# Veslefrikk cessation - Permanent P&A

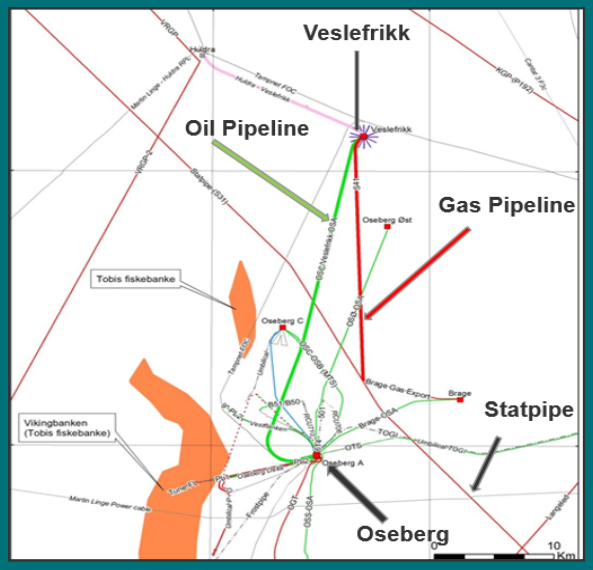
10th Plug and Abandonment Seminar

20.10.2022 Stavanger

# Veslefrikk Permanent P&A cessation project


- Veslefrikk field
- Scope of work
- Preparations
- Strategy
- Execution
- Experiences
- Summary

# Veslefrikk field




| Production License | Equinor Energy AS Operator | Petoro AS | Repsol Norge AS | Wintershall DEA Norge AS |
|---|---|---|---|---|
| PL052 | 18,0% | 37,0% | 27,0% | 18,0% |

| DG 2 | DG 3 | DG 4 |
|---|---|---|
| December 2016 | Q4 2020 (PP&A) | 2027 |

| Key figures | |
|---|---|
| Waterdepth (m) | 175 |
| VFA Topside (tonnes) | 5 500 |
| VFA Jacket (tonnes) | 10 500 |
| VFB Semi-sub (tonnes) | 25 500 |
| Production start | 1989 |
| Number of wells | 24 |
| VFB construction year | 1986 |

| | Original* | Actual** |
|---|---|---|
| Oil (MSm3) | 55,4 | 55,3 |
| Gas (BSm3) | 5,4 | 4,2 |
| NGL (MSm3) | 1,8 | 3,4 |
| Total (MSm3) | 64,2 | 63,0 |

* Recoverable volumes, ref NPD 2022
** Production saleable, ref NPD 2022

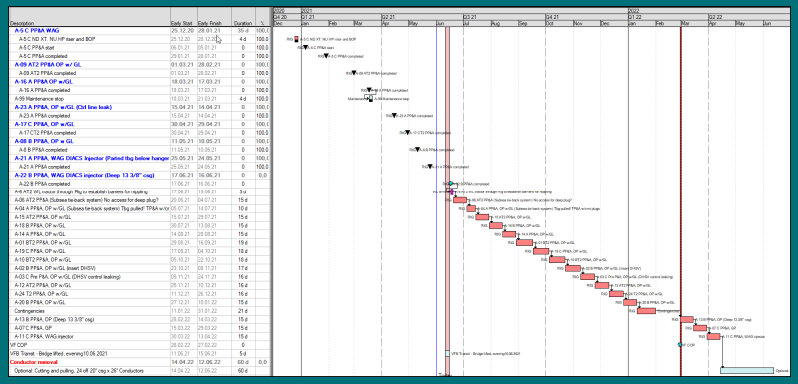
# Permanent P&A

## HSE

- SIF = 0
- LTI = 0

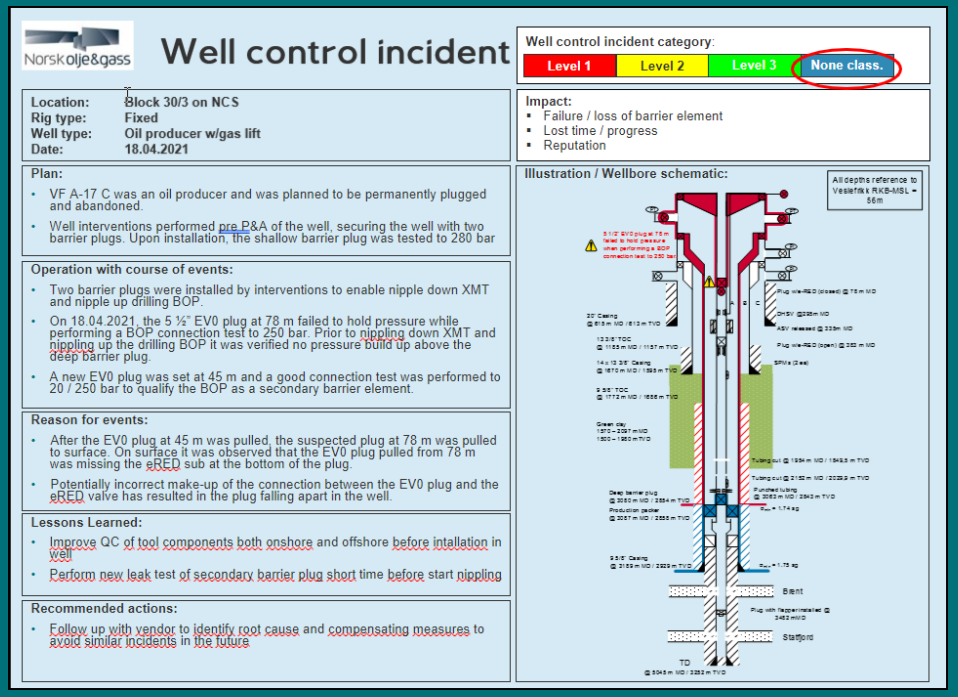
## PP&A completed

- 24 of 24 wells incl 2 w/subsea wellhead + tie-back
- Stops for FG = 0, repair of bridge, main crane, HTV
- Start PP&A 06.01.2022 – End PP&A : 24.05.2022



## Well control

- 1 x Incident, classified as Grey
  - Bottom sub unscrewed from shallow plug as secondary barrier



Norsk olje & gass

**Well control incident**

Well control incident category: Level 1 | Level 2 | Level 3 | None class.

Location: Block 30/3 on NCS
Rig type: Fixed
Well type: Oil producer w/gas lift
Date: 18.04.2021

Impact:
- Failure / loss of barrier element
- Lost time / progress
- Reputation

Plan:
- VF A-17 C was an oil producer and was planned to be permanently plugged and abandoned.
- Well interventions performed pre P&A of the well, securing the well with two barrier plugs. Upon installation, the shallow barrier plug was tested to 280 bar

Operation with course of events:
- Two barrier plugs were installed by interventions to enable nipple down XMT and nipple up drilling BOP.
- On 18.04.2021, the 5 ½" EV0 plug at 78 m failed to hold pressure while performing a BOP connection test to 250 bar. Prior to nippling down XMT and nippling up the drilling BOP it was verified no pressure build up above the deep barrier plug.
- A new EV0 plug was set at 45 m and a good connection test was performed to 20 / 250 bar to qualify the BOP as a secondary barrier element.

Reason for events:
- After the EV0 plug at 45 m was pulled, the suspected plug at 78 m was pulled to surface. On surface it was observed that the EV0 plug pulled from 78 m was missing the eRED sub at the bottom of the plug.
- Potentially incorrect make-up of the connection between the EV0 plug and the eRED valve has resulted in the plug falling apart in the well.

Lessons Learned:
- Improve QC of tool components both onshore and offshore before intallation in well
- Perform new leak test of secondary barrier plug short time before start nippling

Recommended actions:
- Follow up with vendor to identify root cause and compensating measures to avoid similar incidents in the future

Illustration / Wellbore schematic:

All depths reference to Vessel MSL = 56m

# VFA: Small platform, limited deck space

# Well overview and status

PP&A completed 100%;

- 19 of 19 x Oil producer w/ Gas lift
- 1 of 1 x Water injector (incl Subsea WH)
- 2 of 2 x WAG injector
- 2 of 2 x WAG DIACS (SMART wells)
- Total 24 wells including

- 2 of 2 with barriers in deep 13 3/8" csg
- 2 of 2 with tie-back from subsea WH

PP&A milestones

- 06.01.2021 Start A-5 C PP&A, well #1
- 17.02.2022 Cease of production
- 28.02.2022 Pre P&A WL completed
- 24.05.2022 End A-1 BT2 PP&A, well #24

N

equinor

| Slot : 19 | Well: | A-16 A |
|---|---|---|
| Type / ASV: | HAP-TRAC | OP w/GL |
| Production (m3/day) : | | 0 |
| Status : | 6M XT cut | PP&A |
| Flowline/Inst. removed : | | Yes |
| Other equip : | | na |

| Slot : 13 | Well: | A-23 A |
|---|---|---|
| Type / ASV: | HAP-TRAC | OP w/GL |
| Production (m3/day) : | | 0 |
| Status : | 10M XT | PP&A |
| Flowline/Inst. removed : | | Yes |
| Other equip : | | DHLV + VR + MSAS |

| Slot : 7 | Well: | A-24 T2 |
|---|---|---|
| Type / ASV: | AV5 | OP w/GL |
| Production (m3/day) : | | 0 |
| Status : | 6M XT | PP&A |
| Flowline/Inst. removed : | | Yes |
| Other equip | | na |

| Slot : 1 | Well: | A-17 CT2 |
|---|---|---|
| Type / ASV: | AV5 | OP w/GL |
| Production (m3/day) : | | 0 |
| Status : | 6M XT cut | PP&A |
| Flowline/Inst. removed : | | Yes |
| Other equip : | | na |

| Slot : 20 | Well: | A-20 B |
|---|---|---|
| Type / ASV: | AV5 | OP w/GL |
| Production (m3/day) : | | 0 |
| Status : | 10M XT | PP&A |
| Flowline/Inst. removed : | | Yes |
| Other equip : | | DHLV |

| Slot : 14 | Well: | A-7 C |
|---|---|---|
| Type / ASV: | HAP-TRAC | OP w/GL |
| Production (m3/day) : | | 0 |
| Status : | 6M XT | PP&A |
| Flowline/Inst. removed : | | Yes |
| Other equip : | | DHLV |

| Slot : 8 | Well: | A-10 BT2 |
|---|---|---|
| Type / ASV: | AVDLM-CTA | OP w/GL |
| Production (m3/day) : | | 0 |
| Status : | 6M XT | PP&A |
| Flowline/Inst. removed : | | Yes |
| Other equip | | na |

| Slot : 2 | Well: | A-8 B |
|---|---|---|
| Type / ASV: | HAP-TRAC | OP w/GL |
| Production (m3/day) : | | 0 |
| Status : | 6M XT cut | PP&A |
| Flowline/Inst. removed : | | Yes |
| Other equip : | | DHLV |

| Slot : 21 | Well: | A-12 AT2 |
|---|---|---|
| Type / ASV: | AV5 | OP w/GL |
| Production (m3/day) : | | 0 |
| Status : | 6M XT | PP&A |
| Flowline/Inst. removed : | | Yes |
| Other equip : | | DHLV |

| Slot : 15 | Well: | A-11 C |
|---|---|---|
| Type / ASV: | na | WAG |
| Production (m3/day) : | | 0 |
| Status : | 10M XT | PP&A |
| Flowline/Inst. removed : | | Yes |
| Other equip : | | na |

| Slot : 9 | Well: | A-19 C |
|---|---|---|
| Type / ASV: | AV5 | OP w/GL |
| Production (m3/day) : | | 0 |
| Status : | 6M XT | PP&A |
| Flowline/Inst. removed : | | Yes |
| Other equip | | DHLV |

| Slot : 3 | Well: | A-15 AT2 |
|---|---|---|
| Type / ASV: | HAP-TRAC | OP w/GL |
| Production (m3/day) : | | 0 |
| Status : | 6M XT | PP&A |
| Flowline/Inst. removed : | | Yes |
| Other equip : | | DHLV |

| Slot : 22 | Well: | A-13 BY2 |
|---|---|---|
| Type / ASV: | AV6 | OP w/GL MLT |
| Production (m3/day) : | | 0 |
| Status : | 10M XT | PP&A |
| Flowline/Inst. removed : | | Yes |
| Other equip : | | na |

| Slot : 16 | Well: | A-21 A |
|---|---|---|
| Type / ASV: | na | WAG DIACS |
| Production (m3/day) : | | 0 |
| Status : | 10M XT | PP&A |
| Flowline/Inst. removed : | | Yes |
| Other equip : | | na |

| Slot : 10 | Well: | A-2 B |
|---|---|---|
| Type / ASV: | HAP-TRAC | OP w/GL |
| Production (m3/day) : | | 0 |
| Status : | 6M XT | PP&A |
| Flowline/Inst. removed : | | Yes |
| Other equip | | SS WH +MSAS+MSAS |

| Slot : 4 | Well: | A-4 A |
|---|---|---|
| Type / ASV: | na | OP w/GL |
| Production (m3/day) : | | 0 |
| Status : | XT removed | PP&A |
| Flowline/Inst. removed : | | Yes |
| Other equip : | | SS WH |

| Slot : 23 | Well: | A-3 C |
|---|---|---|
| Type / ASV: | HAP-TRAC | OP w/GL |
| Production (m3/day) : | | 0 |
| Status : | 6M XT | PP&A |
| Flowline/Inst. removed : | | Yes |
| Other equip : | | SS WH + DHLV |

| Slot : 17 | Well: | A-5 C |
|---|---|---|
| Type / ASV: | na | WAG |
| Production (m3/day) : | | 0 |
| Status : | 10M XT | PP&A |
| Flowline/Inst. removed : | | Yes |
| Other equip : | | SS WH |

| Slot : 11 | Well: | A-1 BT2 |
|---|---|---|
| Type / ASV: | AV5 | OP w/GL |
| Production (m3/day) : | | 0 |
| Status : | 10M XT | PP&A |
| Flowline/Inst. removed : | | Yes |
| Other equip | | SS WH + DHLV |

| Slot : 5 | Well: | A-18 B |
|---|---|---|
| Type / ASV: | HAP-TRAC | OP w/GL |
| Production (m3/day) : | | 0 |
| Status : | 10M XT | PP&A |
| Flowline/Inst. removed : | | Yes |
| Other equip : | | na |

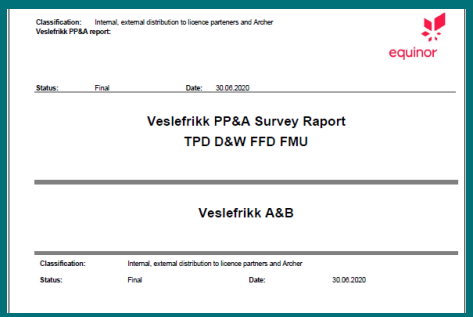
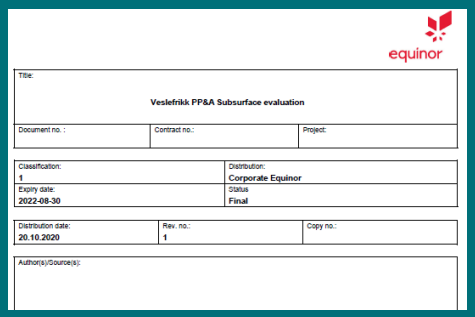
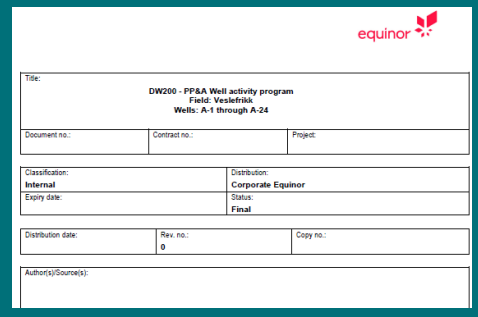
| Slot : 24 | Well: | A-9 AT2 |
|---|---|---|
| Type / ASV: | AVDLM-CTA | OP w/GL |
| Production (m3/day) : | | 0 |
| Status : | 6M XT | PP&A |
| Flowline/Inst. removed : | | Yes |
| Other equip : | | na |

| Slot : 18 | Well: | A-6 AT2 |
|---|---|---|
| Type / ASV: | na | WI |
| Production (m3/day) : | | 0 |
| Status : | 10M XT | PP&A |
| Flowline/Inst. removed : | | Yes |
| Other equip : | | SS WH |

| Slot : 12 | Well: | A-22 B |
|---|---|---|
| Type / ASV: | na | WAG DIACS |
| Production (m3/day) : | | 0 |
| Status : | 10M XT | PP&A |
| Flowline/Inst. removed : | | Yes |
| Other equip : | | na |

| Slot : 6 | Well: | A-14 A |
|---|---|---|
| Type / ASV: | HAP-TRAC | OP w/GL |
| Production (m3/day) : | | 0 |
| Status : | 6M XT | PP&A |
| Flowline/Inst. removed : | | Yes |
| Other equip : | | MSAS(+VR) |

# Preparation and main studies

| Discharge Permit | Ready for Operation | Subsurface Evaluation | Activity Program |
|---|---|---|---|
|  |  |  |  |
| • Application<br>• Meetings with Mdir<br>• Approval | • Establish status of the drilling facilities<br>• Identify equipment and systems requiring corrective actions | • Cross disciplinary report with personnel from operational geology, rock mechanics, geophysics, reservoir technology and drilling | • Scope of work, 24 wells<br>• Pre P&A operations<br>• Pull tubing/casing<br>• Verify barriers<br>• Establish P&A barriers |

# HSE exposure

| NORM /LRA /LSA | Benzene /VOC | H2S |
|---|---|---|
|  |   |   |
| • Normally Occurring Radioactive Material (NORM)<br>• Establish procedures for measurements and handling | • Benzene, VOC and toxic fumes<br>• Personal VOC detectors<br>• PPE availability<br>• Benzene detectors available | • H2S specialist services |

# Preparation for Operation

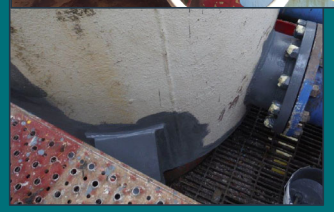
- Dropped object inspection in derrick
- Winches and man riders Certification


Condition monitoring Report

KARSTEN MOHOLT







VIRVELSTRØM RAPPORT
EDDY CURRENT REPORT

OCEANEERING

| | | | |
|---|---|---|---|
| Kunde PO/Customer PO<br>PO: 4590189933, AO: 25254763 | Vårt prosjektnr./Our project no.<br>0000180463 | | Rapportnr / Report no<br>1009001 | Rev<br>0 |
| Kunde/Client<br>Archer AS | Antall vedlegg/Appendixes<br>1 | | Testdato/Date of test<br>2020-09-02 til/to 2020-09-03 | |
| Adresse/Address<br>Postboks 338 | Prosedyre/Procedure<br>INS-PRO-400-NO, rev. 3 | | Aksept standard/Accept std.<br>INS-TEC-401-NO, rev. 2 | |
| Postaddresse / Postal address<br>4002 STAVANGER | Omfang/Extent<br>Se vedlagte bilder | | Resultat/Result<br>Akseptert/Accepted | |
| Kontaktperson/Supervisor<br>Per Egil Refvik | Utstyr/Equipment<br>Phased 3, ID 3194 | | Materiale/Material<br>CS | |
| Undersøkelsessted/Test site<br>Vosslvikk A | Tegning nr./Drawing No.<br>Se vedlagte bilder. | | | |
| Inspeksjon av/Inspection of<br>Skiddejekker, hoved og travers, 1120-10-BM01A, 01B, 02A og 02B. | | | | |
| Overflate/Surface<br>Sons sveist | Sveisemetode/Welding proc | Fugetype/Joint | Varmebehandlet/Heattreated | |
| Materialtykk./Material thick. | Referanseblokk/Ref. block<br>STD | Referansefeil/Ref. defect<br>0,5/ 1,0/ 2,0 mm dybde | Rapporteringsnivå/Rep. level<br>50% av 1mm ref. | |

| Sonde/Probe | Frekvens/ Frequency | Fase/Phase | Alarmnivå/ Alarmlevel | Forsterkning/ Gain | X:Y akse/X:Y axis | Program nr./ Program No. |
|---|---|---|---|---|---|---|
| B0DP01MB1P | 100 MHz | 16 | Filter DC/ 300 | 40 dB | 70/ -10 | |

Anmerkninger/Comments
Resultat/Results

Det er utført virvelstrømsinspeksjon på ikkomlige plasser og visuell inspeksjon på sveiser og stressområder, se vedlagte bilder.
Det er notert overflatekorrosjon og overflatebelegg er flasset på noen plasser, se bilder.

Resultat:

Ingen indikasjoner eller deformasjoner påvist ved inspeksjon.

# Veslefrikk drilling systems and equipment - Status

Well control equipment

- BOP and HP risers - 5 yr certification
- BOP control unit verification
- Accumulator bottles serviced and certified

Established extensive and detailed PM/CM plan

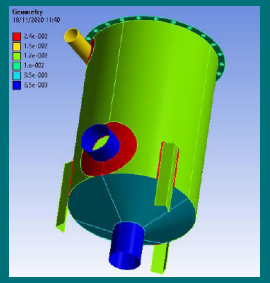
- Vibration analysis of DW, DDM, MPs, Sheaves
- NDT of drilling equipment
- Annual verification of lifting appliances
- Perform service company rig surveys

General Other

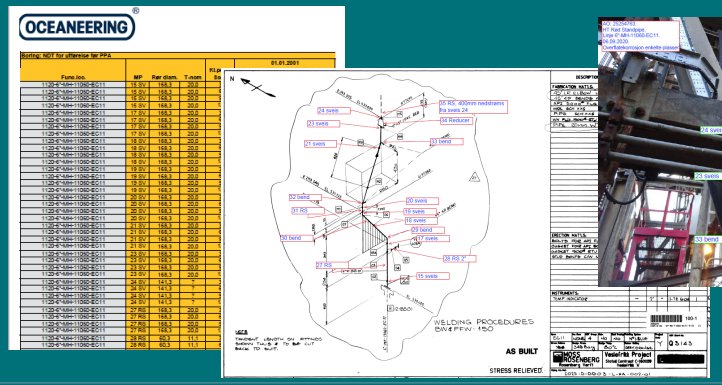
- Replaced lightning fixtures in drilling areas
- Established contingency plans for main risks
- Video inspection and certification of HP hoses

Corrective maintenance / Operational limitations

- Poorboy – Strengthen integrity in pitting areas

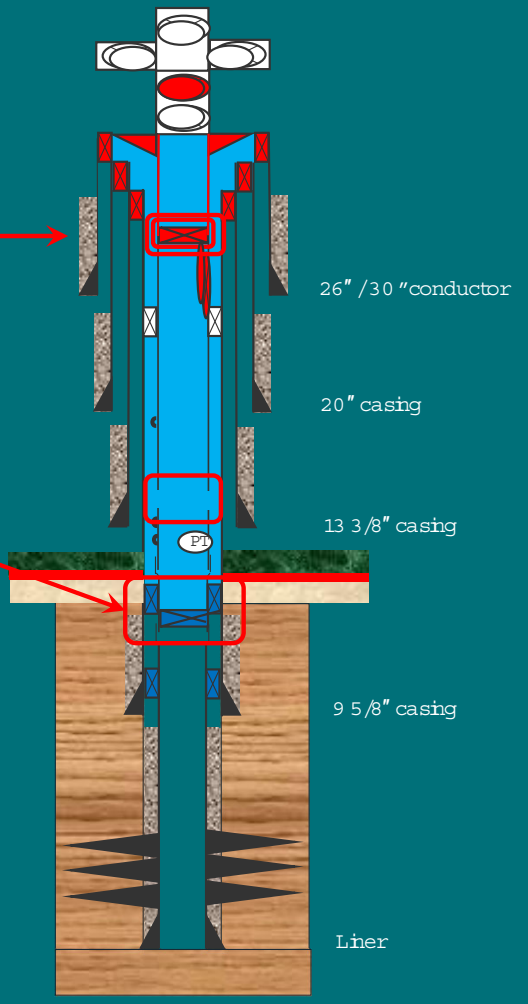


- Red stand pipe – Reduced operating pressure 280 bar

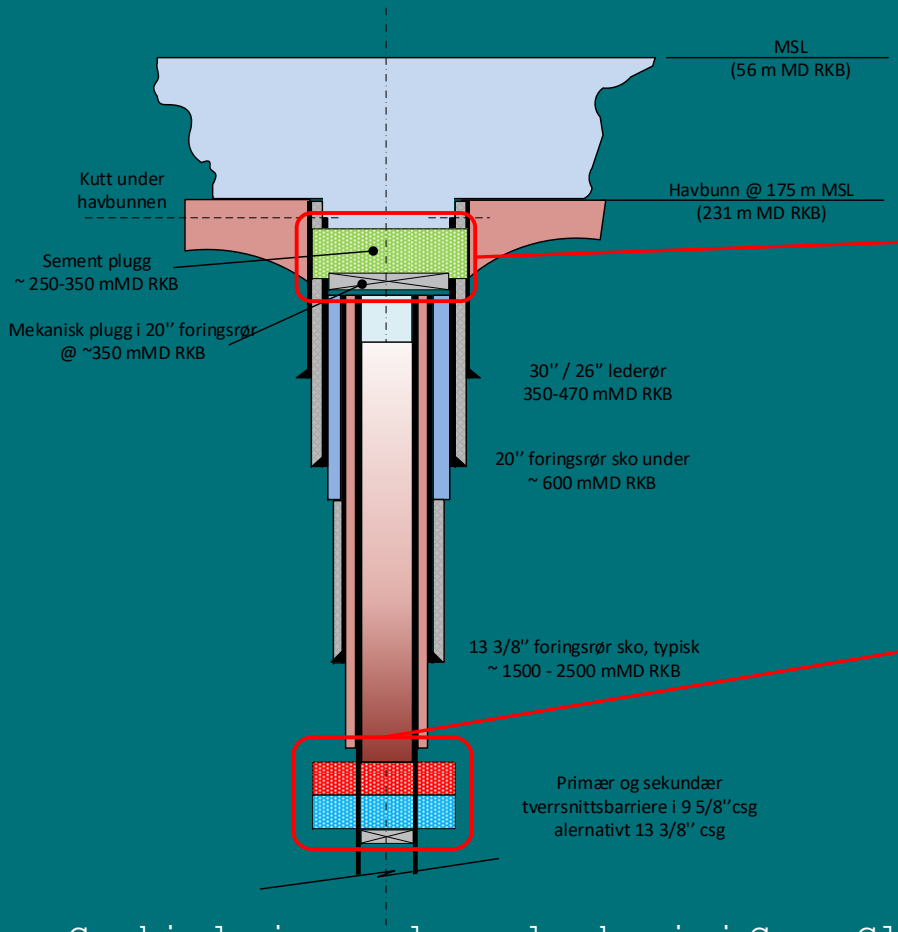


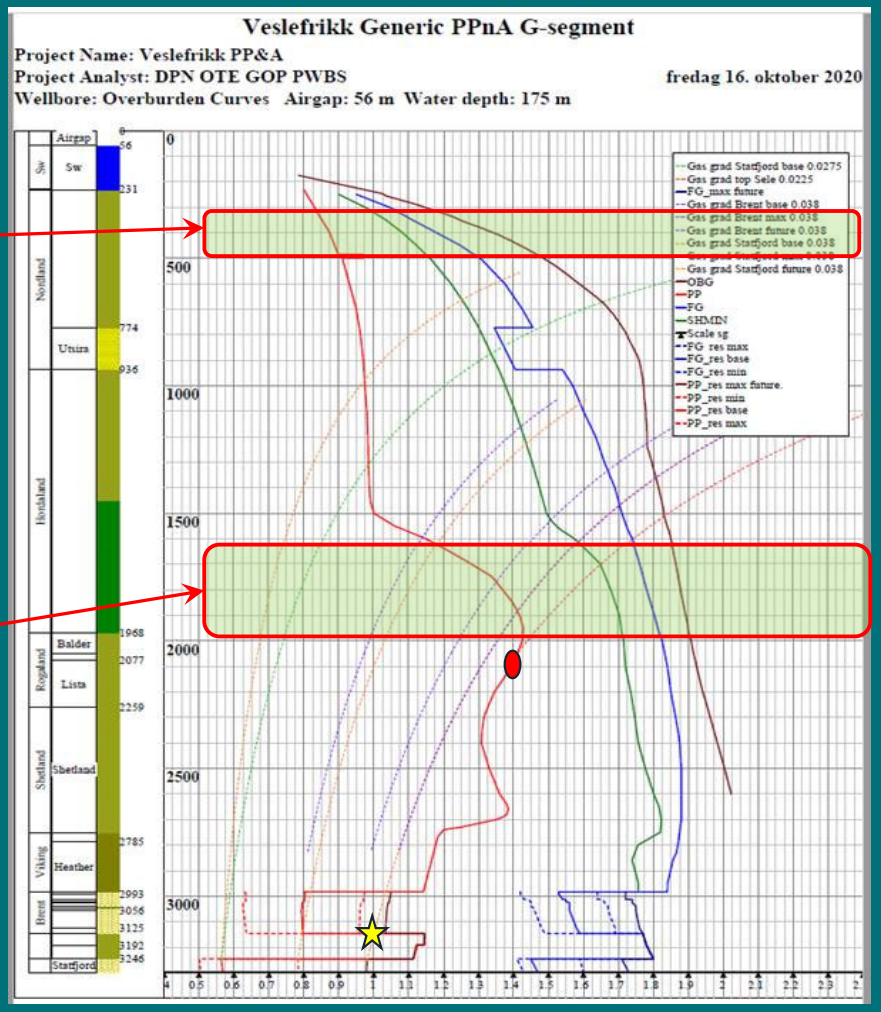
# Pre P&A – Prepare for rig operation

- Secondary barrier - Shallow plug
- Primary barrier – Deep plug
  - Alternative :Pumping weighted fluid
  - Perforate or cut tubing
  - Displace tubing and A-annulus to sea water
  - Release/prepare for pulling ASV and tubing
- Well intervention performed in parallel with PP&A rig operations when possible
  - 2 wells performed through rig on rig time



# PP&A strategy – Barriers

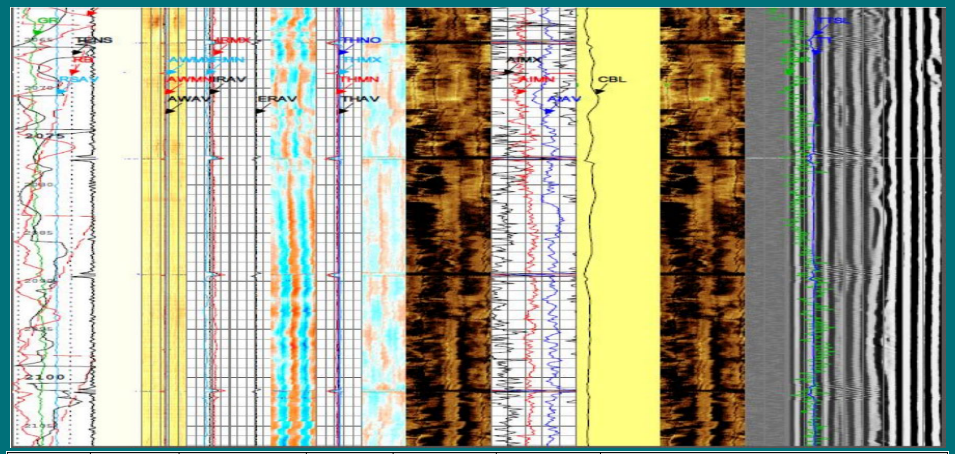



- Combined primary and secondary barrier in Green Clay
- Shallow plug isolating wellfluids from sea

# Verification of annulus barrier

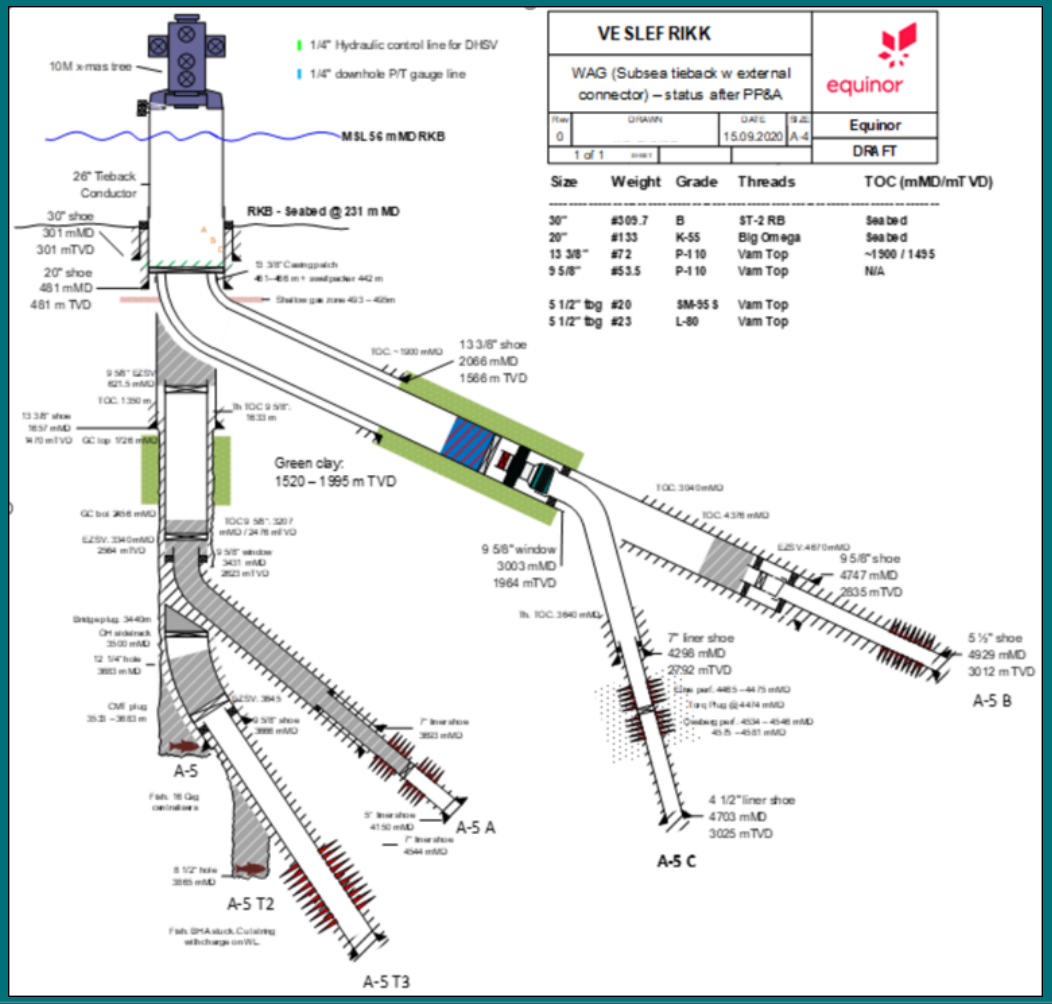
- Formation as barrier qualified in Green Clay by XLOT;
  - Performed in two wells
  - Across intervals with different bg responses
- Annulus barriers verified by bgging
  - Identified cement or creeping formation as barrier
- Mechanical plug set at depth with verified annulus barrier




| Interval Top (mMD) | Interval Bottom (mMD) | Cement or Formation or Combination of both | Cement or Formation Bond Quality | Potential for Hydraulic Isolation[1] | Length of Interval if Isolating Potential is 'High' (m) | Comments |
|---|---|---|---|---|---|---|
| 2062 | 2900 | Formation | Good/Medium | High[2, 3] | 838 | Relatively homogeneous azimuthal distribution – CBL higher for the same apparent impedance observed in lower sections which indicates formation collapse. But still CBL is less than 10 mV. Slight sign of ovalization is observed here (See Figure 5). |
| 2900 | 2925 | Formation | Poor | Low | | USIT indicates low impedance and CBL |

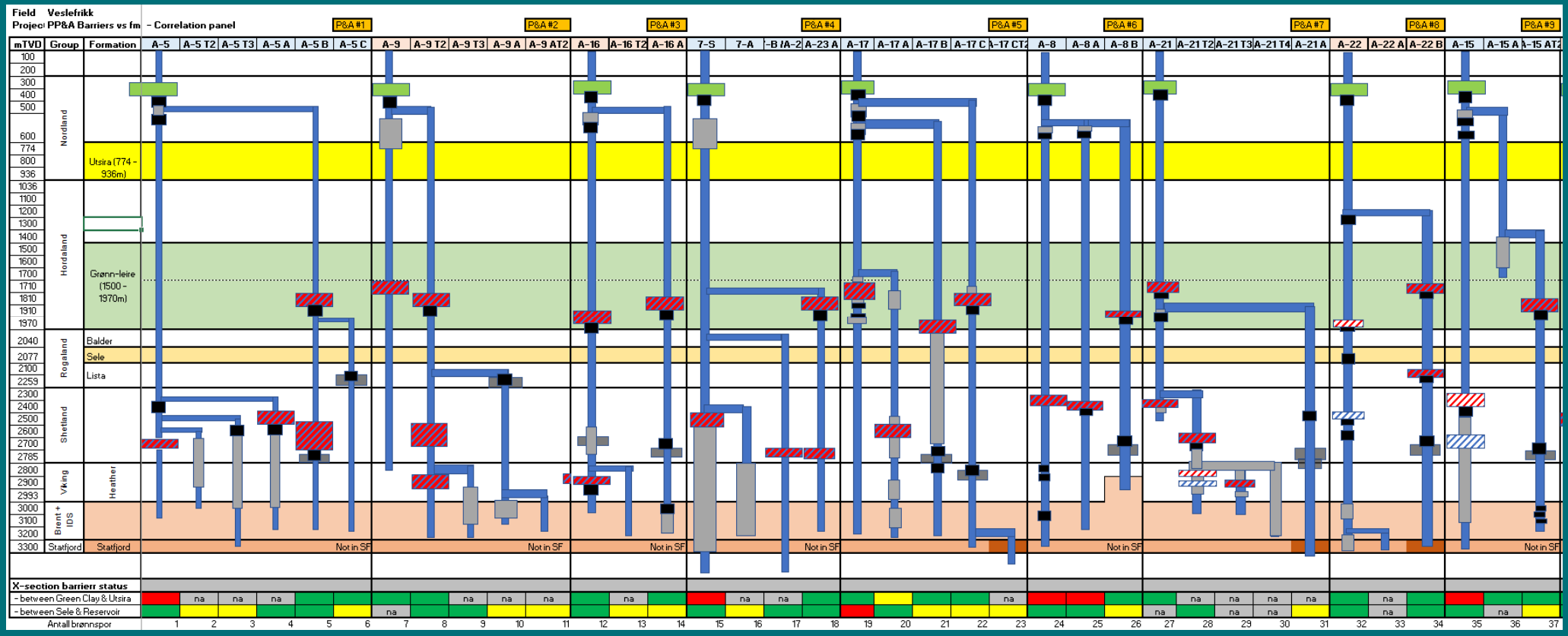
# Wellsbtvs Wellbore barriers

- Singelwellsbt
- Multiple wellbores
- Complexbarrierstatus
- P&A performed over 30 years
  - Variations in governing requirements



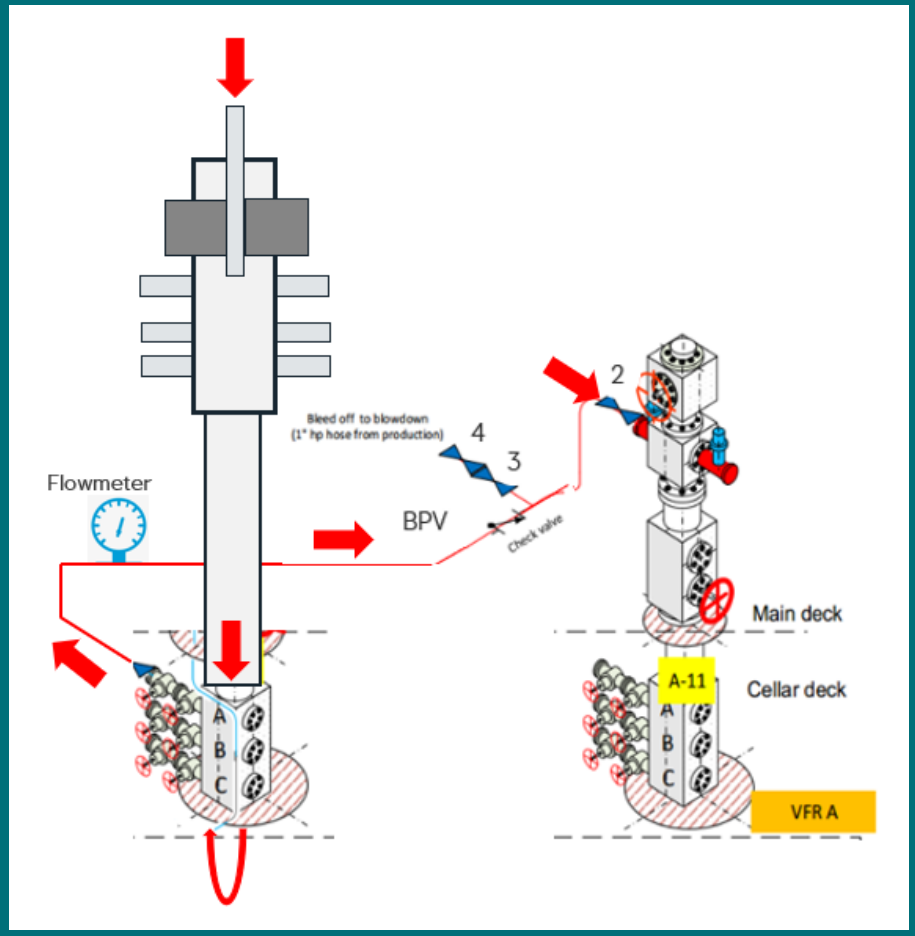
# Formation vs barrier correlation panel

## 24 wells/sbts and 92 wellbores



# Handling of gas in return flow

- Circulated to verify gas free well before pulling tubing
  - Crude in return resulted in gas alarm
- Performed risk evaluation
  - Established procedure for injection of return fluids
- Rigged up temporary lines for injection



# Operational challenges

Abrasive water jet Cutting of XMT bolts


Tubing dropped 5m after ASV release and jammed on tubing belw deep cut. Pulled 680 m extra tubing


Retrieved ASV after milling

Fished clamps from wellhead

# Operational challenges

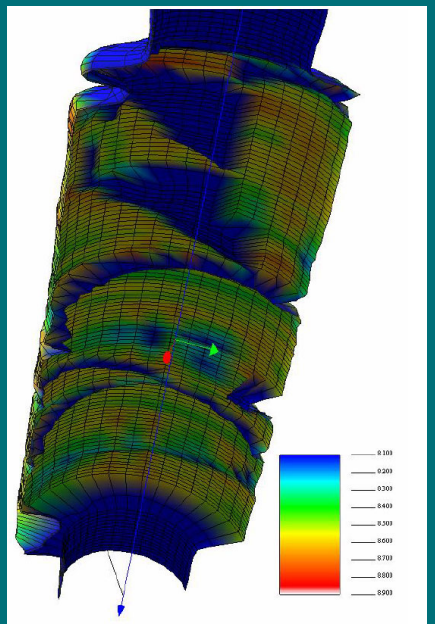
DIACS well with 7 control lines and bumper wires
Control line bird's nest pulling tubing

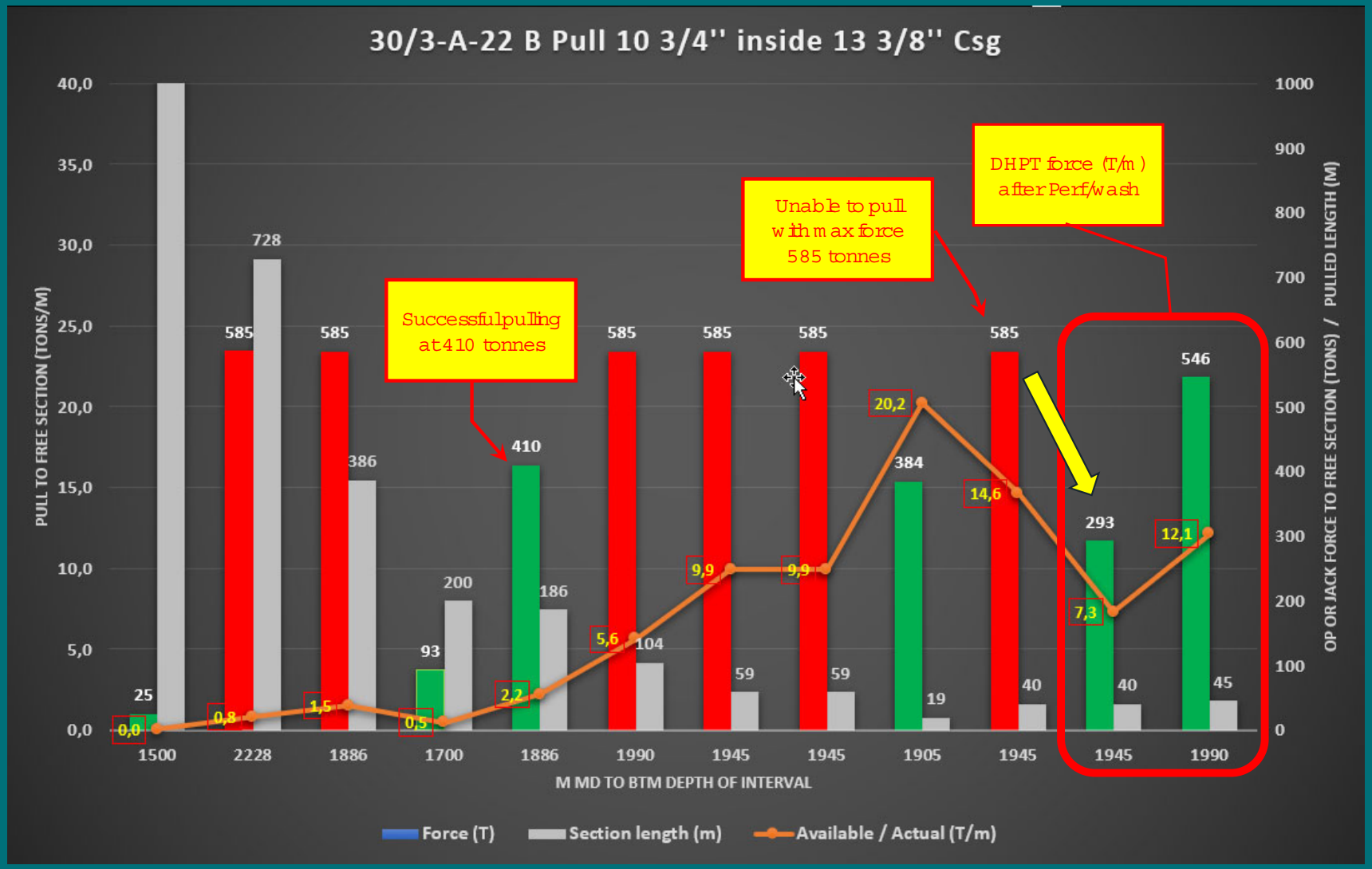
Assisted pulling of C-section
with hydraulic jacks.

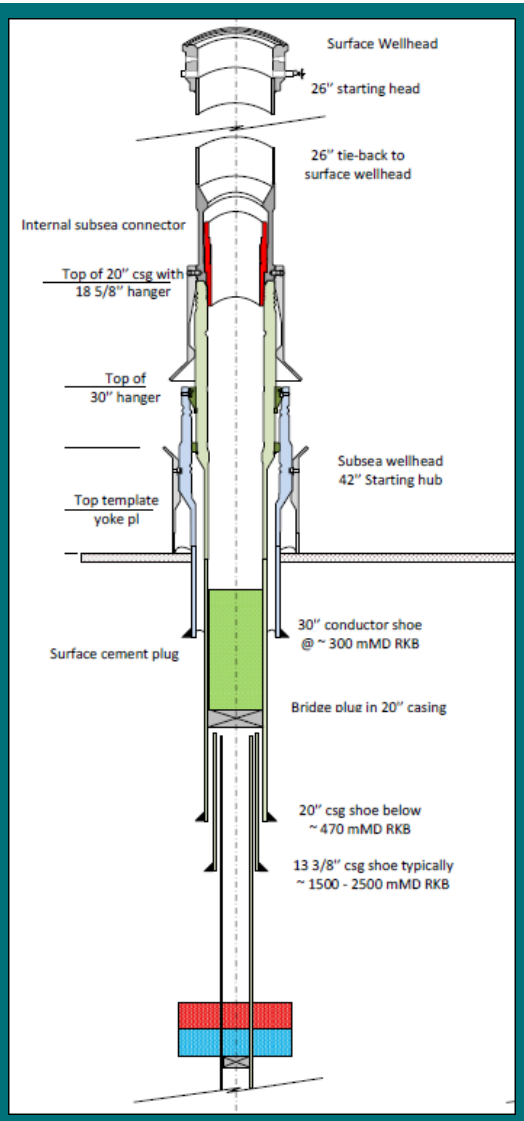
# Cutting casing at surface, pulling parted tubing

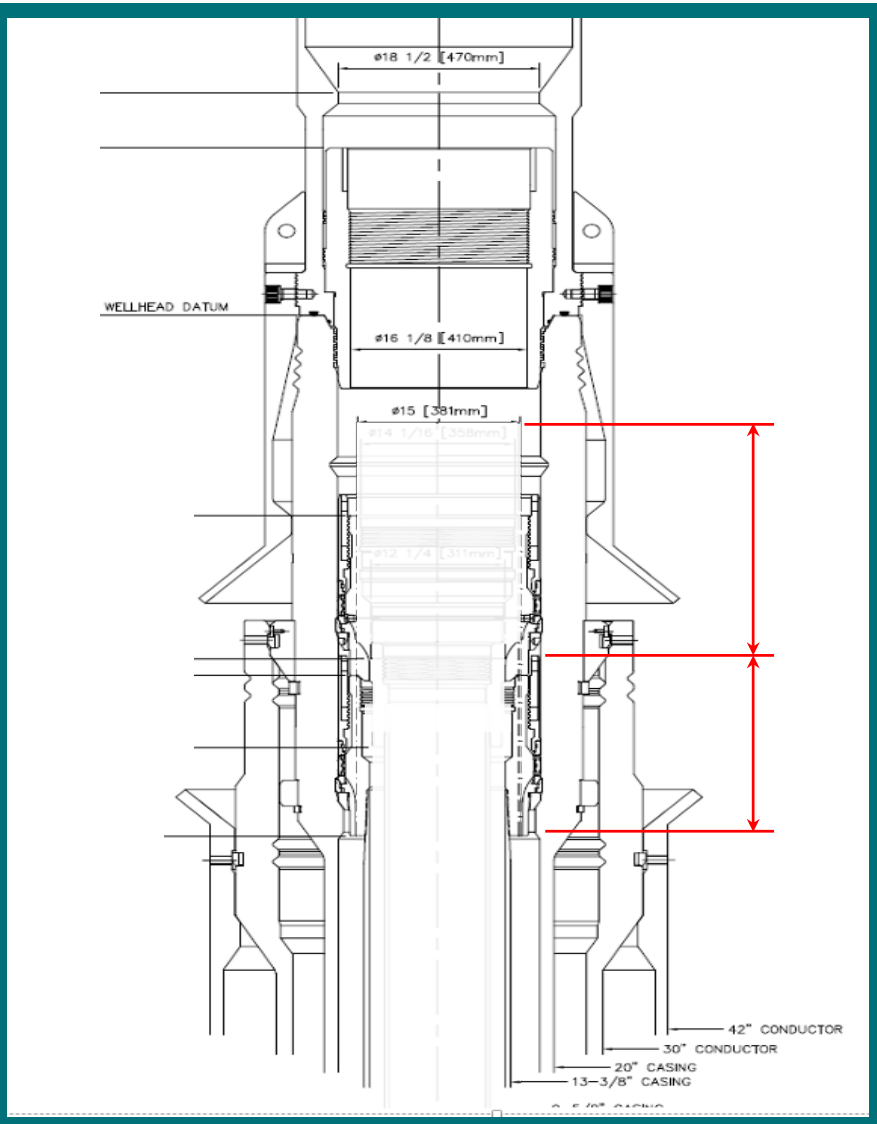
Successful cut of 13 3/8" P-110 # 72 csg
Link


Pulled parted tubing
Parted during injection below hanger




30/3-A-22 B Pull 10 3/4'' inside 13 3/8'' Csg
PULL TO FREE SECTION (TONS/M)
OP OR JACK FORCE TO FREE SECTION (TONS) / PULLED LENGTH (M)
M MD TO BTM DEPTH OF INTERVAL
Force (T)
Section length (m)
Available / Actual (T/m)
Successfulpulling at410 tonnes
Unable to pull with max force 585 tonnes
DHPT force (T/m) after Perf/wash
1500
2228
1886
1700
1886
1990
1945
1945
1905
1945
1945
1990
25
585
728
585
386
93
200
410
186
585
104
585
59
585
59
585
384
19
585
40
293
40
546
45
0,0
0,8
1,5
0,5
2,2
5,6
9,9
9,9
20,2
14,6
7,3
12,1

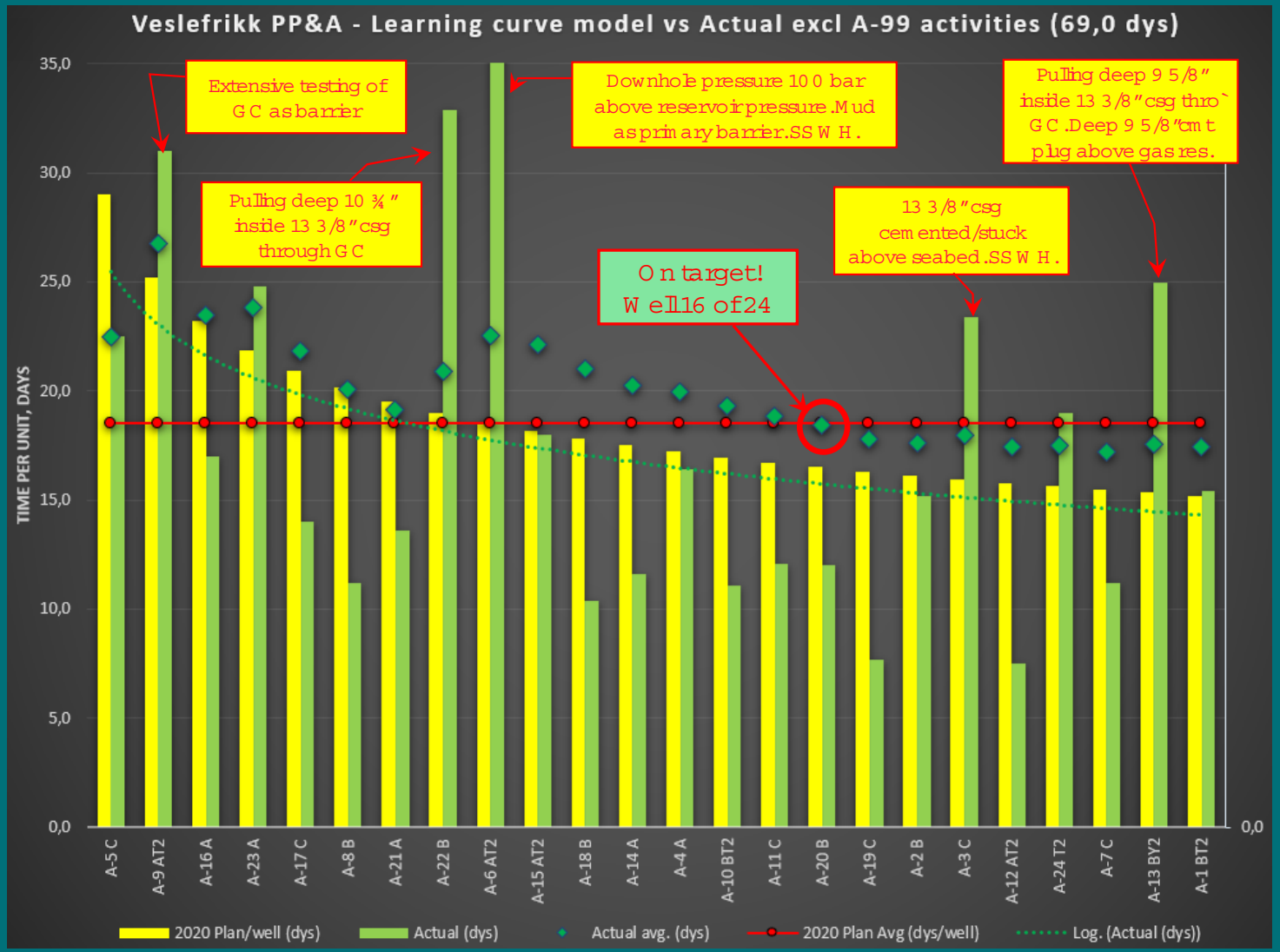



# Pulling subsea hangers

9 5/8" csg hanger
- Milled with 15" mill
- Pulled 9 5/8" hanger and casing

13 3/8" csg hanger
- Milled with 15" mill
- Pulled casing

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# Learning curve model

Planned time vs actual as;

- Days per well incl waiting on weather and skidding
- A-6 Performed in two operations
  - Establish barriers
  - Pull subsea tie-back
- Not including activities
  - PM/CM : 472 dys
  - WLw/RIG : 151 dys
  - Crane repair 218 dys
- Last PP&A completed 24.05.22

# Experiences

Challenging to startup old rig with new crew

- Equipment status, relevant crew experience vs installation specific equipment

Equipment requiring extensive amount of repair, upgrades and adjustments

- Unitong, HTV arm, URA/RA (racking arms) HTV causing most of total NPT
- Corrective maintenance Elmagco and main crane

Operation

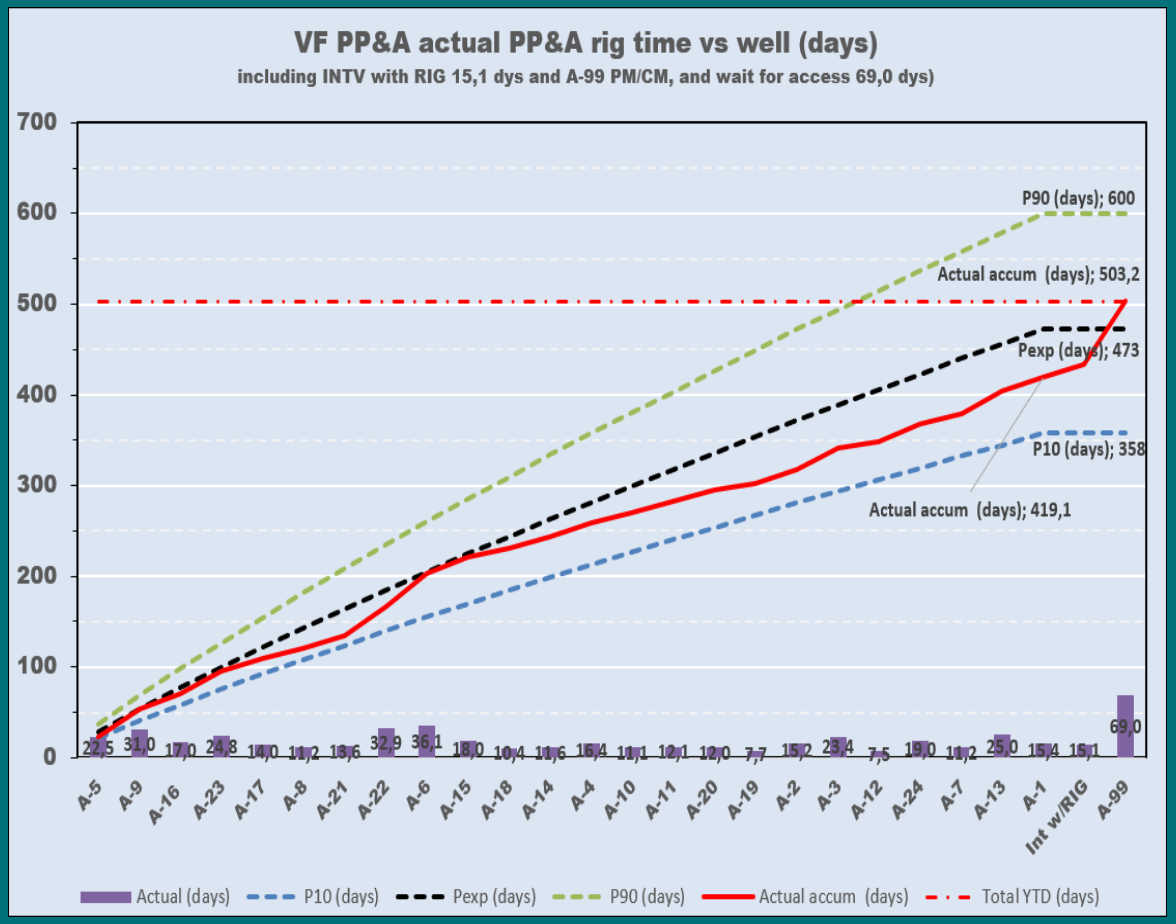
- ASV removal – Optimized cutting, milling, pulling sequence for each ASV type
- Optimized and removed bottle necks in nippling operations, reduced from almost 4 days to less than 1 day
- Performing majority of operations in TSW to minimize mud handling cost and optimize cement quality
- Cutting XMT bolts with abrasive water jet cutting and performing WL operations as simultaneous operations
- Improved efficiency by fabrication of prototype 13 3/8" csg cutter technology
- Efficiency improvements by standardising operational sequences and using dedicated personnel (Cmt, Fishing, WH)

Planning

- Build general database with all well data. Identify weaknesses or differences between wells.
- Mitigation of operations with elevated risk level

# Summary

- HSE : No serious incidents or accidents
- Simultaneous production, P&A and interventions
  - Cease of Production : 17.02.2022
  - Maximize production volumes
- Verifications and audit
  - Regular partner meetings for experience transfer
  - PSA audit P&A Planning and Execution - Positive feedback
- Time/cost, actual vs budget
  - Time: 84% of budget, 503 dys vs 599 dys
  - Cost: 72% of budget



# Veslefrikk cessation – Permanent P&A

Stephen Stragiotti,
P&A Project leader

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# Challenges and Improvements

- Equipment failures, NPT (Unitong, HTV arm, URA/RA)
- Downhole controlline experiences
  - Lines broken in several places and lost in hole
  - Clamps broken off, fished or pushed to bottom
  - Use extra drillcrew to operate spooling unit
  - Retrieved birds nest on several occasions
- ASV
  - ASV with design flaw
    - Required to cut and pull on DP in several runs
  - Milled ASV in one well
- Completion
  - Tubing dropped after ASV released, and jammed to tubing below at deep cut
- Reduce time for reconfiguring Unitong
  - Fabricated prototype 13 3/8" csg cutter
- Fluid handling
  - Perform operations in SW. Reduced need for mud.
  - Introduced plan for injecting tubing and A-annulus fluid directly into A-11. Reduced risk for gas/muster alarm
  - Measuring devices available for monitoring exposure to H2S, Benzene, HC, exhaust.
    Airstream masks etc available.
- Formation as barrier, XLOT in two wells in Green Clay
  - Tested hydraulic isolation across 5m and 10m