BISMUTH AS A BARRIER MATERIAL FOR P&A APPLICATIONS

PAF Seminar 2019

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Agenda

- Qualification testing of Bismuth plug
- Installation of Bismuth plug in well A-30 on Valhall DP
- Verification process
- Way forward

- Qualification testing of Bismuth plug

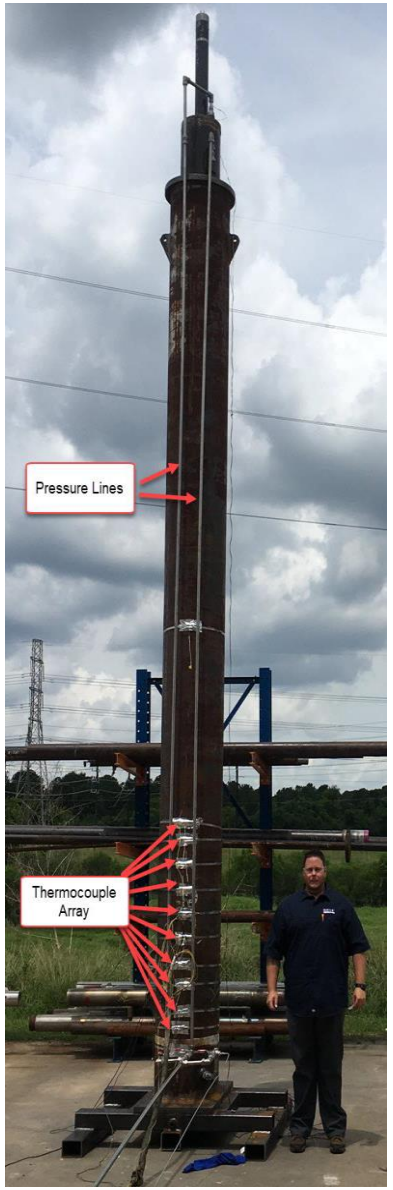
EXTENSIVE TEST PROGRAM
13 3/8’’ x 20’’

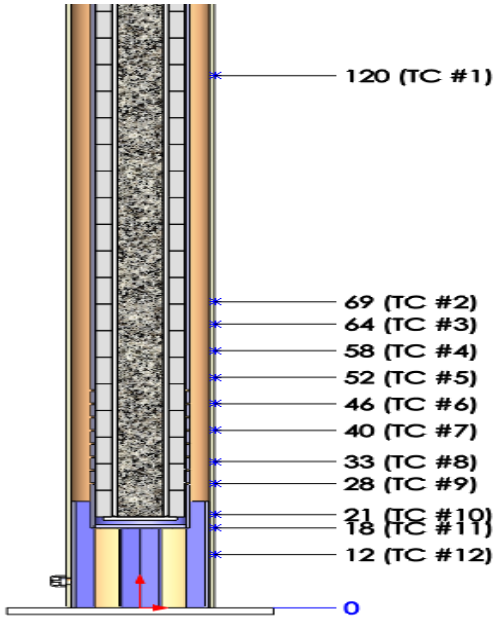
Requirement:
Pull heater
500 psi test using water above and below
500 Psi – 12 Hours using N2
- No bubbles

Repeat same after 12 -14 days

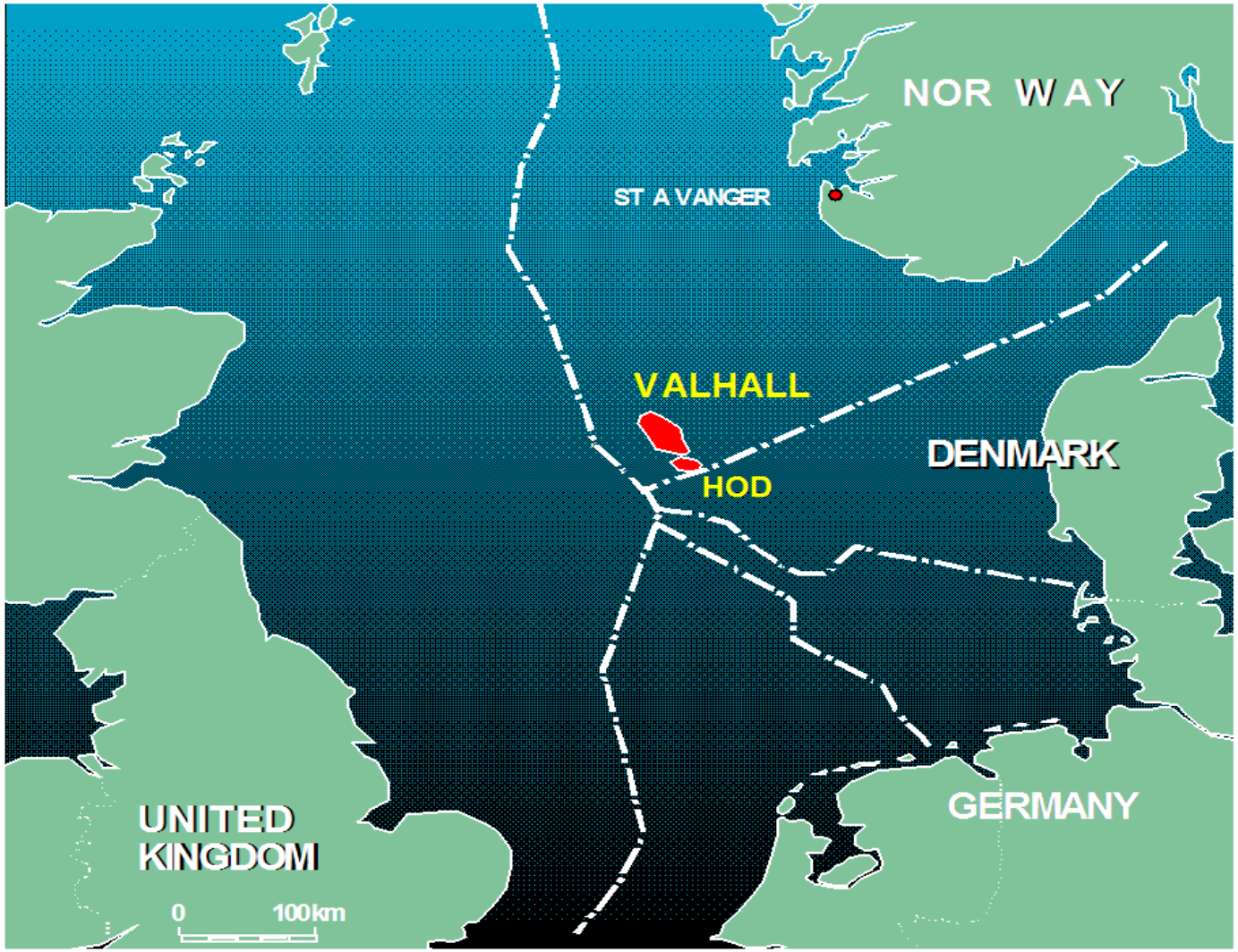
Two repetive tests with same results

Offshore installation and pressure monitoring

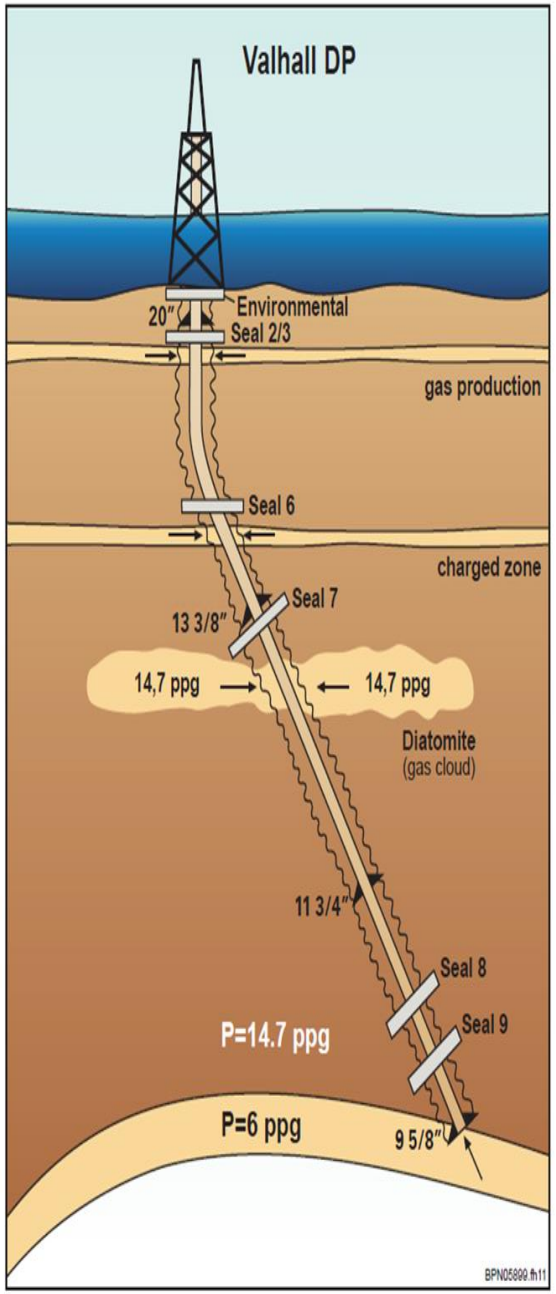


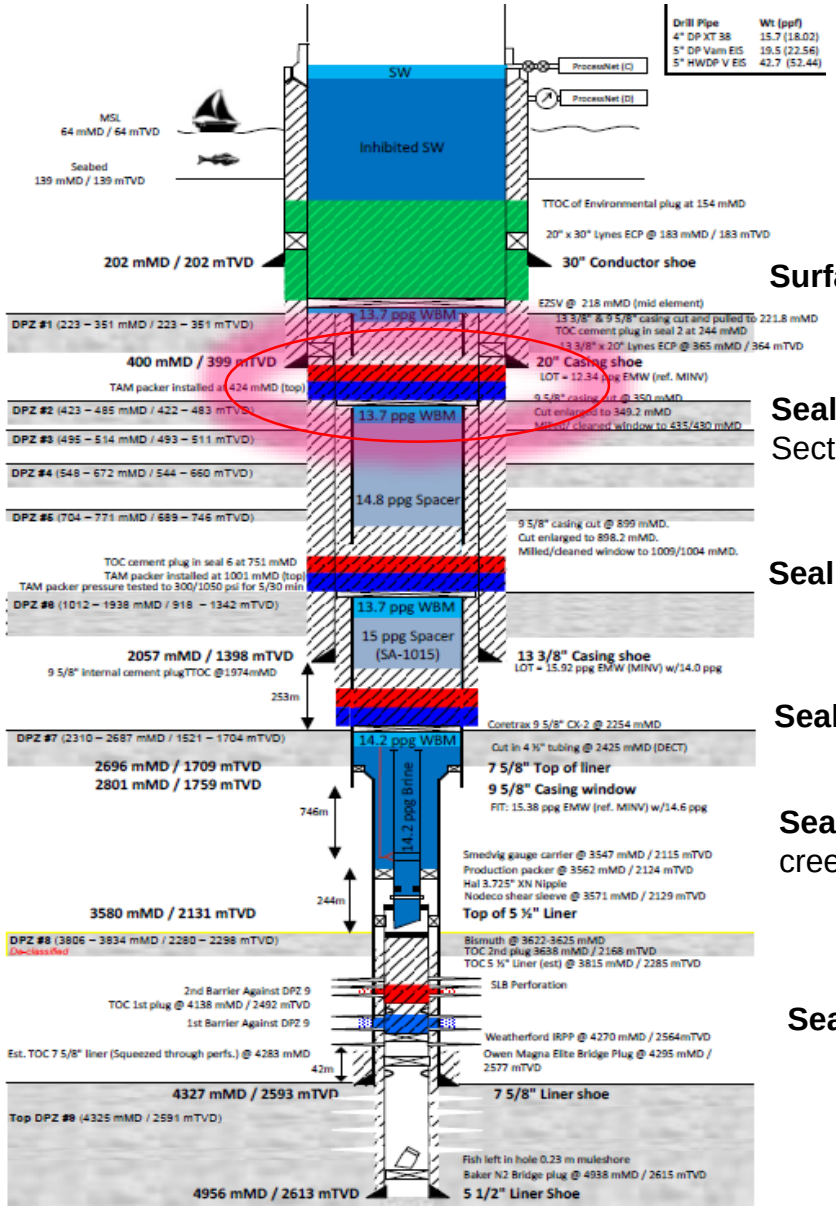


Installation of Bismuth plug in well A-30 on Valhall DP platform



Overview of Valhall DP

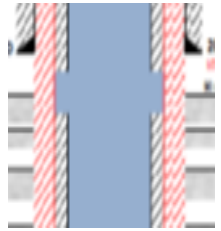




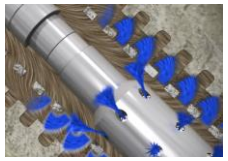
Surface Plug

Seal 2 – Internal cement plug / Section milling inside casing

Seal 6 – Section milling inside casing



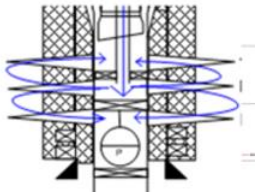
Seal 7 – Perf, Wash & Cement



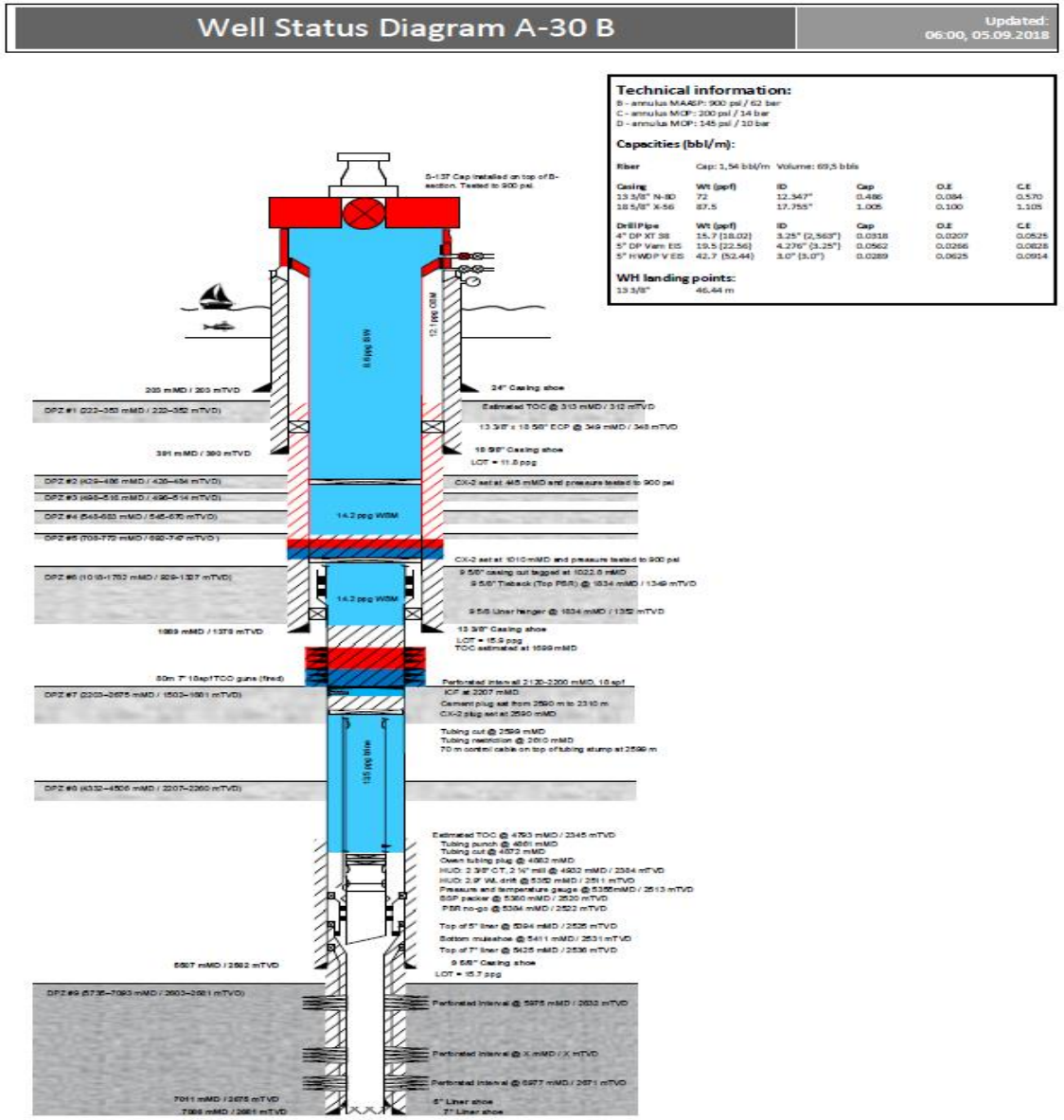
Seal 8 – Proven area with shale creep

Understand geology.
Declassify some DPZ 8's

Seal 9 - Rigless P&A – Coiled Tubing



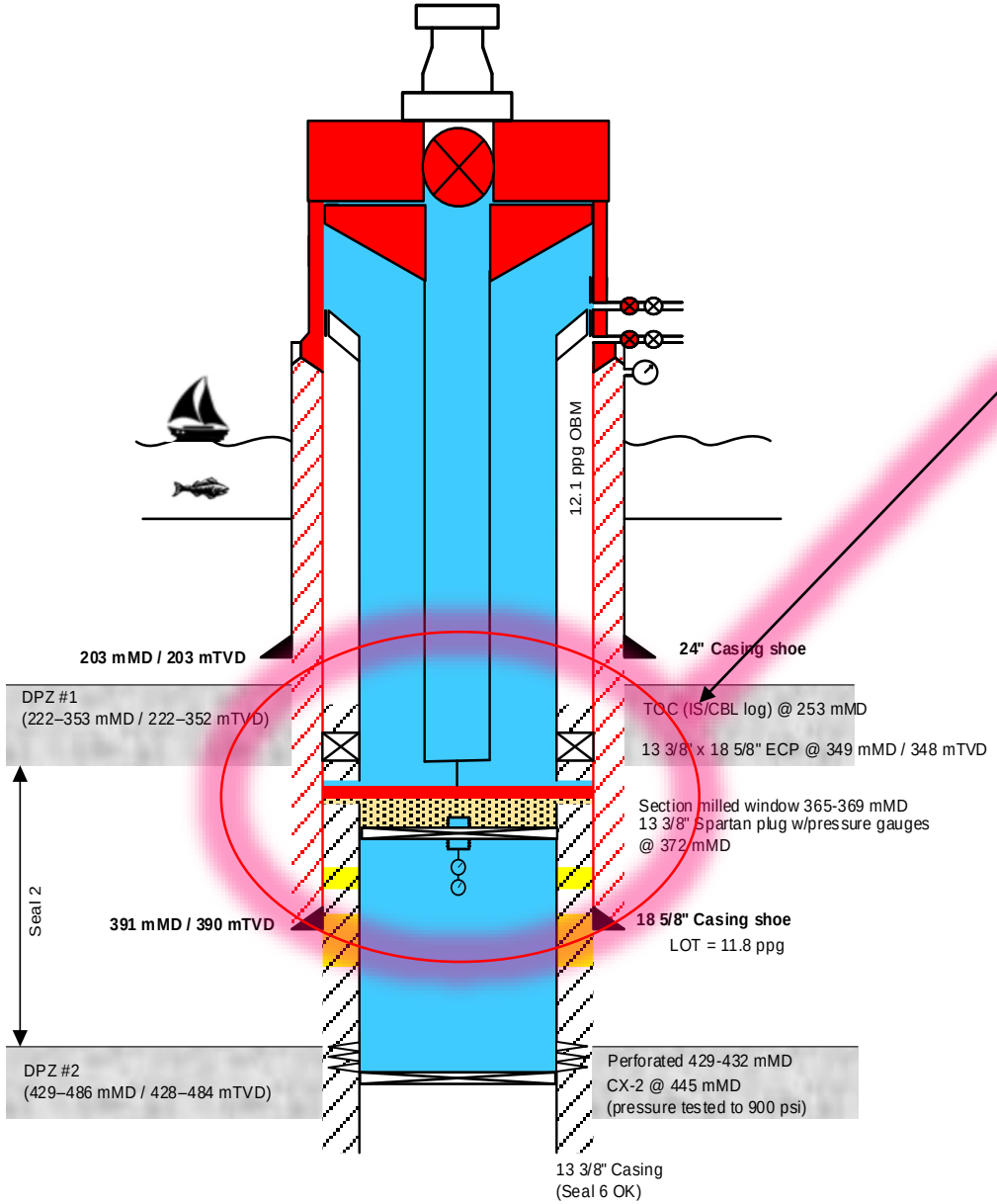
Well status prior to installation



- **Purpose for the Bismuth plug installation is to qualify Bismuth plug in a well as a permanent P&A material - based on test results seen in laboratory. The plan is to monitor the pressure above and below the Bismuth plug for approx. 2 years.**

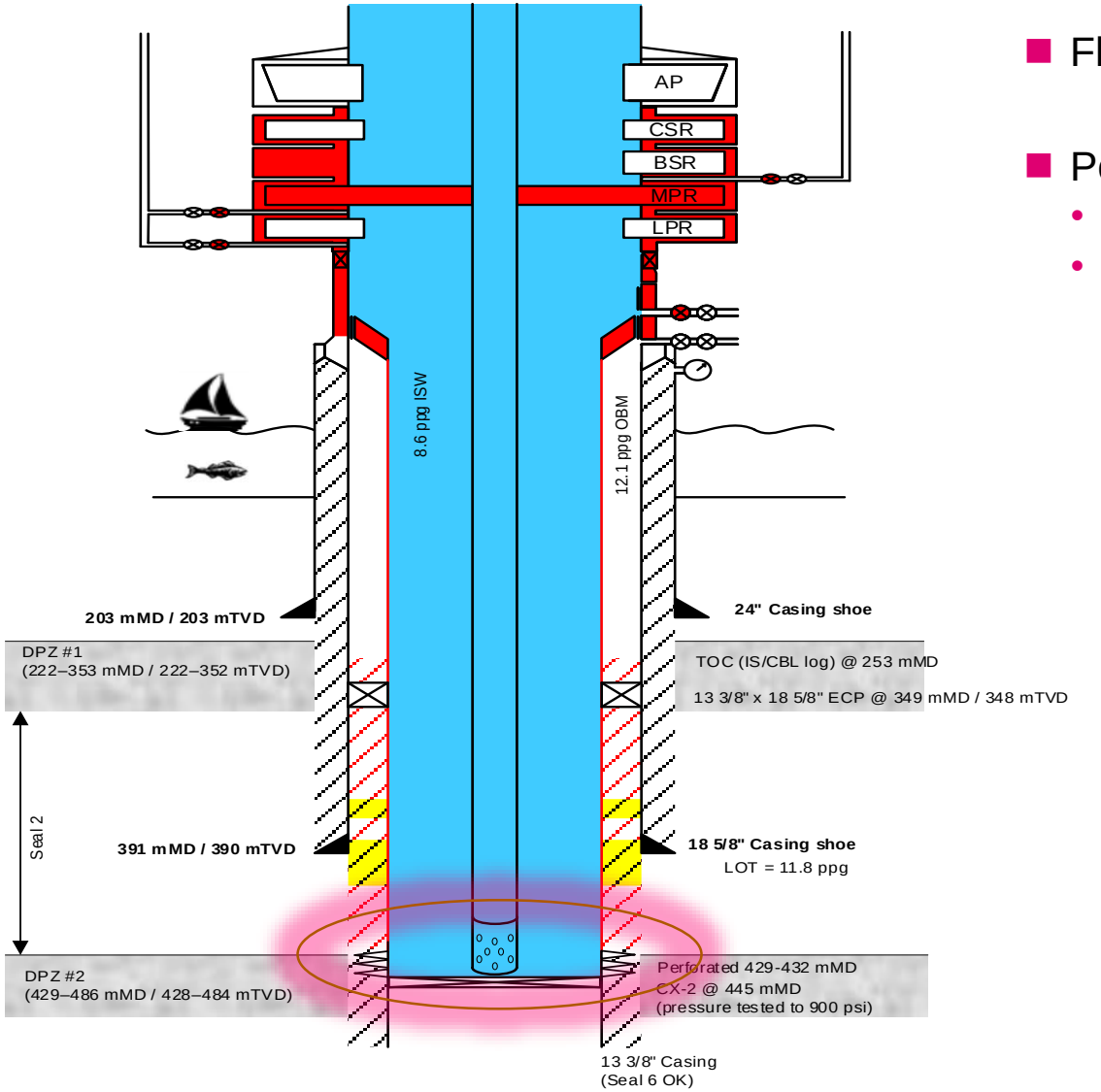
- Well restored up to Seal 6
  - Fluid in well: ISW

This is what we wanted to achieve



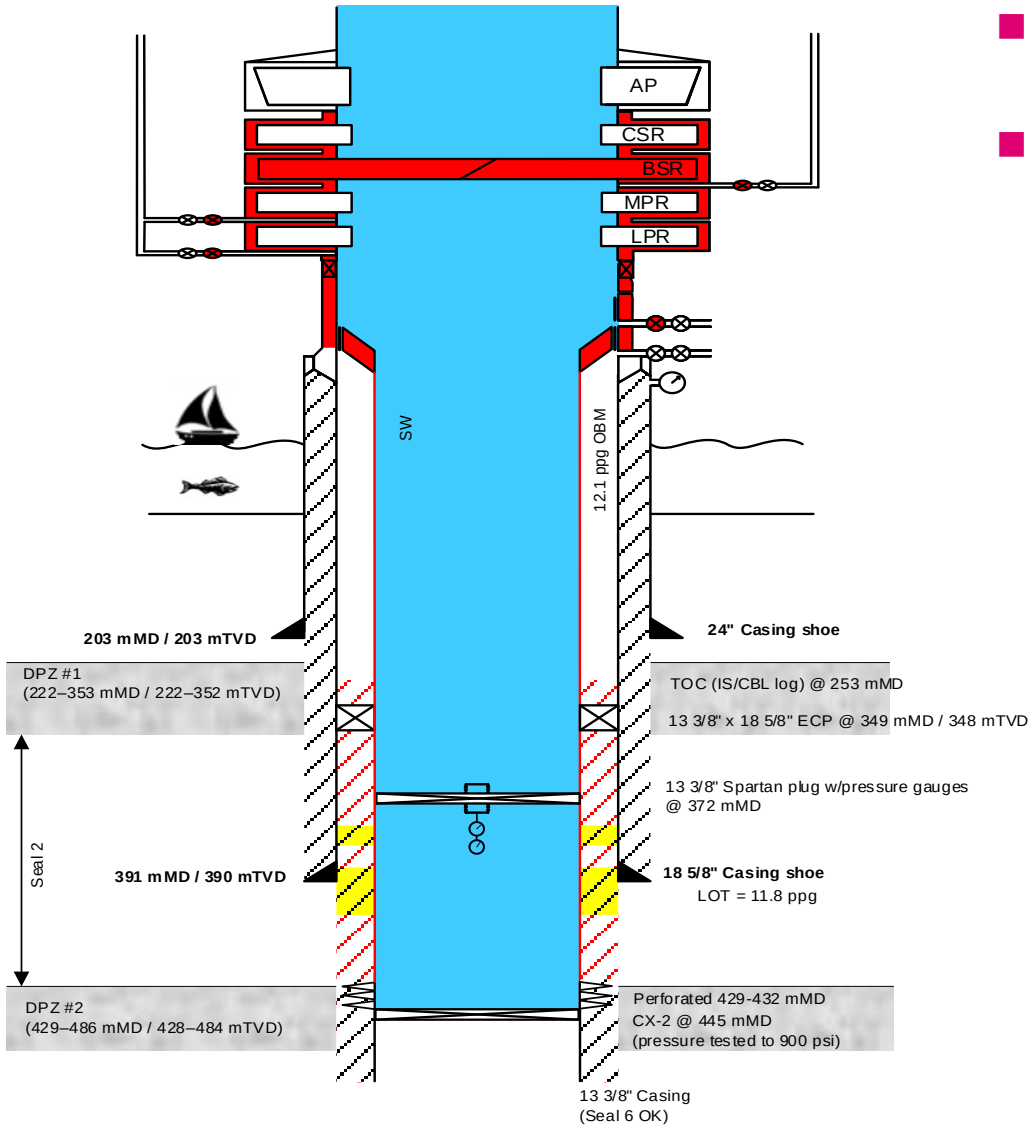
- A Bismuth Plug place across the casing to act as a barrier plug
  - With verification devices installed
    - With the intention to have a retievable system

Perforate top DPZ 2

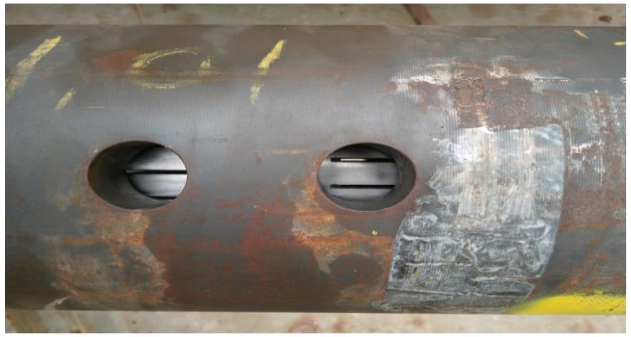


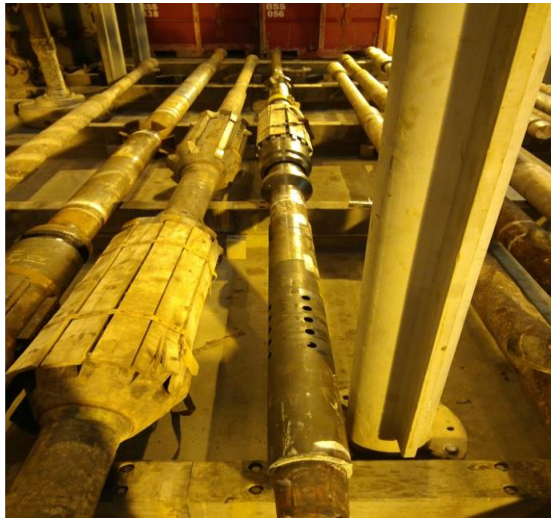
- Fluid: ISW
- Perforate 5 m (427-432 mMD)
  - Displace to SW
  - Perforated 2,5 meter into the DPZ and 2,5 meter into the Seal 2 area

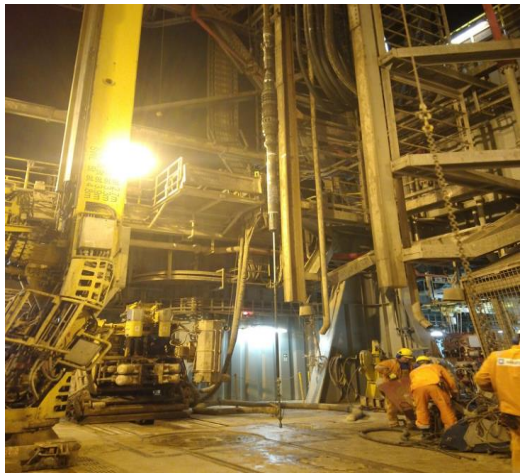
Set “leaking” bridge plug



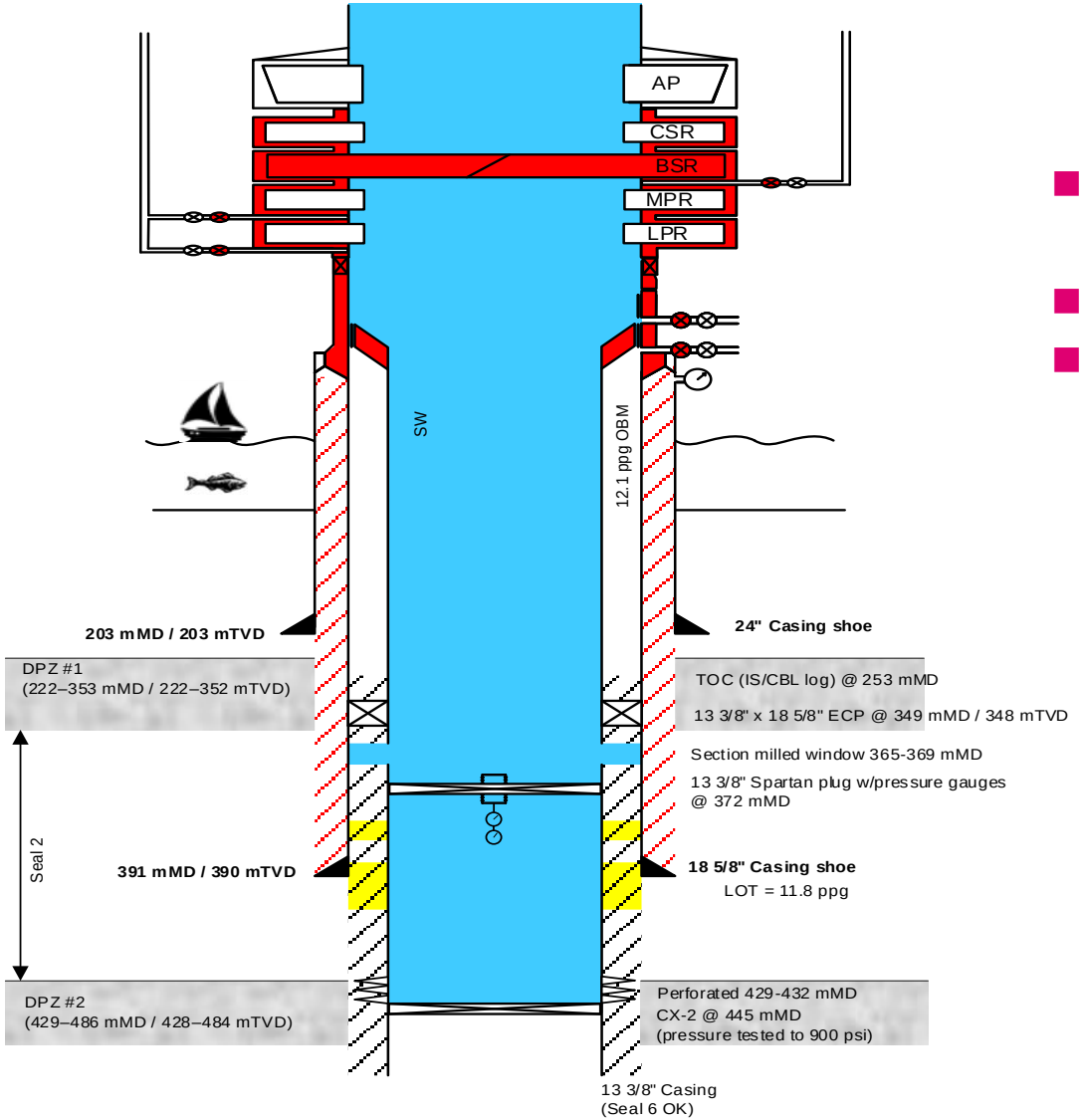
- Fluid: SW
- Two pressure gauges installed below bridge plug
  - Acoustic gauge (Live monitoring)
  - Memory gauge





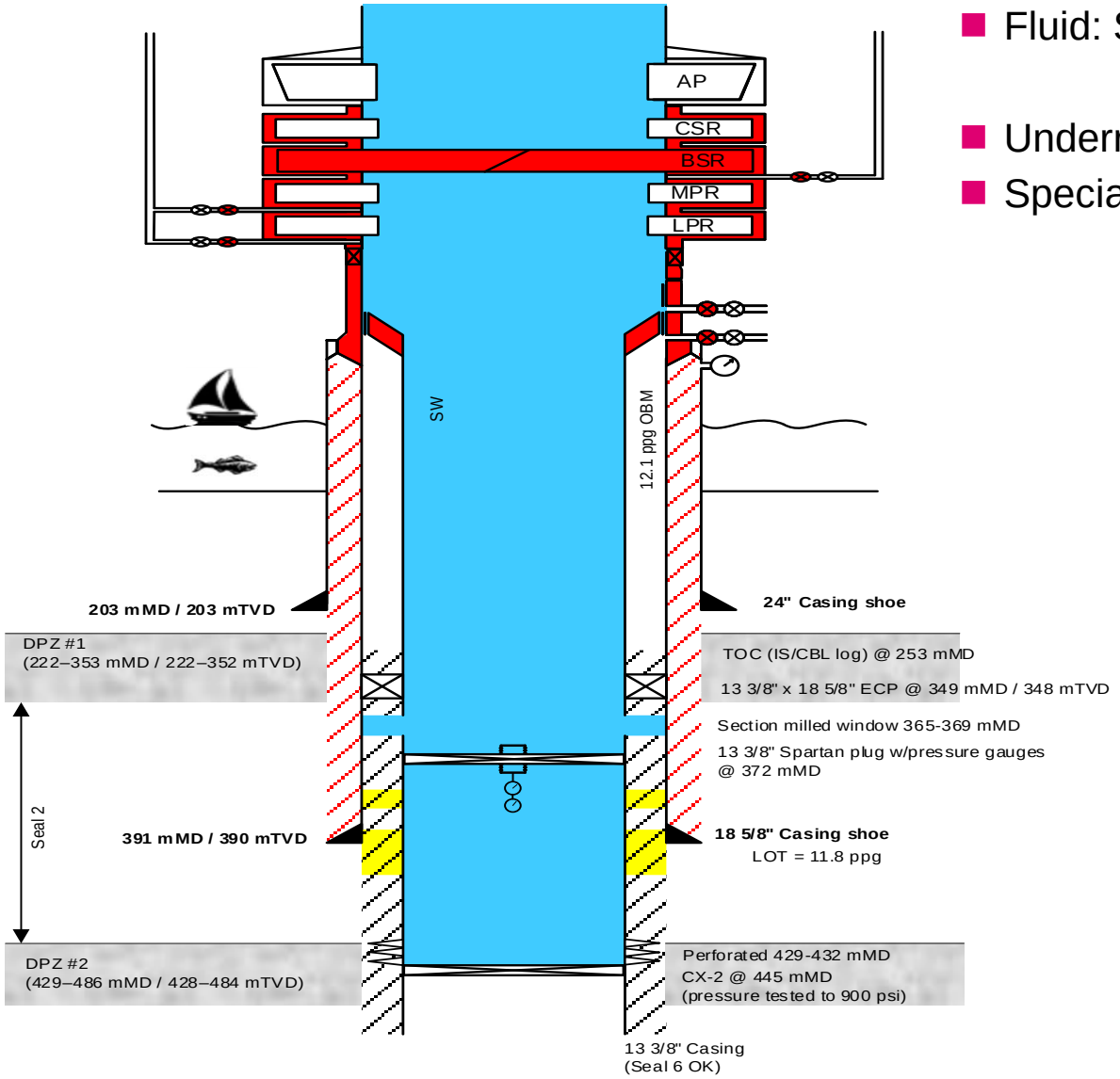


Section mill a 4 meter window



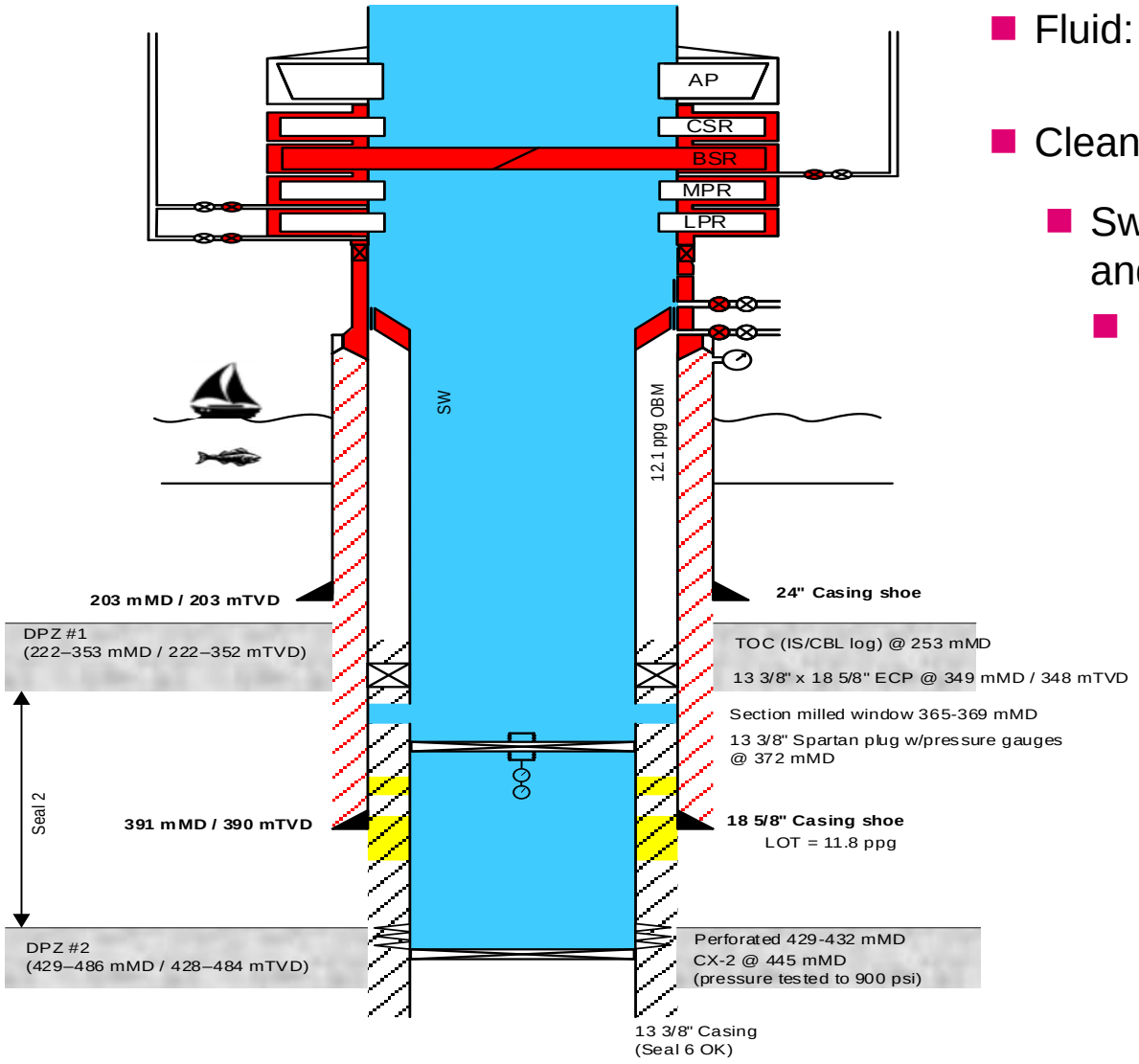
- Fluid: SW w/sweeps
- Cut opening window – 0,5 meter
- Section mill 4 m window (365-369 m)

UR section milled window



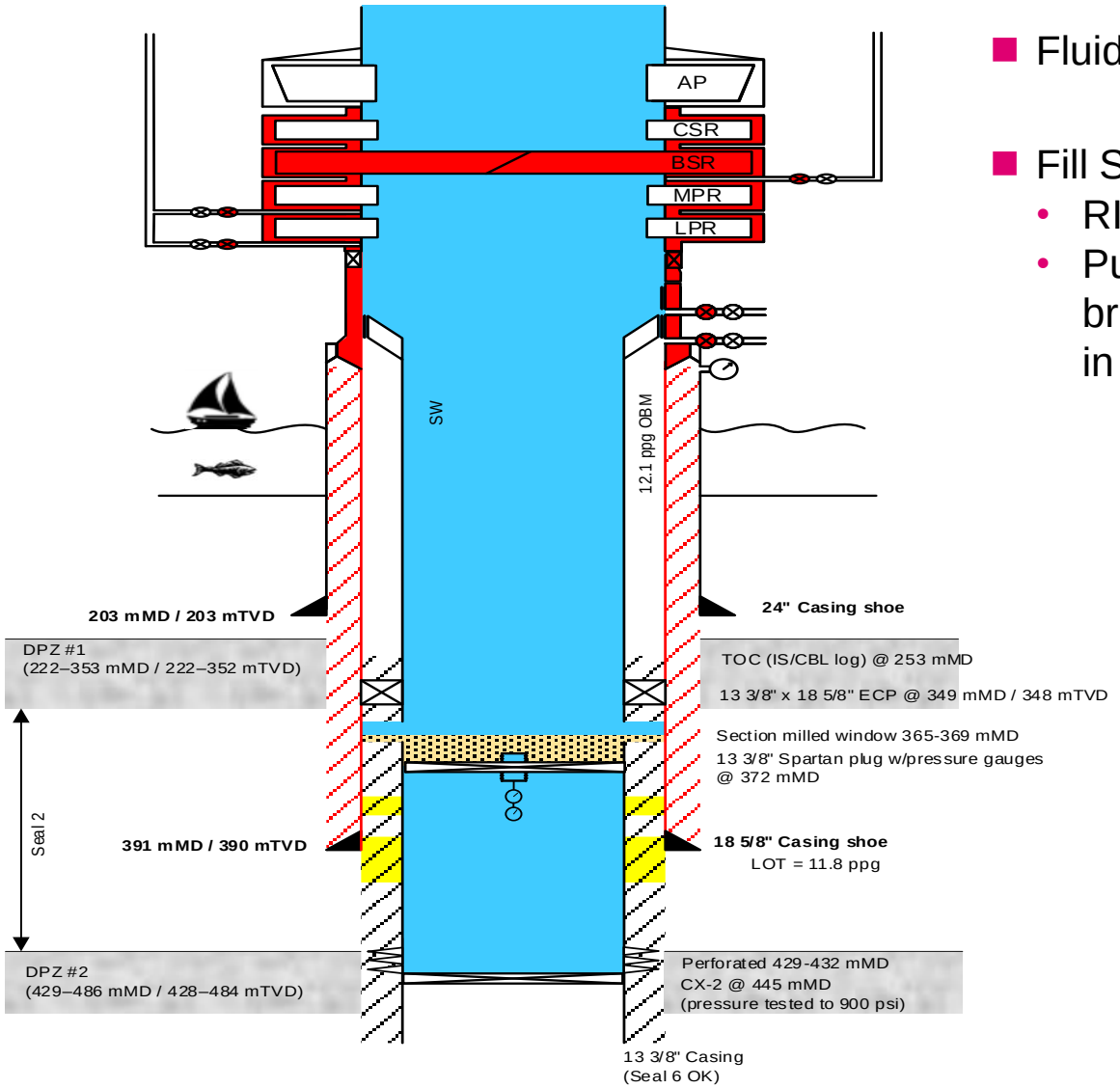
- Fluid: SW w/sweeps
- Underream / polish milled window
- Special designed arms made for this job

Clean out section milled window



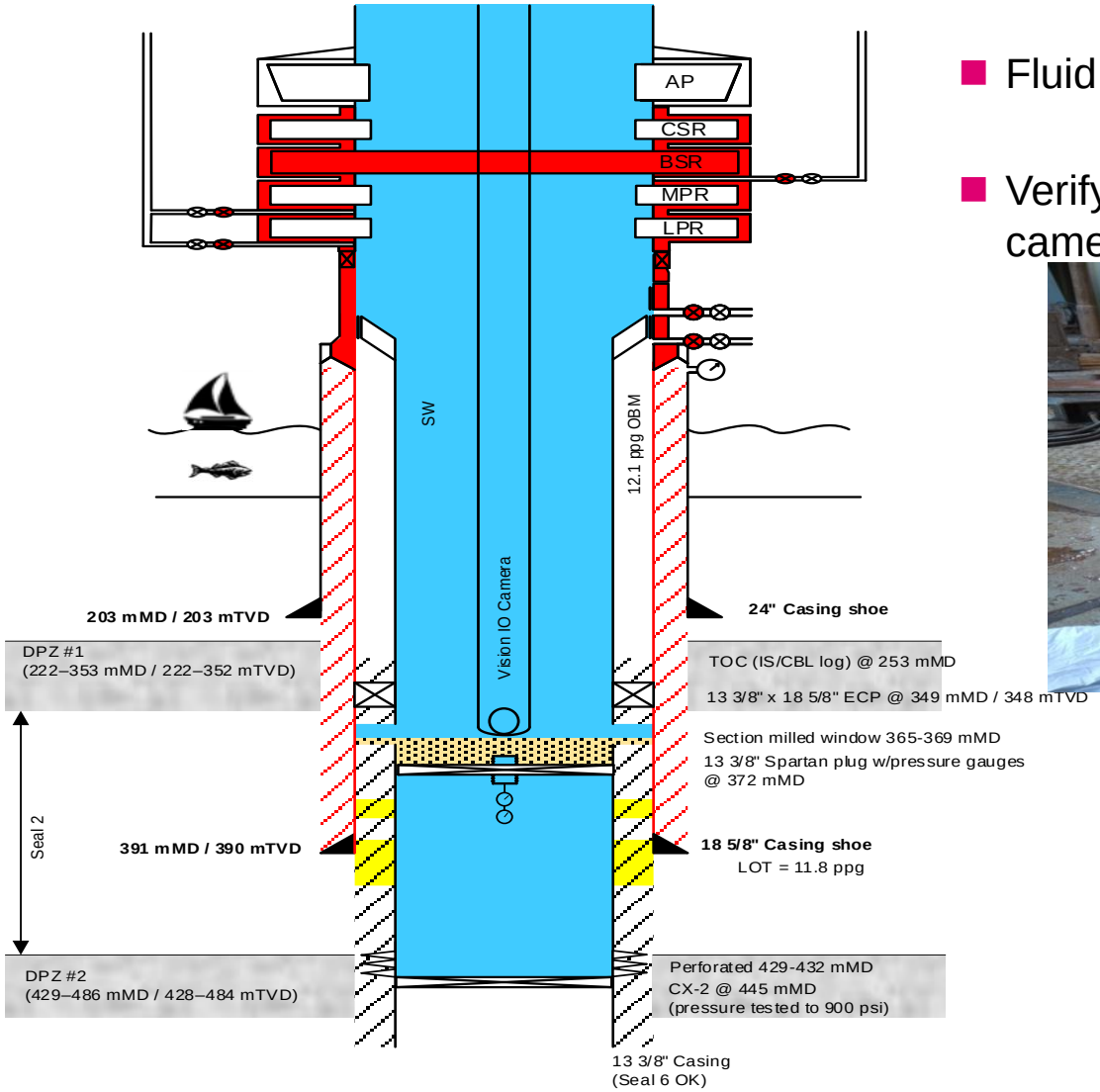
- Fluid: SW
- Clean out section milled window w/modified Tornar tool
  - Swarf removal essential for later recovery of bridge plug and pressure gauges
    - Pumped sweeps

Fill sand on top of plug

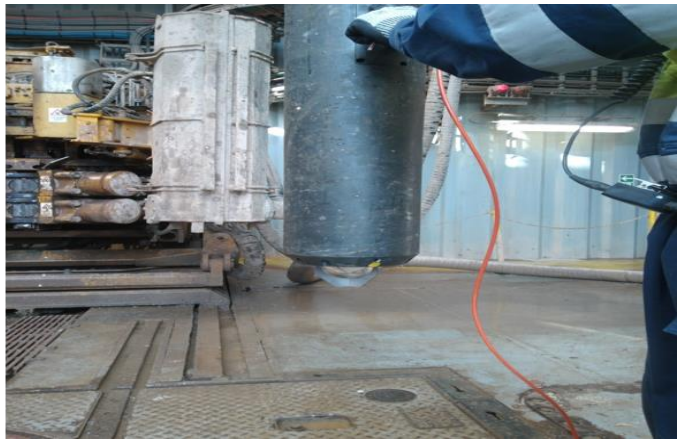


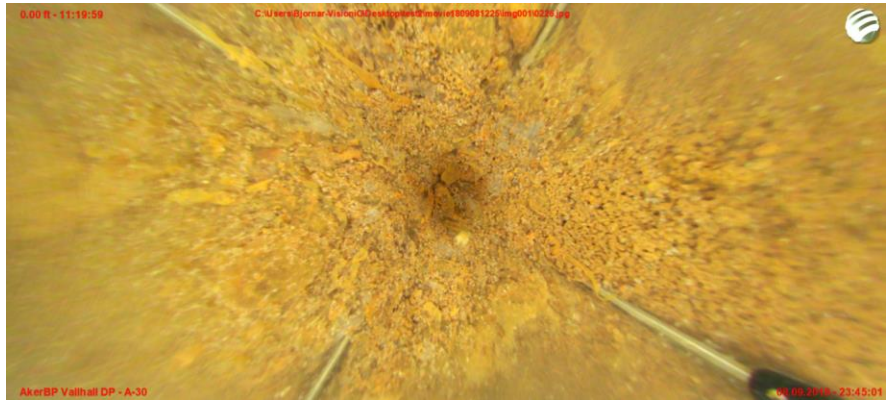
- Fluid: SW
- Fill Sand
  - RIH w/ open ended DP to top of section milled window
  - Pump sand from surface through drillpipe to protect bridge plug fishneck and ensure base of bismuth plug in outer casing
    - Gelled up sand to keep sand in suspension while pumping (to avoid fall

Verify top of sand

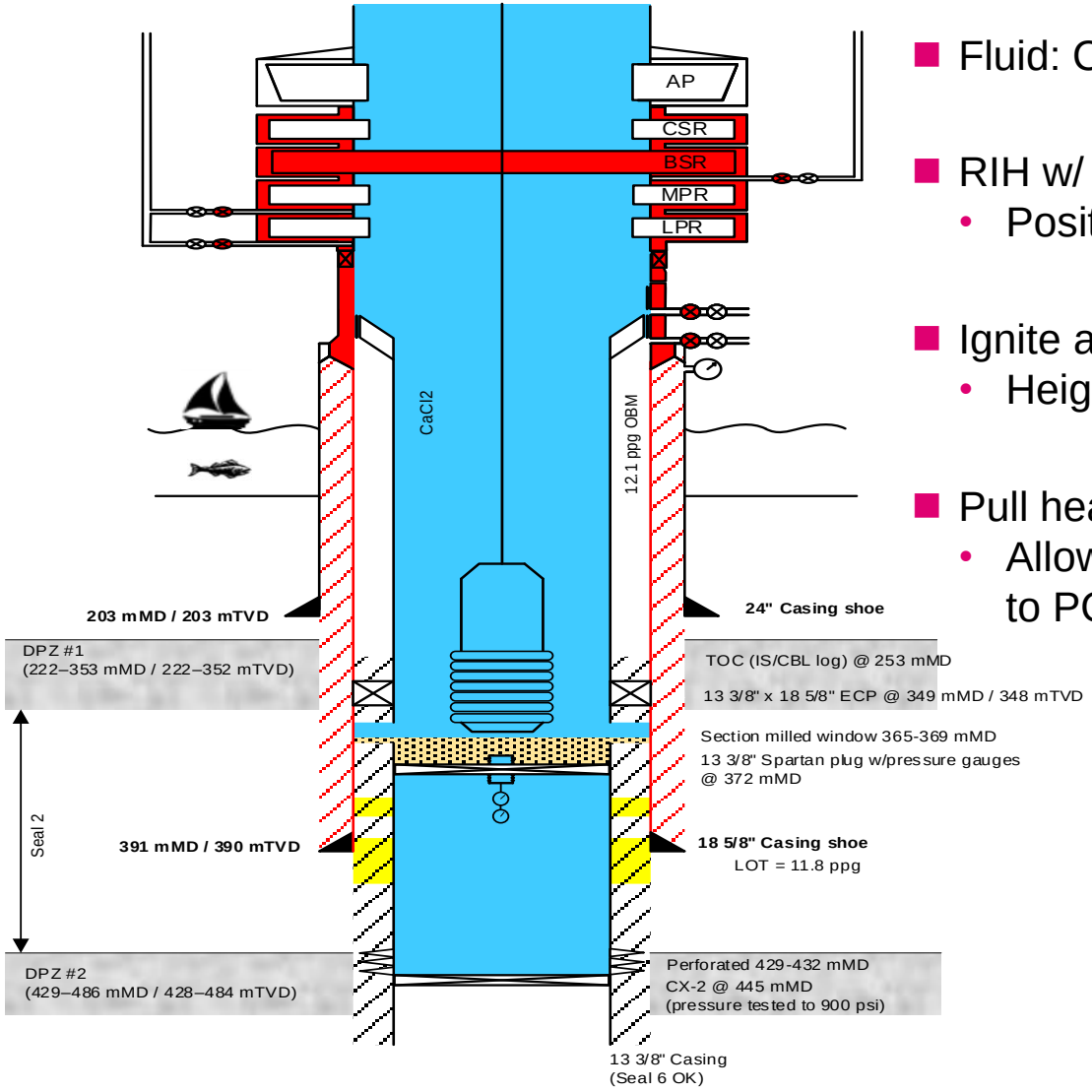


- Fluid: SW
- Verify section milled window and top of sand using camera – run on drillpipe

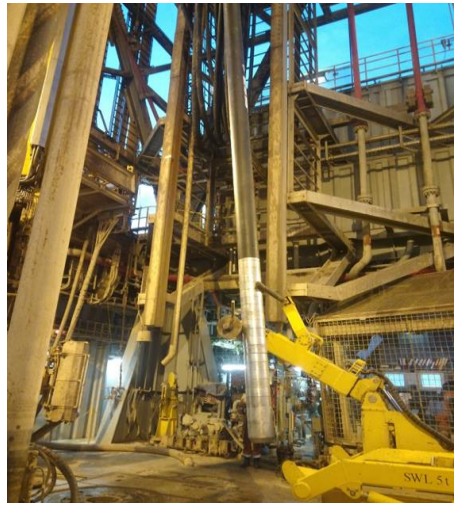




Install Bismuth plug

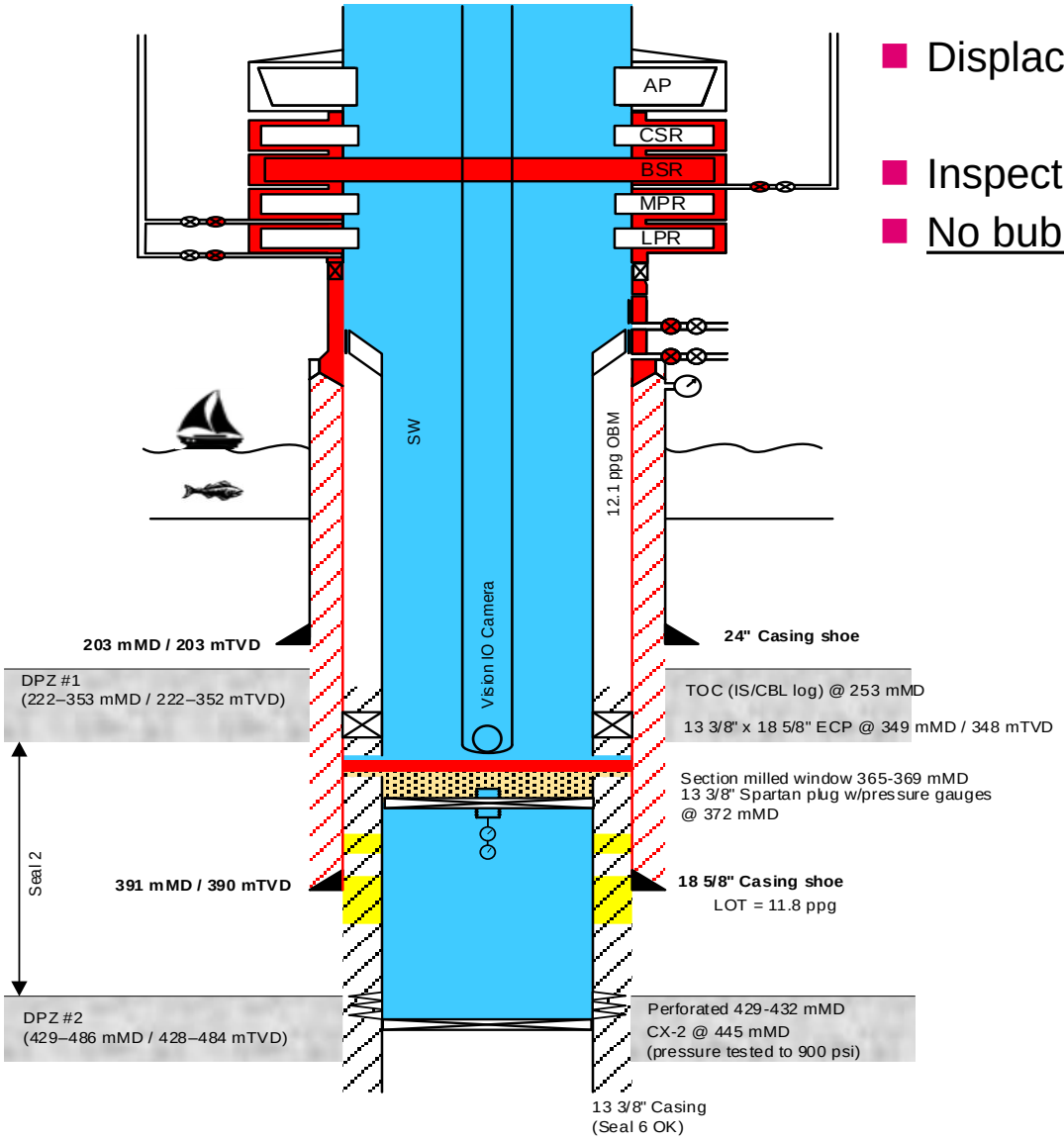


- Fluid: CaCl2
- RIH w/ Bismuth plug on 7/16" monocable
  - Positive tag at correct depth
- Ignite and set Bismuth plug
  - Height of melted Bismuth plug = 2 m
- Pull heater 10 m above melted plug
  - Allow minimun 2 hours for running tool/heater to cool down prior to POOH

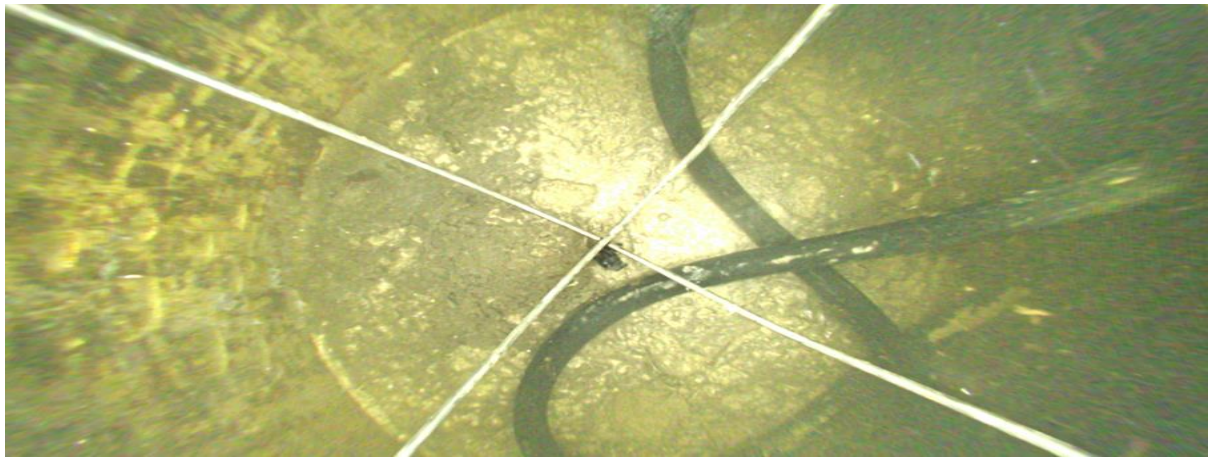


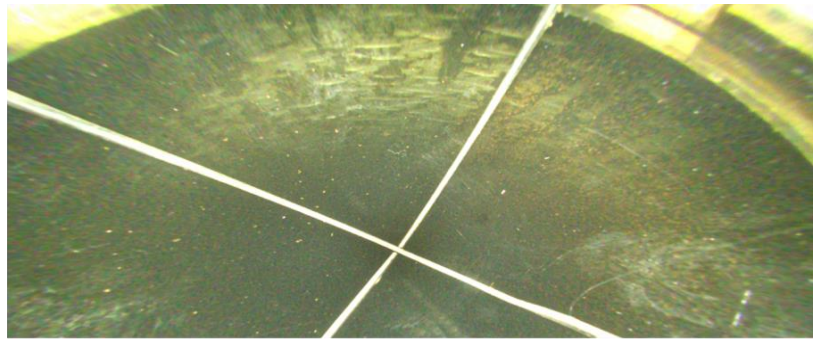
Out of hole with heater

Inspection



- Displaced to drillwater to increase visability
- Inspect bismuth plug and section milled casing
- No bubbles observed

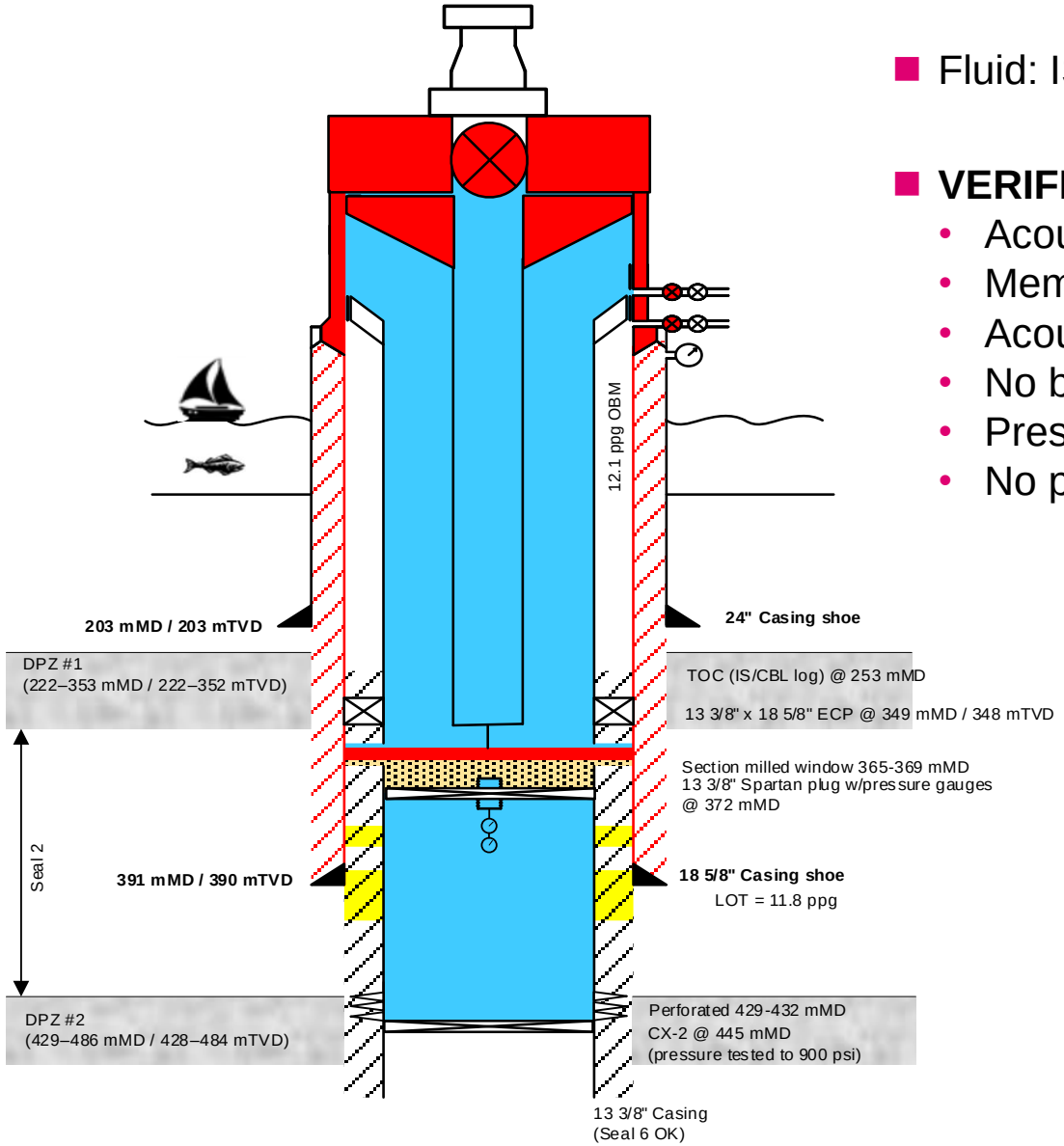




Effect of underreamer

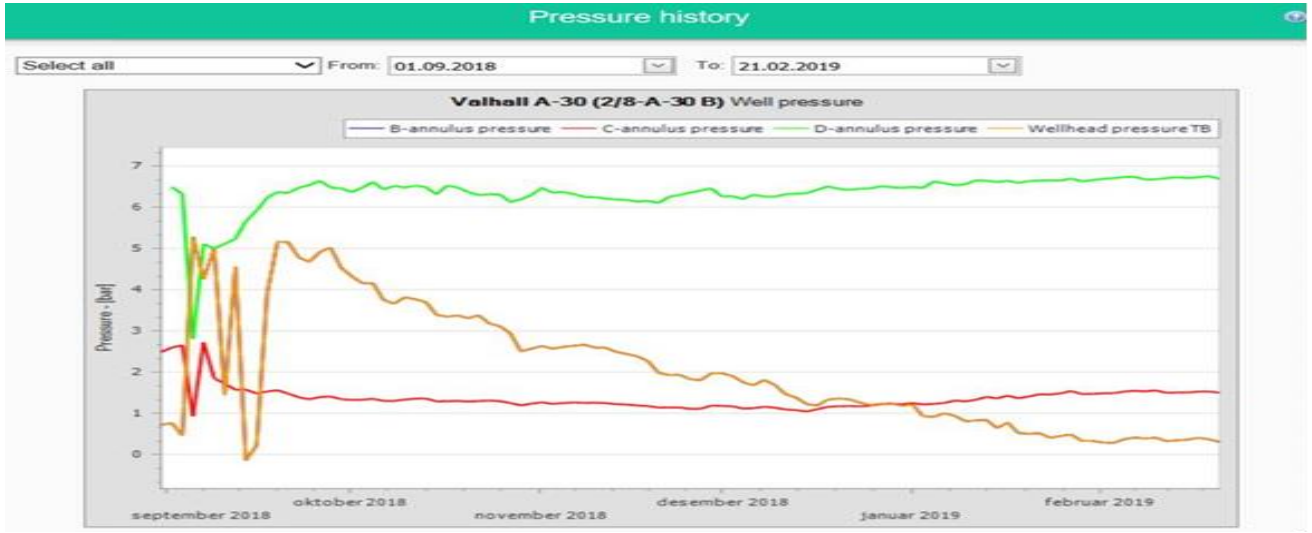
- Verification process – how to qualify Bismuth as a barrier material for P&A

Field verification



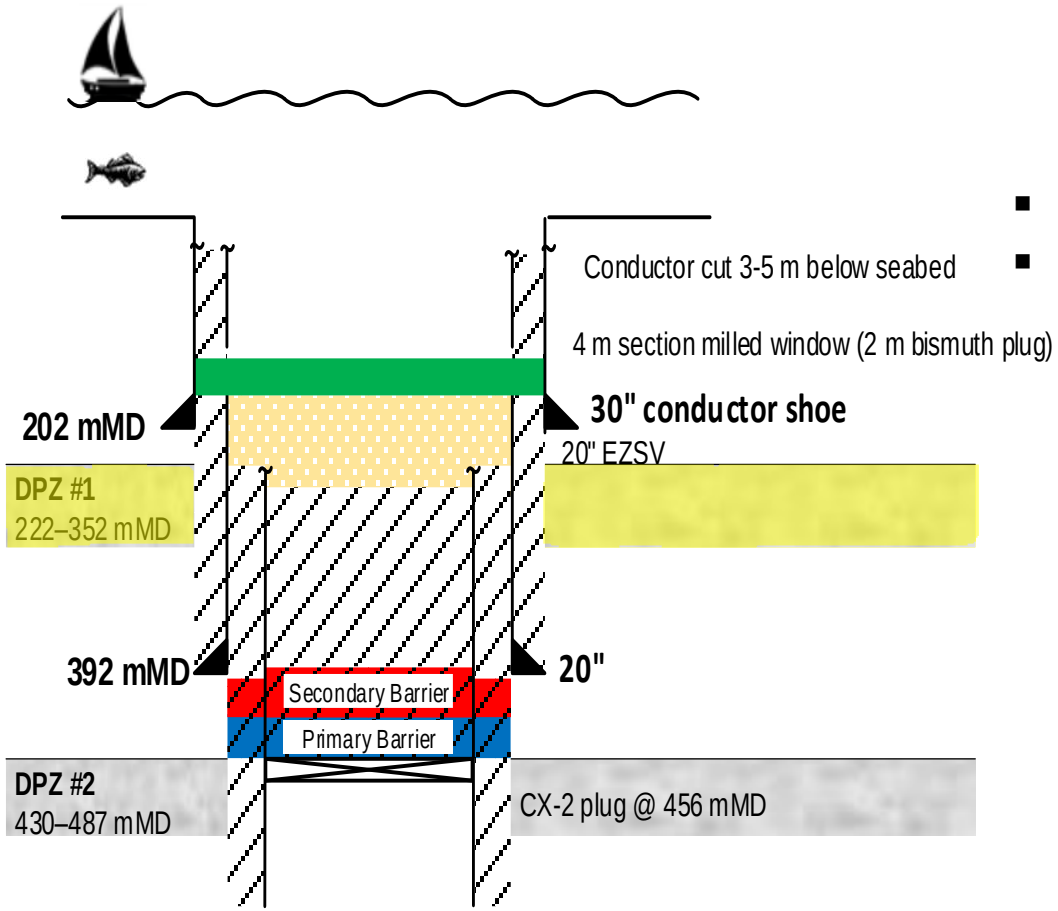
- Fluid: ISW

- **VERIFICATION OF INSTALLED PLUG**
  - Acoustic gauge below plug – curently not connected
  - Memory gauge below plug – active
  - Acoustic gauge installed above plug – active
  - No bubbles detected with camera run above plug
  - Pressure tested plug from above for 1,5 hrs
  - No pressure build up above plug detected since installation



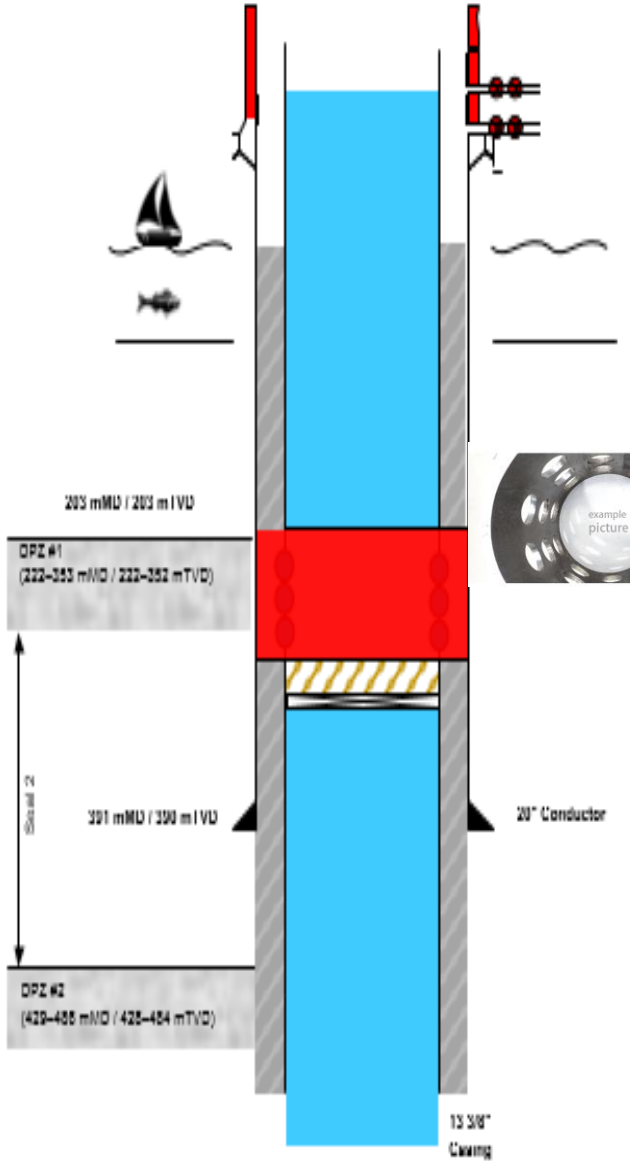
Way Forward

- 20 x 30 Bismuth plug used as an Environmental plug or to «cap» the well prior to cut & pull surface casing and conductors



- Program initiated October 2018
- Testing started March 2019
  - Access to 20 x 30» annulus by section mill a 4 meter window

Bismuth application for wellhead change out



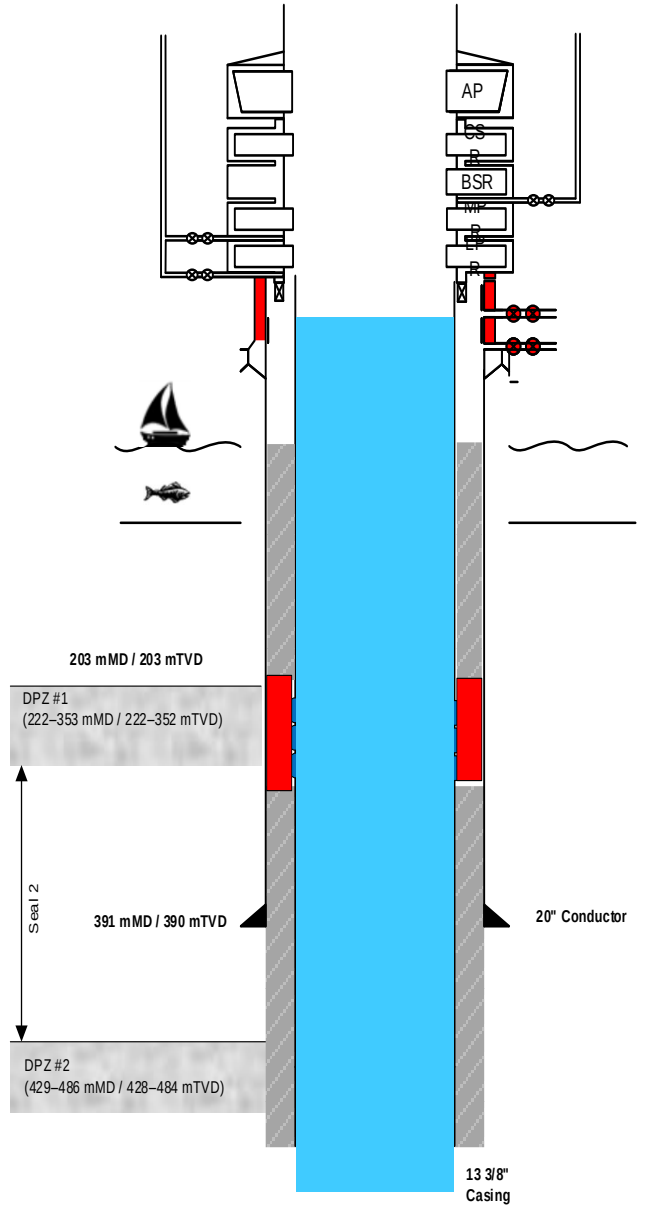
Technologies Required – $(TB)^2$

- Tyrfing

- Bluespark

Tornar

Bisn



University of Stavanger

FACULTY OF SCIENCE AND TECHNOLOGY

MASTER'S THESIS

Study program/Specialization: Petroleum Engineering, Drilling Technology	Spring Semester, 2019 Open
Author: Trine Knutsen	Trine Knutsen (signature of author)

Faculty Supervisor: Kjell Kåre Fjelde

External Supervisors: Egil Thorstensen (Aker BP), Kjetil Vadset (Aker BP)

Title of master`s thesis:

A Novel Approach to Qualifying Bismuth as a Barrier Material

Credits: 30

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https://uis.brage.unit.no/uis-xmlui/handle/11250/2621291

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