



HALLIBURTON
100 YEARS

2019 Norway P&A Forum Cementing update

17.10.2019

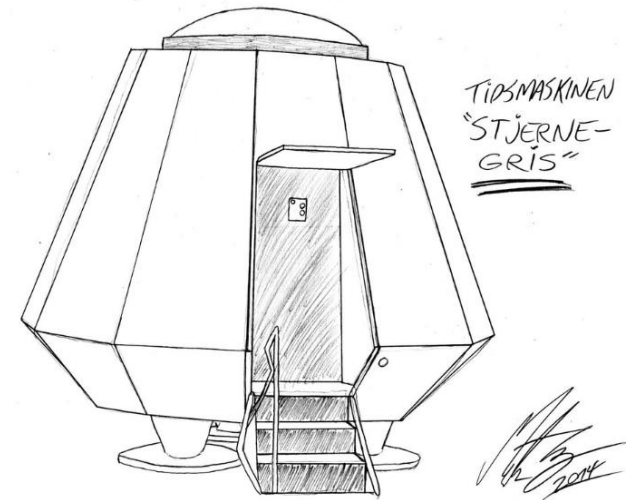
Gunnar Lende

Technical manager, Cementing

Halliburton Norway

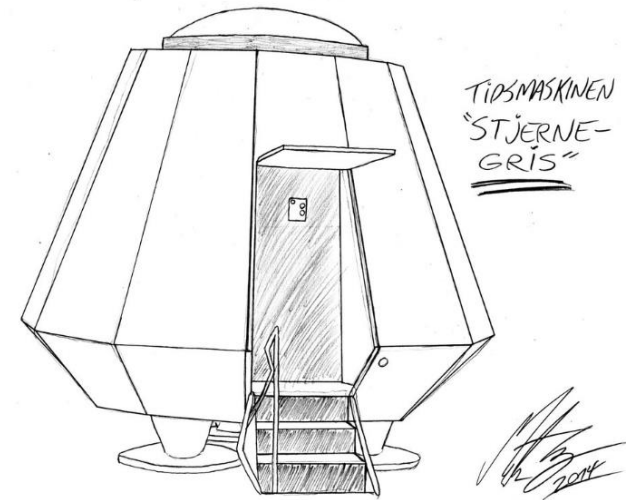
Presentation topics

- What happened since 2013?
 - Realized the power of formation collapse
 - Statistics
 - Tergovis II EF
 - Expanding cement – the power of expansion
 - Lean P&A
 - » P&A with tubing in place
 - » Tools and practices
 - » Sealing the A-annulus
 - Understanding what works and why
 - Details matter at small scale
 - Control lines
 - Conventional P&A
 - » Tools

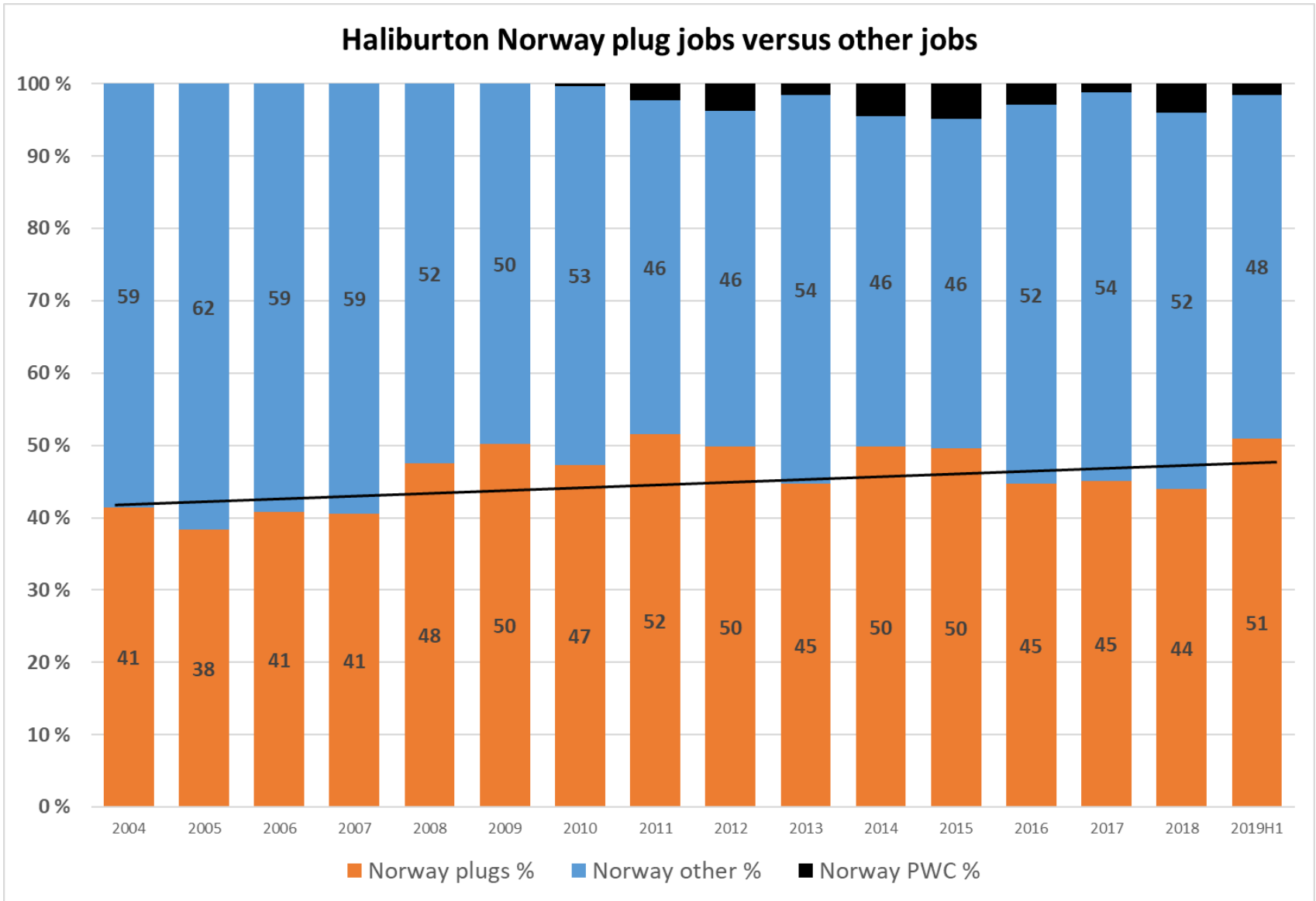


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 - » ~~Tools and practices~~



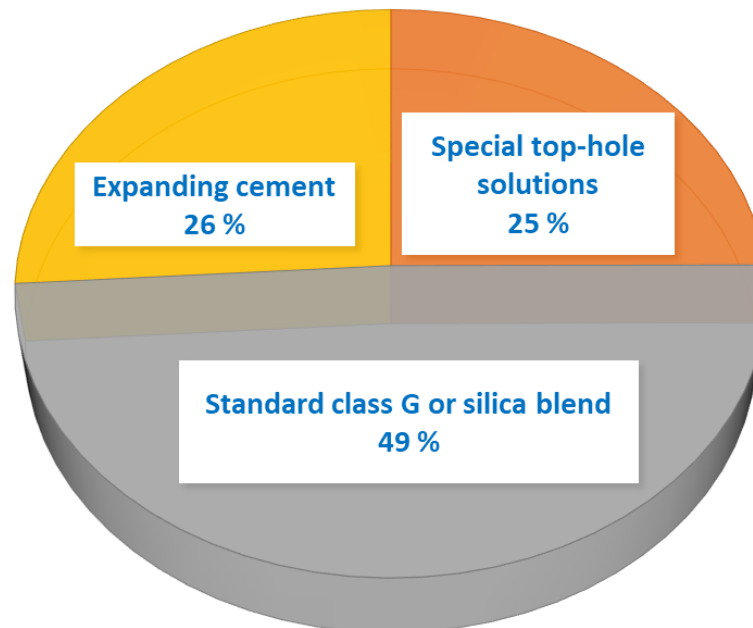
Statistics - Job count moving towards more plugging?



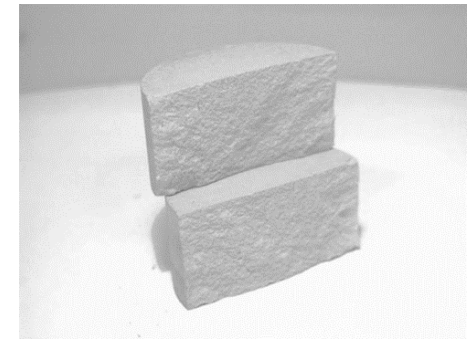
Statistics

- Still using Portland cement based barriers...
- On Jotun P&A project used lightweight version 1,50 SG
- Better adoption of expansion – industry understands importance?

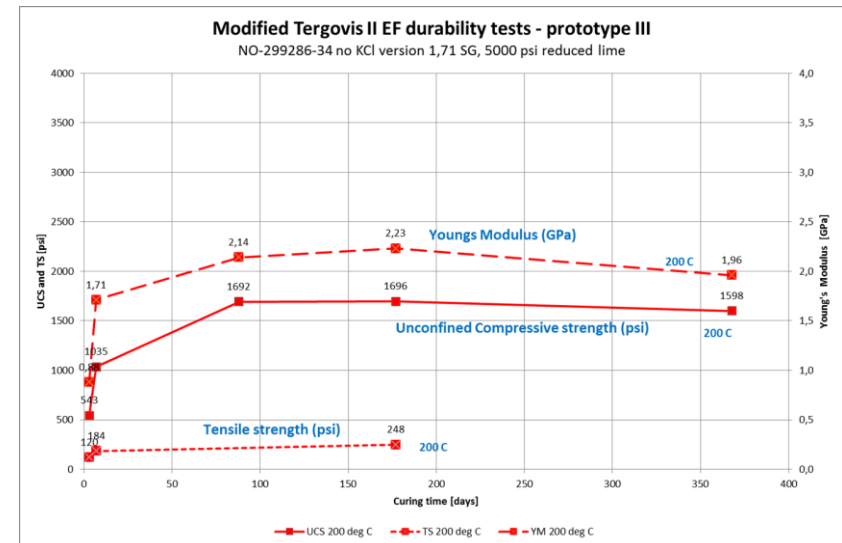
LAST 12 MONTHS CONSUMPTION



Tergovis II EF

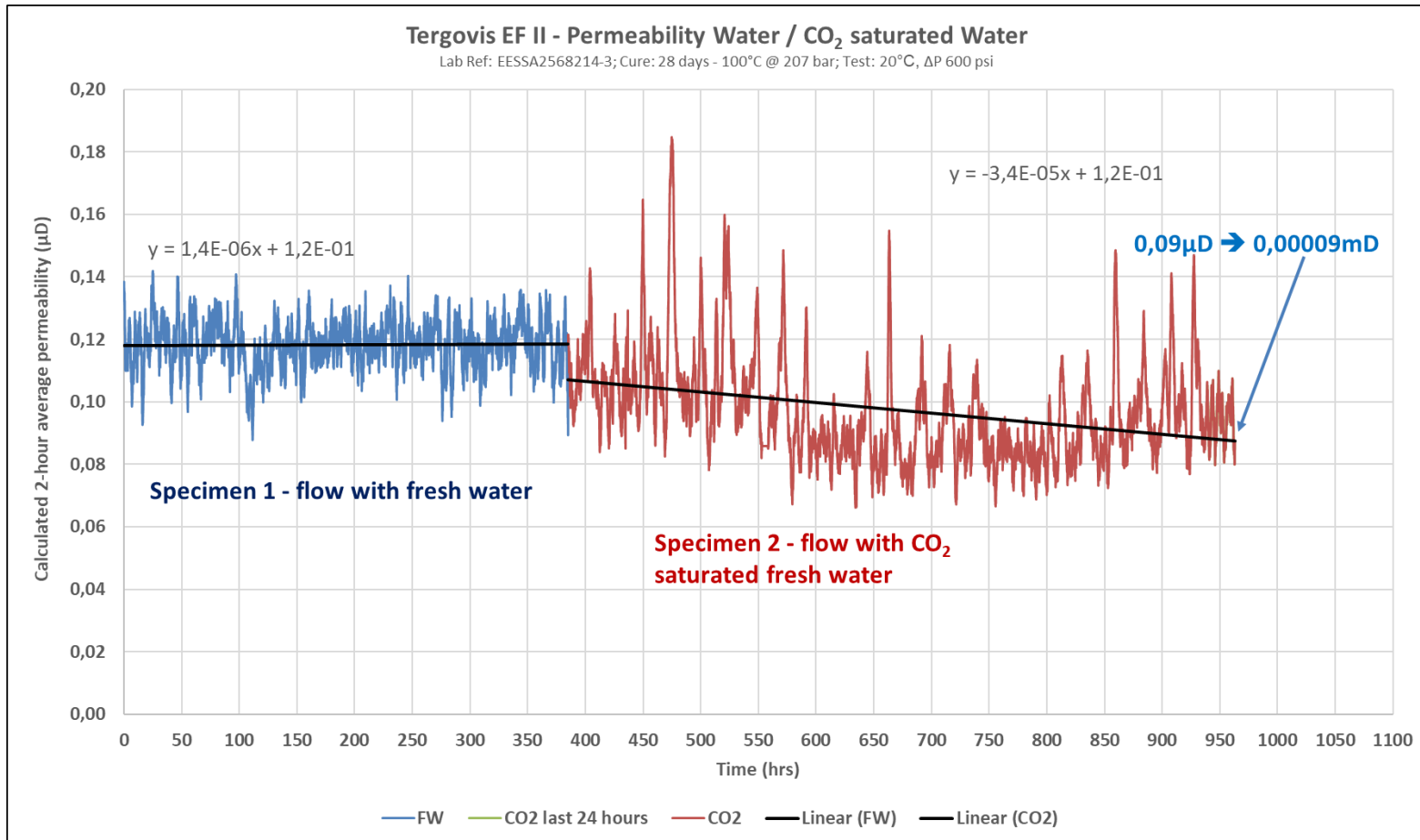
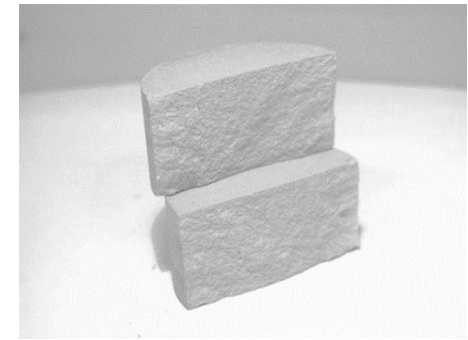


- First presented in 2013...
- Non-cement barrier material (no OPC at all)
 - Opportunity to deploy as two-component liquid system for projects where no cement unit is available
 - Significantly reduced CO₂ footprint
 - Good compatibility with OBM and WBM
 - Favourable mechanical properties
- No uptake in market yet
- Long term curing done
 - 150&200°C 1 year
- CO₂ exposure ongoing



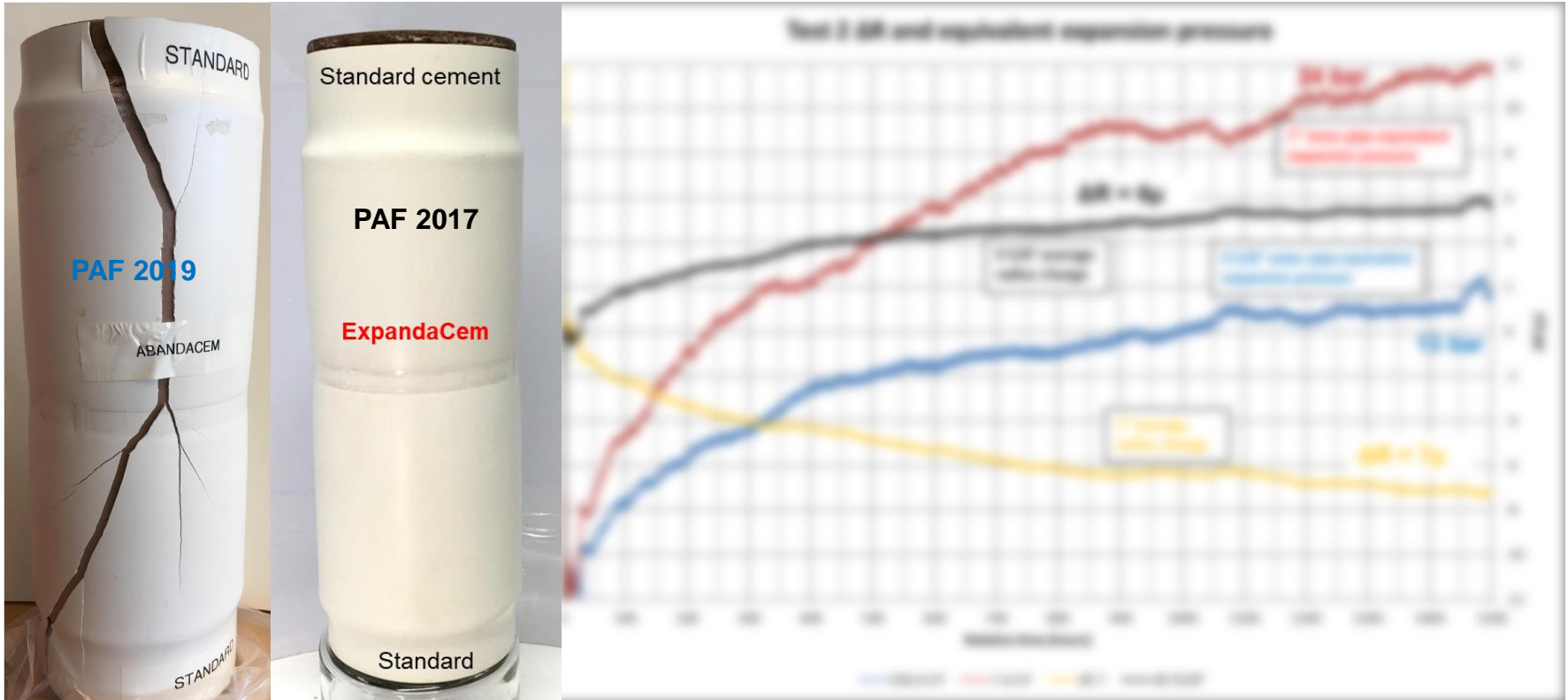
Tergovis II EF

- CO₂ exposure ongoing:



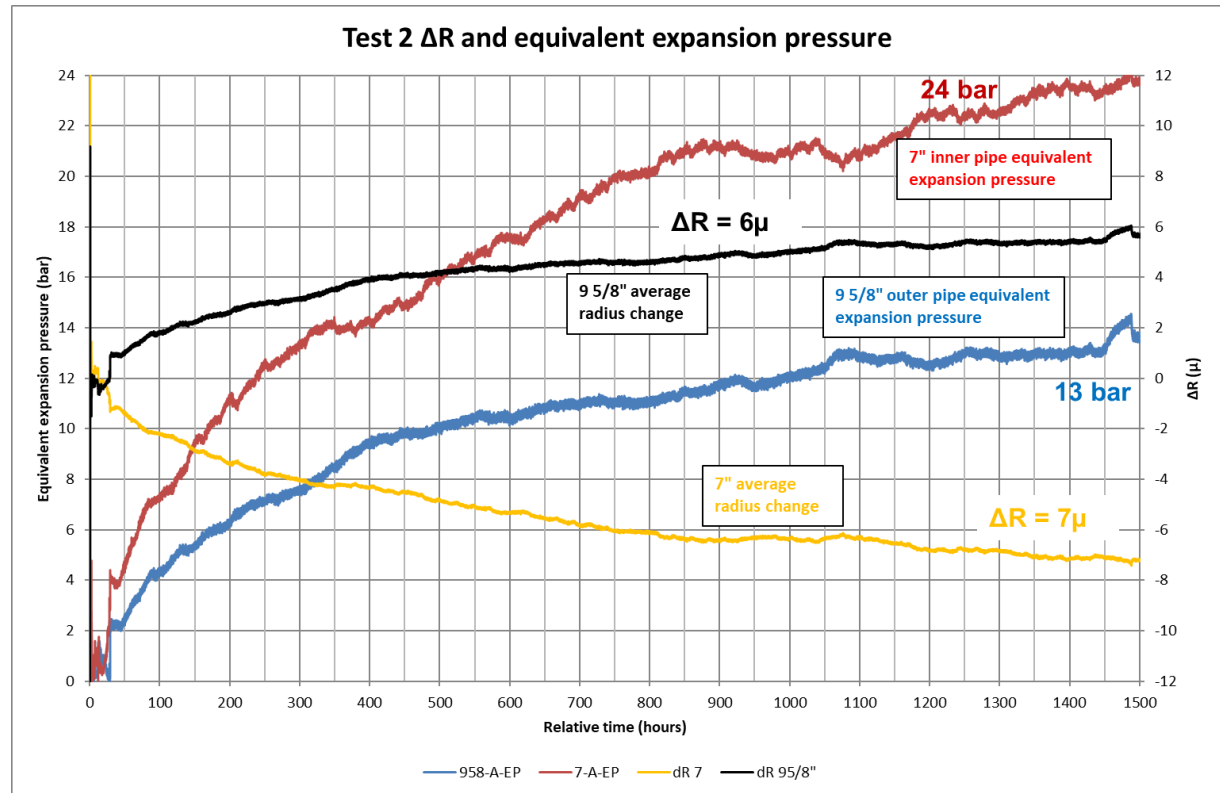
Expanding cement – the power of expansion

- 7" 32ppf tubing in 9-5/8" 53,5ppf casing, 13-3/8" 72ppf casing
- Impact of expansion measured with strain gauges
 - Wide and narrow side of eccentric tubing (averaged)



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Lean P&A – leaving tubing in place

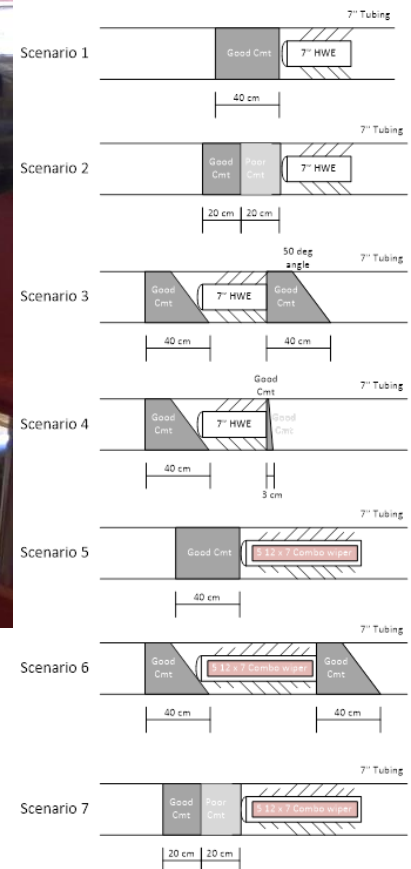
- Cost savings, offline activity
- Eliminate need for drilling rig on platforms
- Pumping and wireline operations only (avoid CT)
 - Inject in well or circulate A-annulus
- Through X-Mas tree pumping and cementing
- Requires adequate B-annulus barriers
 - By cementing A-annulus B-annulus verification may be done with alternative methods (differential pressure tests)
- Ongoing project for tag tests with wireline stroker and spear



Lean P&A – leaving tubing in place



- Ongoing project for tag tests with wireline stoker and spear 02:24 – 02:30



Lean P&A – leaving tubing in place

- Through X-Mas tree pumping and cementing
 - H₂S compliance
 - Height restrictions
 - Wellhead access
 - Live neighbour wells
 - Interface with topside facilities in production mode
 - Combination with wireline operations
 - Stand-alone surface equipment package
- Volume control and accuracy
 - Use of packers and wiper plugs
 - Complex geometry - side pocket mandrels, PBR's, restrictions
 - Plug container (cement head)

Lean P&A – leaving tubing in place

- Plug container design
 - Tailored to fit VXT with 7-1/16" 10K API 6A flange
 - H₂S compliant, NACE MR-01-75
 - Facilitate multiple long wipers
 - Allow wireline operations

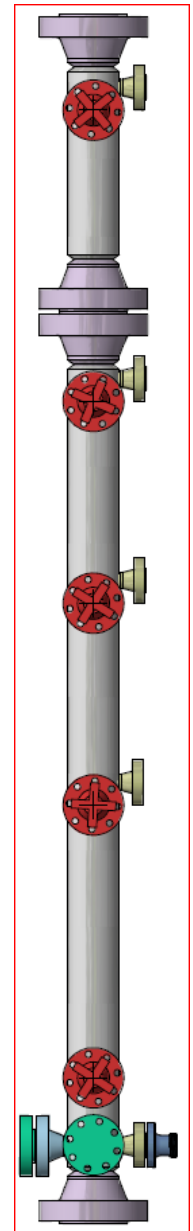


Existing model

Tailored wiper

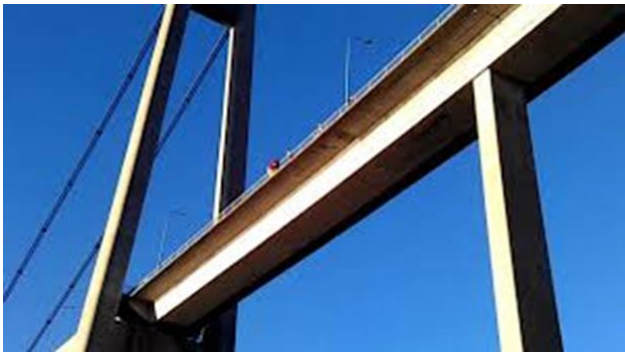


New model



Lean P&A - sealing the A-annulus

- Understanding what works and why
 - Pure Portland cement is not a sealant
 - Pure Portland cement is not used for constructions
 - Admixtures → difference between raw material and final product
- Can we seal casing x casing annulus with wellbore cement?

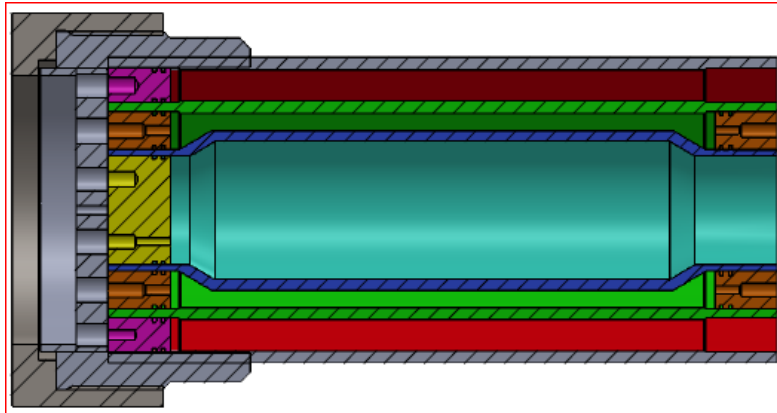


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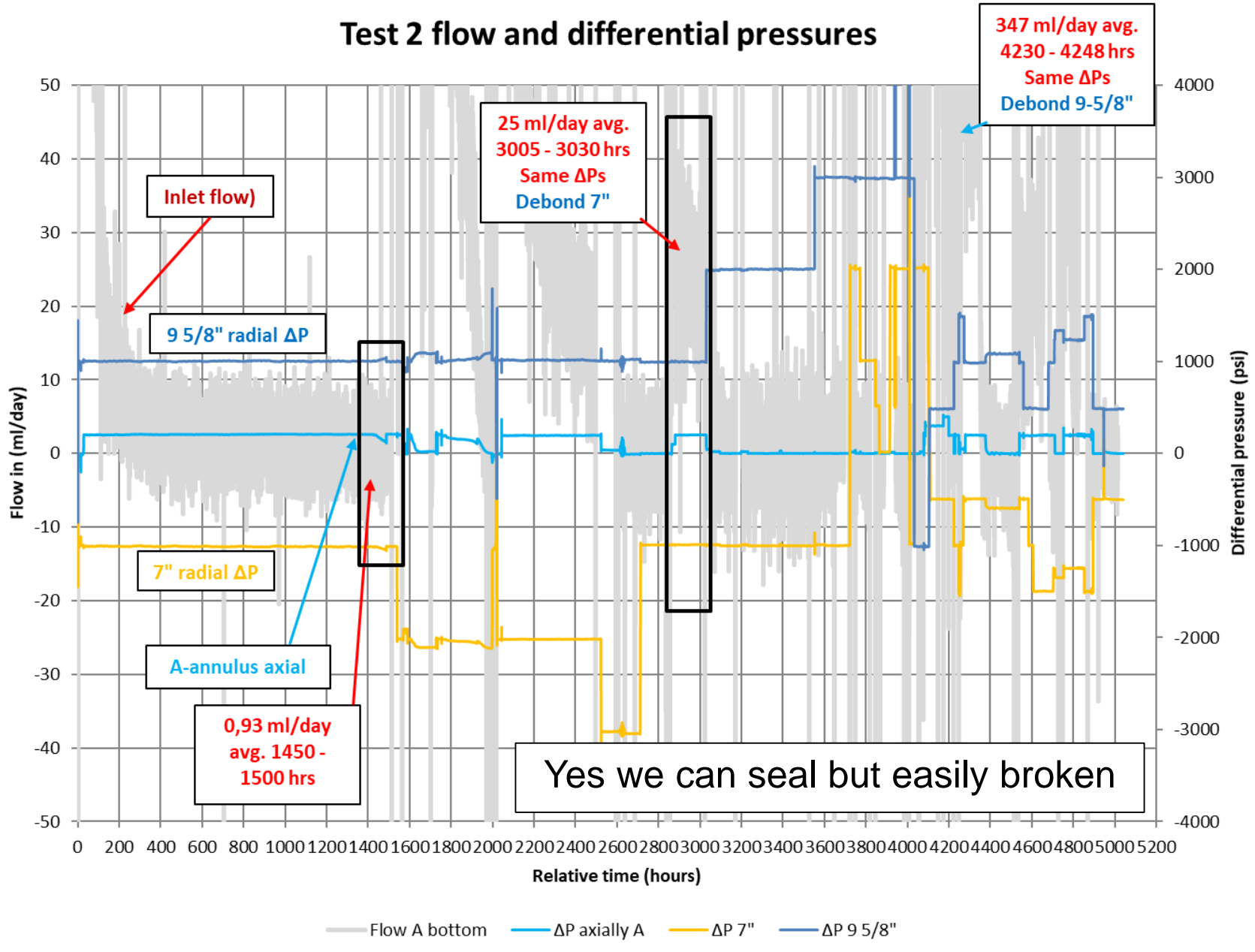


Lean P&A - sealing the A-annulus – understanding what works

- Can we seal casing x casing annulus with wellbore cement?
- Full (radius) scale test cell in Tananger
 - 7" 32ppf tubing in 9-5/8" 53,5ppf casing, 13-3/8" 72ppf casing
 - Maximum 10000 psi / 690 bar, 120°C
 - Q_{Ai} , Q_{Ao} , $P_{Ce,A,B}$, $T_{Ce,A,B}$, $\epsilon_{1i,2o,3o}$
 - Barrier material in A-annulus

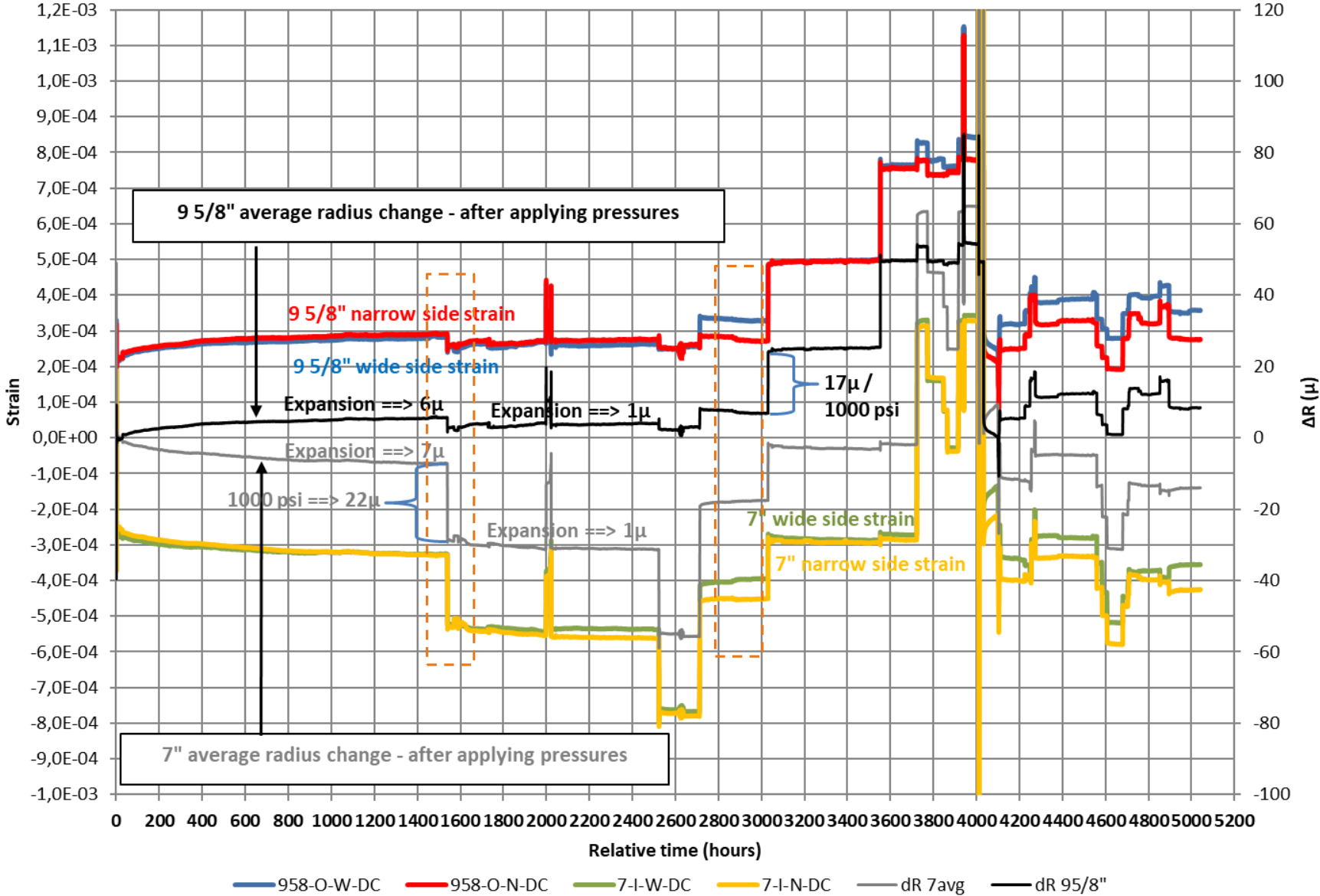


Test 2 flow and differential pressures



Yes we can seal but easily broken

Test 2 absolute strains and relative ΔRs

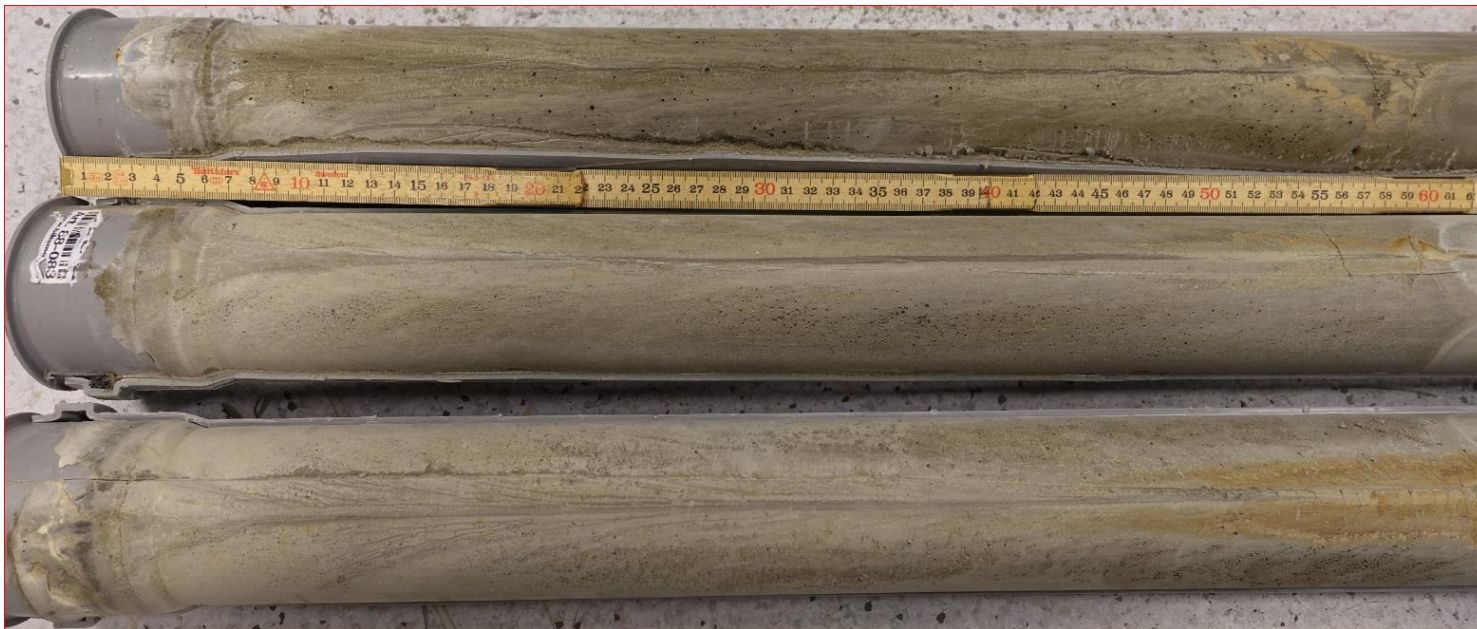


Lean P&A - Sealing the A-annulus

- Details matter at small scale
- **Short barriers? Better get it right!**
 - 30 m barrier at 3000 m? $30/3000 = 0,01 \rightarrow 1\%$
 - Want 10% error margin on 30 m? $\rightarrow 0,1\%$ placement accuracy
 - Cannot rely on pump efficiency
 - Have to use effective wipers and land on something
- Alternatively balance fluid heights

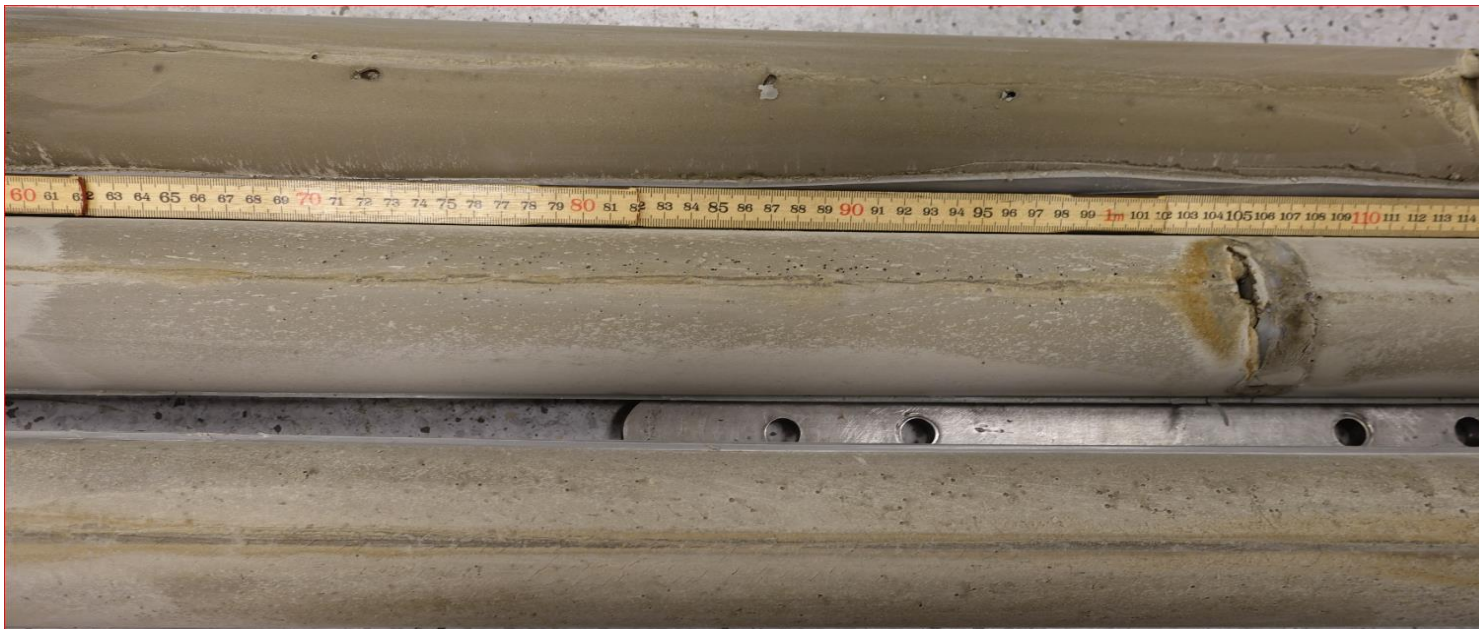
Lean P&A - Sealing the A-annulus

- Trapped water can jeopardize your barrier



Lean P&A - Sealing the A-annulus

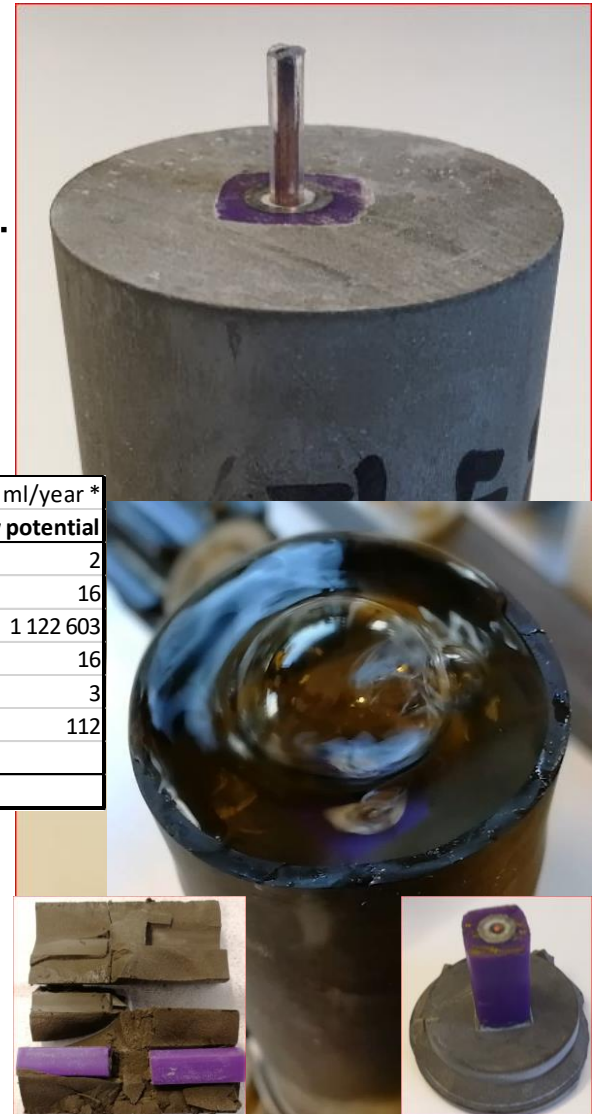
- Trapped water can jeopardize your barrier



Lean P&A - Sealing the A-annulus

- Control lines
 - Even if you could seal around a control line...
 - It leaks through it
 - We found leakage at the outside corners

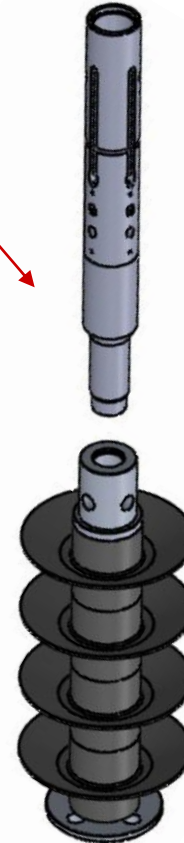
Water permeability tests	mm	psi	ml/min	cm ²	ml*mm/psi/min	%	ml/year *
Case	Length	dP	Flow	Cmt flow area	Normalized flow	Rel. leak	flow potential
Reference, pure cement	34	497	0,0010	11,4	0,00007	100 %	2
Round control cable core multi-conductor	64	594	0,0050	11,0	0,00054	759 %	16
Roxar unplugged cable	88	10	4,0000	10,2	36,83	52028268 %	1 122 603
Roxar cut cable & between cut combo	85	598	0,0037	10,2	0,00053	746 %	16
Roxar between cut cable only **	15	598	0,0037	11,4	0,00009	130 %	3
Roxar plugged cable	91	397	0,0161	10,2	0,00368	5206 %	112
Roxar old cable Heidrun A6 cut							
** Assumes full diameter cross-sectional area		*Length:	50	m	Delta P =	200	bar



- **Better get rid of them**
- **Or split them into discrete pieces**

Conventional P&A - Tools

- Enhanced diverter with integrated fundament
 - Fundament and diverter can be run separately or together
 - Section milled application →
 - Cut and removed pipe application →
 - OH application →



THANK YOU

