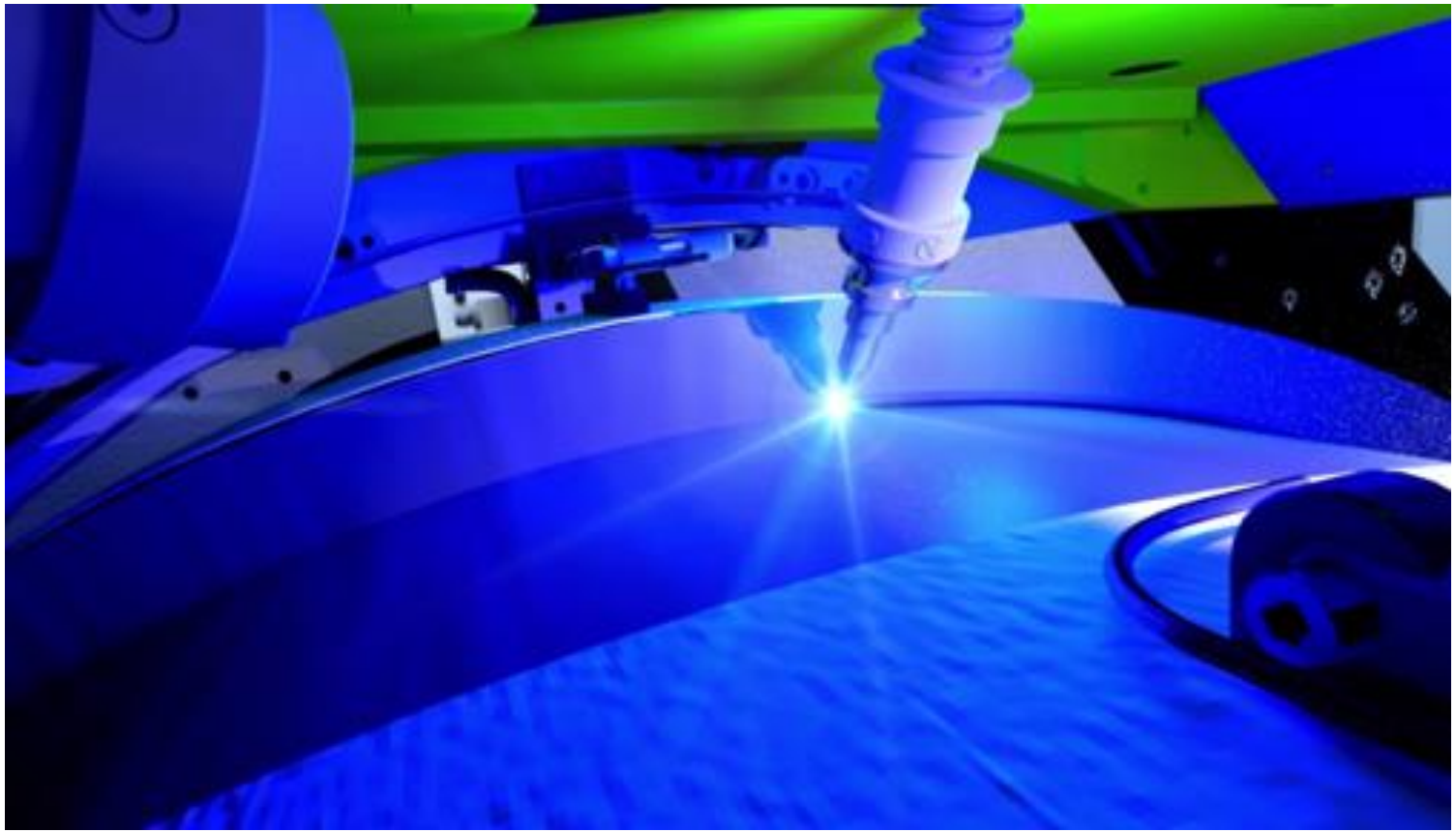
Heimdal Subsea Bypass – Remote Hyperbaric Welding

FFU 2024

History

2019: 2 welds (new pipeline)
36”Johan Sverdrup Oil export

2023: 2 welds (live pipelines)
36” Oseberg Gas Transport
32” Vesterled



Heimdal Subsea Bypass: Remote Hyperbaric Welding

- Remote Hyperbaric Welding
- Heimdal Subsea Bypass


subsea 7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DEEPOCEAN
Technip-DeepOcean PRS JV DA


GASSCO


equinor

Killingøy, Haugesund
Pipeline Repair and Subsea Intervention Pool (PRSI pool)

Equinor administrates on behalf of 75 international partners

15000 kilometers of pipelines covered

TechnipFMC
DEEPOCEAN
Technip-DeepOcean PRS JV DA

PRSJV Operates the base

Close to 100 hyperbaric welds
(Two unplanned)

Pipeline Repair System (PRS)

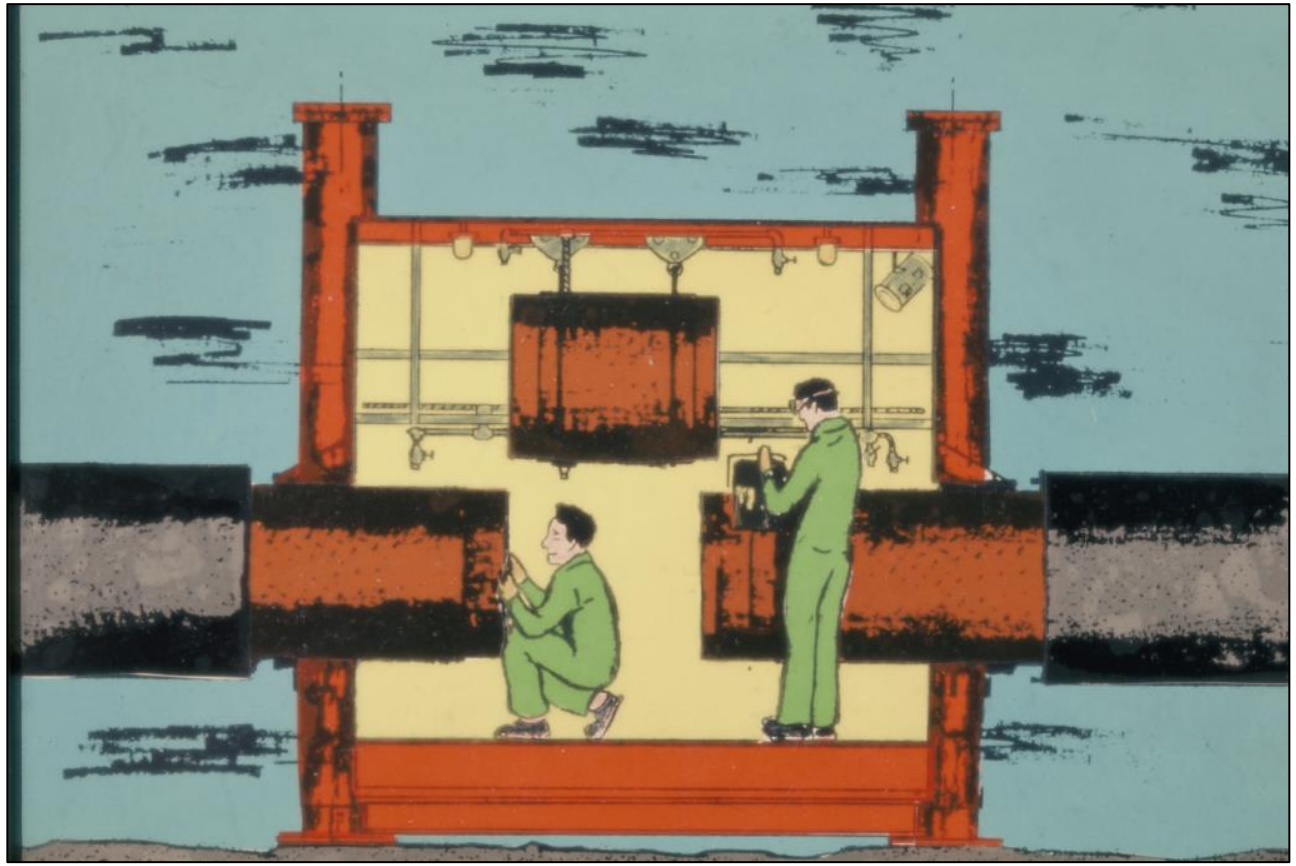
- PRS Inventory
  - Welding habitats
  - Pipe handling frames
  - Plug Installation tools
  - Coating removal tools
  - Etc.

Diver habitat

Remote Habitat

Pipe handling frames

1970's: Manual hyperbaric welding



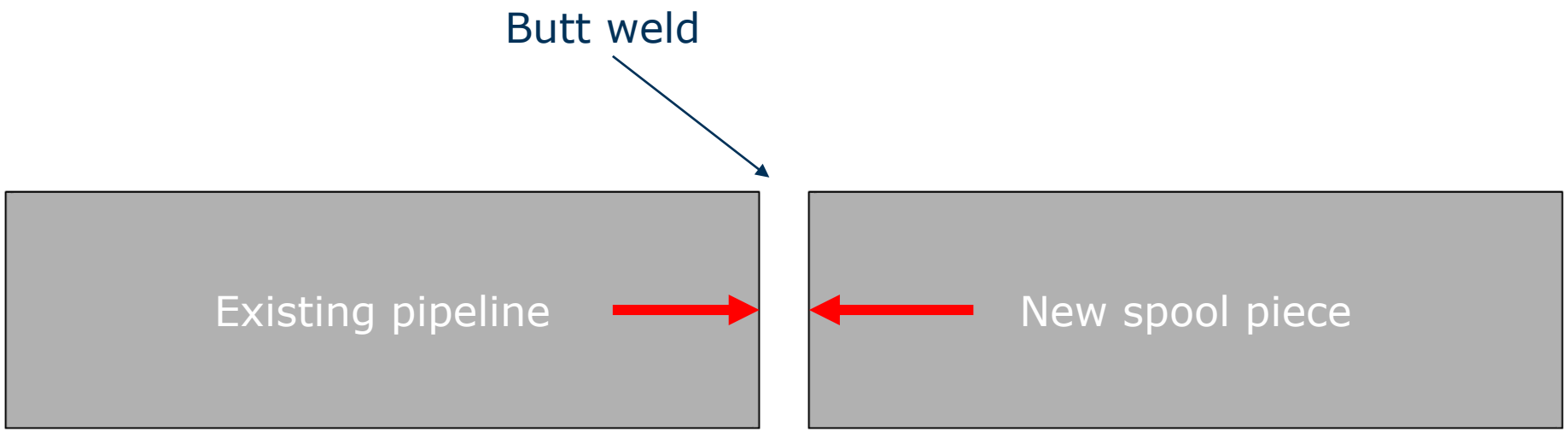
https://www.norskolje.museum.no

1988: Oseberg – Diver assisted remotely operated hyperbaric weld

"RWS" – Remote Welding System
Divers are ordinarily limited to 180 meters depth.
RWS rated to 1300 meters depth.

"Remotely operated repair methods are repairs that are performed without the aid of divers."

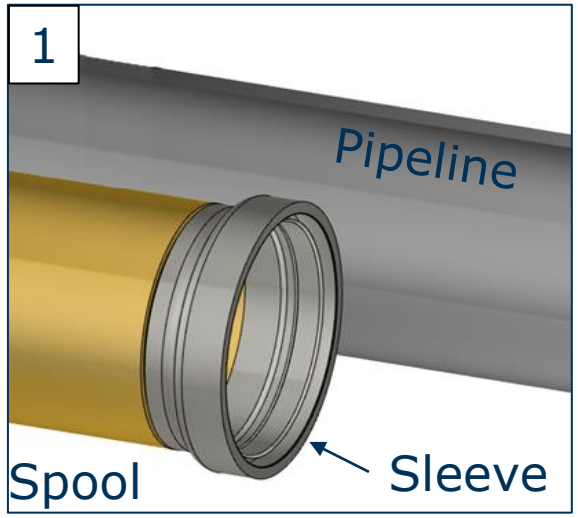
Diver assisted welding

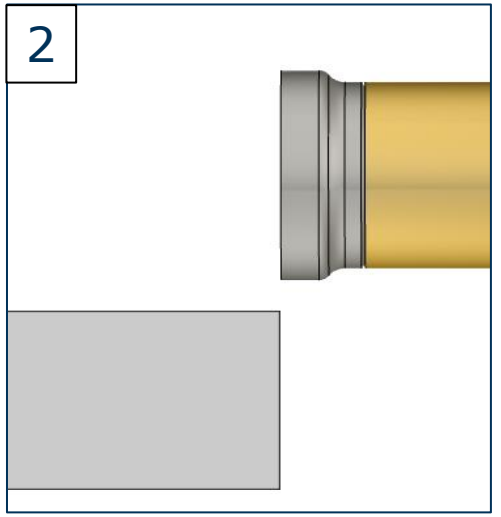


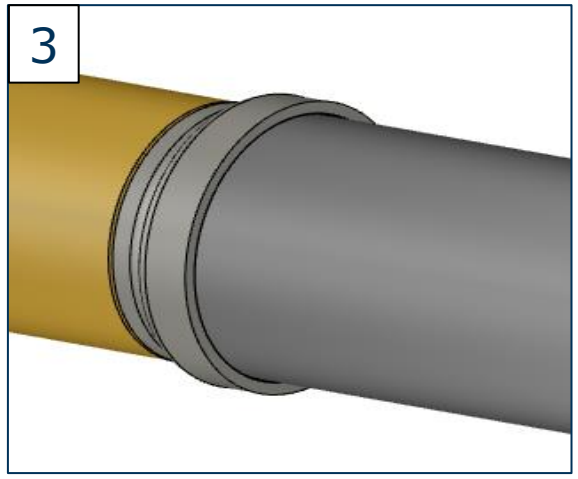
Diver installs welding machine

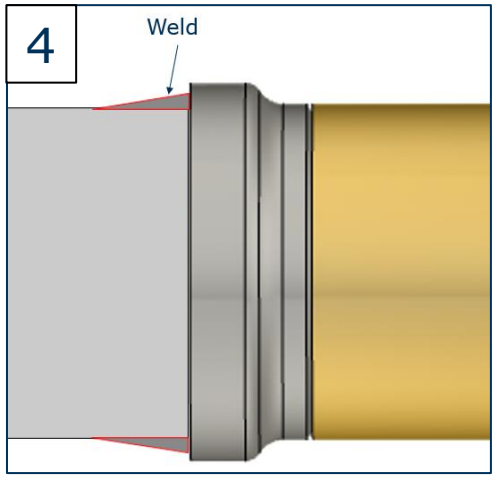
Remote Hyperbaric Welding – PRS Approach

1. Install a spool with a welding sleeve
2. Cut the old pipeline
3. Insert the pipeline into the sleeve
4. Complete fillet Weld









Remote Hyperbaric Welding – PRS Approach

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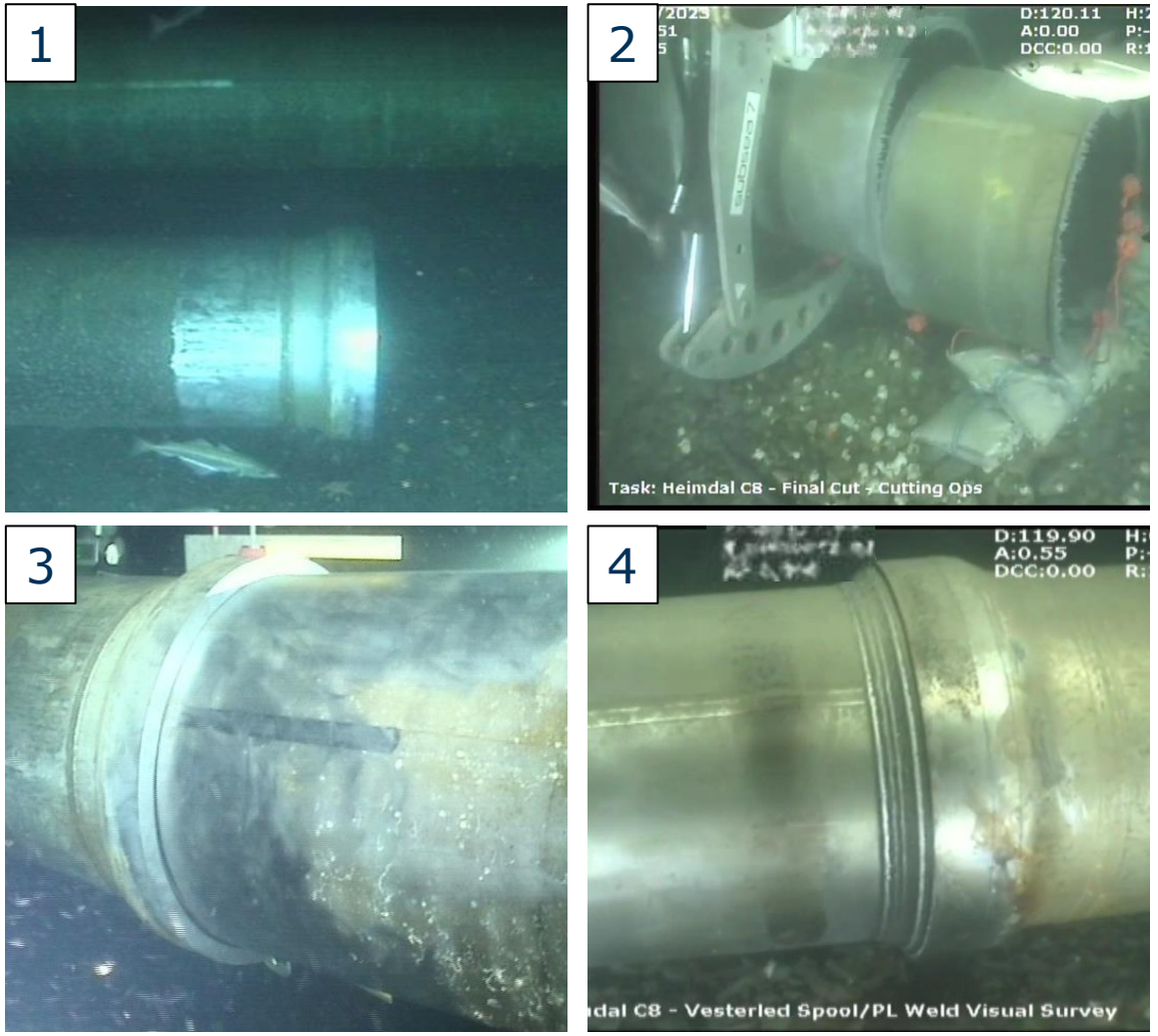
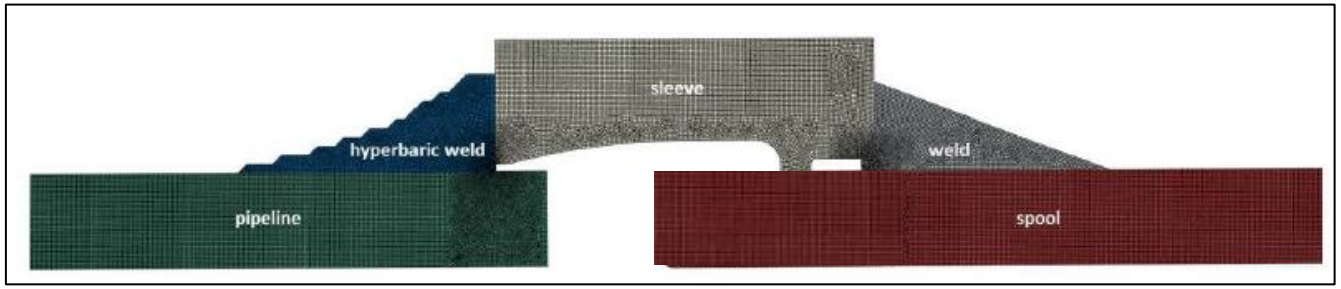
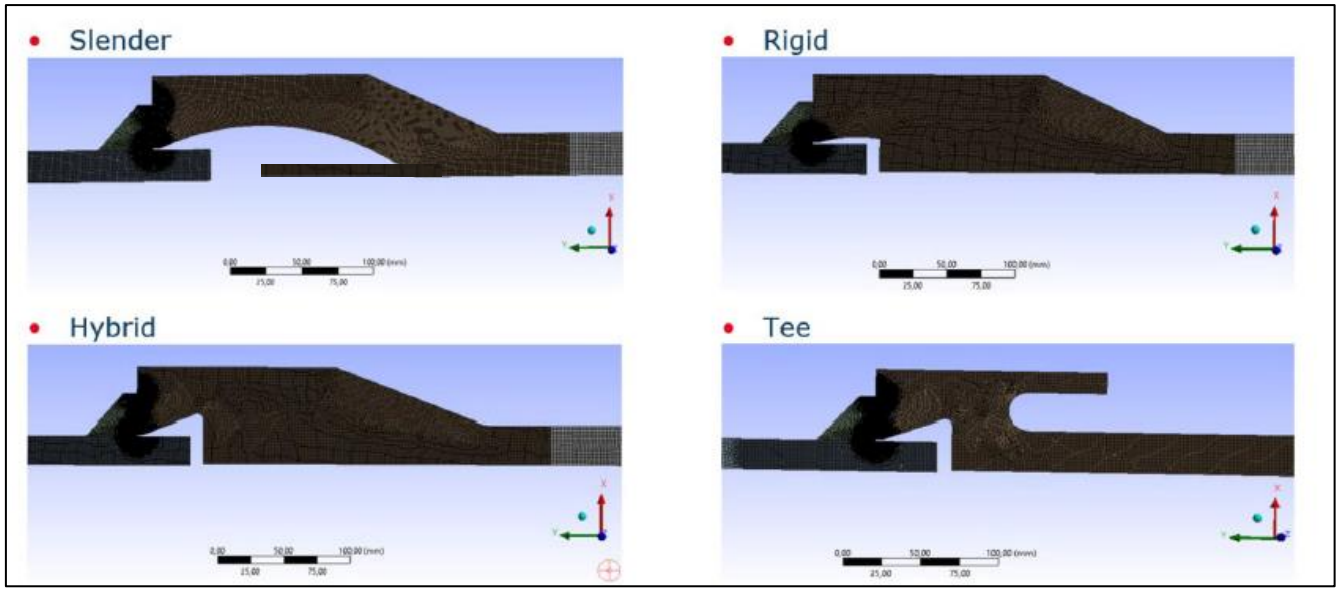


Weld and welding sleeve

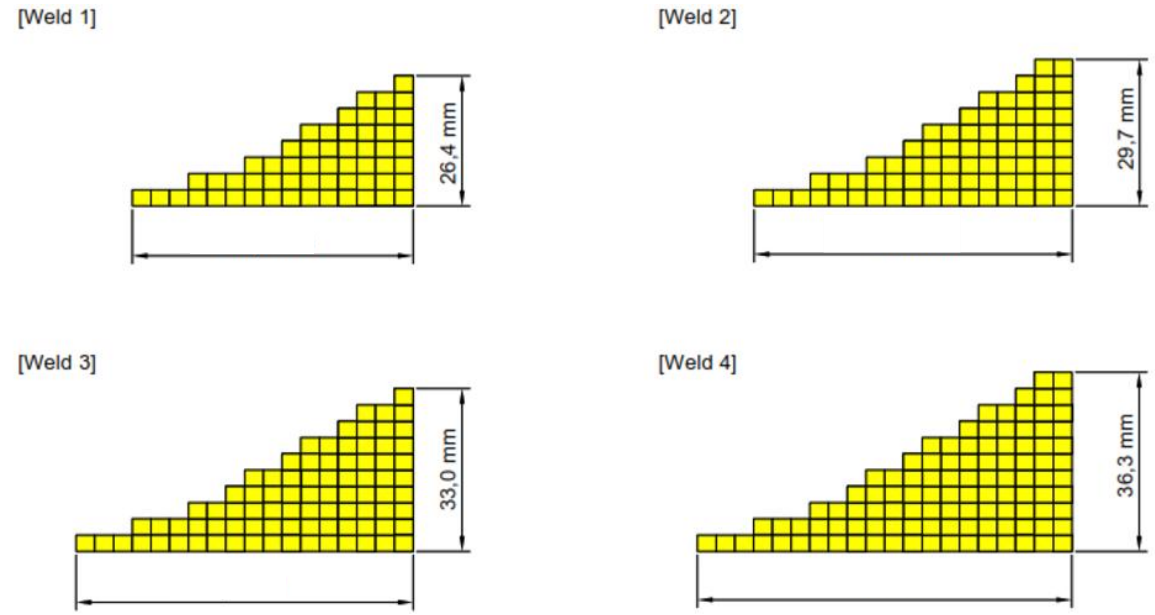
- Johan Sverdrup:
  - Sleeve welded to spool
- Heimdal:
  - Improved design: Diameter transition
- Sleeve geometry selection
- «Slender»
  - Strong
  - Reduced stiffness

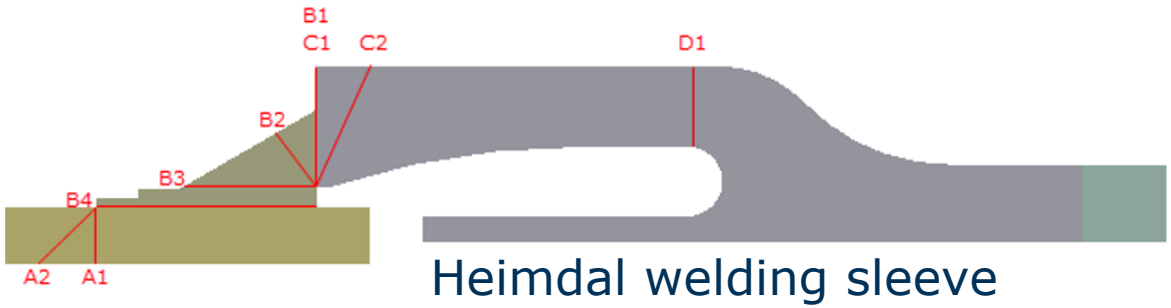




Weld and welding sleeve

- MIG welding
- Fillet weld
- Adaptability for weld sizing
- Golden Weld

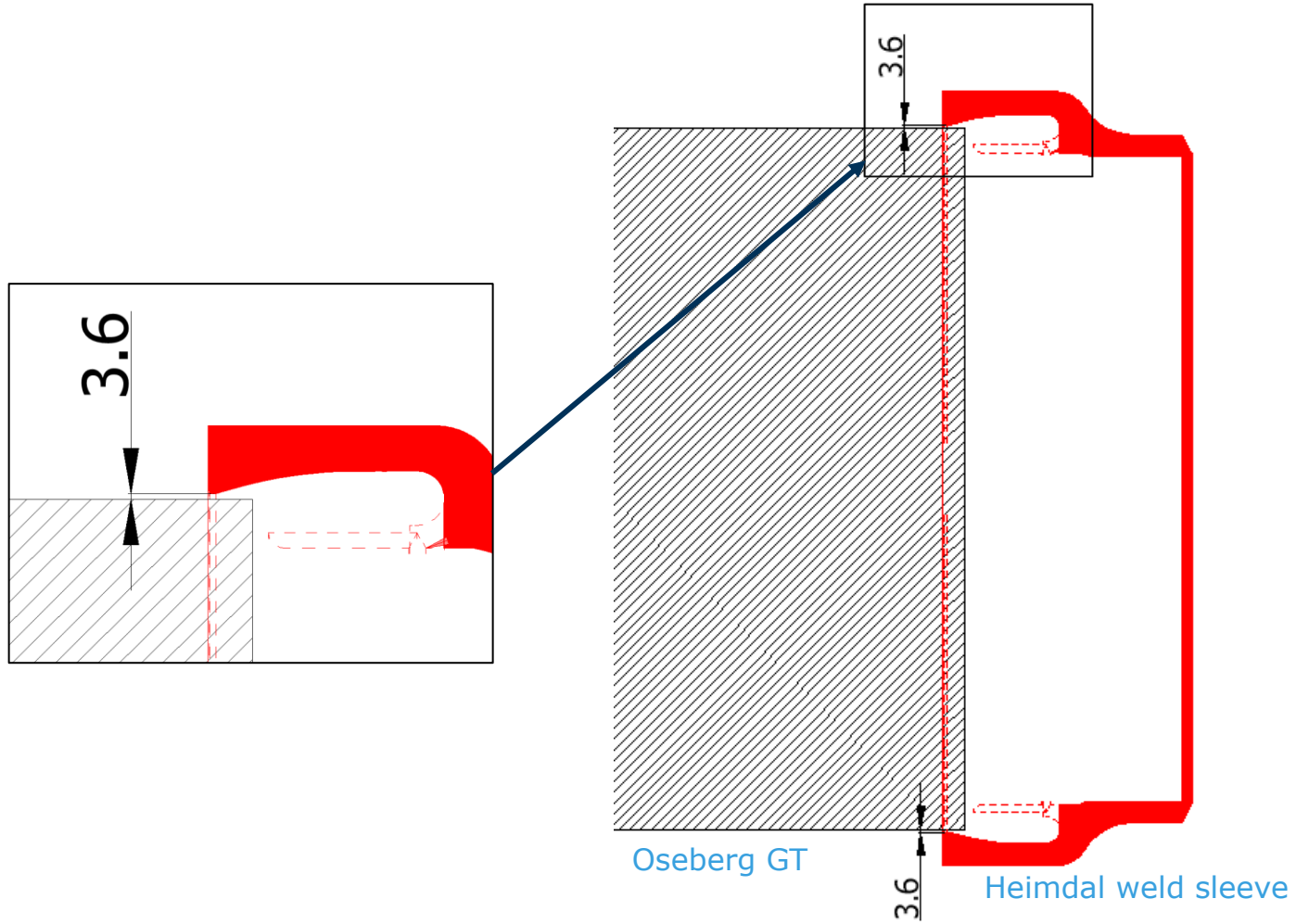




Heimdal welding sleeve

Inserting the pipeline into the sleeve

- Minimal gap between pipe and sleeve improves geometry and reduces weld size
- Relative dimensions:
  - Oseberg GT OD: 933mm
  - Welding sleeve ID: 941mm
  - Nominal gap: 3.6mm



Inserting the pipeline into the sleeve - Trials

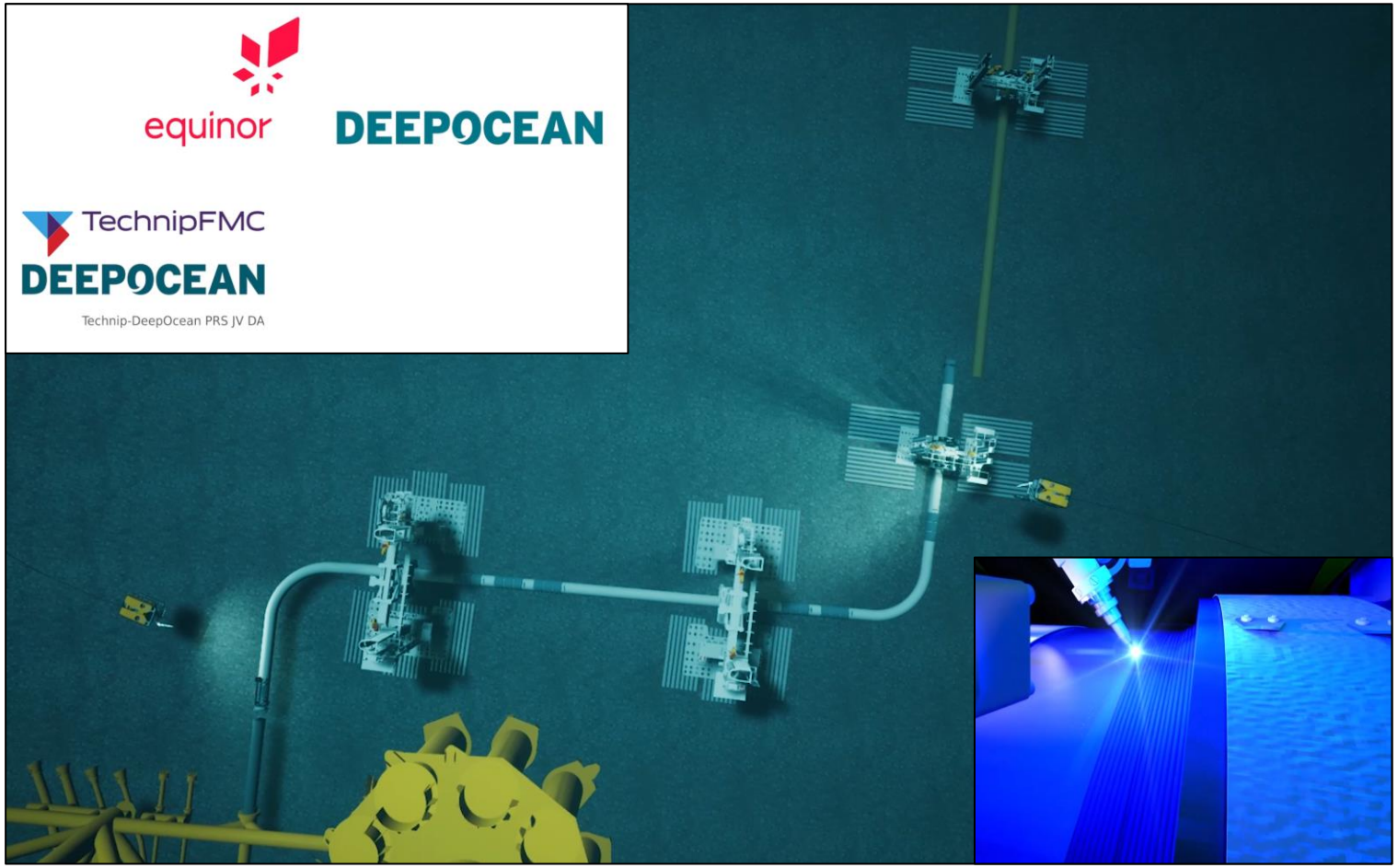
- Insertion with tiny tolerances

Johan Sverdrup project:

- Mock-up spool (1:2)
- Insertion trials successful

Remote Hyperbaric Welding – Worlds first!

- 2002: Start of development
- 2019: Worlds first fully remotely welded subsea tie-in (Johan Sverdrup Oil Export)



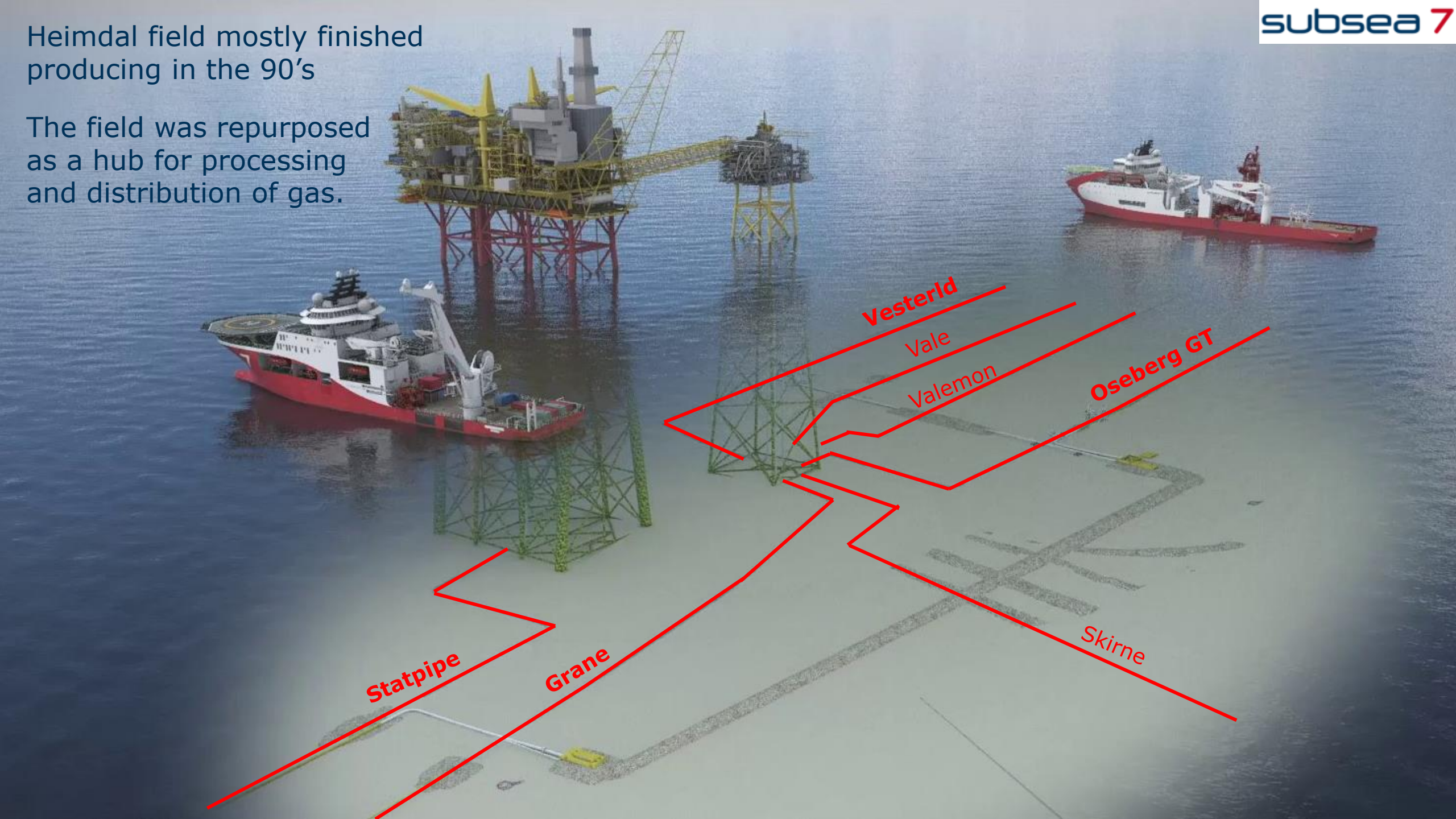
Heimdal Subsea Bypass: Remote Hyperbaric weld on a live pipeline


Ormen Lange
Statfjord
Tjeldbergodd
Nyhamna
LANGELED NORTH
Mongstad (Vestprosess)
Sture
Kollsnes
Bergen
Oseberg
OGT
Heimdal
VESTERLED
Grane
Haugesund
NORWAY
Kårstø
STATPIPE
Draupner S/E
Stavanger
St Fergus
STATPIPE
EUROPIPE
https://map.gassco.eu/map

Heimdal field mostly finished producing in the 90’s

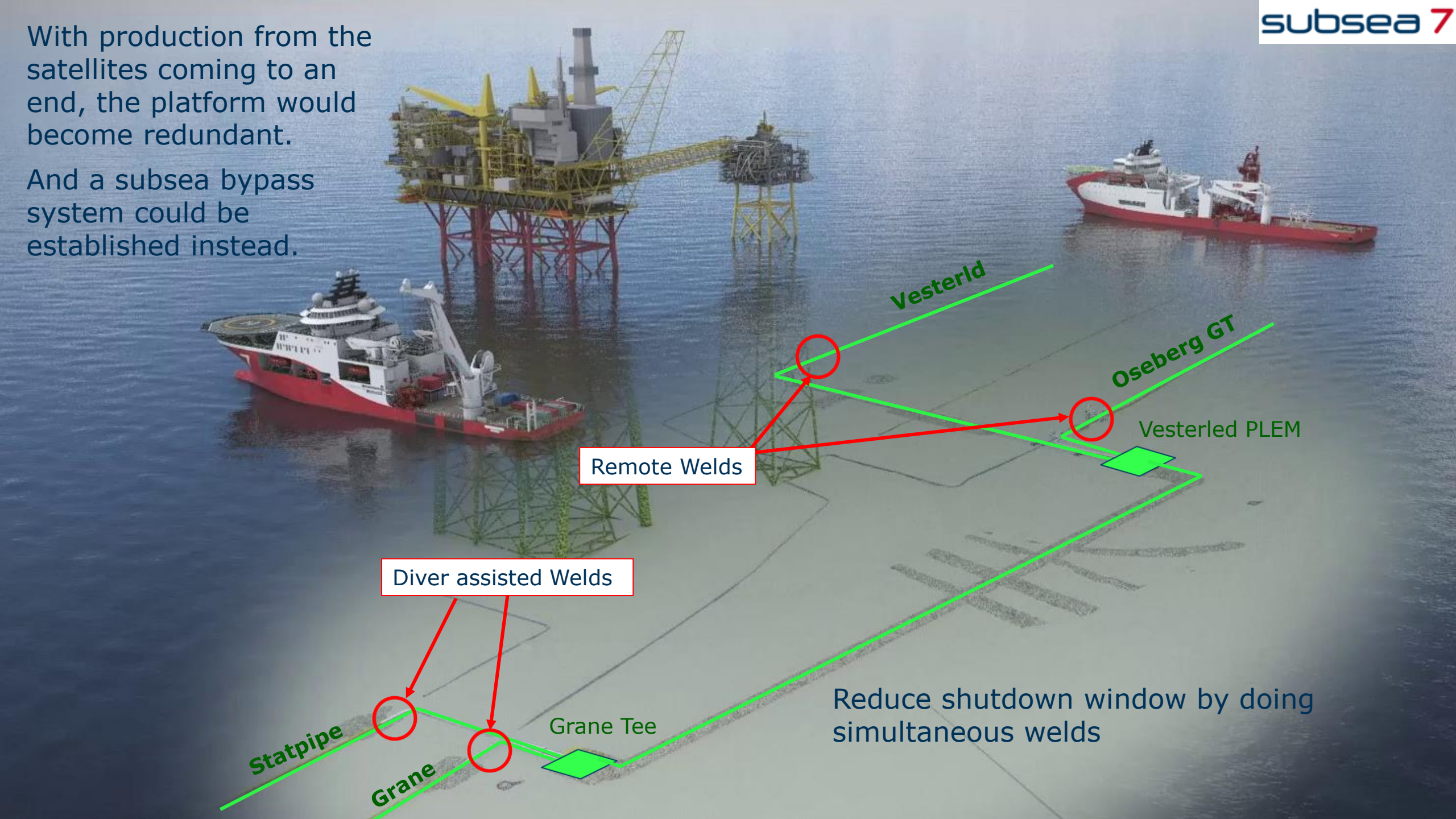
Heimdal field mostly finished producing in the 90’s

The field was repurposed as a hub for processing and distribution of gas.



With production from the satellites coming to an end, the platform would become redundant.

And a subsea bypass system could be established instead.



Reduce shutdown window by doing simultaneous welds


PLEM

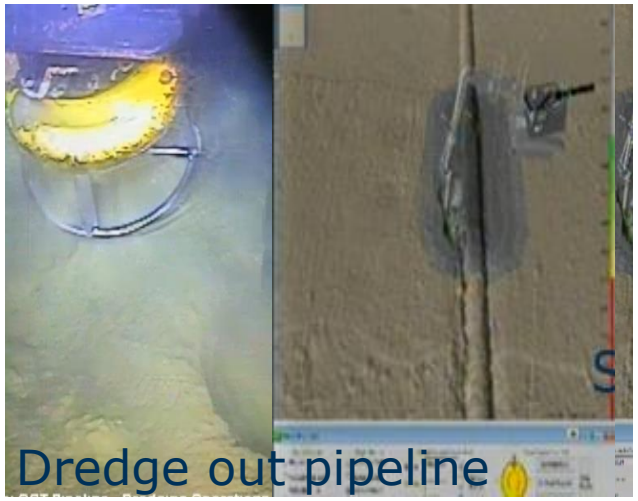

330m towed spool

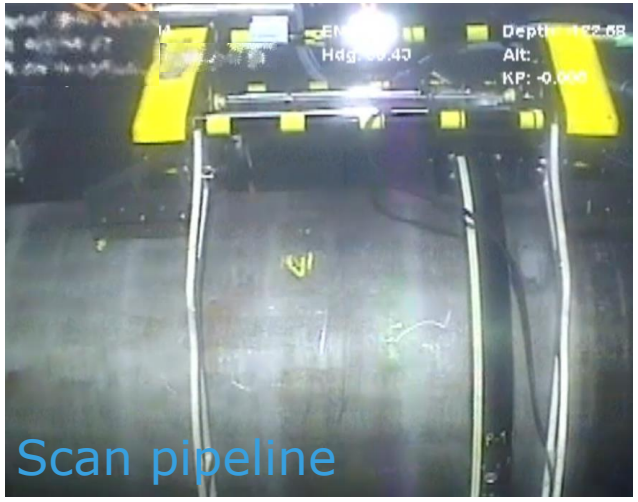

PLEM GRP cover

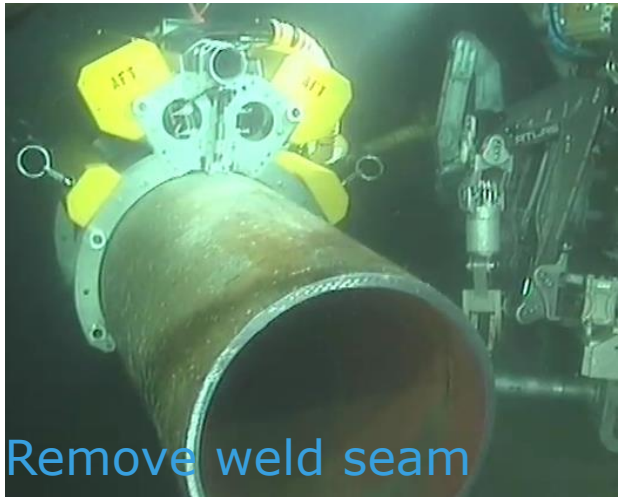

Tie-in spools

Welding Preparations

1. Dredge out pipeline
2. Remove concrete coating
3. Scan the pipeline
4. Remove weld seam







PRS Remote Welding System (RWS)

- Mobilisation time:
  - 1st weld: 5 days
  - 2nd weld: 3.5 days
- >900 tons of equipment
- >20 PRSJV technicians and engineers

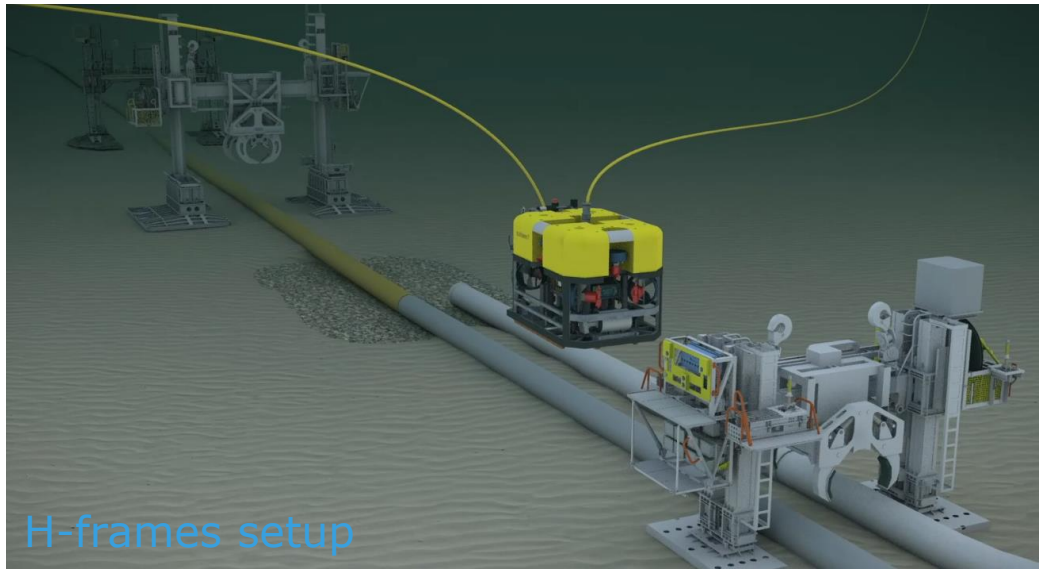
Pipe Handling Frames (H-frames)

- 5 units
- Seawater hydraulics
- Lift capacity: 60-150 tons
- 3D-handling
  - Vertical lift
  - Axial push/pull
  - Transverse stroke
- Sensors provide sub-mm accuracy during operations

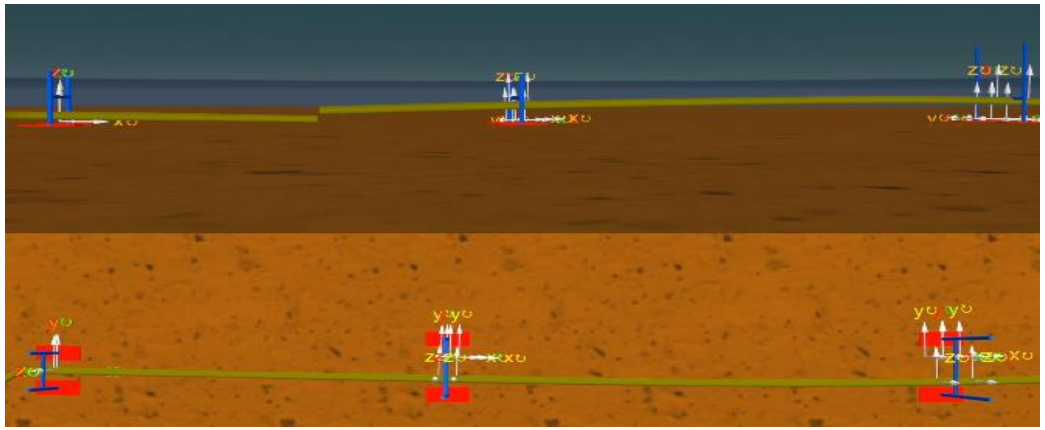
Pipe Handling Frames (H-frames)

- Typical setup:
  - 1 H-frame over spool
  - 2 H-frames over pipeline

- Pipeline can be «hogged» during alignment



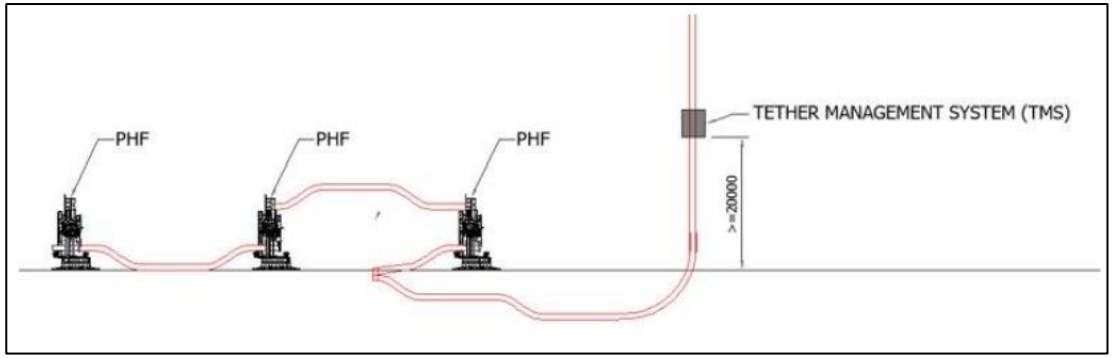
H-frames setup

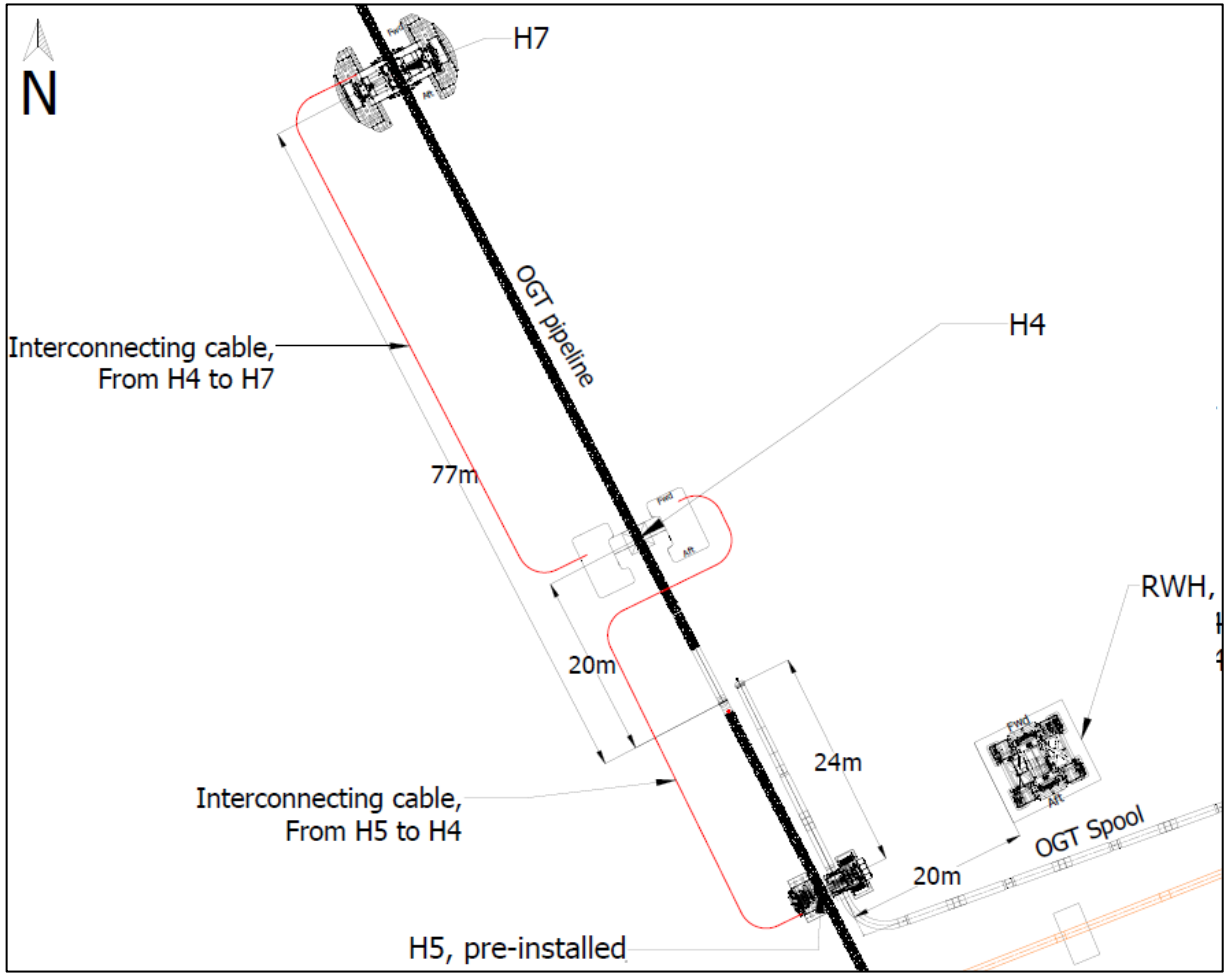


Pipeline retracted by «hogging»

Interconnection System

- All units connected in series
- «Master» unit connected to vessel
- All units are operated from control containers on deck





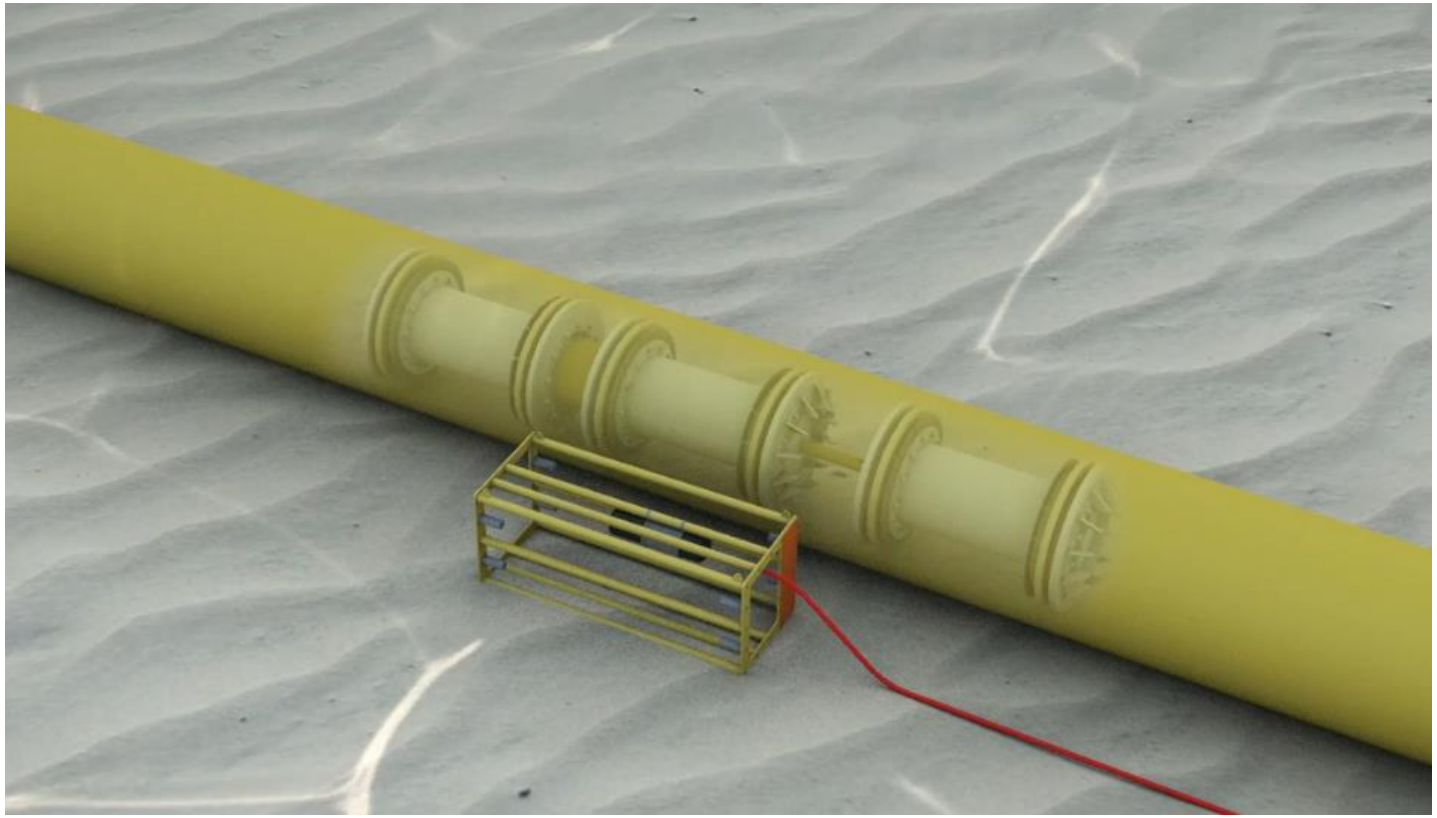
Interconnection System

- H-frames and habitat fitted with umbilical winches
- Interconnection cables installed between units
- Power and signals
- Redundancies

ROV connecting umbilical

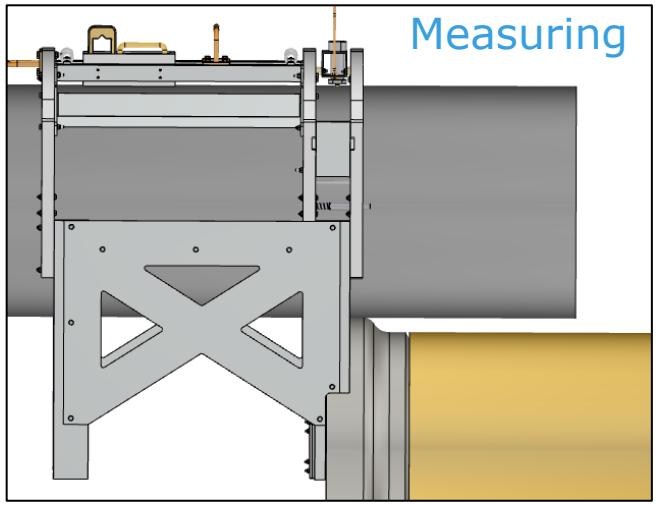
Pipeline Isolation

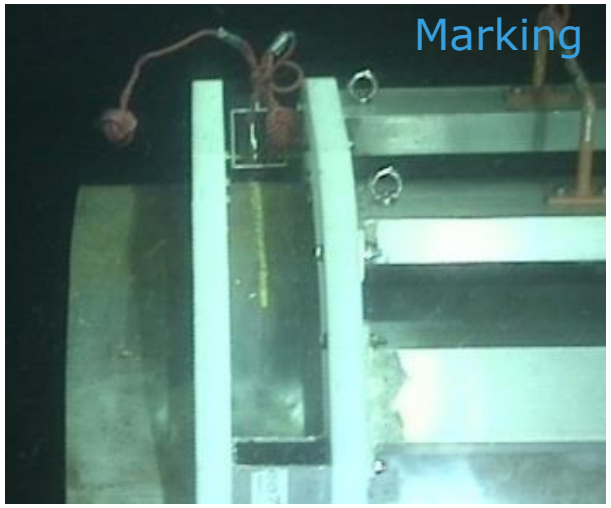
- High Pressure Isolation Tool (TDW)
- Positioned using ELF antenna
- Engaged and released remotely
- Oseberg Gas Transport:
  ~25 MSm3/day

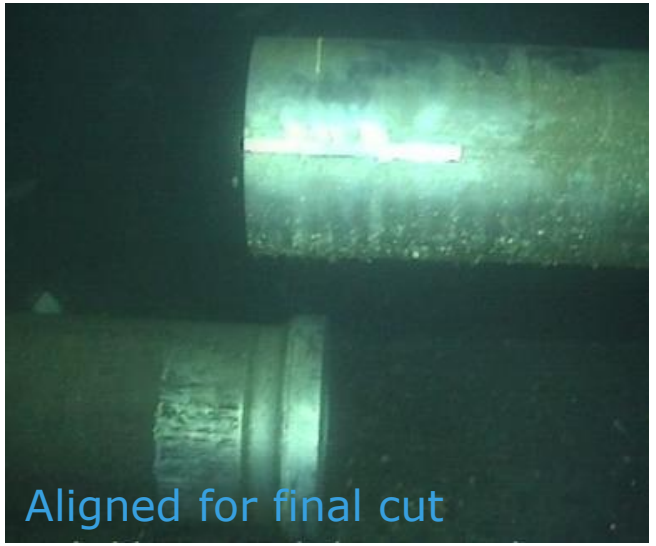


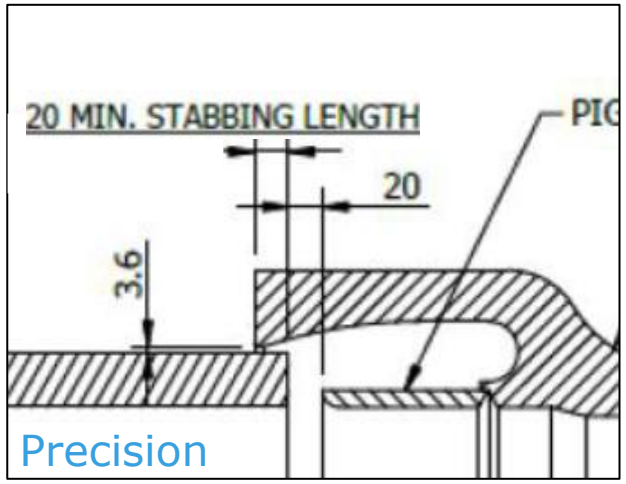
Cutting pipeline

- Rough cuts
- Measure final cut location
  - Required cut precision: +/- 20mm
- Marking
- Cutting







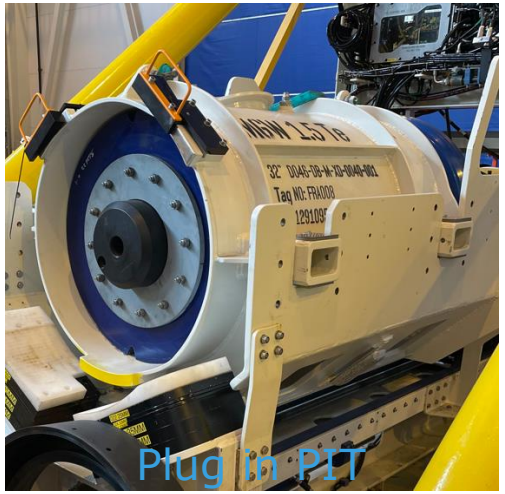


Welding Plug Installation

- Dry work space: Welding plug installed in spool and pipeline

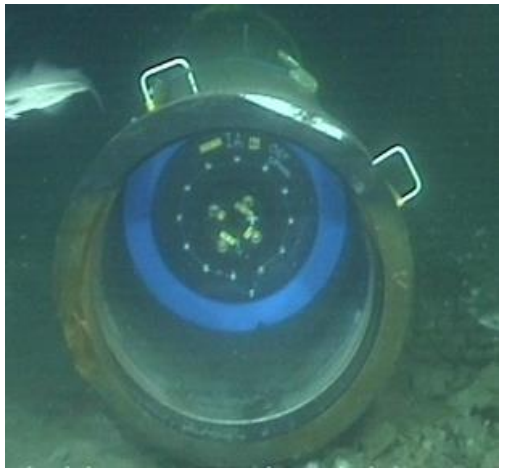
Welding Plug Installation

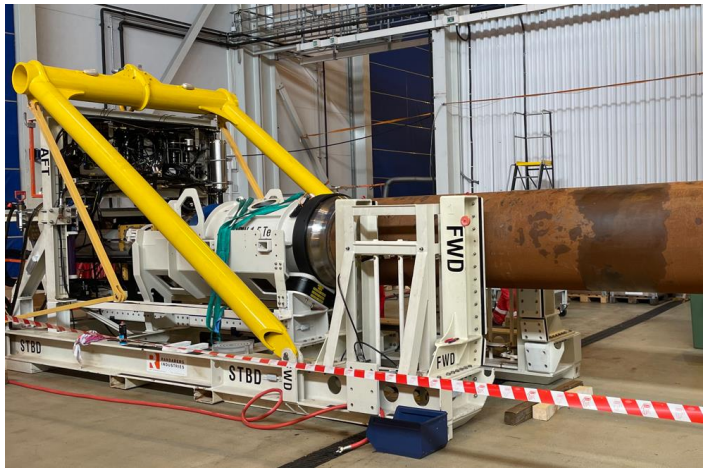
- Plug Installation Tool (PIT)
- Seals inflated by seawater
- Water between seals purged by gas
- Seal tested
- Deflated by diff. pressure



Plug in PIT

PIT installed

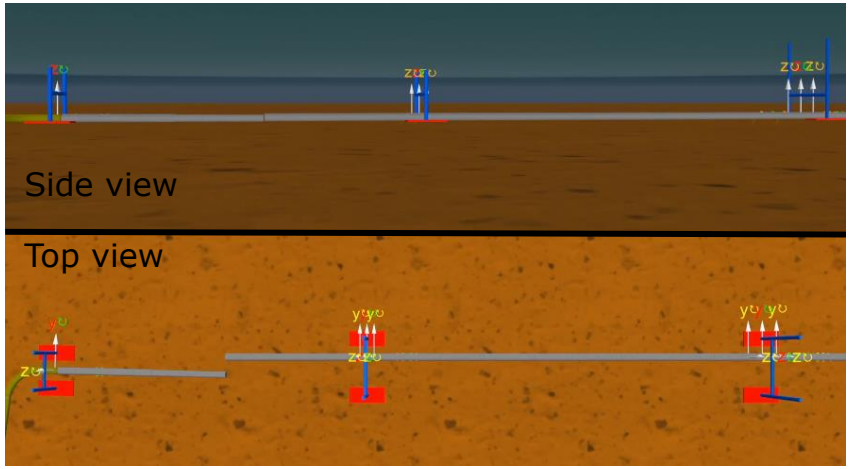

Plug in spool



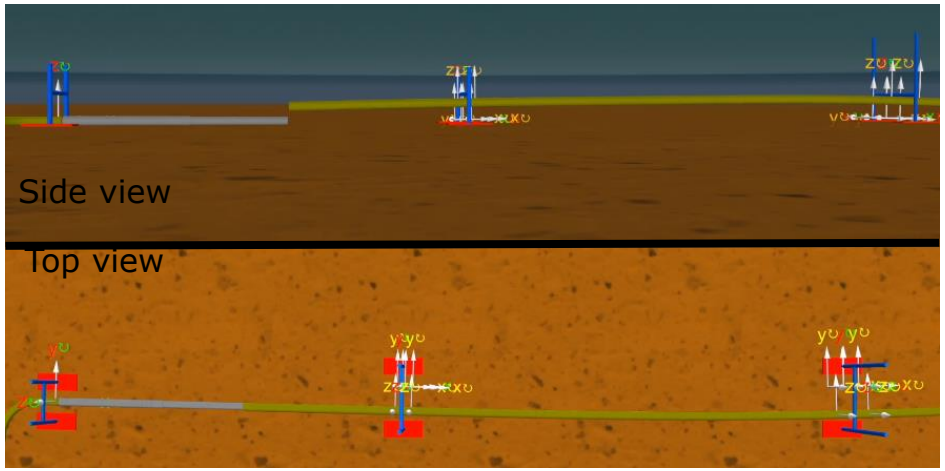
PIT installed

Lift & shift pipeline

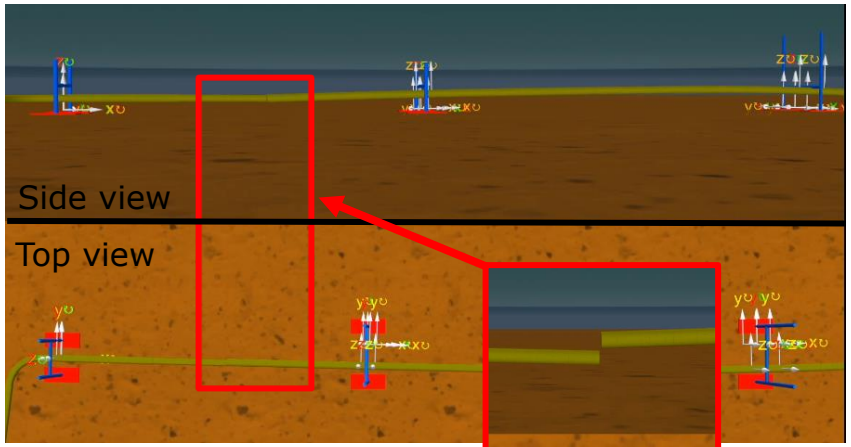
- Pipeline lift & shift:
  1. Pipe and spool on seabed
  2. Lift, shift and retract pipeline («hog»)
  3. Lift spool into position
  4. Release pipeline «hog» to extend



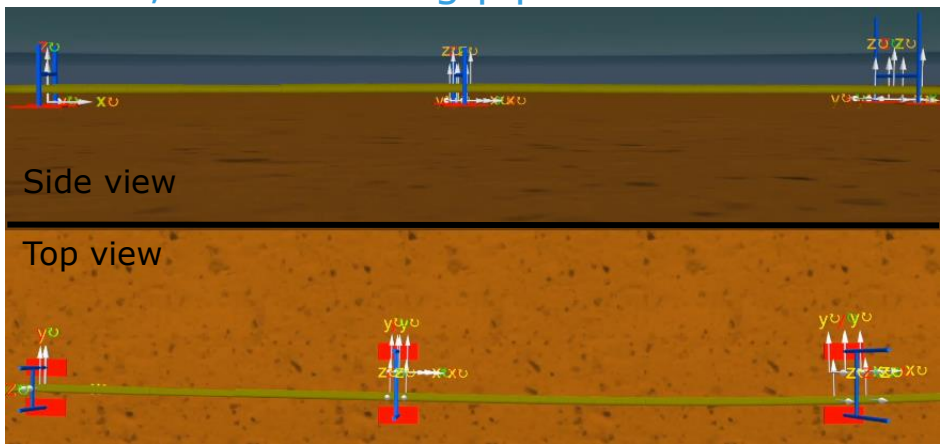
1: Initial status



2: Lift, shift and hog pipeline to retract



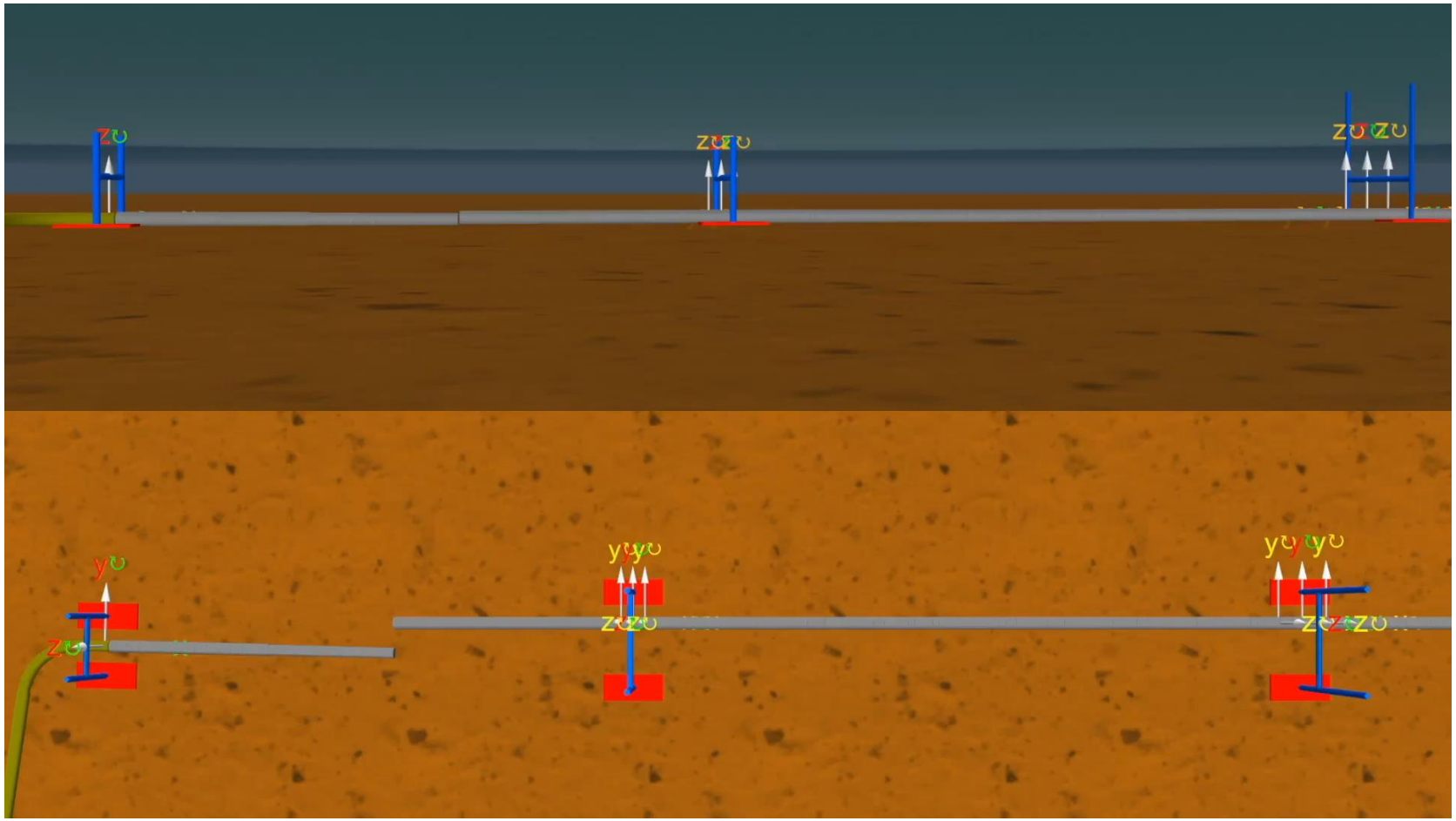
3:Lift spool to height



4: Release hog to extend pipeline

Lift & shift pipeline

- Pipeline lift & shift:
  1. Pipe and spool on seabed
  2. Lift, shift and retract pipeline («hog»)
  3. Lift spool into position
  4. Release pipeline «hog» to extend
- ~90 tons vertical lift on H-frames

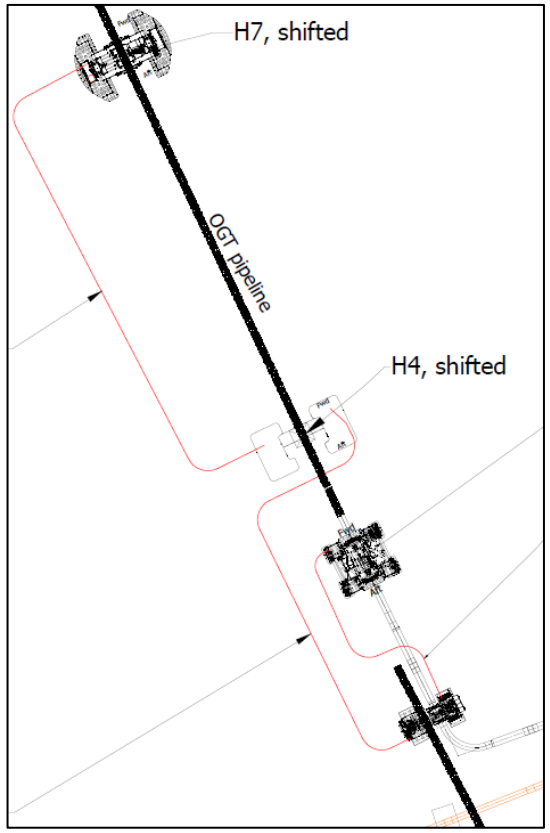


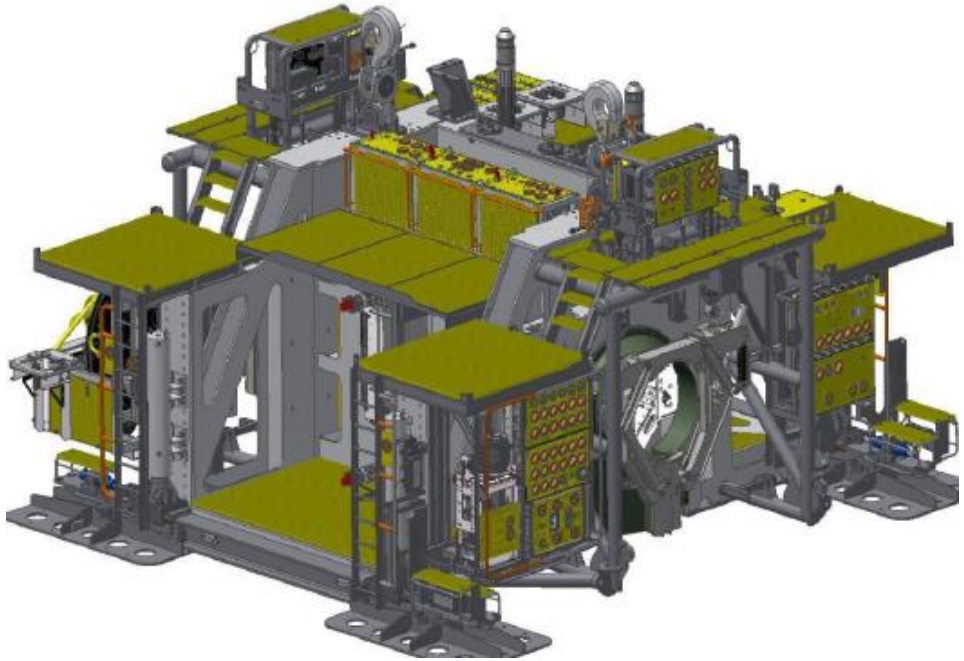
Insertion into welding sleeve

- Pipeline retraction ~9 cm
- Nominal clearance: 3.6 mm
- Pipe OD: 933 mm
- 20 – 40mm insertion into sleeve

Remote Welding Habitat (RWH)

- Interconnected with H-frames
- Seawater hydraulics
  - Legs
  - Doors
  - Clamps





Remote Welding Habitat – Sealing off

- Clamps and shims
- Door seals around the pipe
- Fine adjustments inside habitat

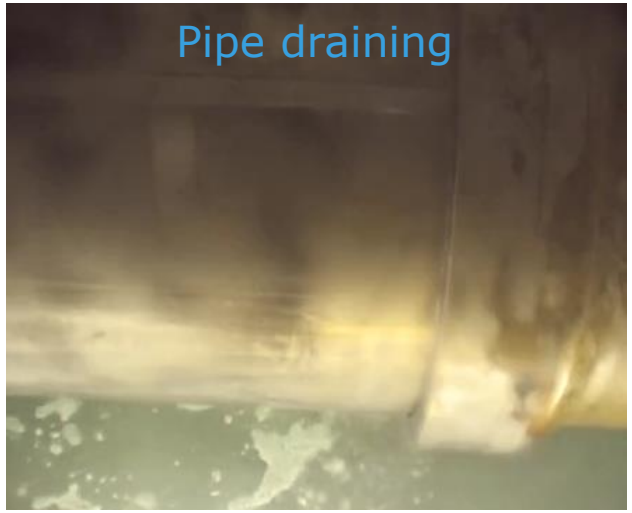
Door seals

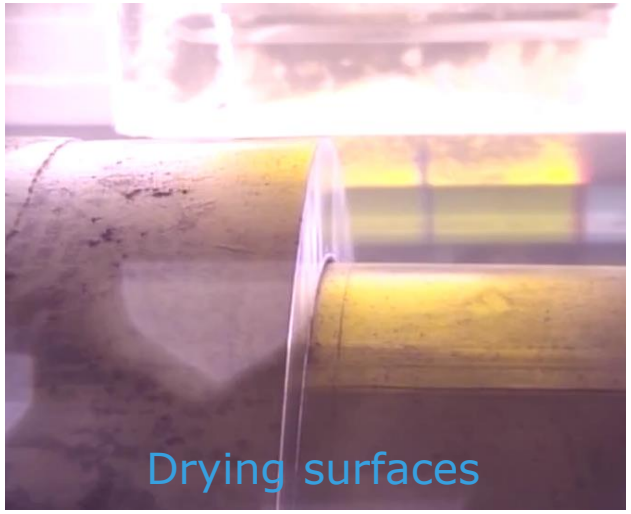
Clamps

Remote Welding Habitat – Dewatering and Drying

- Water purged with Argon
- Water emptied from pipe
- IR heating lamps dries the surfaces


Water level monitoring


Pipe draining


Drying surfaces


Ready for welding tool

Remote Welding POCO

- «Power and Control»
- Transport container for welding tool
- Supplies to habitat:
  - Power
  - Signals
  - Gas

Remote Welding POCO

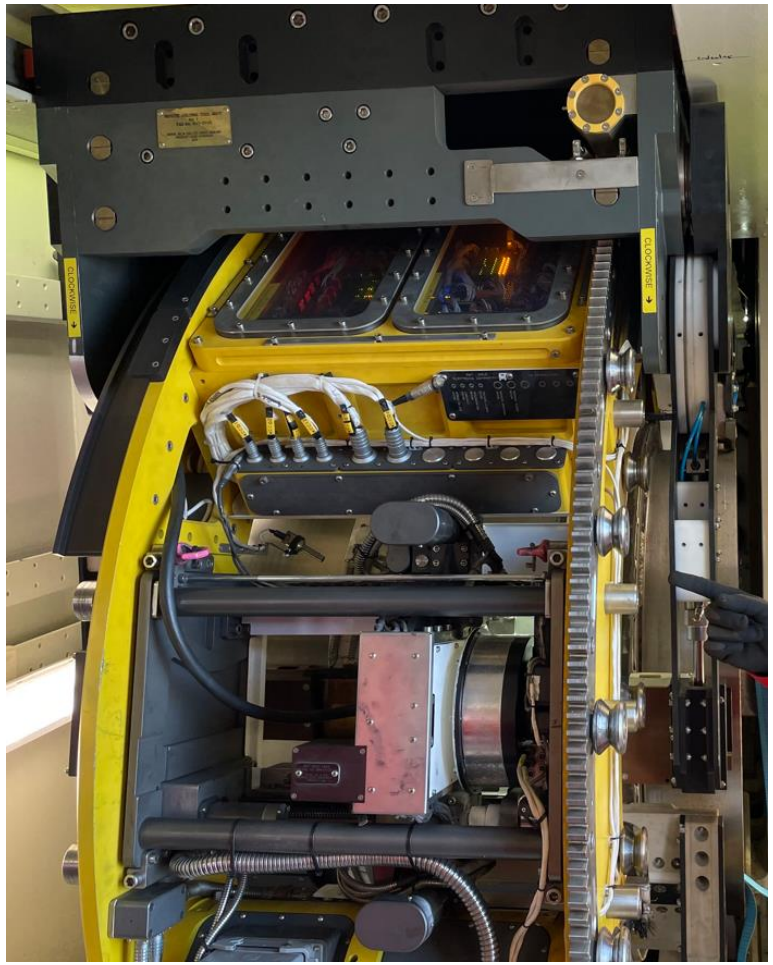
- AHC Electric LARS
- Docked onto Habitat
- Connected to RWH
- Gas, signal and power

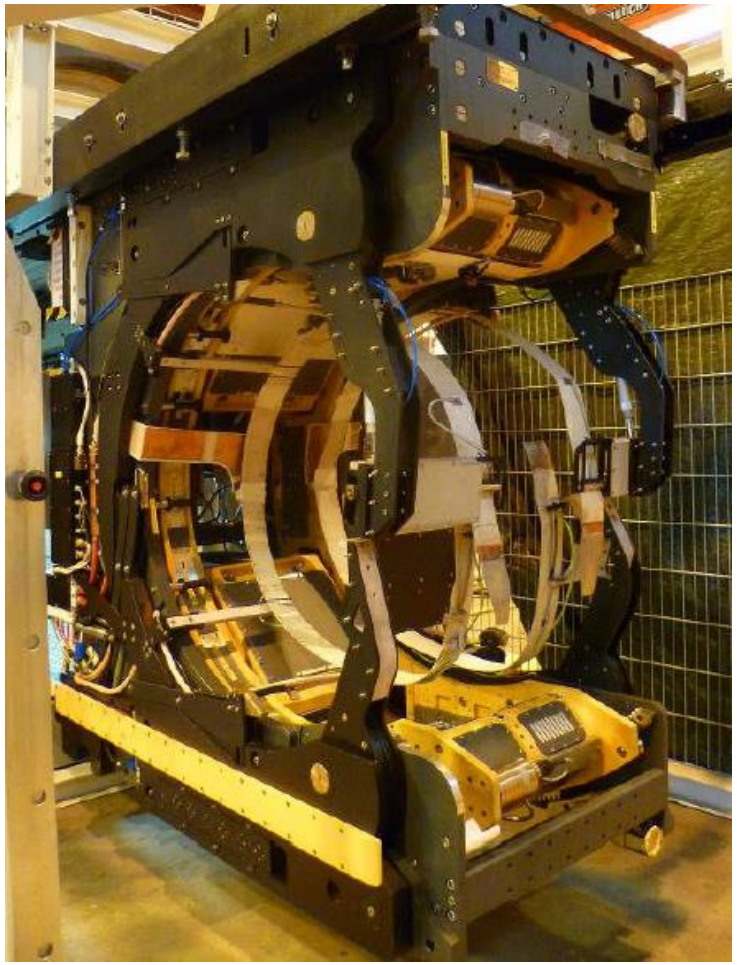
LARS2 A-frame

POCO docked on habitat

Remote Welding Tool

- Pre-heating
- Measurements
- Sensors
- Welding





Remote Welding Tool

Welds completed – Bypass established

Oseberg Gas Transport, June 2023

Vesterled, October 2023


subsea 7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THANK YOU