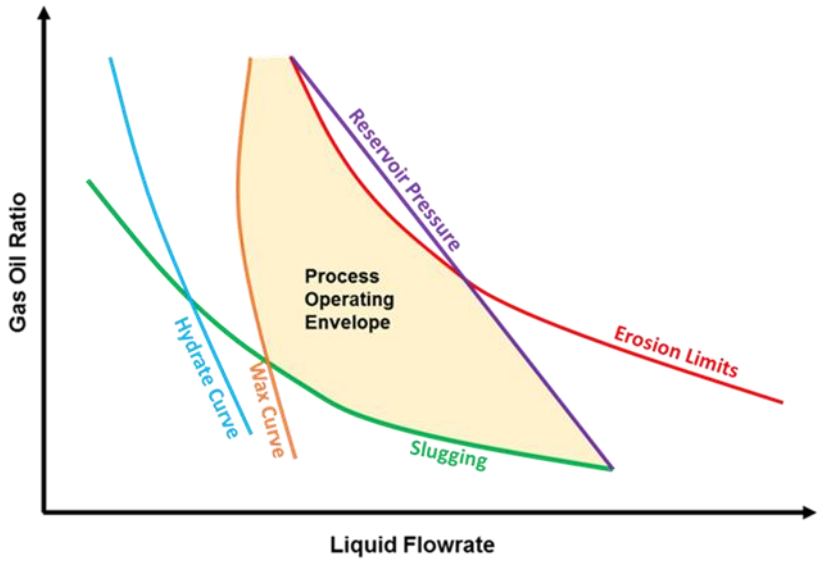
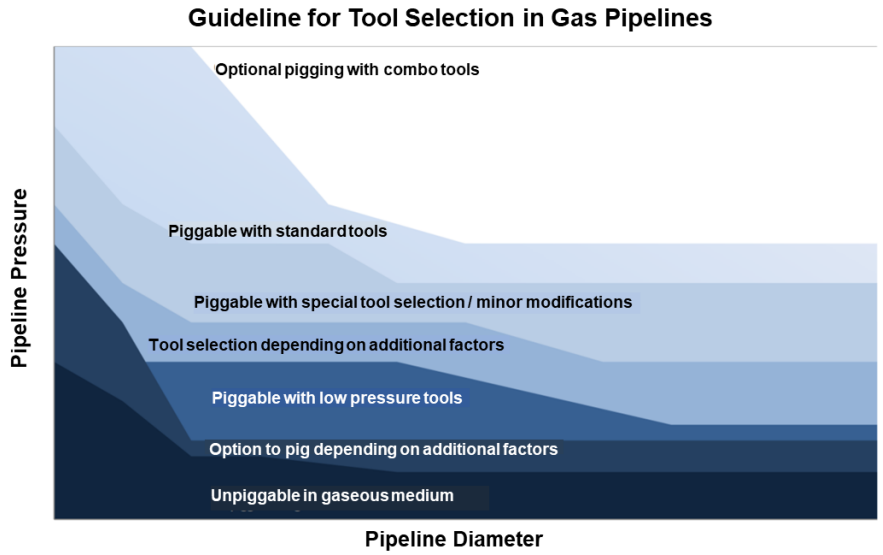
Process Operating Envelope



Pigging Operating Window



Objective:

- Optimized process conditions for economical ***"off-the-shelf" pigging solutions***
- ***Assured piggability*** of the system

FLOW ASSURANCE & PIGGING FEASIBILITY SERVICES

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Cleaning

- Pigging frequency for sand / wax / liquid management
- Liquid holdup estimation and surge calculations
- Pig velocity tracking and validation
- Pigging feasibility & configuration e.g. standard / bypass pig, challenging tool

Inspection

- Pig velocity tracking
- Optimization of pigging operation in single & multiphase flow

Corrosion

- Corrosion models integrated with flow calculations, e.g. DeWaard, Norsok, TOLC IFE
- Support NACE ICDA for un-piggable lines
- ILI data validation
- Inspection location prioritization
- Optimize inhibitor injection rates & performance

Integrity

- Risk studies: Water hammer / pressure surge analysis, blowdown modelling etc.
- Black powder: root cause analysis and mitigation
- Erosion in slurry / sand transporting lines: root cause analysis and mitigation

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Case Study –
Condensate line cleaning & ILI

CASE STUDY – CONDENSATE LINE CLEANING & ILI

OVERVIEW

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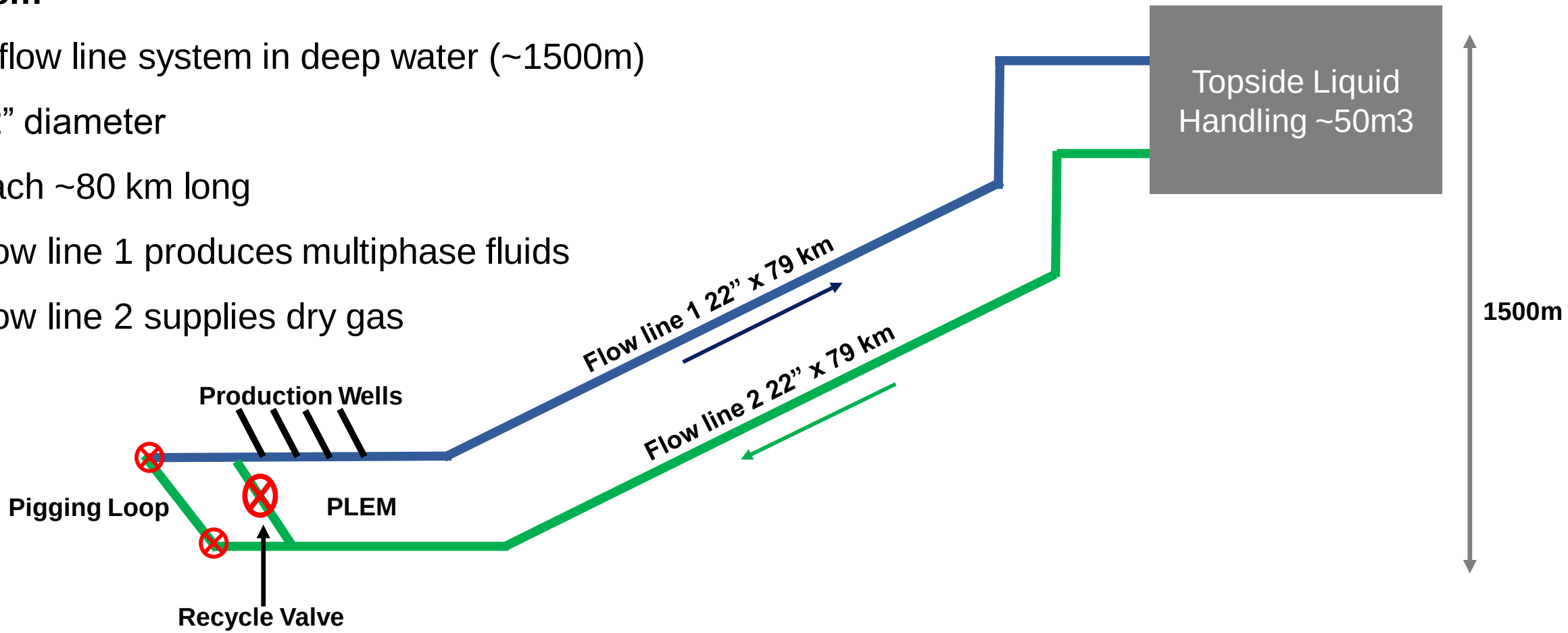
System

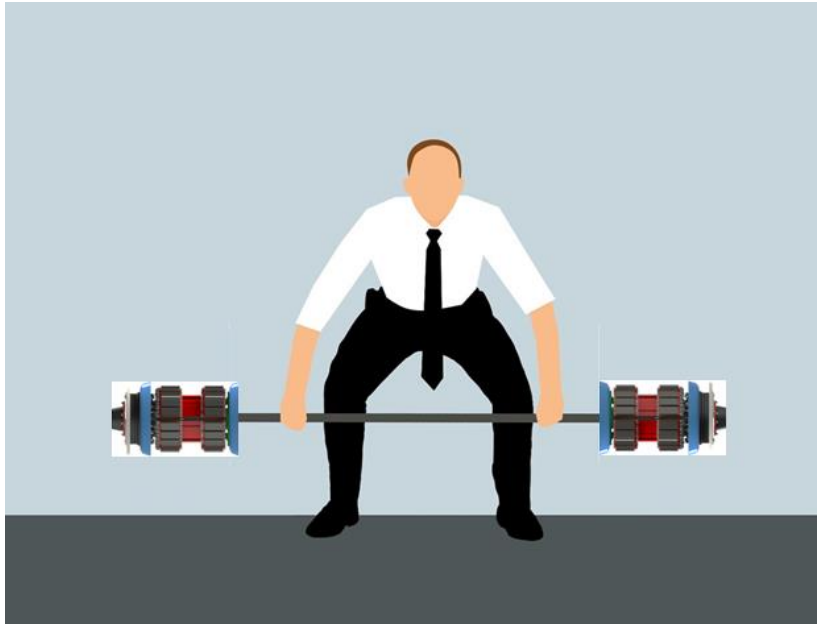
Dual flow line system in deep water (~1500m)

- 22” diameter
- Each ~80 km long
- Flow line 1 produces multiphase fluids
- Flow line 2 supplies dry gas



CASE STUDY – CONDENSATE LINE CLEANING & ILI
CHALLENGES

- Client preferred **“online”** pigging at **maximized production:**
  - The asset produced most of the client’s revenue.
- Multiphase in deep water → Large liquid holdup (>1500 m^3):
  - Limited liquid handling capacity of 50 m^3
- Large hydrostatic head
  - Insufficient driving pressure for pigging
  - Well close to backing out
- Different service fluids
  - Compressible gas in one and multiphase fluid in other.
- Maintaining pig velocity challenging in multiphase line



CASE STUDY – CONDENSATE LINE CLEANING & ILI

SCOPE OF WORK

The scope of work consisted of the following:

- Data Review
- Site Visit

- Mechanical Feasibility Study
- Identify Requirements for Cleaning and Baseline Inspection
- Flow Assurance for In-Service Progressive Pigs and ILI

- Develop In-Service Progressive and ILI Procedures
- Emergency Response Procedure
- Pig Tracking Procedure
- Pig Stuck Emergency Rescue Plan
- Supervise Pigging Operation

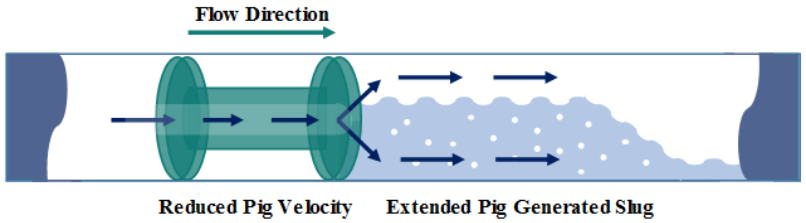
CASE STUDY – CONDENSATE LINE CLEANING & ILI

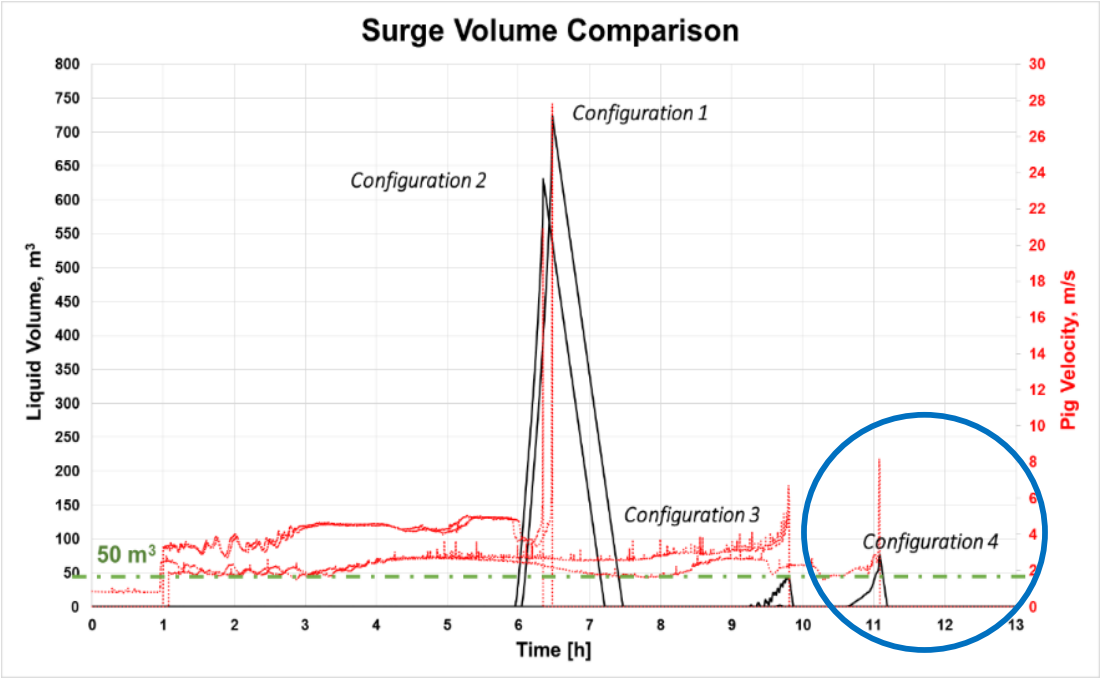
METHODOLOGY

- **OLGA multiphase hydraulic simulator** employed to estimate the liquid inventory in the flow lines
- Bypass pig calculations
- Critical pig wall frictional factors to model pig behavior
- Various configurations considered:
  - Gas wells, increased gas velocity, standard pigs, passive and active bypass pigs etc.

Optimized cleaning pigging (Configuration 4):

- Sweep the line with gas at high flowrates
- Passive or “fixed” bypass pigging at reduced production





CASE STUDY – CONDENSATE LINE CLEANING & ILI

STANDARD PIG

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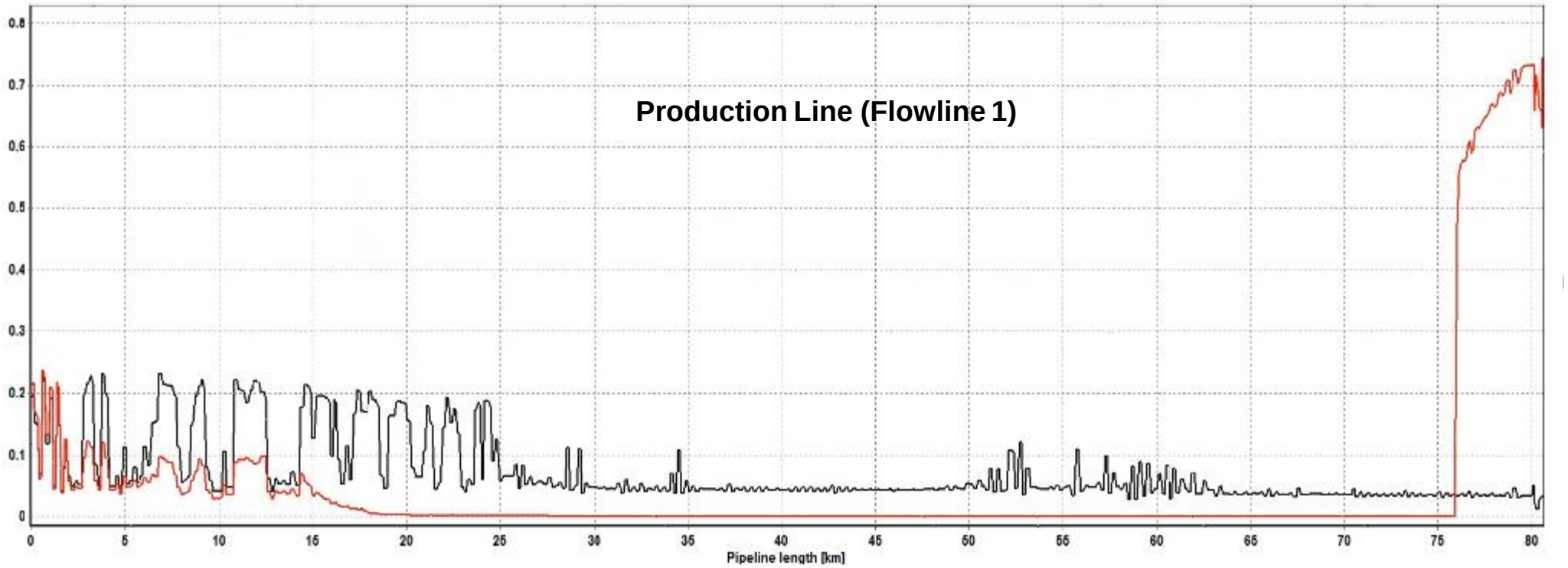
Liquid Holdup (Standard pig)



CASE STUDY – CONDENSATE LINE CLEANING & ILI

THE SOLUTION

A standard pig would:

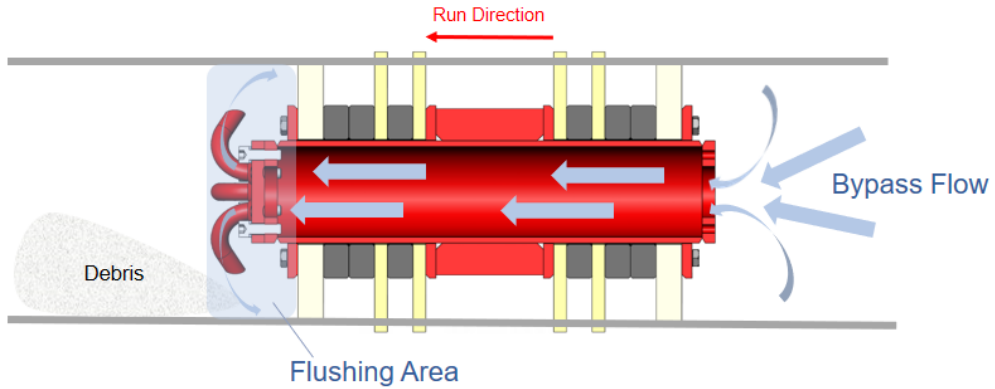
- Cause the wells to back out
- Overwhelm the receive facilities causing a trip / shutdown

Therefore a solution was sought…

Solution

High velocity sweep of the pipeline to remove excess liquid holdup

Cleaning pigs with 3% bypass – Pigging needed to be continuous as liquids were replenished within 24 hours



CASE STUDY – CONDENSATE LINE CLEANING & ILI

BYPASS PIG

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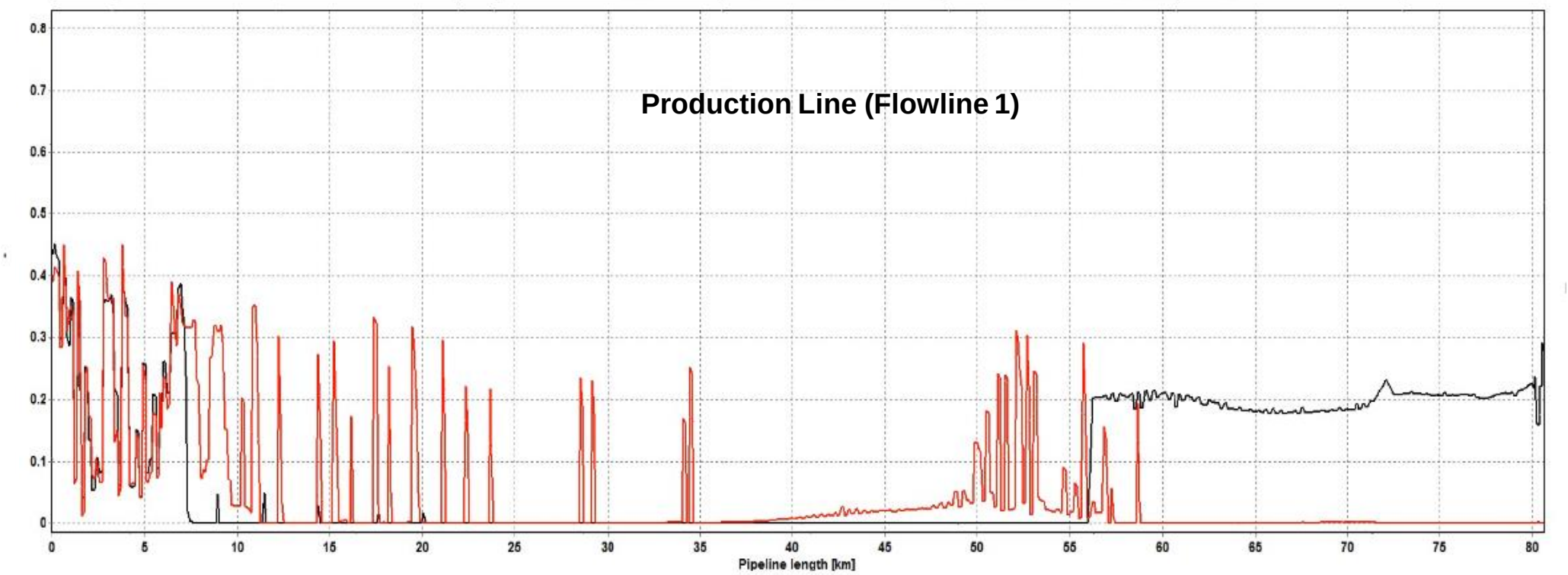
Liquid Holdup (3% bypass pig)



CASE STUDY – CONDENSATE LINE CLEANING & ILI
CONCLUSIONS

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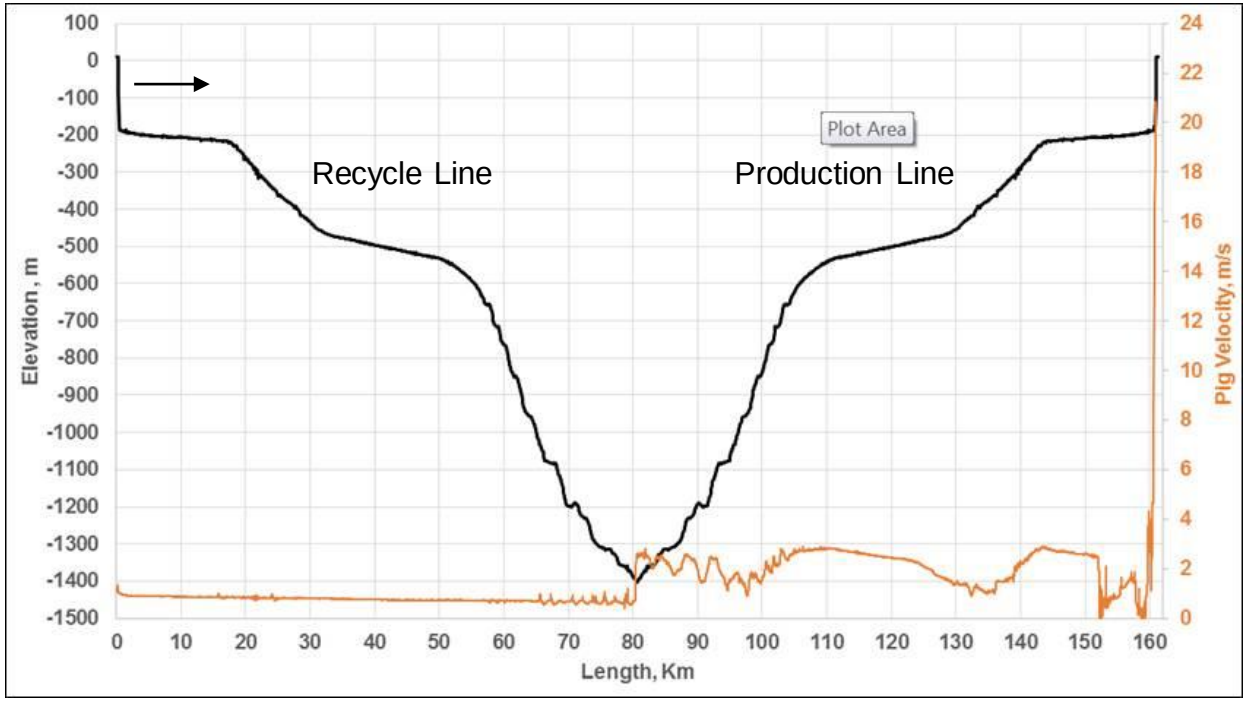
Overall Results:



KEY BENEFITS

- ***Reliable*** and ***cost effective*** solution for an “online” pigging specification
- An ***acceptable level of production*** could be maintained

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Conclusions

FLOW ASSURANCE & PIGGING FEASIBILITY
CONCLUSIONS

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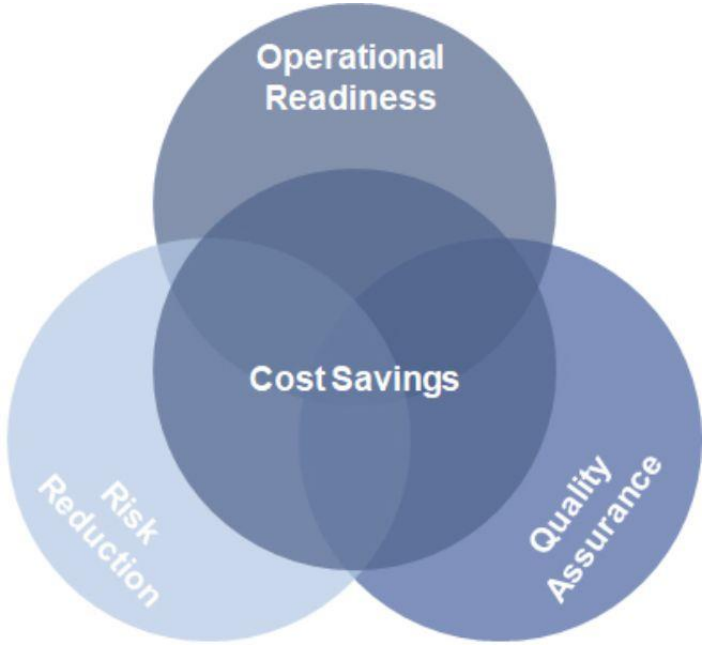
Flow assurance is key for ensuring operational feasibility:

- **OLGA Multiphase simulator** for solid / liquid estimates
- **Pig frictional factors** for predicting bypass pig behavior
- **Access** to PDL diagnostics and inspection data for **validation**

Combining flow assurance into pigging feasibility studies is beneficial for:

- **Assurance** of a pigging solution
- **Management of risks** in complex challenging assets
- **Profitable, safe and efficient** running of a pipeline asset



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Questions…?

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