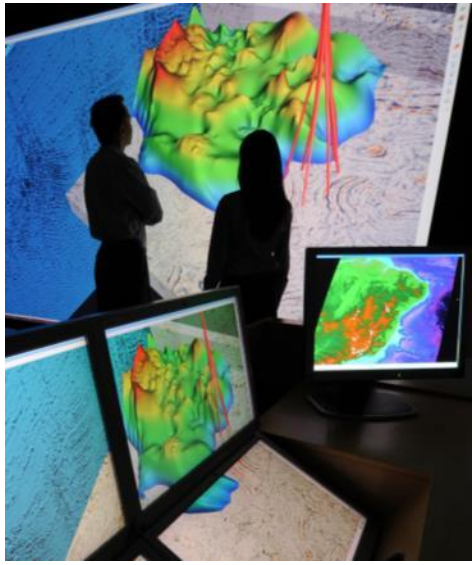



Pre-Inspection Cleaning of “Unpiggable” Subsea Operational Pipelines

Pigging Products & Services Association Annual Seminar

Robert Davidson and Jakub Budzowski

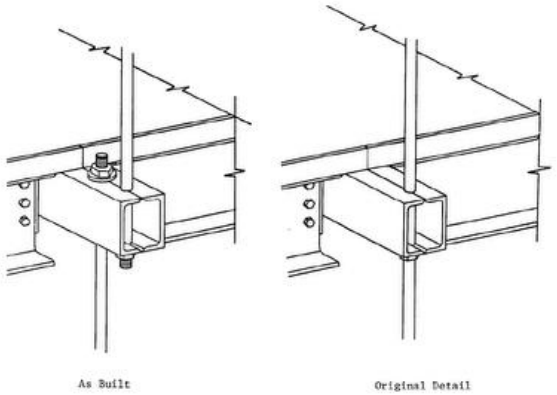
Ardoe House, Aberdeen

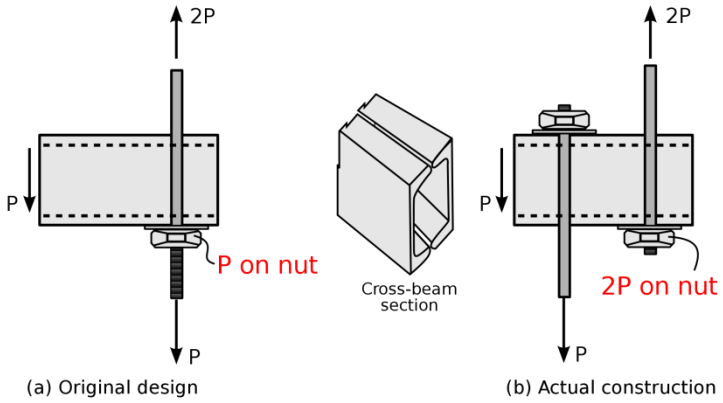
8 November 2017

HALLIBURTON

Safety Moment: Management of Change

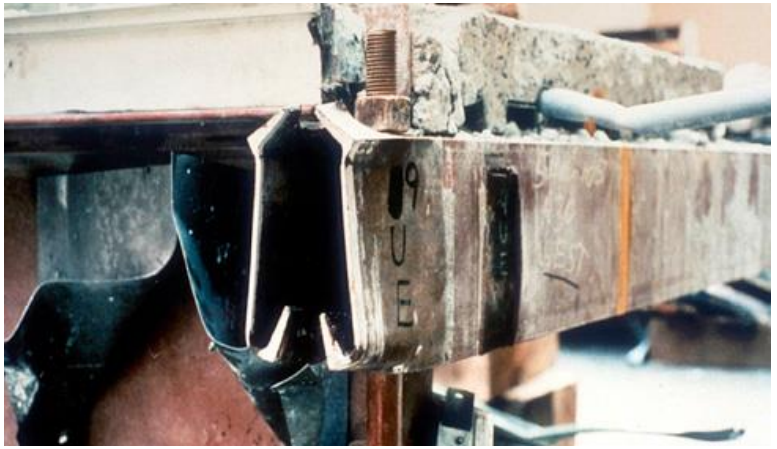
- Hotel walkway collapse, July 1981
  - Elevated walkways collapsed in a hotel atrium during a tea dance
  - 114 People killed
  - 216 People injured





Safety Moment: Management of Change

- Design changed during construction
- Change not risk assessed
- Change not communicated
- Resulted in disaster

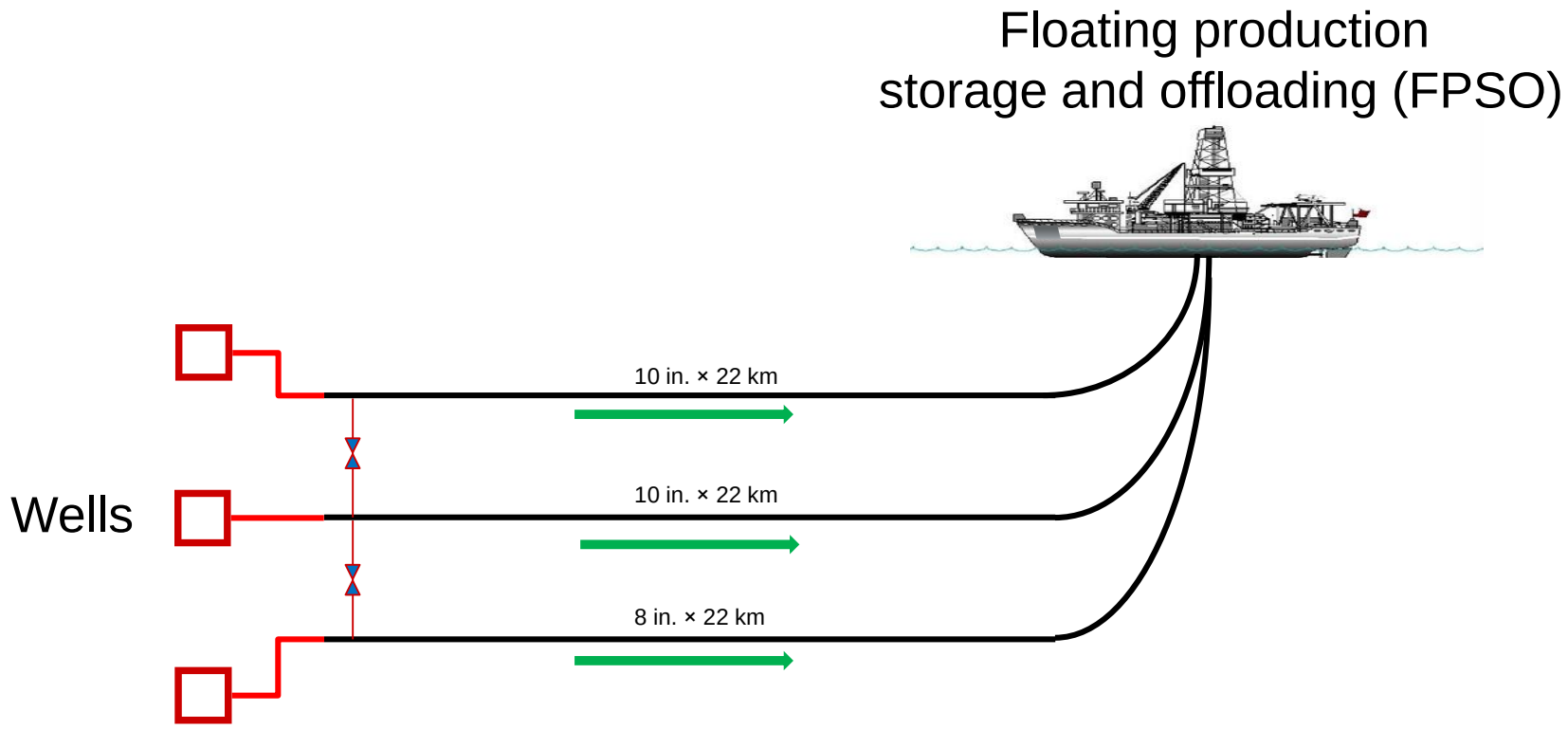


Pre-Inspection Cleaning of “Unpiggable” Subsea Operational Pipelines

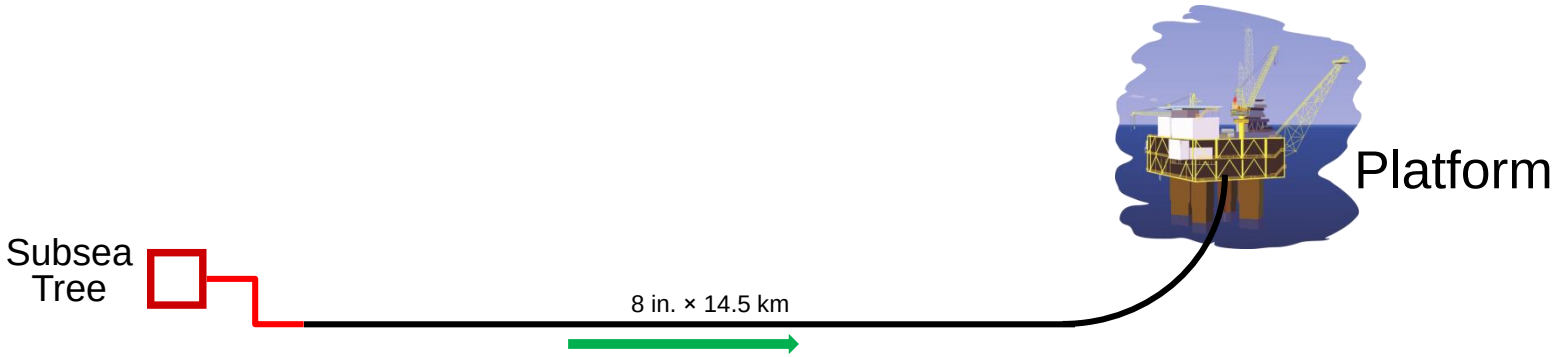
Project Overview

- Ultimate requirement to perform in-line inspection (ILI) on subsea lines
- Which meant a requirement for pre-inspection cleaning
- Which meant a requirement to retrofit pig launch/receive capability
- Which meant a requirement to clean/flush lines to allow for intervention

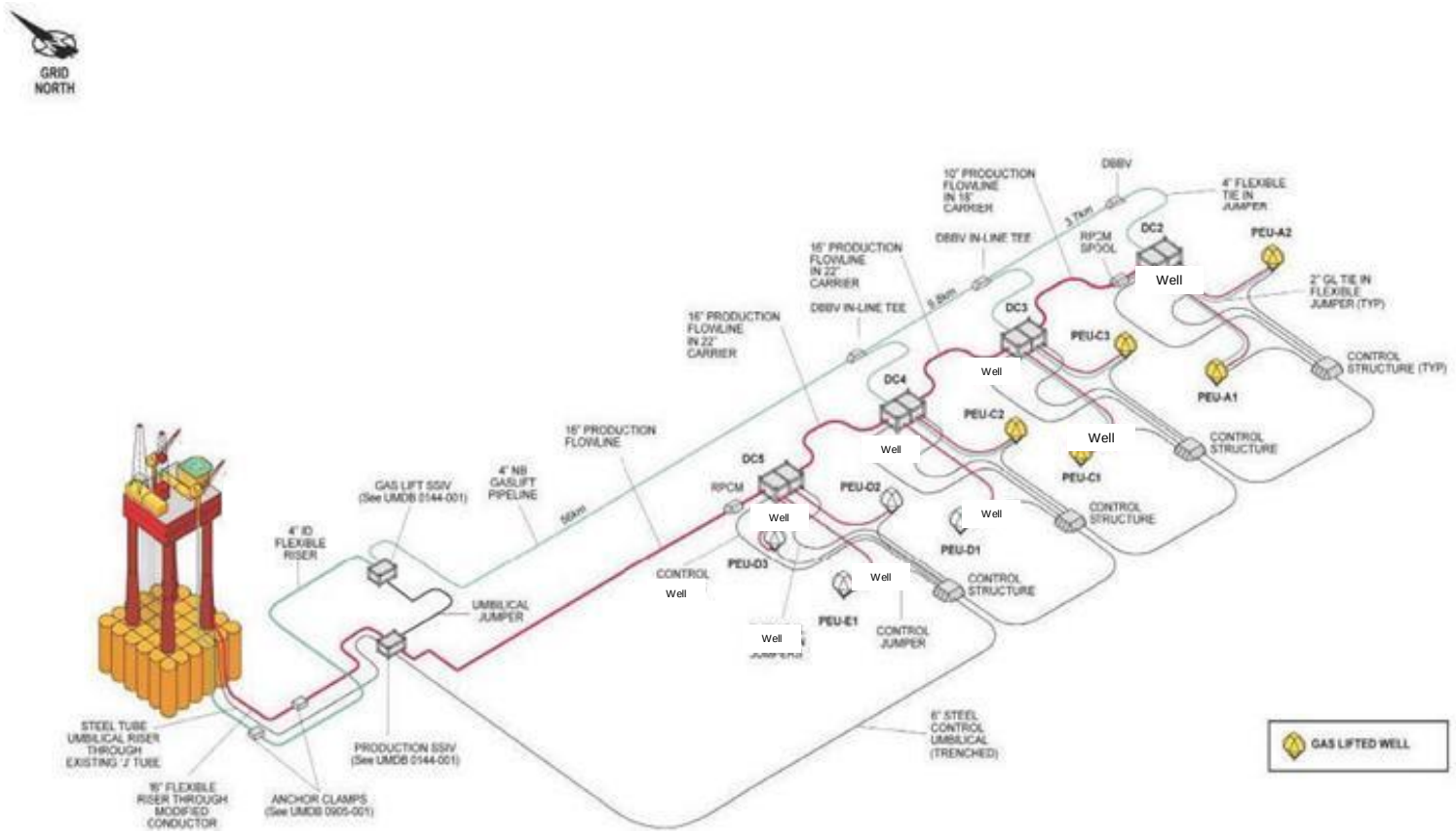
Field Layout: Field 1



Field Layout: Field 2



Field Layout: Field 3



Challenges

- Subsea lines not designed for pigging operations
- Subsea lines in operation
  - Requirement for minimal interruption to production
- Internal line conditions unknown
  - Crude, produced water, possible H_2S, corrosion products, scale, wax, sand
- No two fields alike
  - Configuration, production profile, end conditions
- Operational planning – the right pigs in the subsea traps at the right time
- Process constraints – handling and processing of received fluids

Challenges: Project Structure

- Requirement to tailor solutions

- Multiple parties involved
  - Ultimate client
  - Field partners
  - Subsea construction company
  - Pigging and testing contractor
  - ILI Contractor
  - Regulatory authorities
  - Cleaning/disposal contractors

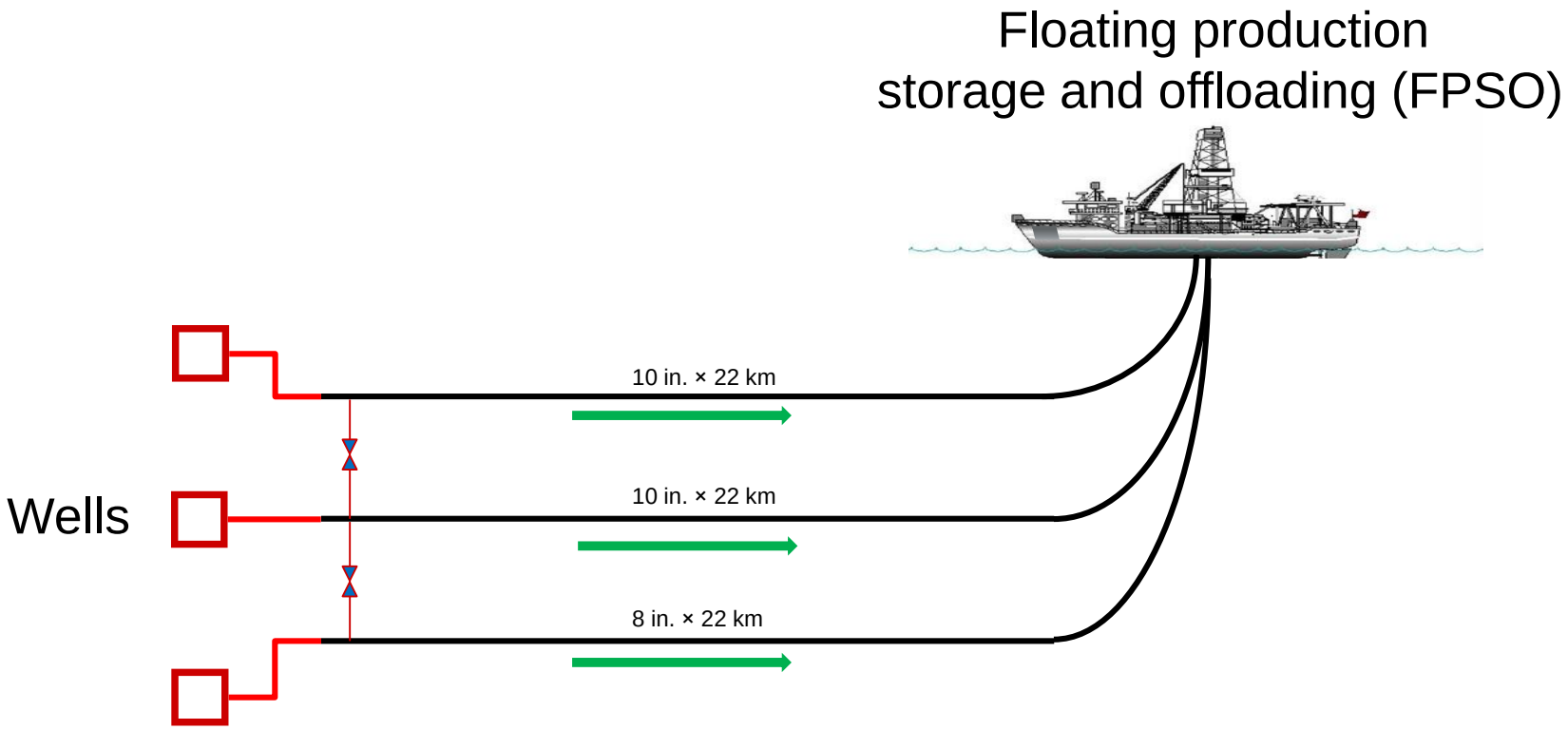
Need for 3 C's.

Communication, Collaboration, Common Goal

Solution: Simple Terms

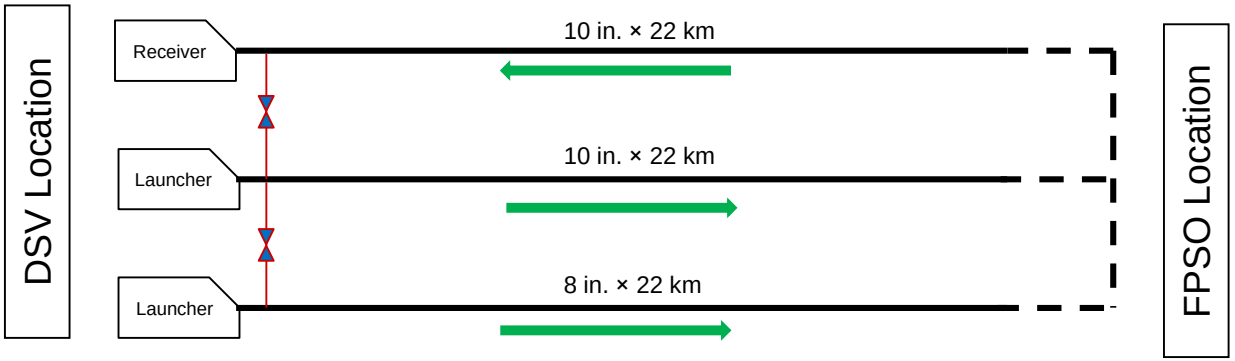
1. Make fields piggable
   - Clean/flush pipelines with solvents without using solid pigs
   - Retrofit pig launch and receive facilities
2. Clean pipelines and measure cleanliness
   - Conventional pigging
   - Flushing
3. Perform ILI runs
4. Remove pigging facilities and reinstate systems

Field 1


Floating production
storage and offloading (FPSO)
Wells
10 in. × 22 km
10 in. × 22 km
8 in. × 22 km

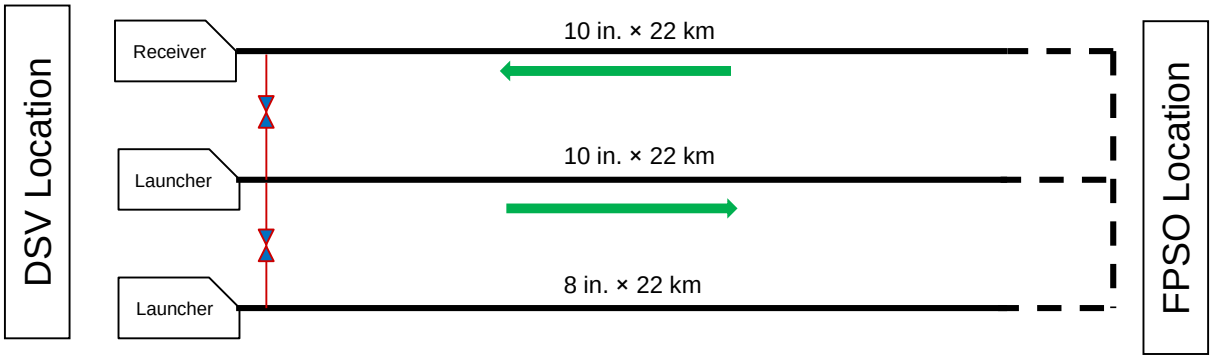
Solution: Field 1

- FPSO water injection system used to flush lines
  - Two loops — 10 and 8/10 in.
- Flowlines disconnected from risers at FPSO and temporary wye and spools fitted
- Temporary pig traps fitted to allow flowline cleaning
  - Pumping conducted from dive support vessel (DSV)
  - Pumping carried out in a closed loop
    - » Cleaned/Processed on DSV and reinjected to minimise waste



Solution: Field 1, 10 inch Loop

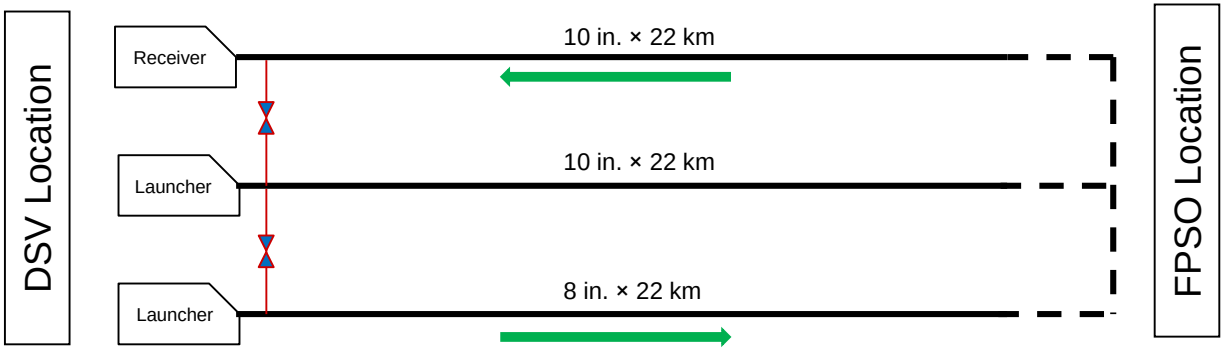
- Caliper foam pig run
- Progressively aggressive pigs run through line
- Gauge pig/proving pig run through line
- ILI performed



Solution: Field 1, 8 inch/10inch Loop

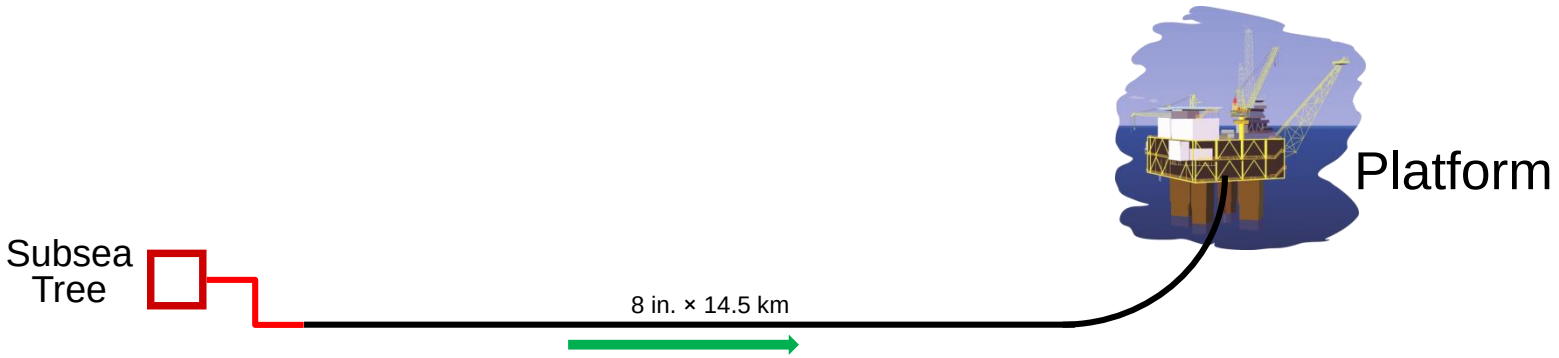
- Progressively aggressive pigs run through line
- Gauge pig/proving pig run through line
- ILI performed

- System reinstated



Field 2

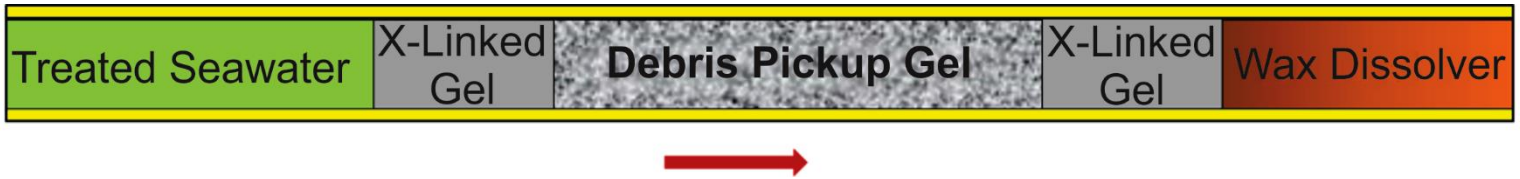
- No topsides Pig Launcher/Receiver
- Undersize Riser – 6”



Solution: Field 2

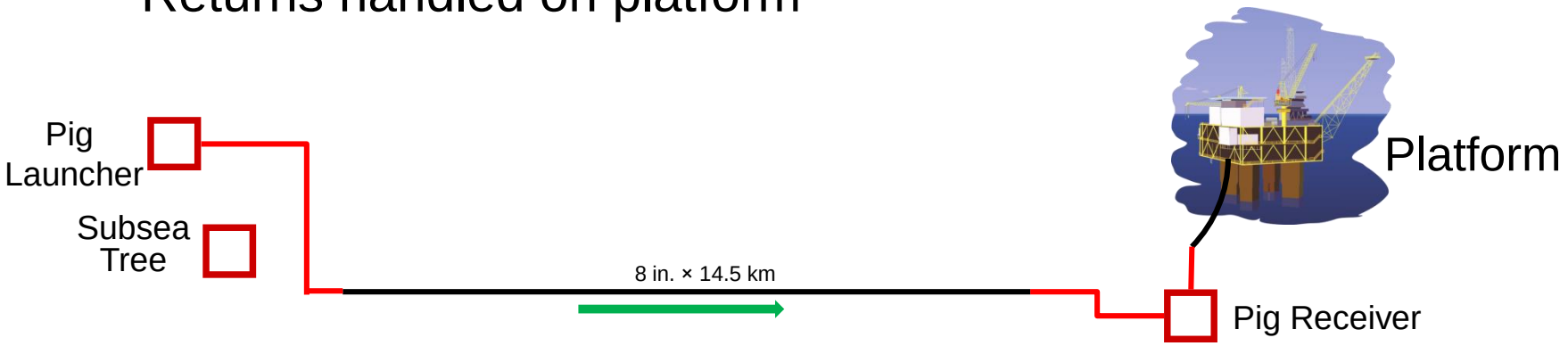
- Operations conducted from Dive Support Vessel
  - Wax dissolver pumped into line
  - Crosslinked gel used to batch debris pickup gel
  - Line flushed with treated seawater (120%)

- After DPG train was run, more than 3.5 tonnes of sand was recovered from the production separator



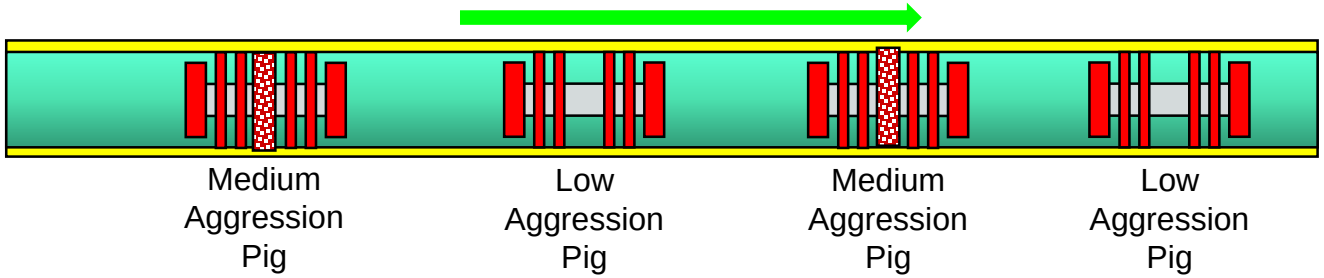
Solution: Field 2

- Post Flush
  - Riser disconnected
  - Pig traps fitted
  - Pig receiver outlet routed to riser
  - Returns handled on platform



Solution: Field 2

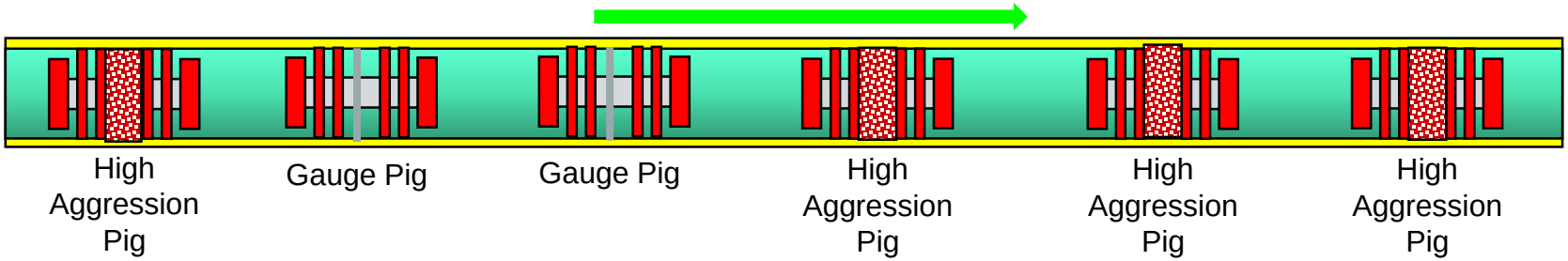
- Two caliper foam pigs — run as a train
  - High ppm oil in water measured so 120% line volume flush conducted
- Mechanical pig train run with small amounts of debris received



- 120% Line volume flush

Solution: Field 2

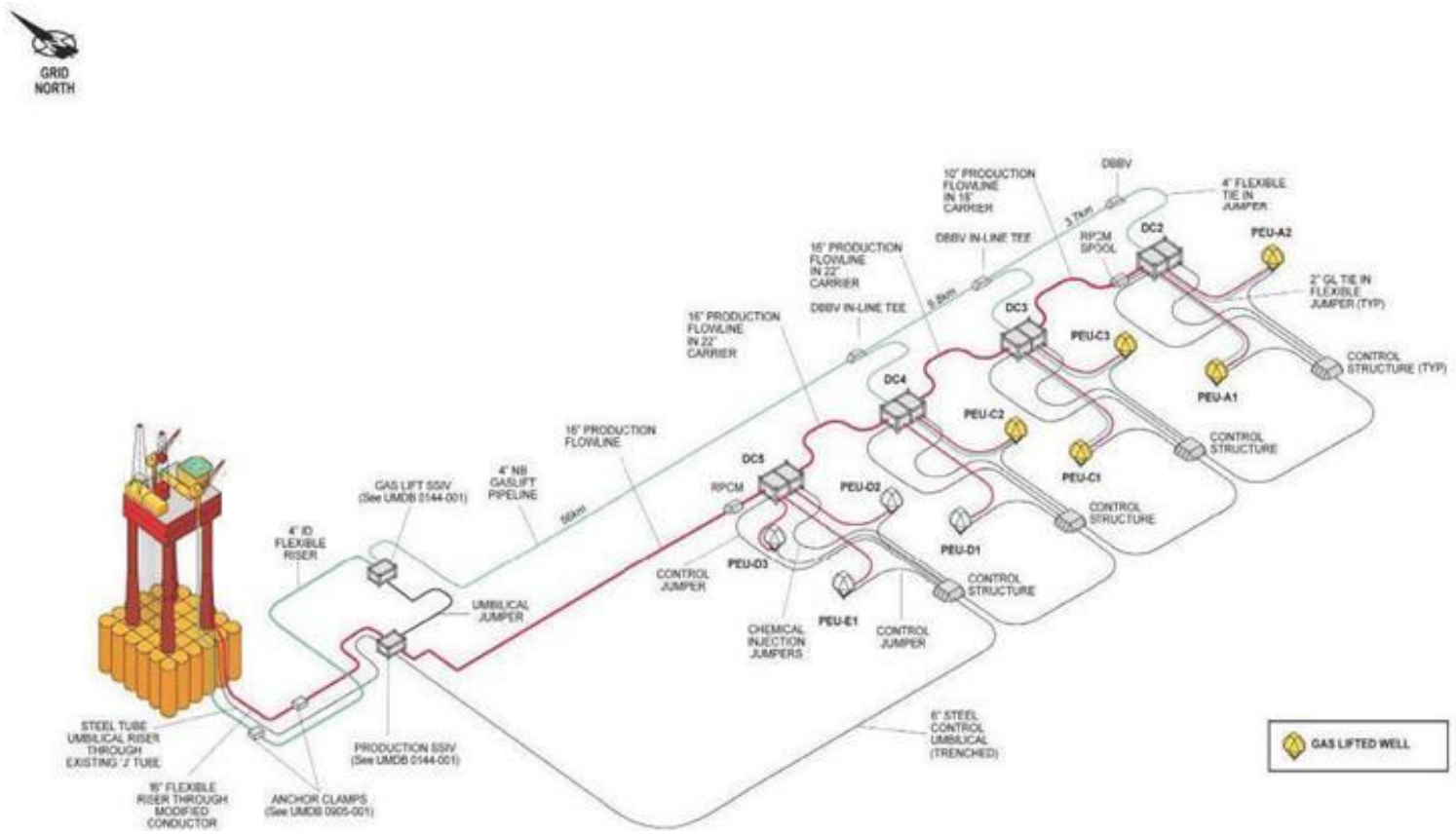
- Second mechanical pig train run with little debris recovered and pigs in good condition



- ILI tool run

- System reinstated
  - Pig traps removed
  - Riser re-connected
  - Well re-connected

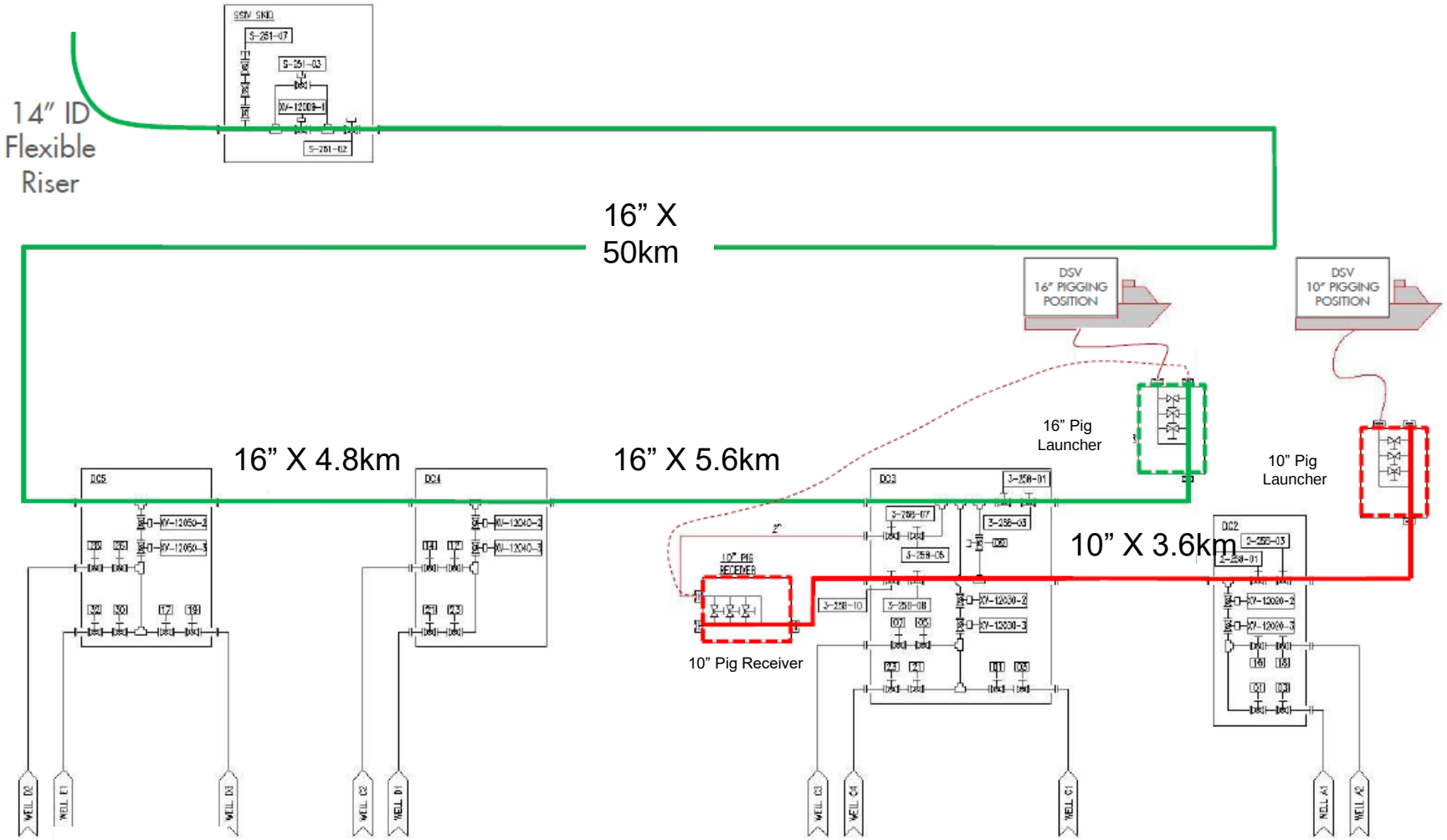
Field 3


GRID NORTH
10" PRODUCTION FLOWLINE IN 16" CARRIER
DBBV
4" FLEXIBLE TIE IN JUMPER
3.7km
DBBV IN-LINE TEE
RPCM SPOOL
DC2
PEU-A2
16" PRODUCTION FLOWLINE IN 22" CARRIER
2" GL TIE IN FLEXIBLE JUMPER (TYP)
DBBV IN-LINE TEE
0.8km
DC3
PEU-C3
16" PRODUCTION FLOWLINE IN 22" CARRIER
CONTROL STRUCTURE (TYP)
DC4
PEU-A1
PEU-C2
16" PRODUCTION FLOWLINE
CONTROL STRUCTURE
DC5
PEU-C1
4" NB GASLIFT PIPELINE
GAS LIFT SSIV (See UMDB 0144-001)
RPCM
PEU-D2
50km
CONTROL STRUCTURE
4" ID FLEXIBLE RISER
PEU-D1
PEU-D3
CONTROL JUMPER
CONTROL STRUCTURE
UMBILICAL JUMPER
PEU-E1
CHEMICAL INJECTION JUMPERS
CONTROL JUMPER
6" STEEL CONTROL UMBILICAL (TRENCHED)
STEEL TUBE UMBILICAL RISER THROUGH EXISTING 'J' TUBE
PRODUCTION SSIV (See UMDB 0144-001)
16" FLEXIBLE RISER THROUGH MODIFIED CONDUCTOR
ANCHOR CLAMPS (See UMDB 0905-001)
GAS LIFTED WELL

Solution: Field 3

- 10-in. Line de-oiled using 2 X foam caliper pigs separated by 100 linear metres (LM) of monoethylene glycol (MEG)
- Propelled with 110% line volume of chemically treated water
- Line product diverted into 16-in. flowline
- 10-in. Subsea pig traps fitted

Solution: Field 3



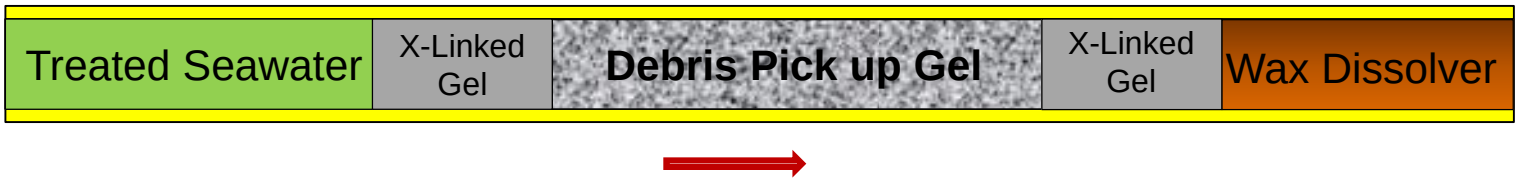
HALLIBURTON

Solution: Field 3

- 16-in. Line de-oiled with the following train

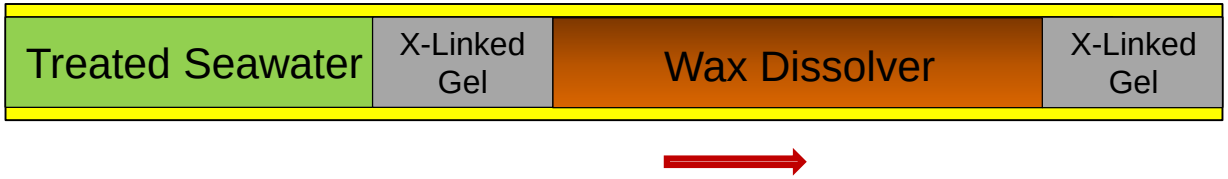
- Solid gel pigs used
- MEG used as an interface between seawater and hydrocarbons

- Chemical cleaning train then run with 105% line volume of treated seawater



Solution: Field 3

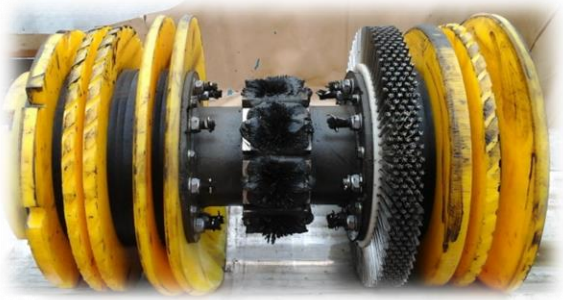
- 16-in. Line chemical soak



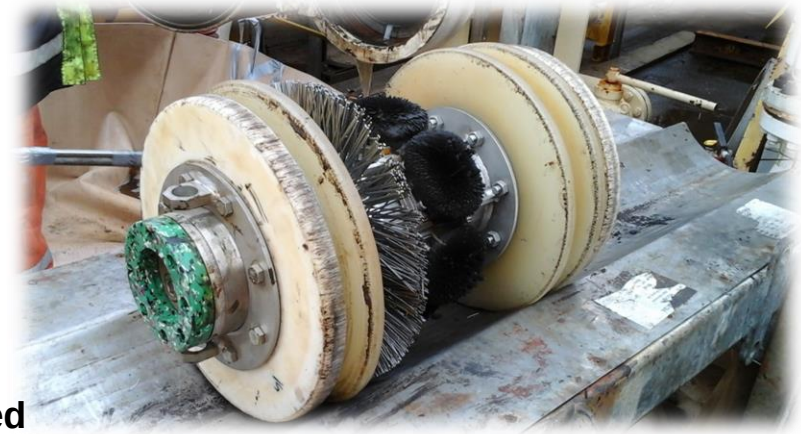
- Gel cross linked on the fly to batch wax dissolver
- Dissolver train parked approx. 25km from launch end to allow soak on advice of client production chemists
- Soak held for approx. 96 hrs whilst pigging 10” line was ongoing
- 16-in. Pig Launcher fitted

Solution: Field 3

- 10-in. Line — progressive pigging performed
  - Pigs run in ones and twos
- 10-in. ILI run conducted



- 16-in. Line — 2 X foam caliper pigs run
- 16-in. Progressive pigging performed
- 16-in. ILI run conducted



- Systems reinstated

Note: Fluids received topsides were processed via temporary spread before being injected into platform storage cells

Benefits

- Increased production throughput — post-cleaning
- ILI data received and used to confirm flowline integrity
- ILI data used to increase field life/change of use
- Proof of concept for other lines

Summary

- Use of gels, chemical applications, and system flushing can allow for line cleaning to acceptable limits to allow subsea intervention to be performed without the need for solid pigs
- Retrofitting of pig launch and receive equipment can then facilitate progressive pigging to remove solids and adhered debris to allow ILI to be performed
- Early collaboration among all relevant parties allow the best fit-for-purpose methodologies to be devised
- Ability to react to operational findings is crucial because of unknown variables
- In certain circumstances and with the right planning, the “unpiggable” can become piggable

THANK YOU