Heimdal Brae De-Waxing Operation

Arild Fahre-Skau, Statoil

Aidan O’Donoghue, Pipeline Research Limited

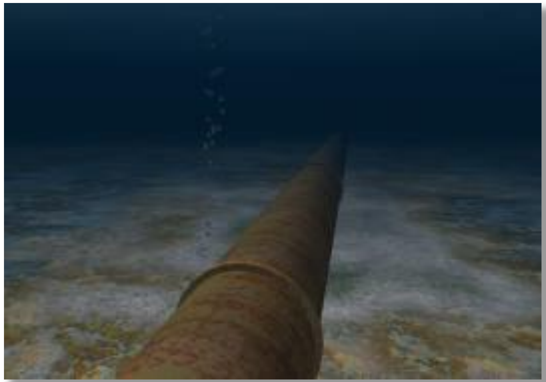
Hans Petter Rønningsen, Statoil

Ketil Rongved, Statoil

PPSA Seminar 20th november 2013

Heimdal Brae Wax Removal Summary

Removing large accumulations of wax using an aggressive high-friction pig with bypass



Presentation contents

- Part 1:
  - System & History

Presentation contents

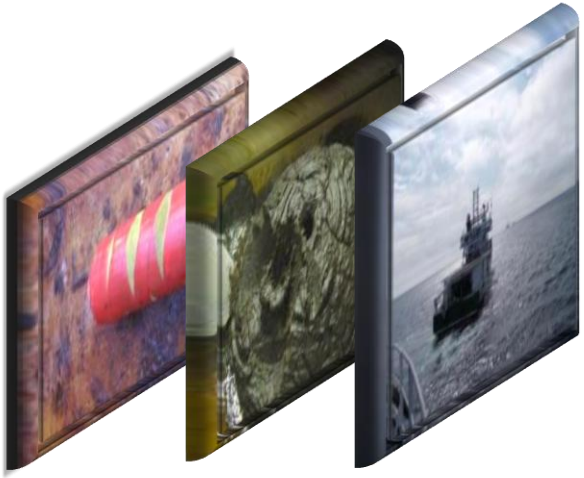
- Part 1:
  - System & History
  - Pipeline conditions

Presentation contents

- Part 1:
  - System & History
  - Pipeline conditions
  - Pigging operation

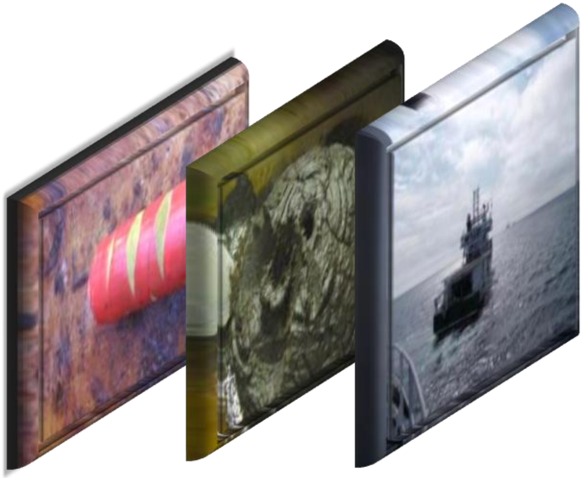
Presentation contents

- Part 1:
  - System & History
  - Pipeline conditions
  - Pigging operation



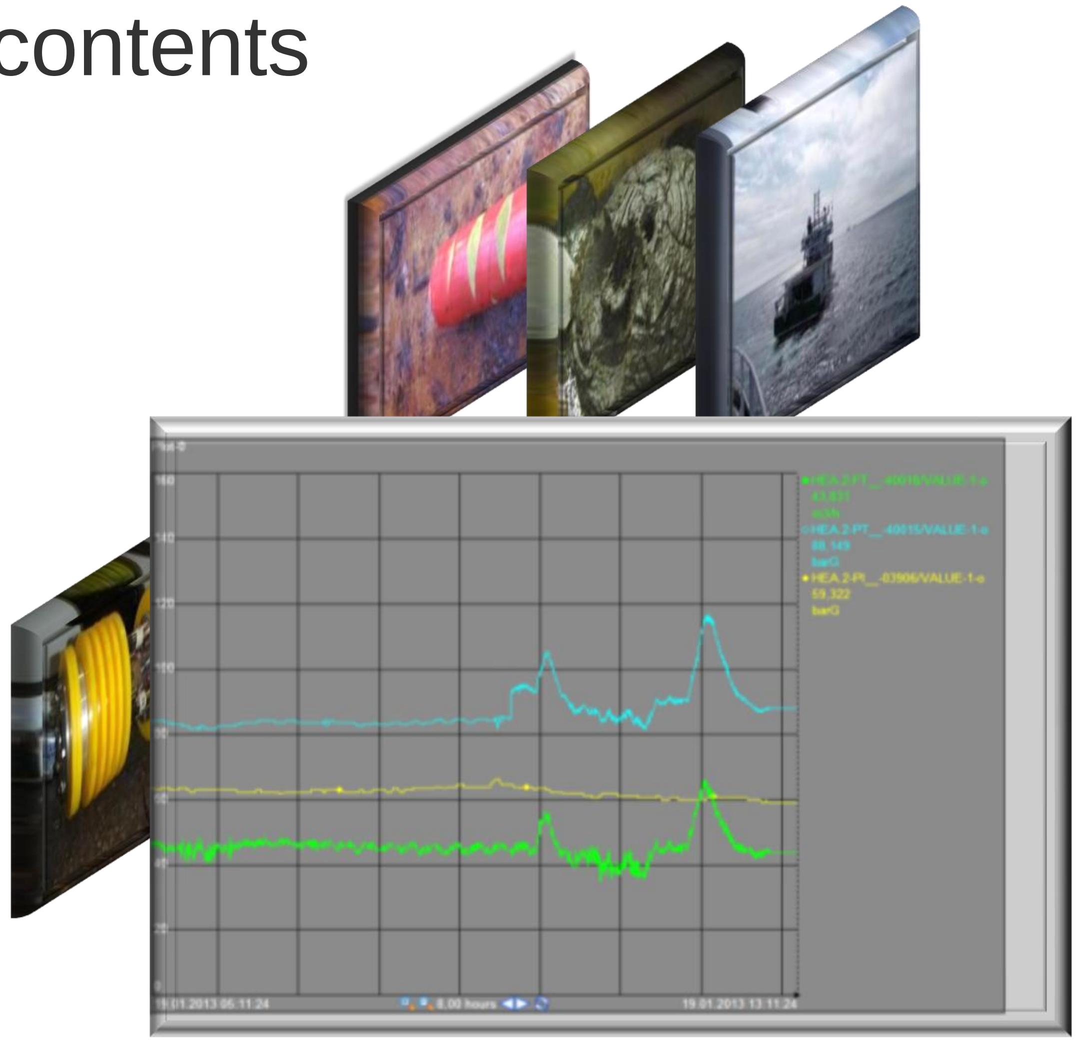
Presentation contents

- Part 1:
  - System & History
  - Pipeline conditions
  - Pigging operation
- Part 2:
  - Pig design



Presentation contents

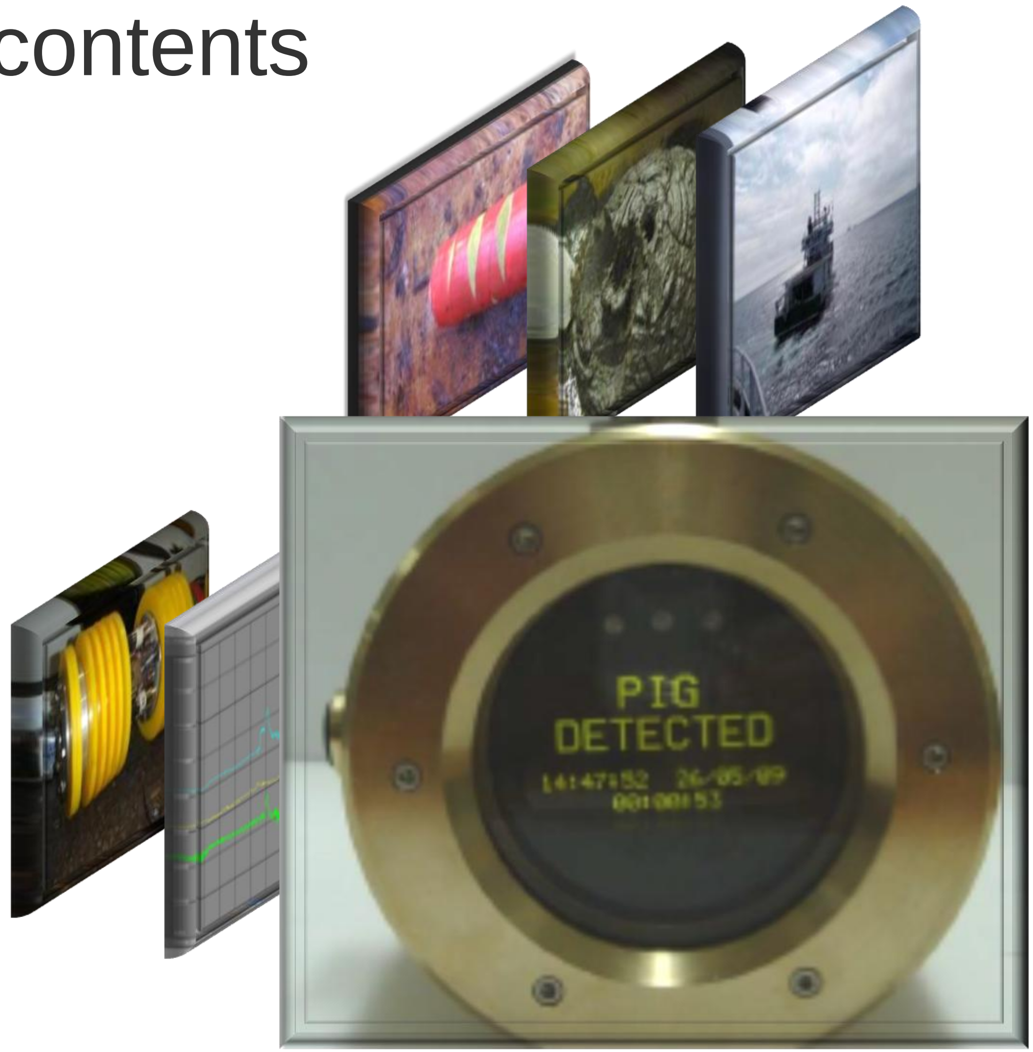
- Part 1:
  - System & History
  - Pipeline conditions
  - Pigging operation
- Part 2:
  - Pig design
  - Pigging dynamics



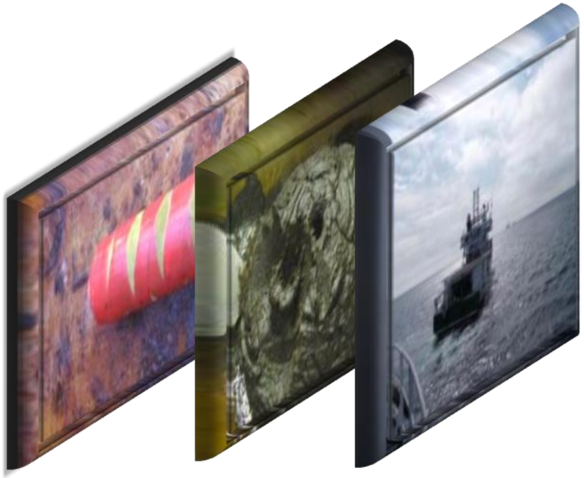
Statoil

Presentation contents

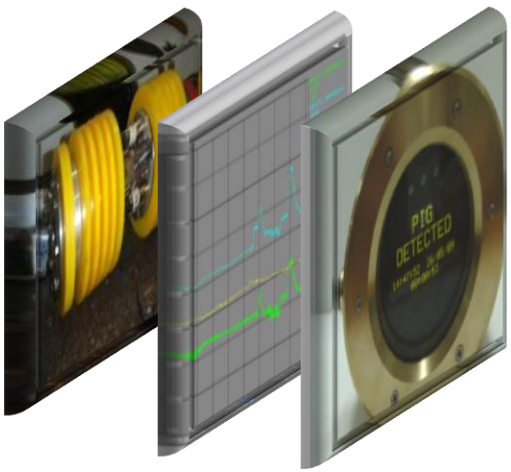
- Part 1:
  - System & History
  - Pipeline conditions
  - Pigging operation
- Part 2:
  - Pig design
  - Pigging dynamics
  - Observations



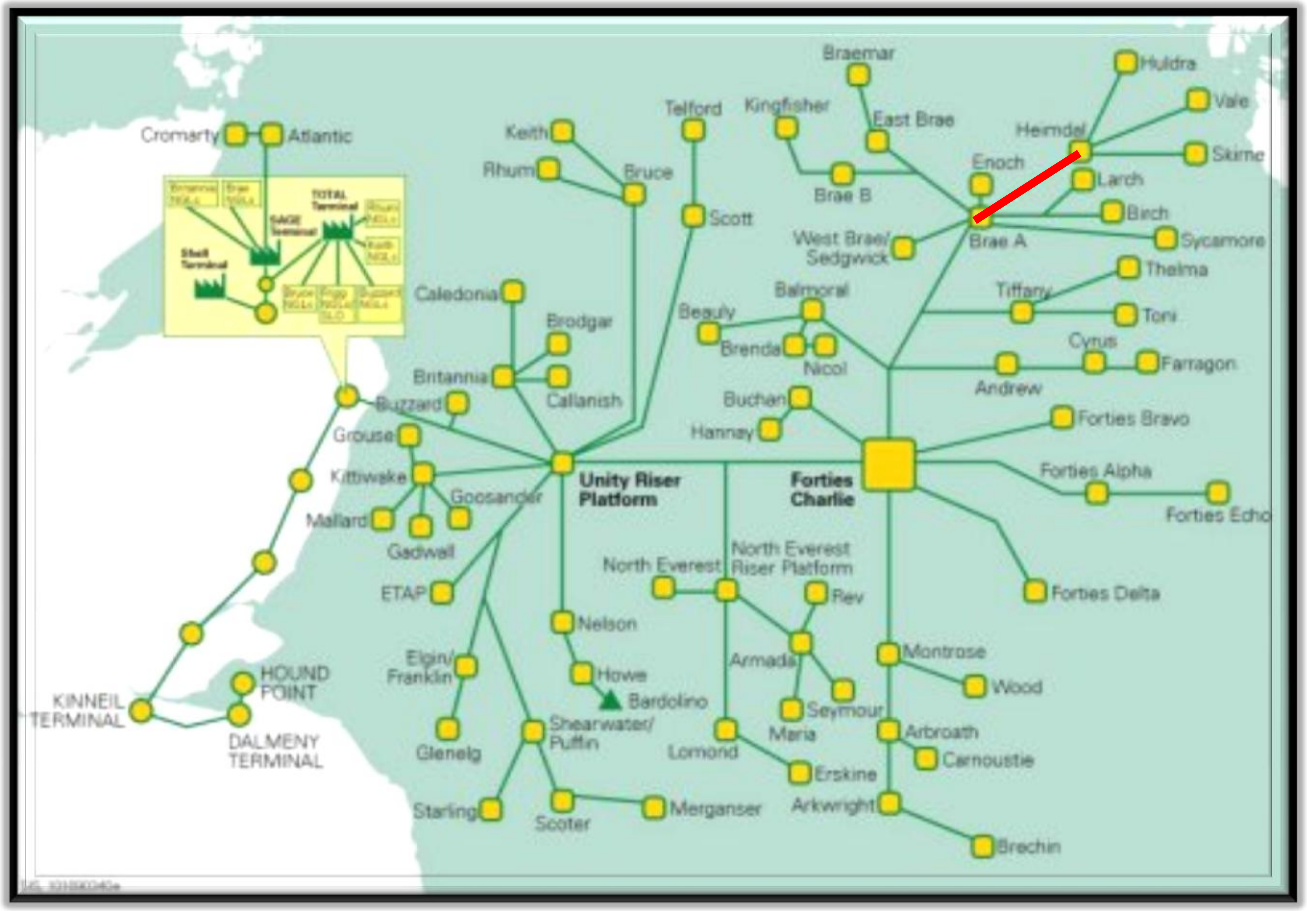
Presentation contents



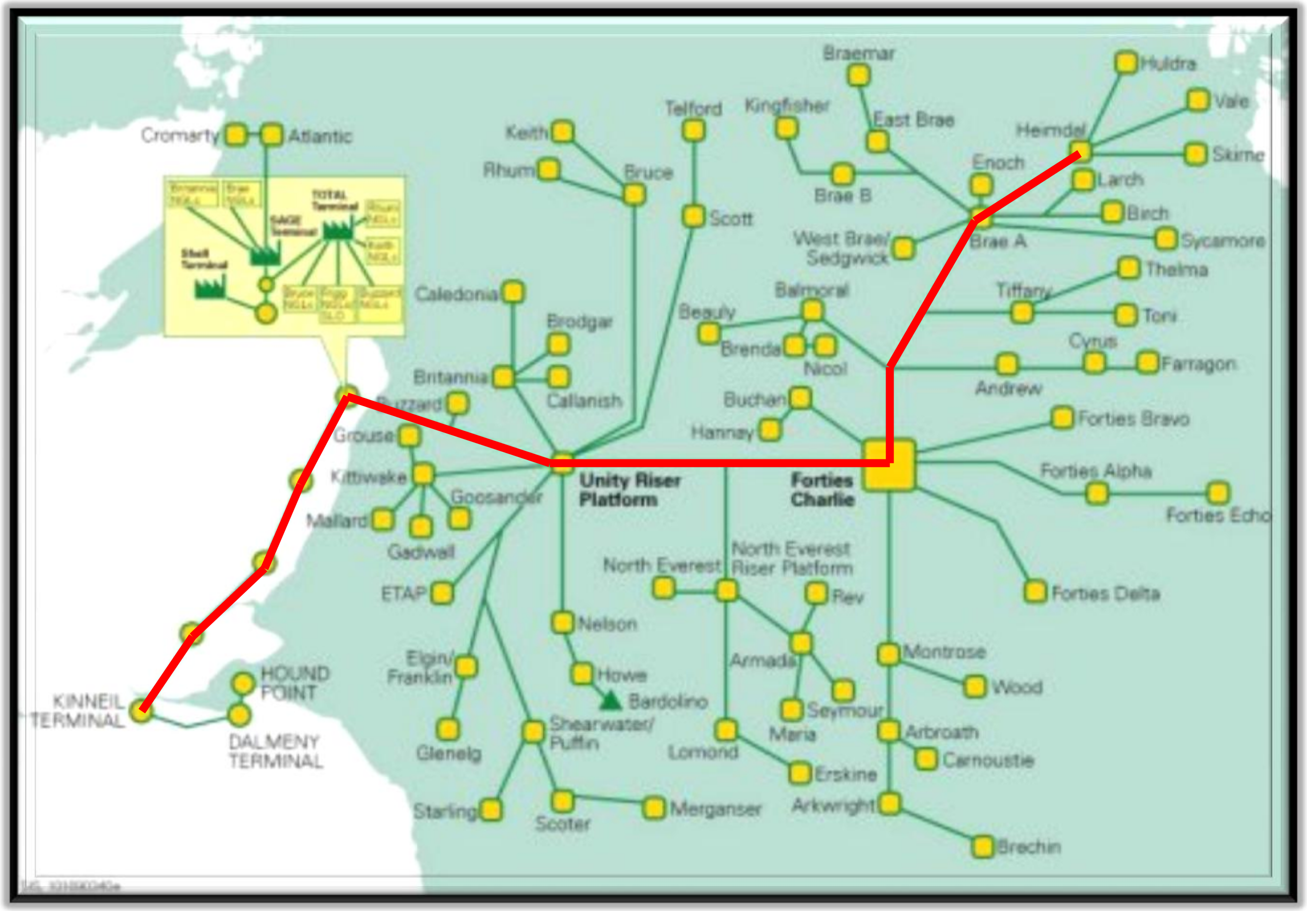
- Part 1:
  - System & History
  - Pipeline conditions
  - Pigging operation
- Part 2:
  - Pig design
  - Pigging dynamics
  - Observations



System

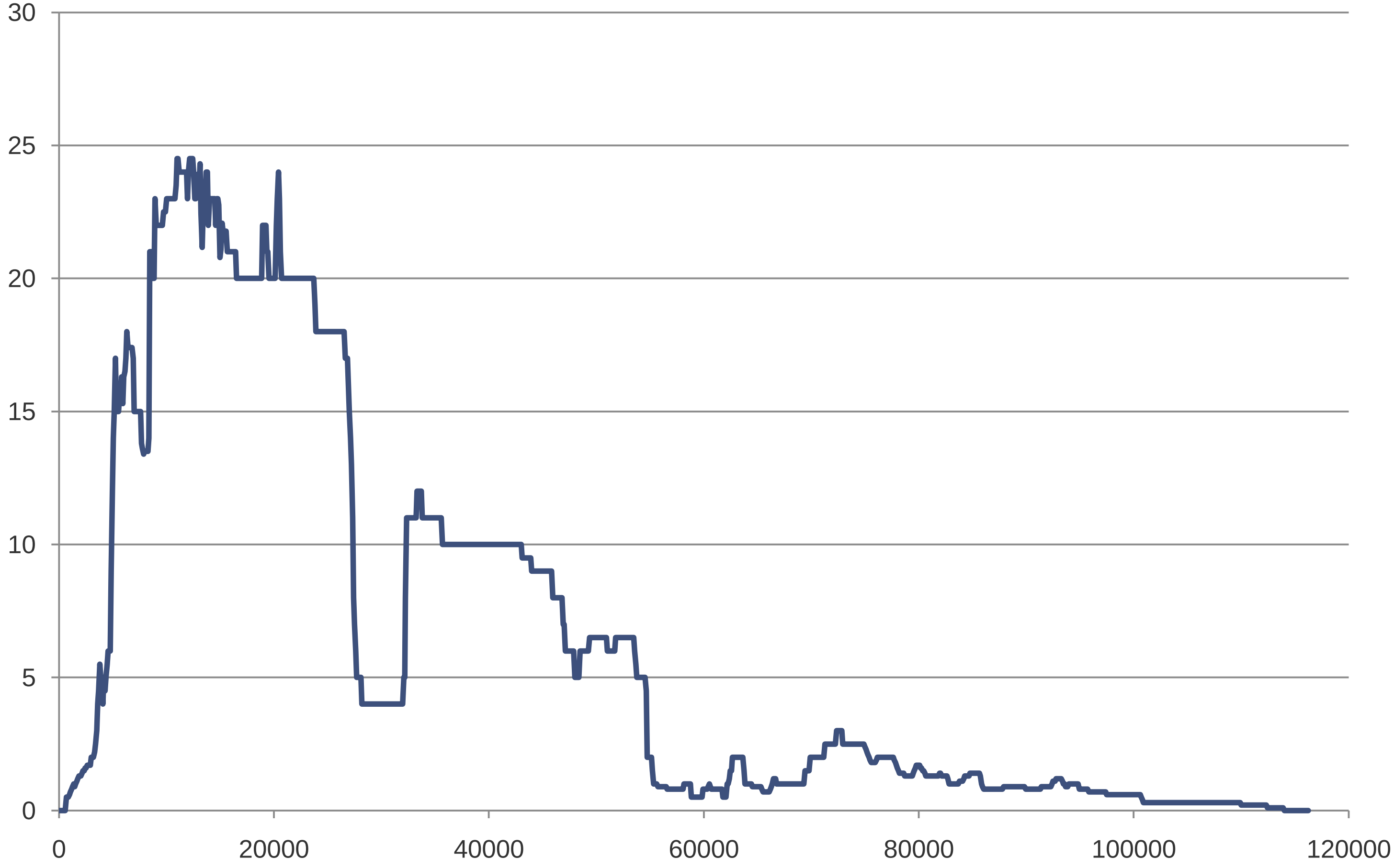

Braemar
Huldra
Vale
Skirne
Heimdal
Larch
Birch
Sycamore
Enoch
Brae A
East Brae
Kingfisher
Brae B
West Brae/
Sedgwick
Telford
Scott
Keith
Rhum
Bruce
Cromarty
Atlantic
Thelma
Tiffany
Toni
Cyrus
Farragon
Andrew
Balmoral
Beauly
Brenda
Nicol
Caledonia
Brodgar
Britannia
Callanish
Buzzard
Grouse
Kittiwake
Goosander
Mallard
Gadwall
Buchan
Hannay
Unity Riser Platform
Forties Charlie
Forties Bravo
Forties Alpha
Forties Echo
Forties Delta
North Everest
North Everest Riser Platform
Rev
ETAP
Nelson
Armada
Montrose
Wood
Elgin/
Franklin
Howe
Bardolino
Seymour
Maria
Arbroath
Carnoustie
HOUND POINT
KINNEIL TERMINAL
DALMENY TERMINAL
Glenelg
Shearwater/
Puffin
Lomond
Erskine
Arkwright
Brechin
Starling
Scoter
Merganser
TOTAL Terminal
SAGE Terminal
Shell Terminal

System



Statoil

Total Wax Volume = 350 m3 (ca)



Statoil

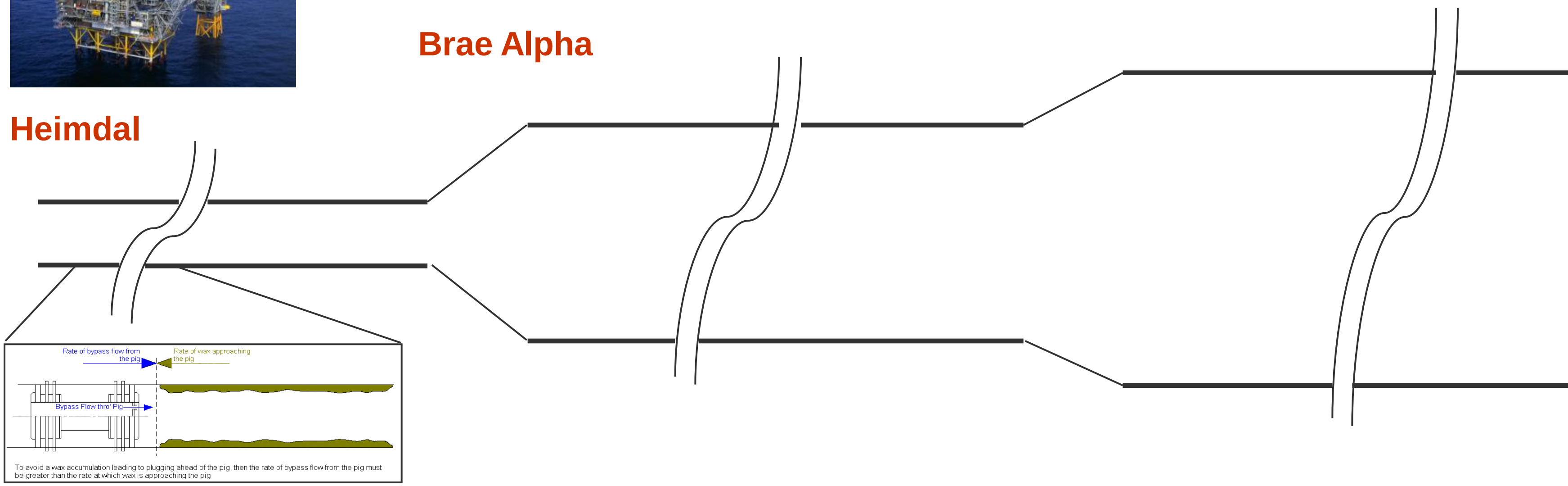
From Heimdal to Kinneil

Heimdal

Brae Alpha

Forties Charlie

Kinneil



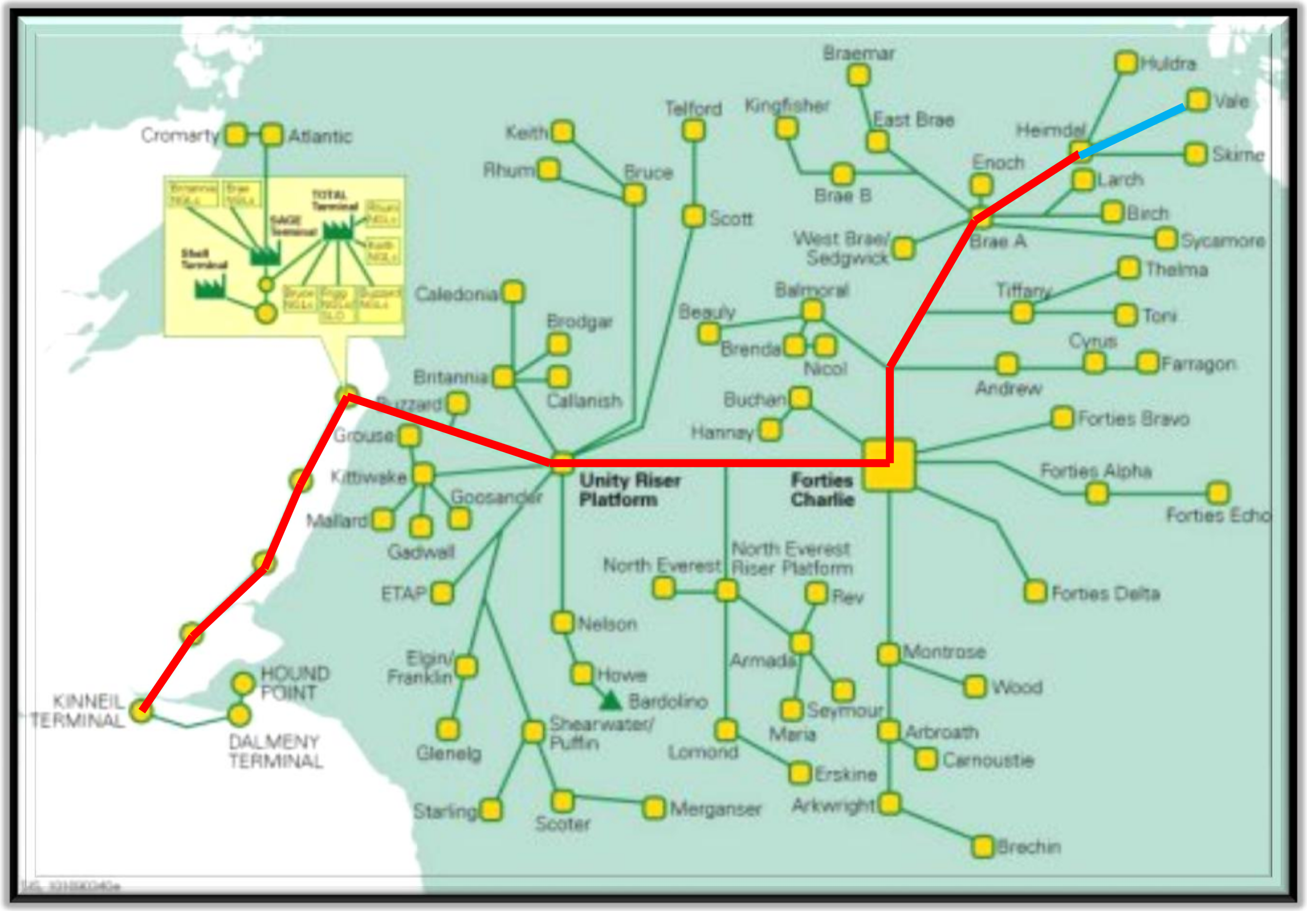
116 km
ID = 197 mm (8")
Turbulent

117 km
ID = 710 mm (28")
Laminar

169 km
ID = 860 mm (34")
Turbulent

Statoil

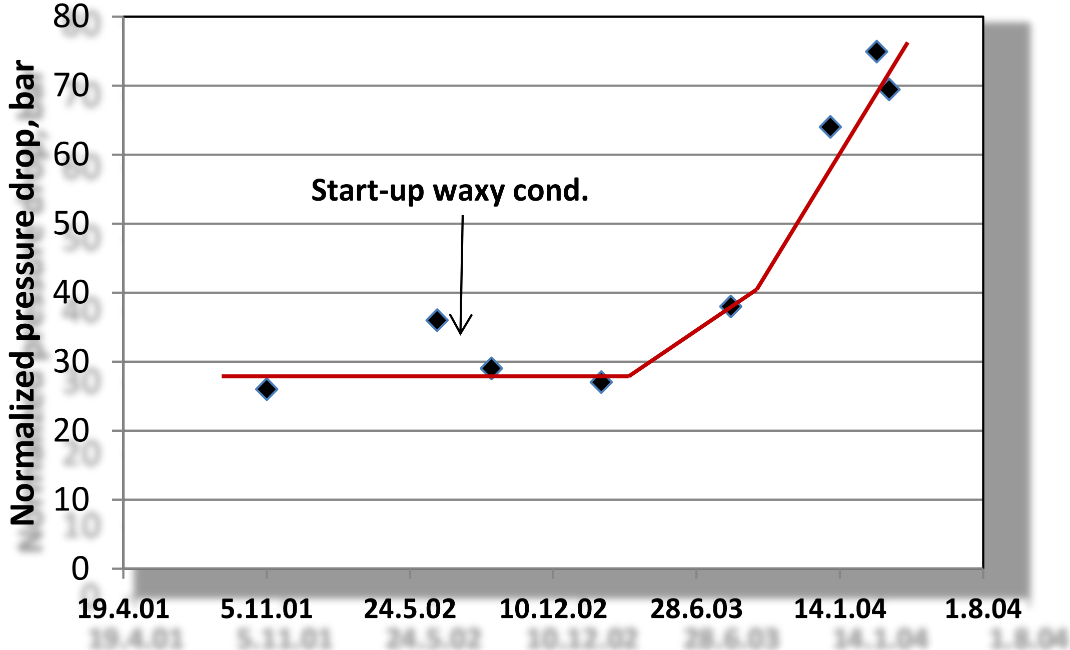
Introduction of Vale fluids in 2002



Statoil

Introduction of Vale fluids in 2002

Before 2002, no wax and no pigging performed. Then Vale field started up with high wax content.



- Build up of line differential pressure was insignificant until 2004

Pigging started early 2004 using foam pigs

First stuck foam pig April 2004

2004 - 2008

- Foam pigging program
- Stuck pigs

2008

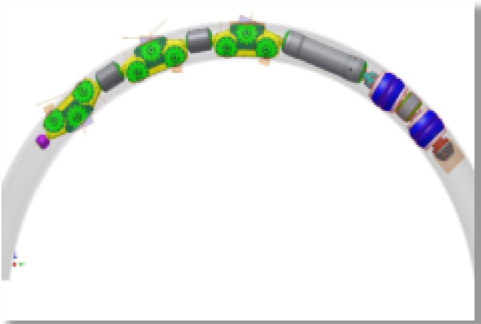
- Fill and soak operation
- Chemical dissolvant
- Very good effect in laboratory
- Only minor effect in field

2008 - 2010

- Foam pigging
- Stuck pigs

2010: Aggressive pigging!

Why change strategy?
1. The pipeline NEEDS to become wax free due to inspection requirements
2. Progressive approach with foam pigs does not work



<u>Two Alternatives for consideration:</u>

1. Hydraulically Activated Power Pig (HAPP)
    - Limited experience
    - Assumed best for downstream facilities

2. High Friction Jetting Pig (HFJP)
    - Well proven technology
    - New application

Overall risk was evaluated together with our downstream partners, and the HAPP was chosen

Statoil

HAPP pigging operation January 2012

Markland tests before and after

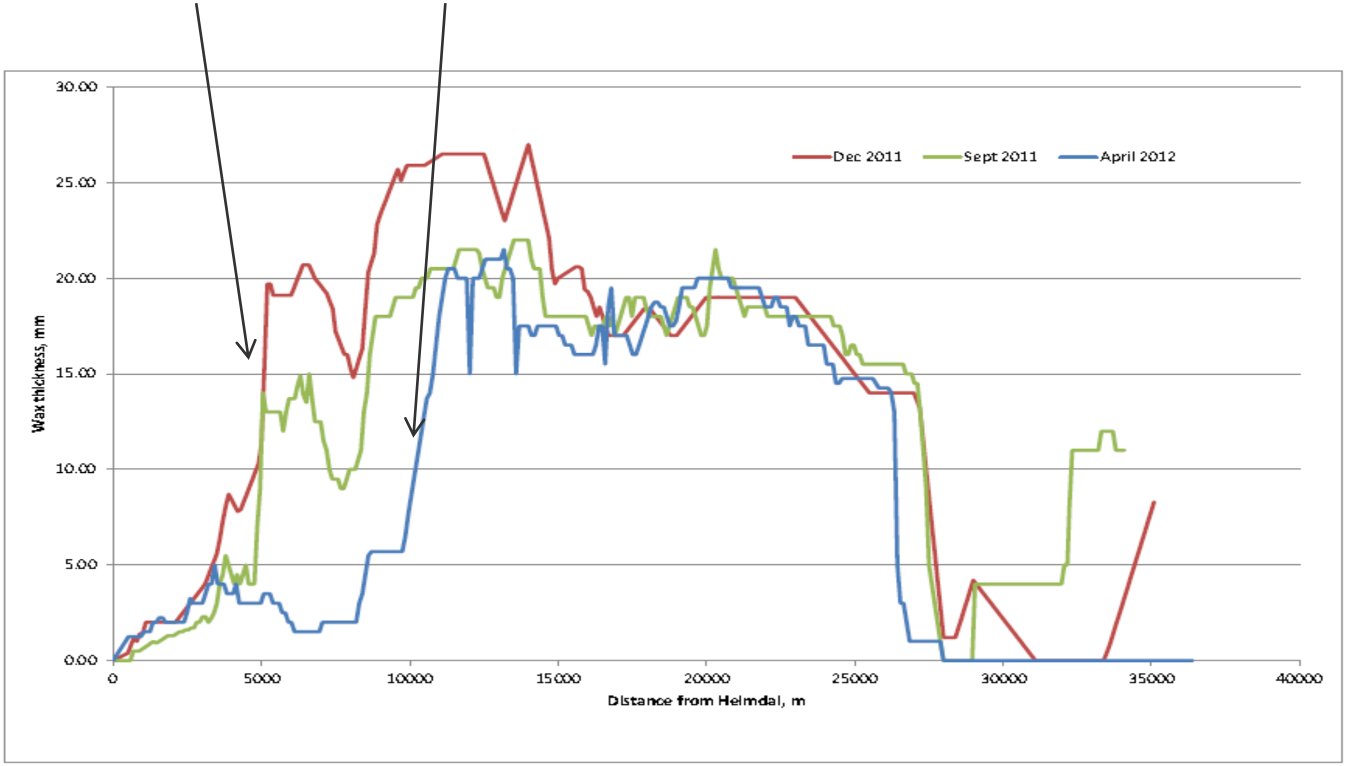
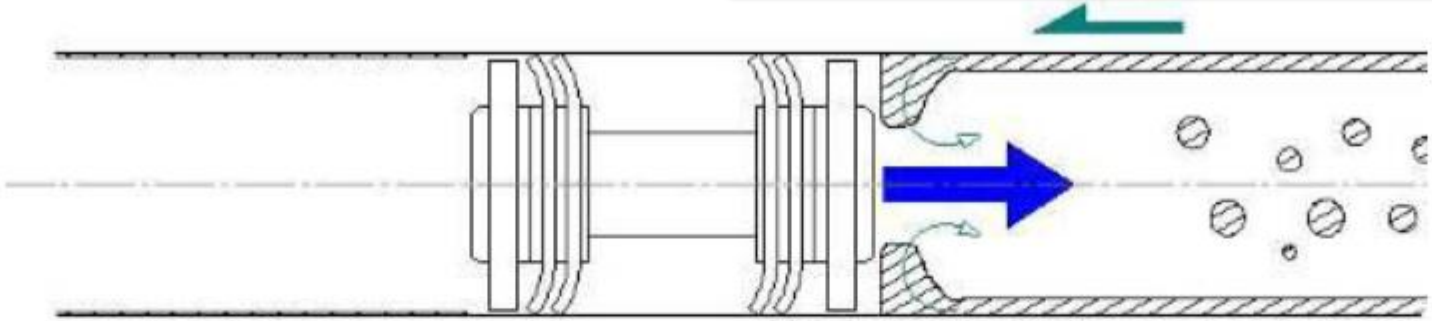


Figure 1. Wax thickness as function of distance from Heimdal, give as an evenly distributed layer around the pipe perimeter.

Pig stopped 15.01.12 at 8357 m

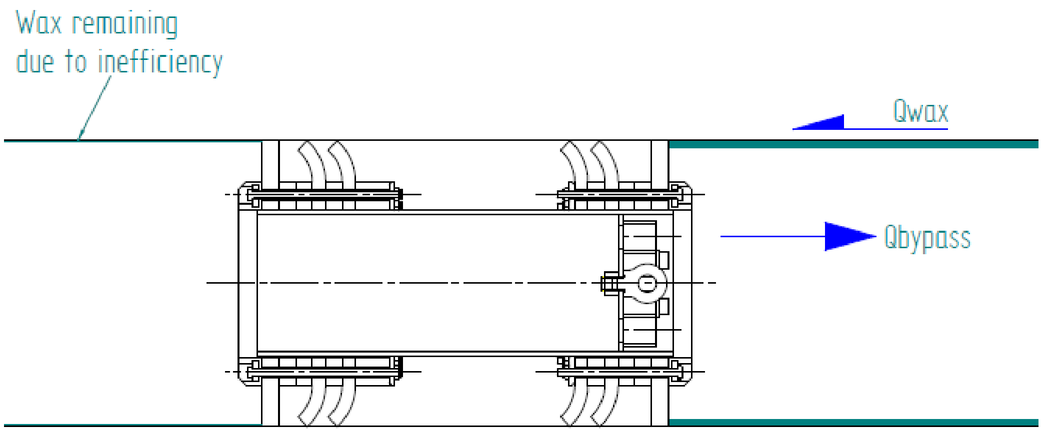
Estimated wax removed by HAPP = 80 m3
Remaining wax in pipeline = approx 350 m3

Decide to go for High Friction Jetting Pig



Statoil

Basis of design

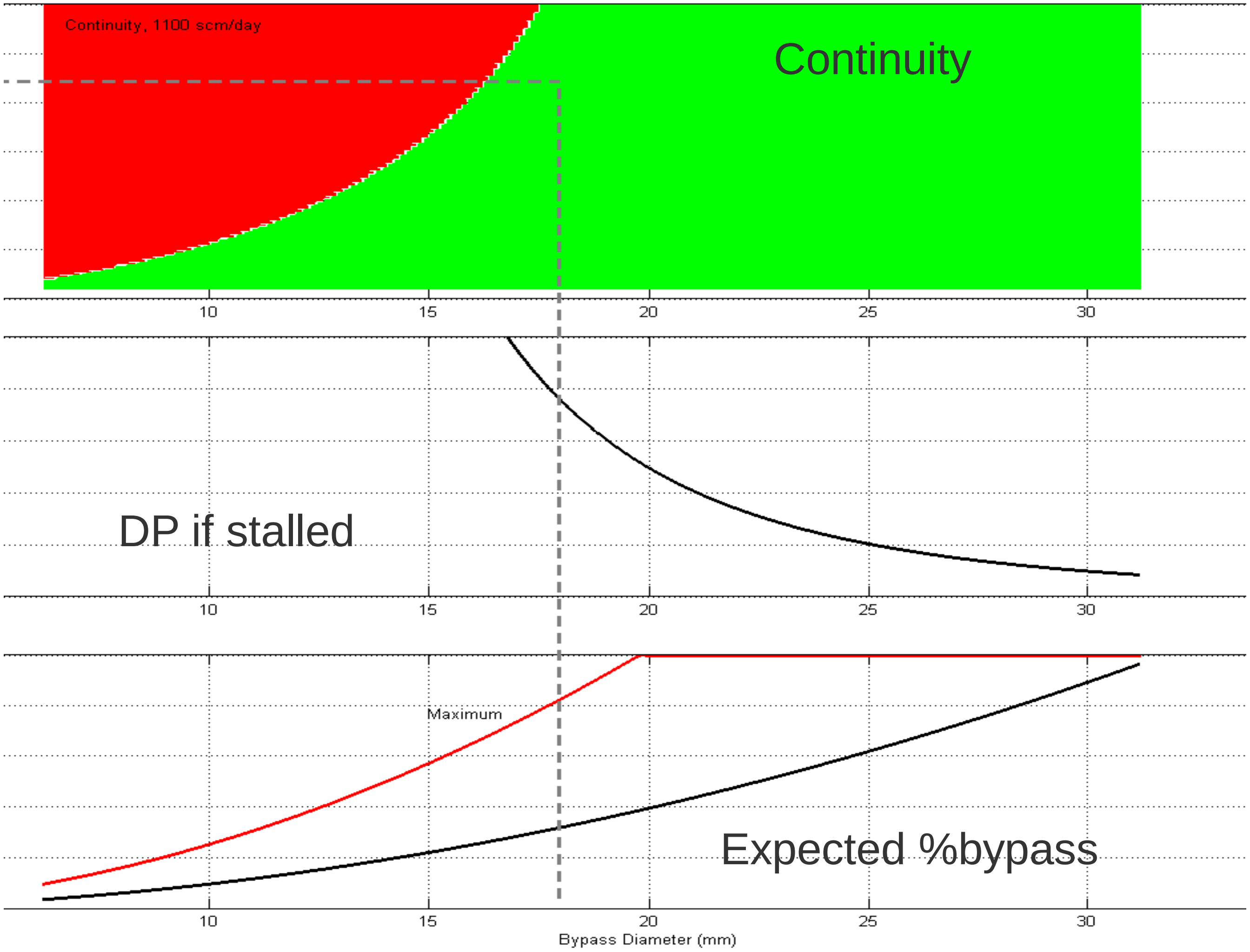


$Q_{bypass} > Q_{wax}$

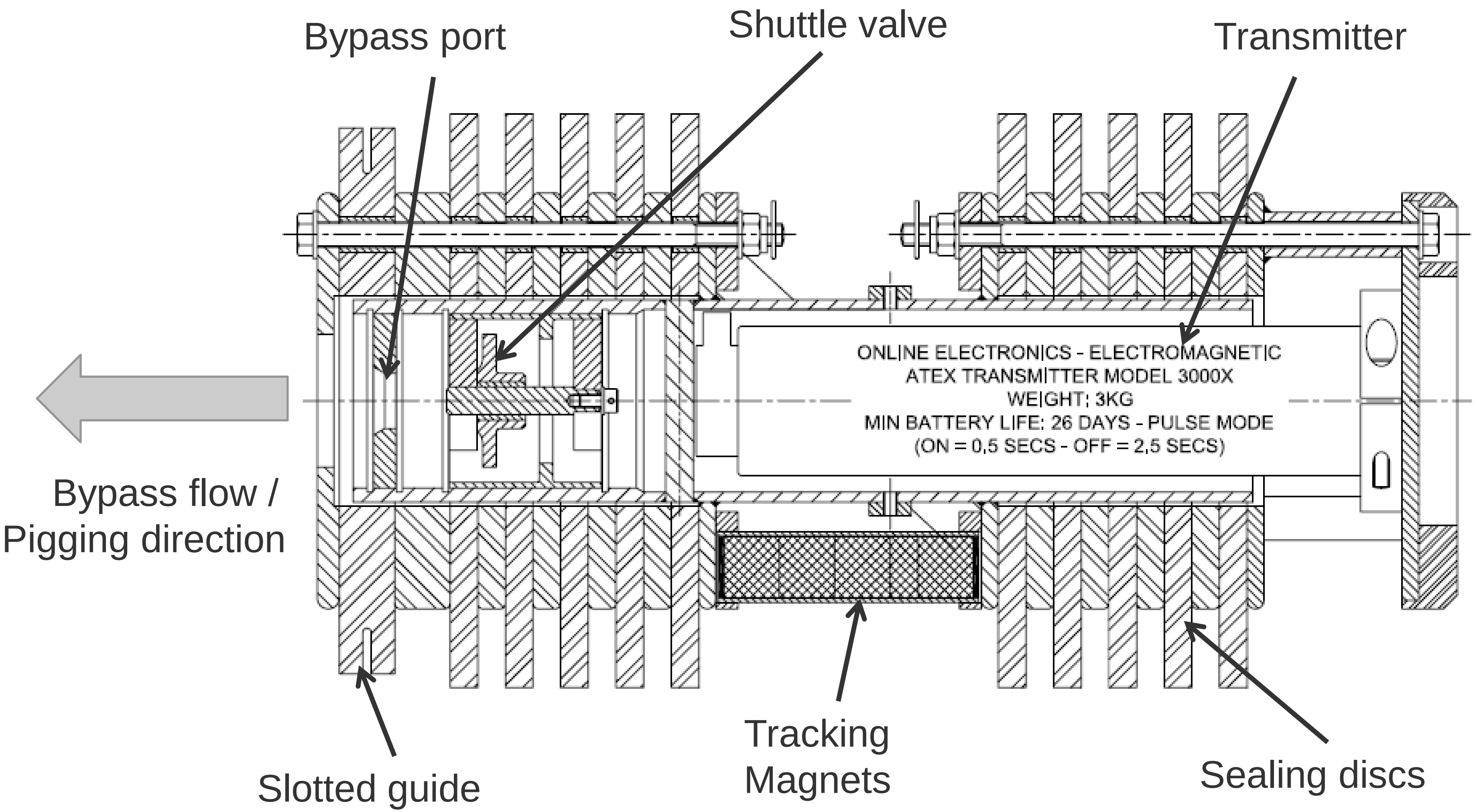
$Q_{wax} > Q_{bypass}$

Statoil

Continuity Principle (5 bar HF Pig, 18 mm port)

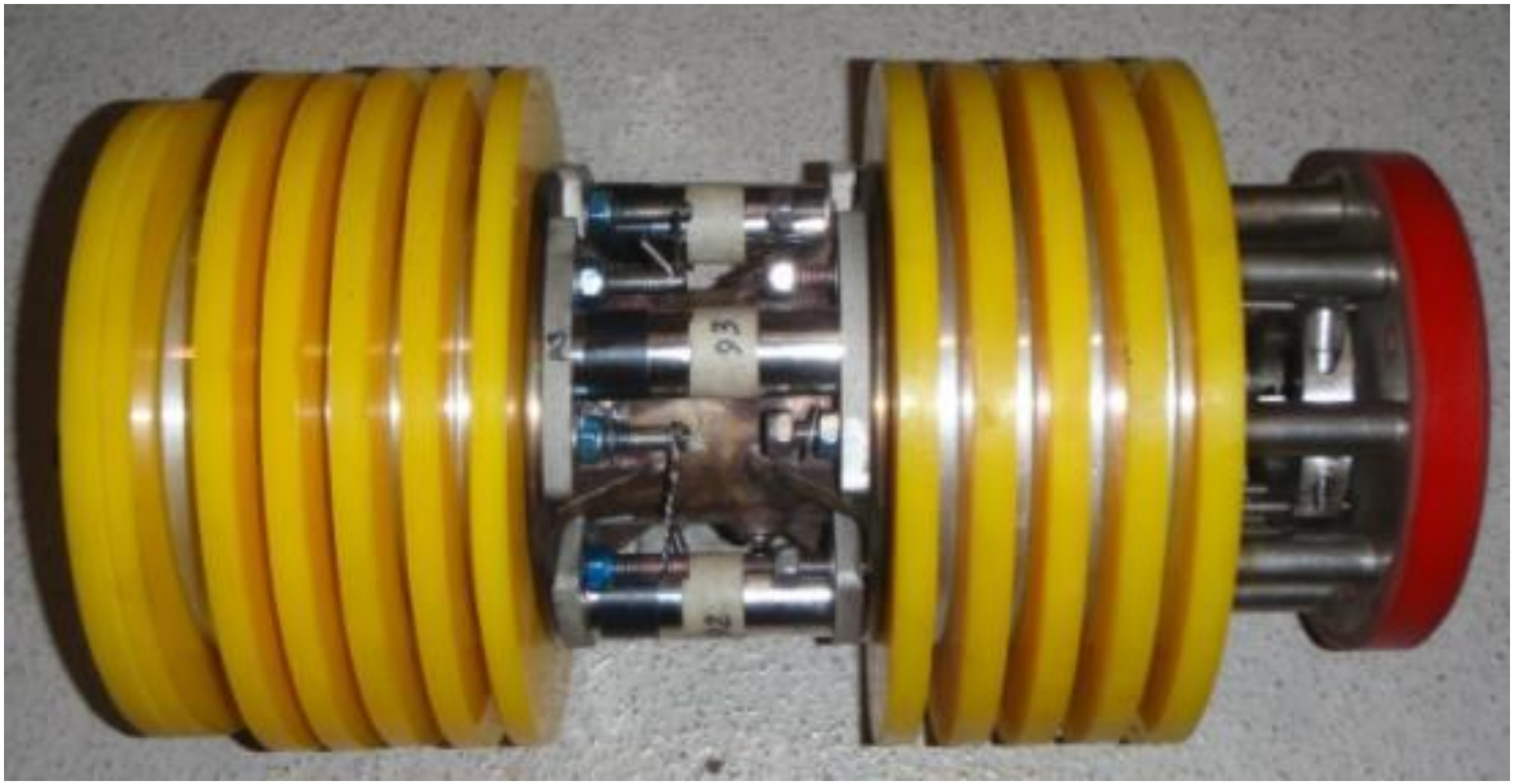


Pig Design



Bypass port
Shuttle valve
Transmitter
ONLINE ELECTRONICS - ELECTROMAGNETIC
ATEX TRANSMITTER MODEL 3000X
WEIGHT; 3KG
MIN BATTERY LIFE: 26 DAYS - PULSE MODE
(ON = 0,5 SECS - OFF = 2,5 SECS)
Bypass flow /
Pigging direction
Slotted guide
Tracking
Magnets
Sealing discs

Final pig ready for deployment

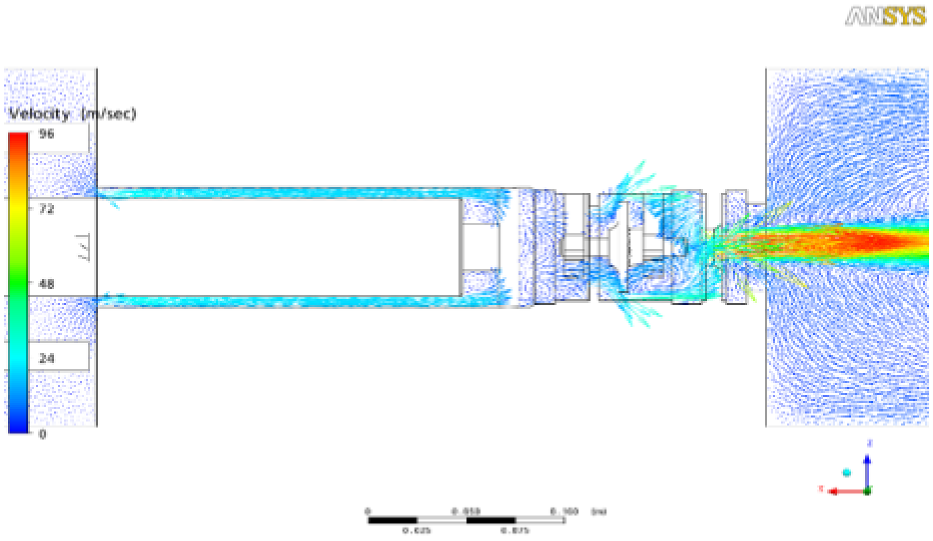


Testing and Validation

Statoil

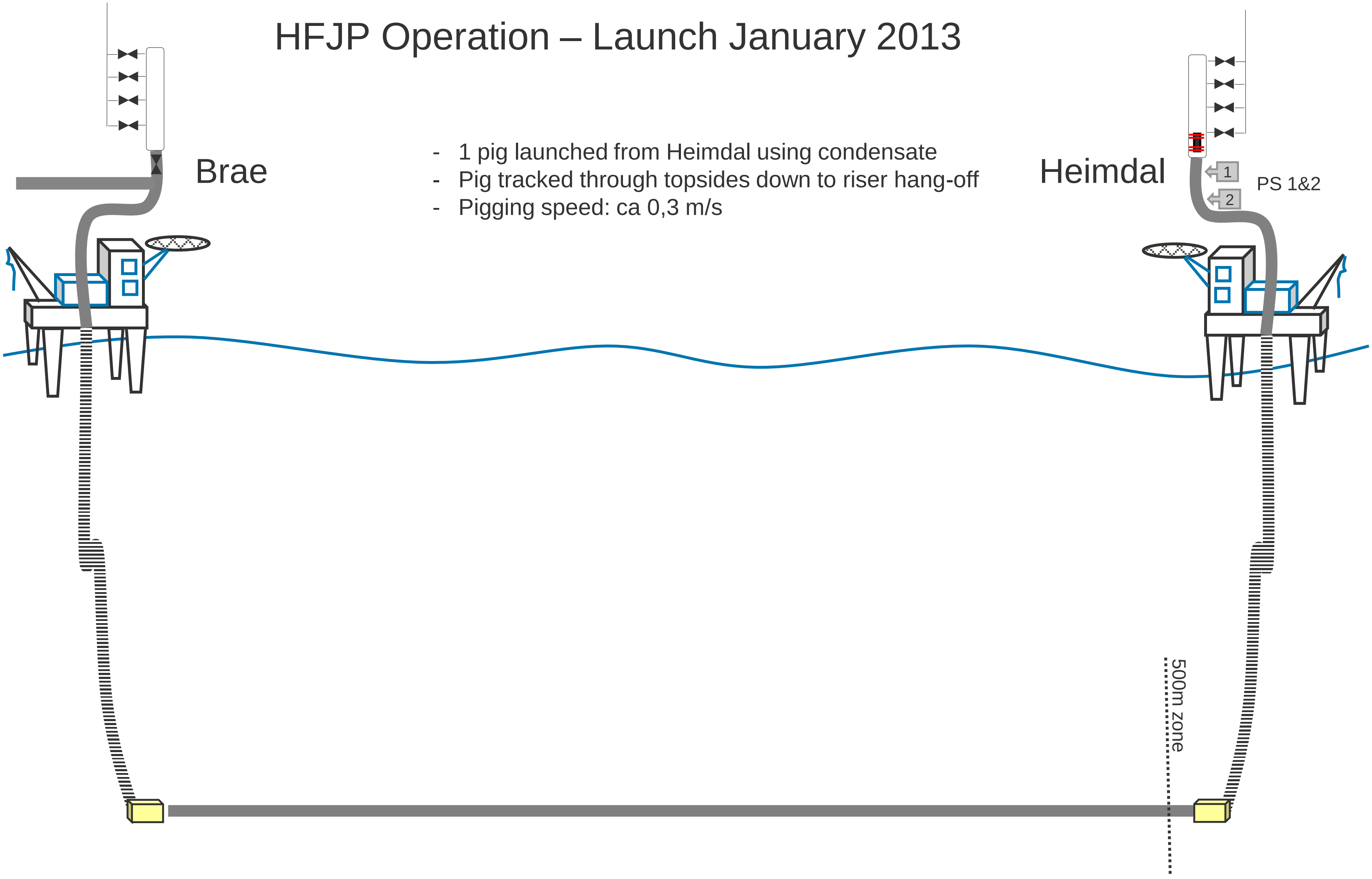
Other assurance

- Piggability studies (Negotiation of line components);
- Slurry study (transportation of wax particles);
- Risk assessments / Hazops;
- CFD work on bypass and forces on the pig;
- FMECA;
- Pig assembly checks / pig build quality.



HFJP Operation – Launch January 2013

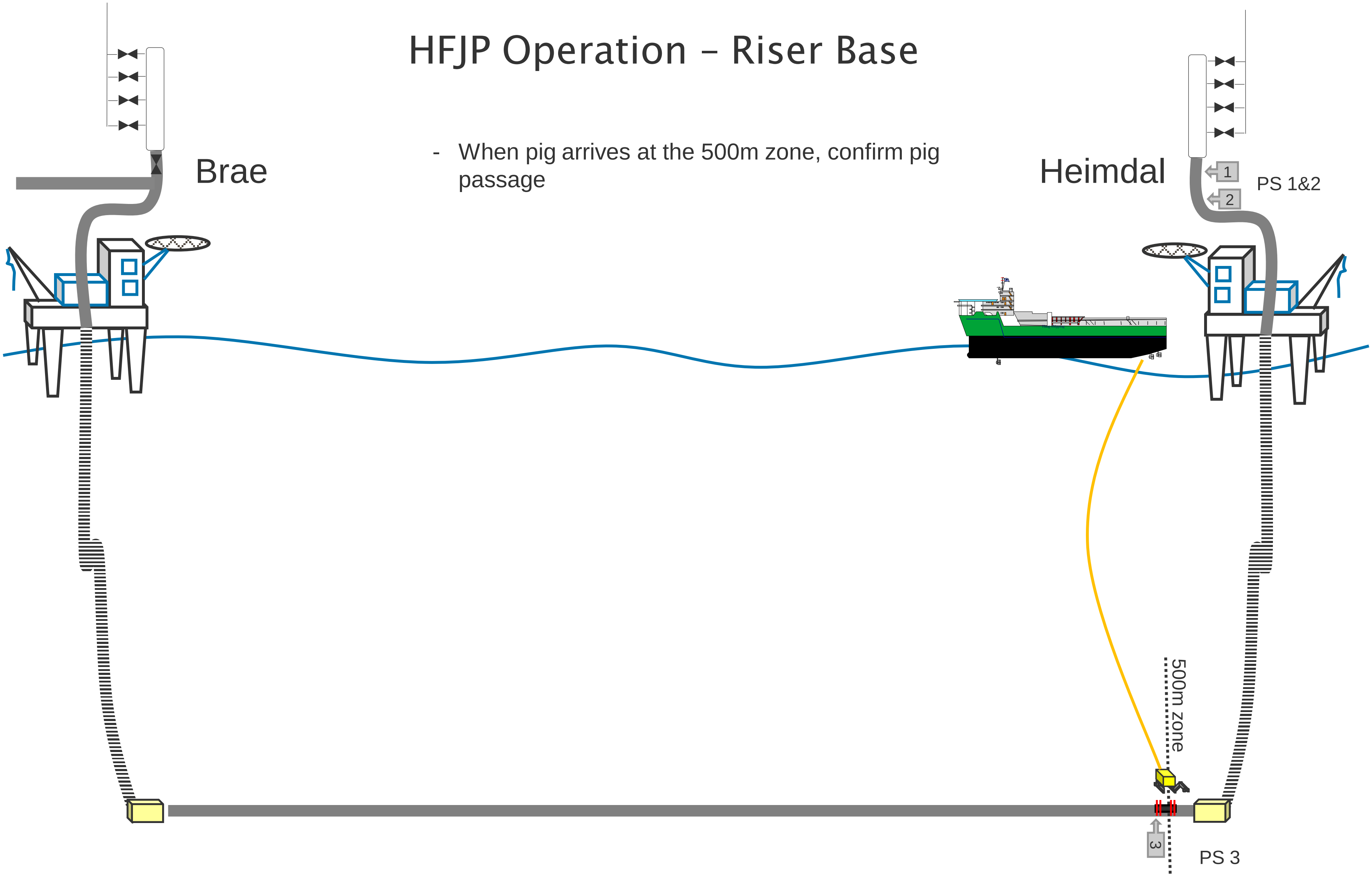
- 1 pig launched from Heimdal using condensate
- Pig tracked through topsides down to riser hang-off
- Pigging speed: ca 0,3 m/s



Statoil

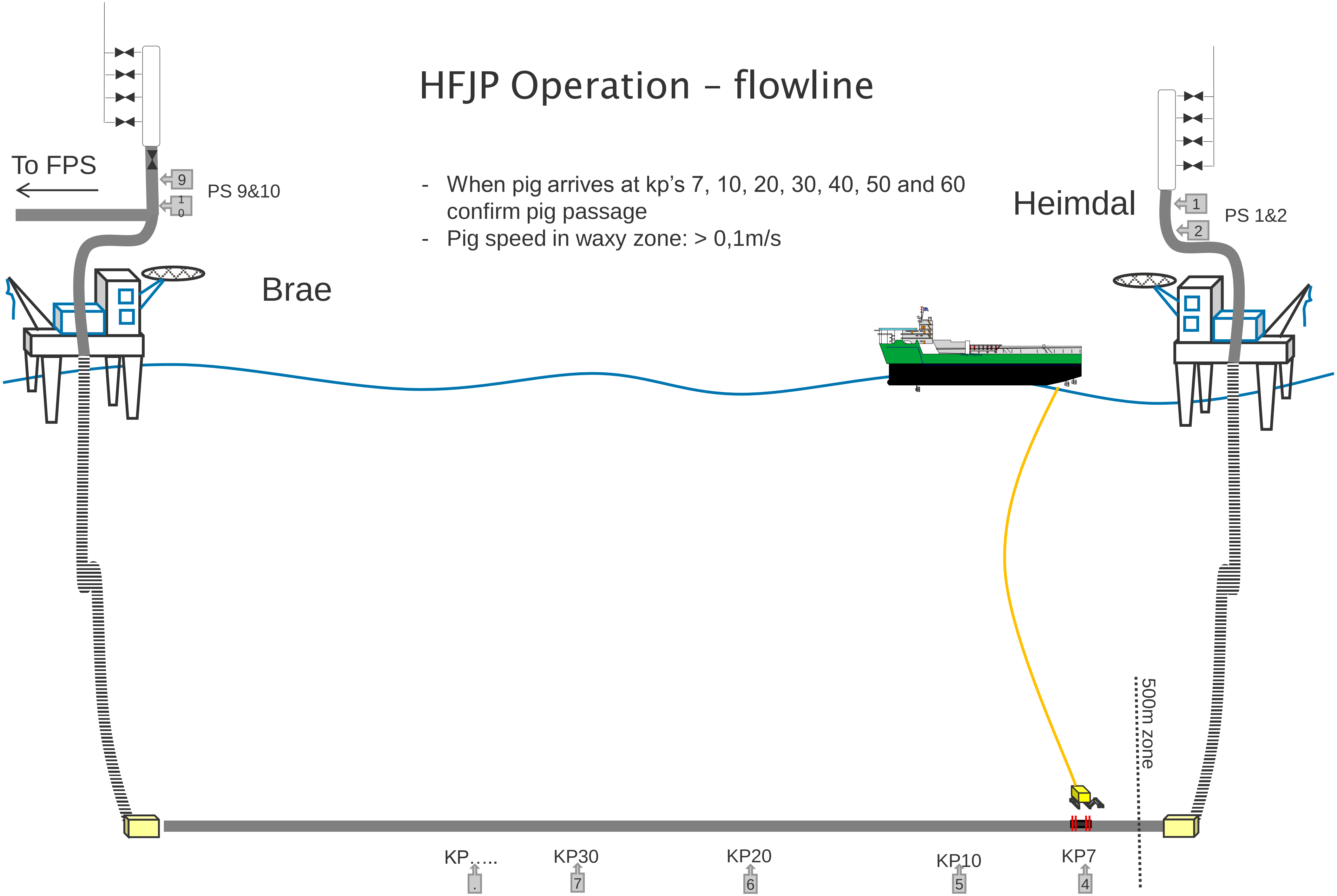
HFJP Operation – Riser Base

- When pig arrives at the 500m zone, confirm pig passage



HFJP Operation – flowline

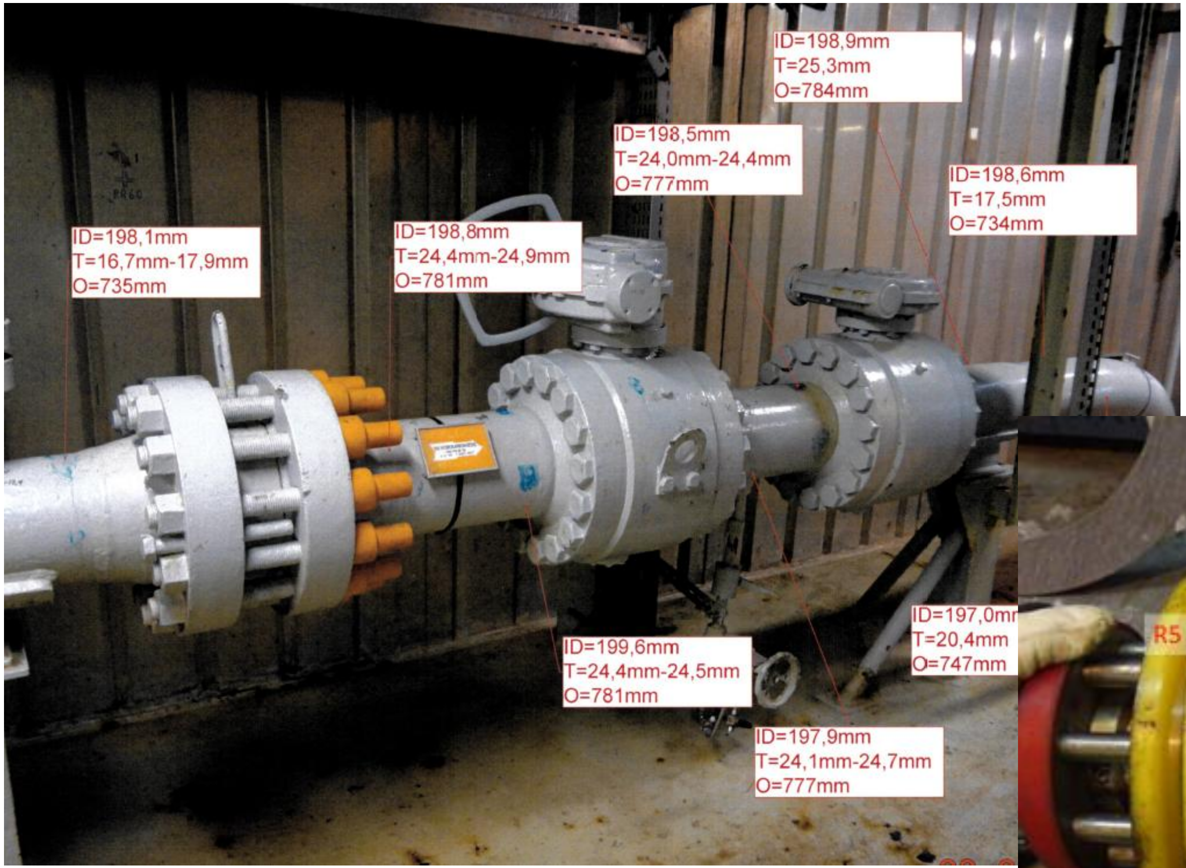
- When pig arrives at kp's 7, 10, 20, 30, 40, 50 and 60 confirm pig passage
- Pig speed in waxy zone: > 0,1m/s



Procedures – monitoring of pressures and flow

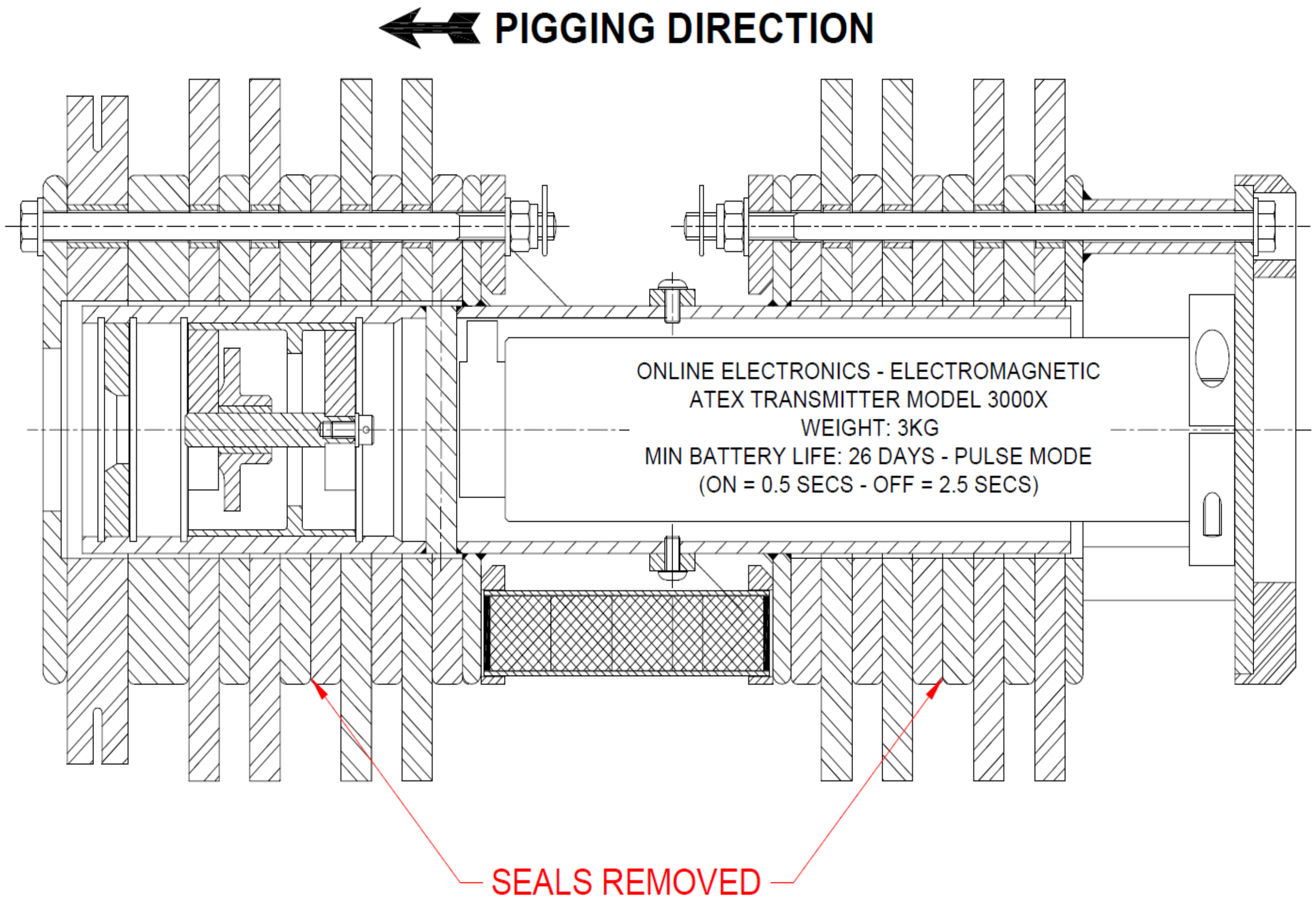
	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5	Scenario 6	Scenario 7
Flow	Steady	Steady	Increase	Rising / falling	Dropping	Steady	Goes to zero
Line Inlet Pressure	Falling slowly	Steady	Falling slowly	Erratic	Rising	Rises to 180bars max	Rises to 180bars max
Line DP	Falling Slowly	Steady	Falling Slowly	Erratic	Rising	Rises 124bar max	Rises 124bar max
Action	Ideal, no action	Monitor, no action	Monitor, no action	Expected behaviour	Reduce Inlet Pressure, 20bar DP increase maximum	Reduce flow and monitor closely. Plan to continue	Stop flow. Reverse

Initial Pig run



Pig stalled topside due to mislaunch through the eccentric reducer

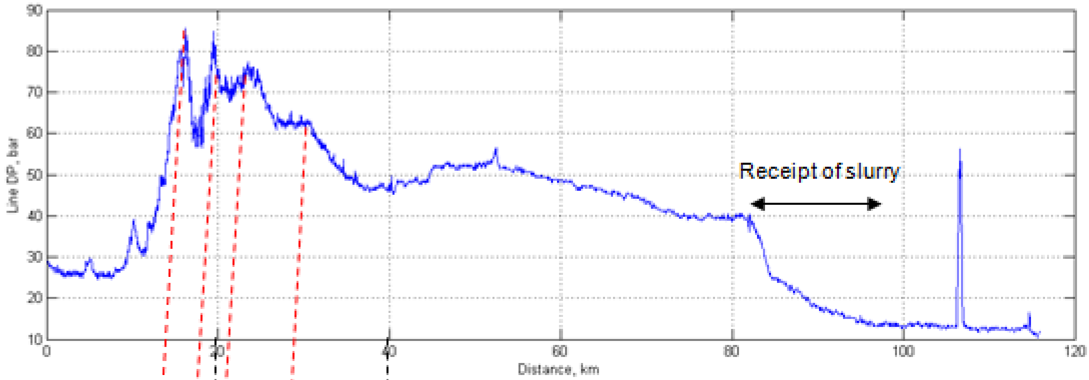
Modified Pig Design

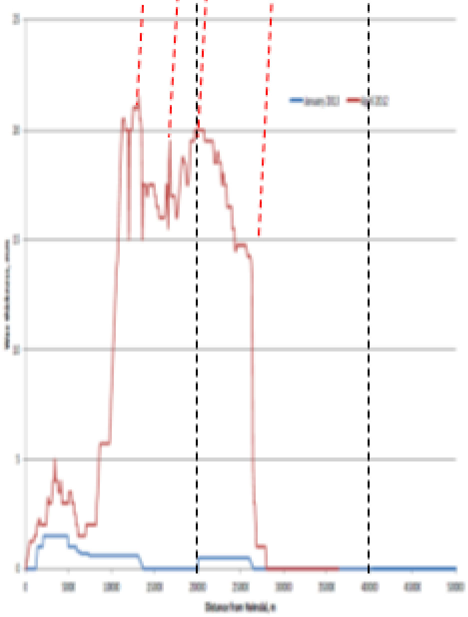


Statoil

Line DP during the run

DP





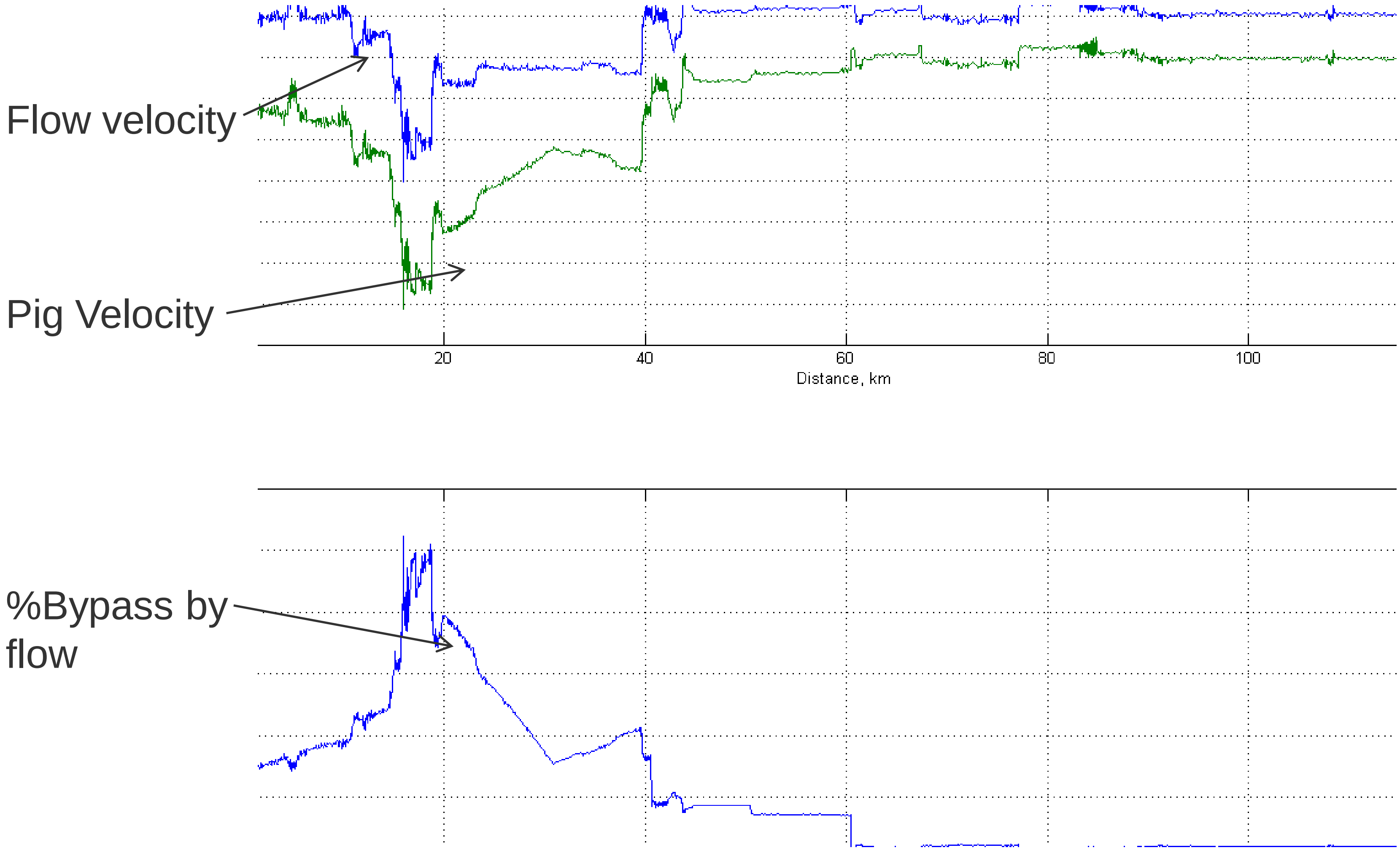
Wax thickness

Statoil

Pig Location against time

Statoil

Pig Velocity against distance

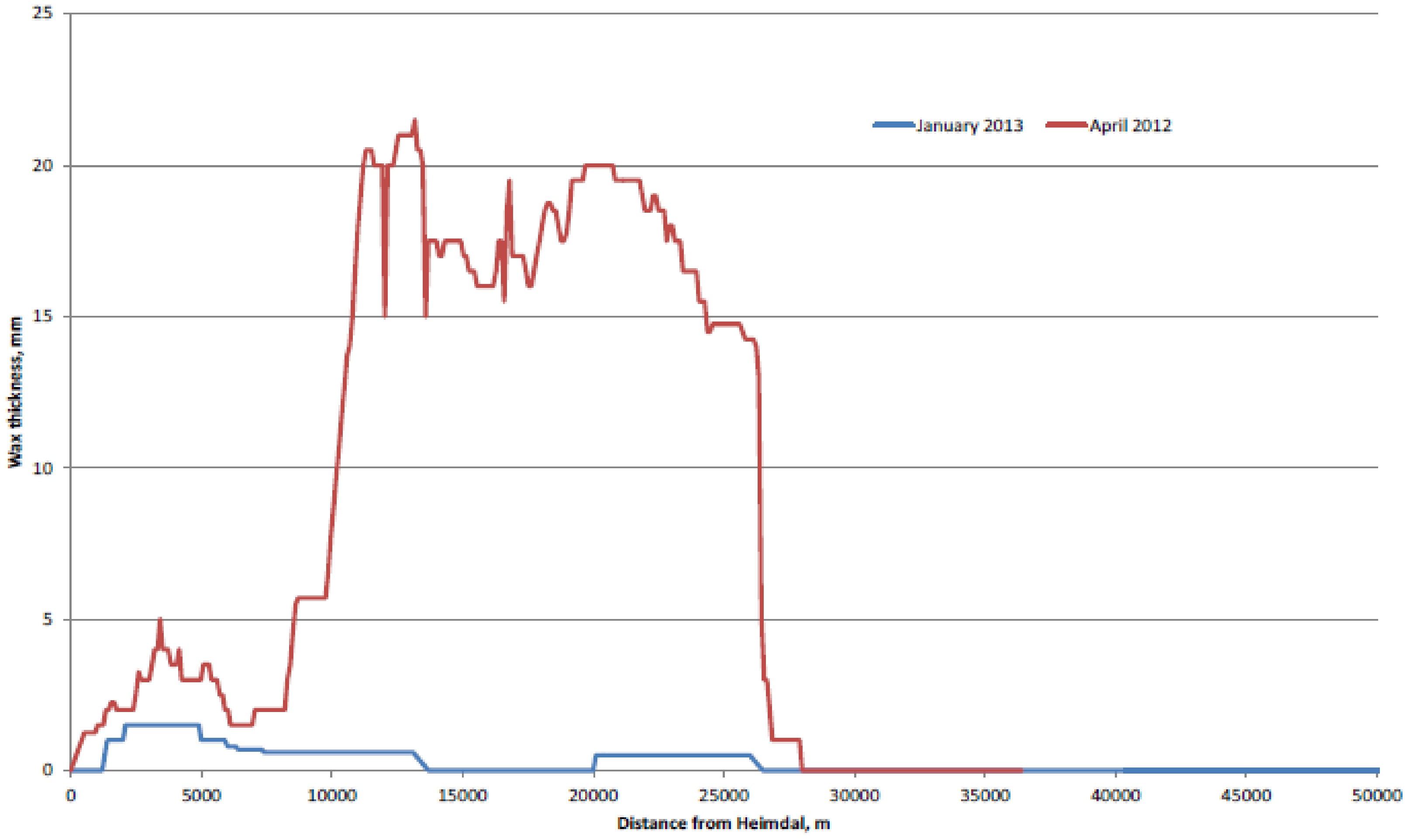


Statoil

Lessons and observations

- Isotopes would be better for location of pig topside;
- Magnetic signaller worked very well subsea;
- Monitoring of flows and pressures / pig location fed in well to the analysis of the pig run in real time;
- Understanding of the flow rate ranges and controllability of the flows is key to the operation;
- Control of outlet pressures and conditions would be good but not always possible (complex system);
- Shuttle valve for reversal was useful during initial mis-launch.

Final Markland test



After the HFJP

- Winter / Spring 2013: 4 operational pigs for wax control, similar design to HFJP
- June 2013: 1 pre-inspection scraper pig + 1 operational pig

X 4 +

- June 2013: Inspection pig from Rosen

Pipeline approved!!

Cake!

There's never been a better time for **good ideas**

Presentation title

Presenters name
Presenters title
E-mail address ……@statoil.com
Tel: +4700000000

www.statoil.com