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# Reducing Reservoir Uncertainty, Optimising Production and Enhancing Well Safety – New Solutions Using Advanced Wireless In-Well Communications

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Expro Wireless Well Solutions



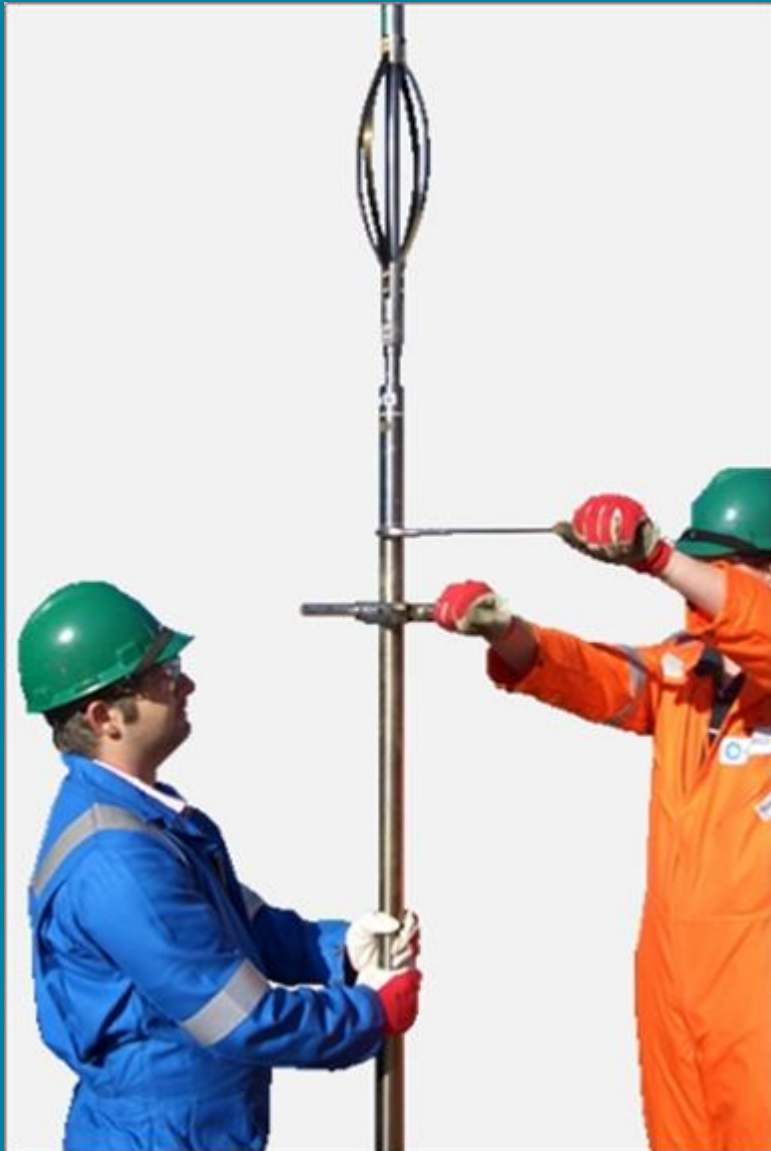
- Wireless technology overview
- Reducing reservoir uncertainty during appraisal & development – Advanced Reservoir Testing™
- Production optimisation in big bore high rate gas wells
- Enhancing well safety during long term suspension or P&A
- Conclusions
- Questions and answers

# Introducing the CaTS™ Wireless Technology



- A battery powered Cableless Telemetry System transmitting pressure and temperature data from downhole to surface in real time using electromagnetic (EM) signals.
- It uses the metallic structure of the well as a conduit along which to transmit the electromagnetic signals.
- Uses standard completion hardware, there is no requirement for a tubing string in the well, data transmission is not affected by cement plugs or bridge plugs
- System addressability enables multi-zone monitoring in a well.
- Works in flowing or shut-in wells and is independent of the well fluid type
- Flexible deployment options via wireline, coil, tubing mounted / casing conveyed or via a large bore gauge mandrel
- The telemetry is duplex and thus also capable of transmitting commands from surface to a downhole receiver

# The Wireless Gauge for Through-Tubing Deployment



- Lithium Battery powered
- ~28ft long
- 1 11/16" OD
- 10K psi & 125°C / 257°F rated
- Quartz crystal pressure sensor
  - Excellent long term stability (<2psi per annum drift)
  - High accuracy & resolution (+/- 2.5 psi, 0.01 psi)
- Full metal-metal primary sealing
- Additional battery sections can be added to increase data volumes
- Using relay stations there is no limit to the achievable transmission range

# Completion Conveyed / External Mounting is also Possible



- The gauge can also be conveyed into the well externally mounted
- Provides access to annulus pressure behind tubing, or formation pressure behind casing



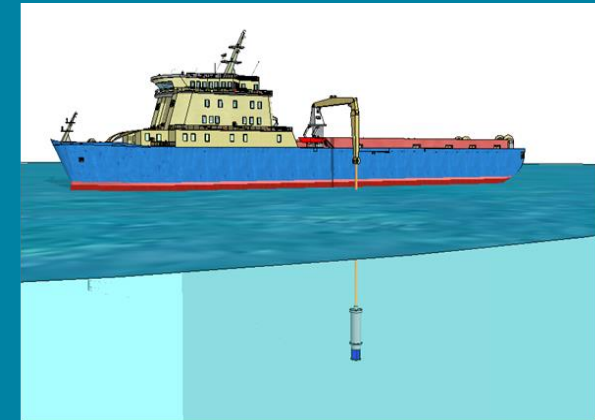
# Subsea Receiver



# Surface Equipment – Data Recovery Operation



- Data from the seabed receiver is uploaded using the surface transceiver system, shown opposite
- On the MODU, the transceiver can be deployed through the moon pool or over the side or the rig
- A support or supply vessel is normally used for routine data uploads
- The transceiver is deployed on a winch or crane line approx 10m below the surface
- P, T, date and time are decoded and presented in Excel



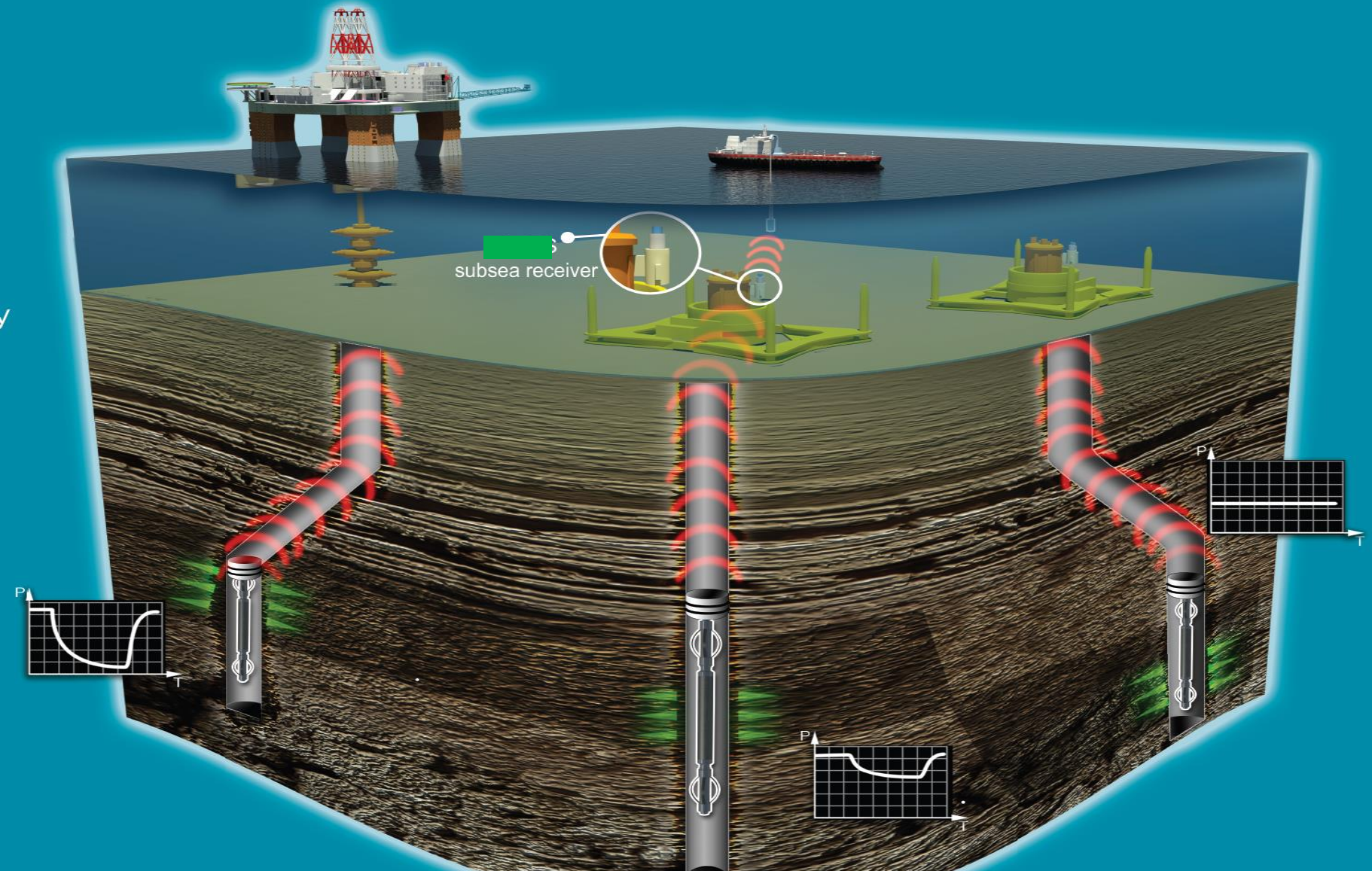
# A New Concept – “Well Testing Beyond Abandonment”



- A key objective of well testing is to investigate Reservoir Continuity
- There is often time / cost pressure for well testing operations to be conducted in the shortest time frame, meaning that testing operations may be terminated early, before pressure transient testing has sufficiently investigated the reservoir
- By the application of CaTS wireless monitoring technology, well testing no longer has to end at well abandonment
- Permanently abandoned subsea or onshore wells can now be used as long term, high value monitoring assets



# Advanced Reservoir Testing Overview





## Advanced Reservoir Testing- Case History #1

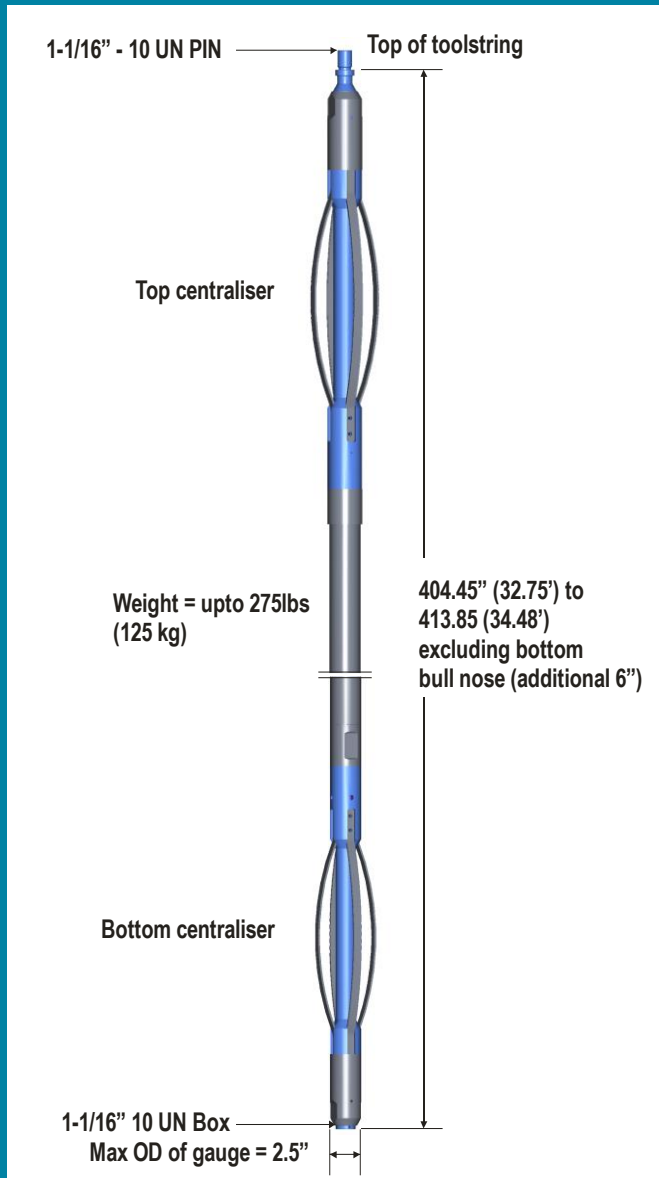


SPE 108435

Clair Field: Reducing Uncertainty in Reservoir Connectivity During Reservoir Appraisal  
- A First Time Application of a New Wireless Pressure Monitoring Technology in an  
Abandoned Subsea Appraisal Well

B.P. Champion, SPE, Expro; I.R. Searle and R.K. Pollard, BP plc

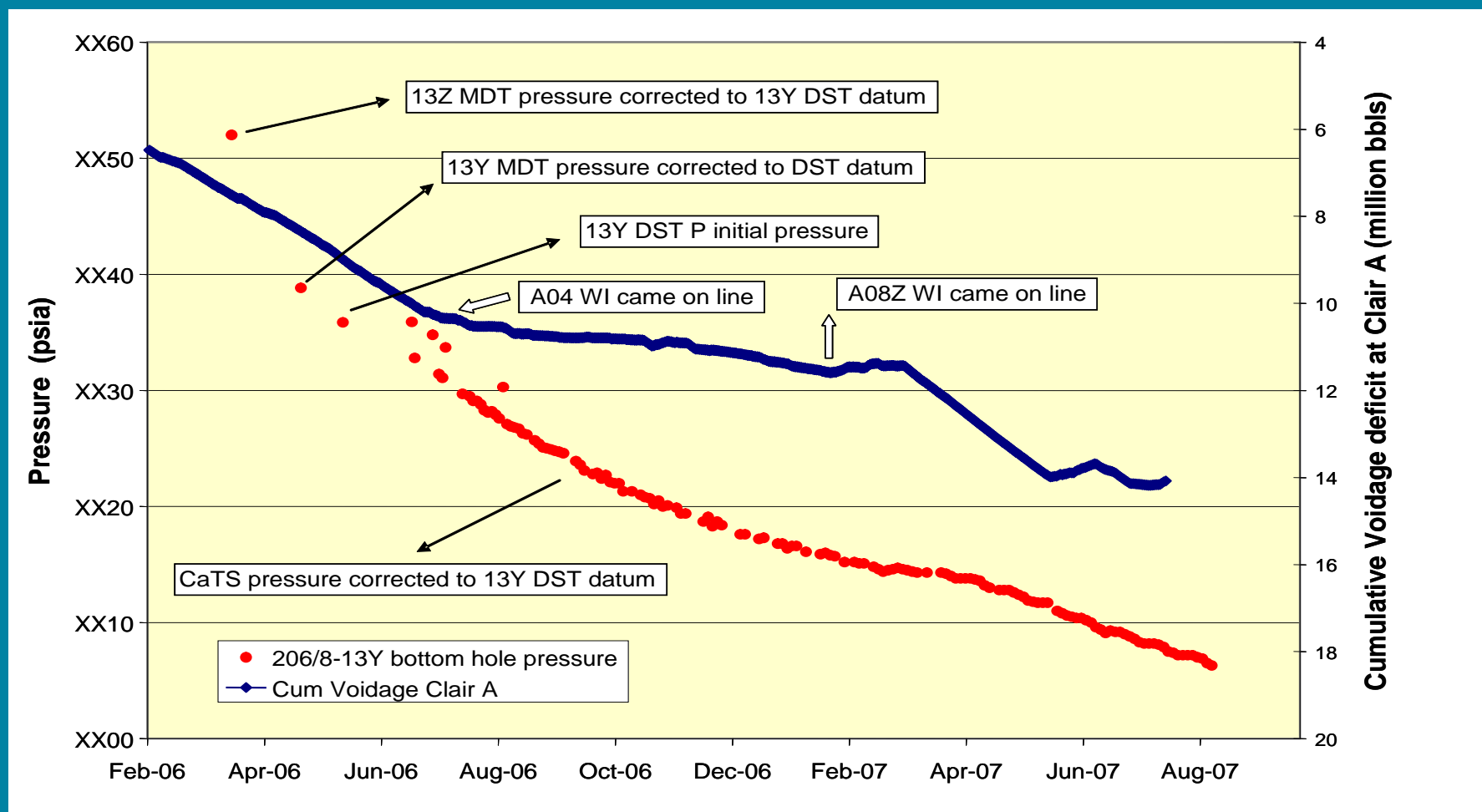
# Tool Schematic and Lower Completion (Ref. SPE 108435)



Tubing String	MDERT (m)	DESCRIPTION
		Packer no-go
		9.56" x 6" Packer 47-53# c/w special bottom sub , 7" 29# Vam Top
		7" 29# 13CR80 Vam Top - Pup Joint, 1.5m
		7" 29# 13CR80 Vam Top - Pup Joint, 6.0m
		Xover
		4" 9.5# 13CR80 Vam Top - Pup Joint, 6.0m
		4" 9.5# 13CR80 Vam Top - 5 Joints
		WEG / Integrated No-Go

- Gauge conveyed in to the well below the well abandonment plug and set in the tailpipe with live hydrocarbons below
- DST string was recovered and the well permanently abandoned

# Abandoned Appraisal Well Monitoring – A Case History (Ref. SPE108435) - Results



- High value data from an abandoned well confirms connectivity with a producing asset 8km away – results incorporated into the field development



## Advanced Reservoir Testing- Case History #2

### Total Norvarg-2 Appraisal - Norwegian Barents Sea

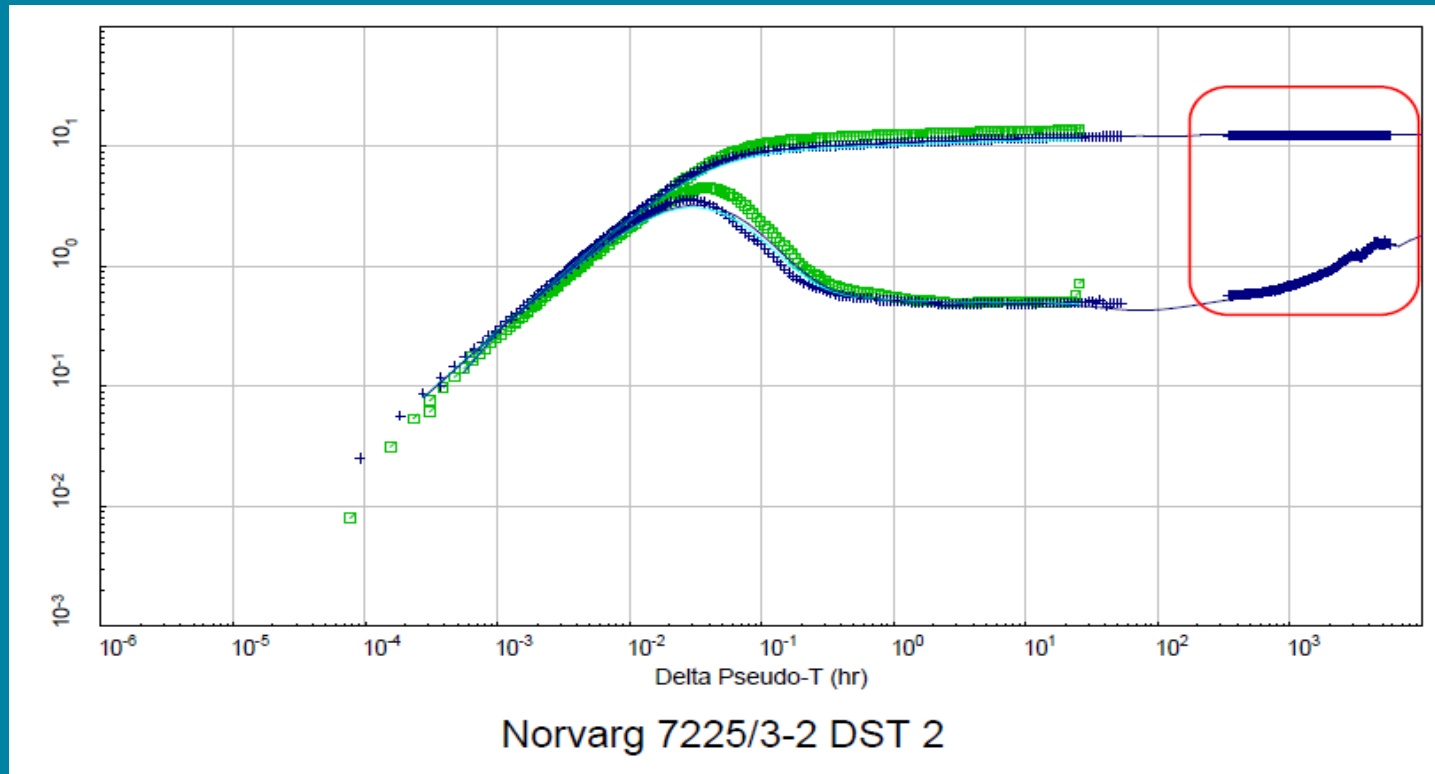


- ### Extended build-up configuration
- 
- 7225/3-2 Norvang-2 Final Well Status**
- Rotary table 0 m MD RKB
- MSL 25 m MD RKB
- Wellhead and break cap left on well for monitoring period
- Sealed 36" Housing station 464 m RKB
- 466.5 m MD RKB
- 474 m MD RKB
- 547 m MD RKB
- 36" x 36" conductor
- 29" casing LOT = 1.18kg
- 13-3/8" casing FIT = 1.75kg
- 8in (water bearing) From 528 to 540m
- 6in x 6in (water bearing) From 551 to 558m
- 9-5/8" liner FIT = 2.31kg
- 1220 m
- 1710 m
- 2400 m
- 7" liner @ 2200 m
- TD 2250 m MD RKB
- TOC at 41-518 m
- TOC @ 626 m MD RKB
- 881 m MD RKB
- TOC at 11-816m
- TOC @ 1014 m MD RKB
- 1072 m MD RKB
- TOC @ 1205 m
- Packer set @ 7470m MD RKB
- Perf interval #2: 1584 - 1610m
- Perf interval #1: 1725 - 1832m



- 3 CaTS gauges were deployed externally mounted on the tailpipe below the packer during the DST
- At the end of the DST the reservoir zone to be monitored was isolated by closing a valve in the tailpipe assembly
- A well kill was performed above the packer, the DST string recovered and the well abandoned downhole
- CaTS subsea receivers installed on an anti-trawl frame
- 9 months of high quality PBU data was collected beyond the end of the DST
- Wellhead severance and recovery was achieved using a boat with no further rig intervention required

# Norvarg-2 – Interpretation of CaTS Long Term PBU Data



- Two no-flow boundaries (not observed during the normal DST period) were identified some 130m and 280m from the wellbore.
- The distance between the flow barriers is much smaller than the width of the seismic Channel (~1.5km)
- Interpreted to mean that the large seismic channel is most likely a channel belt with individual smaller channels with internal flow barriers



## Production Optimisation in Ormen Lange - A Completion Conveyed Wireless Solution

### Case History #3



**SPE 145581**

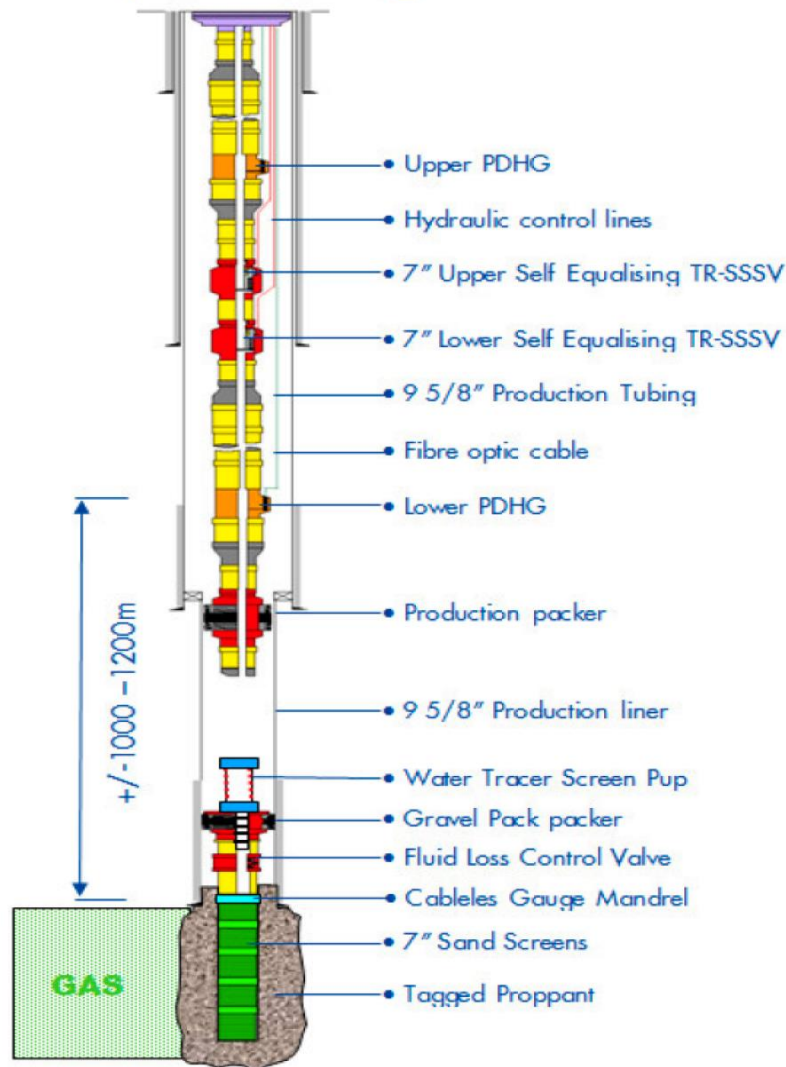
**Ormen Lange: Delivering Production Optimisation and an Improved Reservoir Understanding Using a New Cableless Sandface Monitoring System**

B.P. Champion, SPE, and D. Elliott, Expro; A. van Kranenburg, SPE, K. Hals, SPE, and C. Combe, SPE, A/S Norske Shell.

# Ormen Lange Big-Bore Completion Design



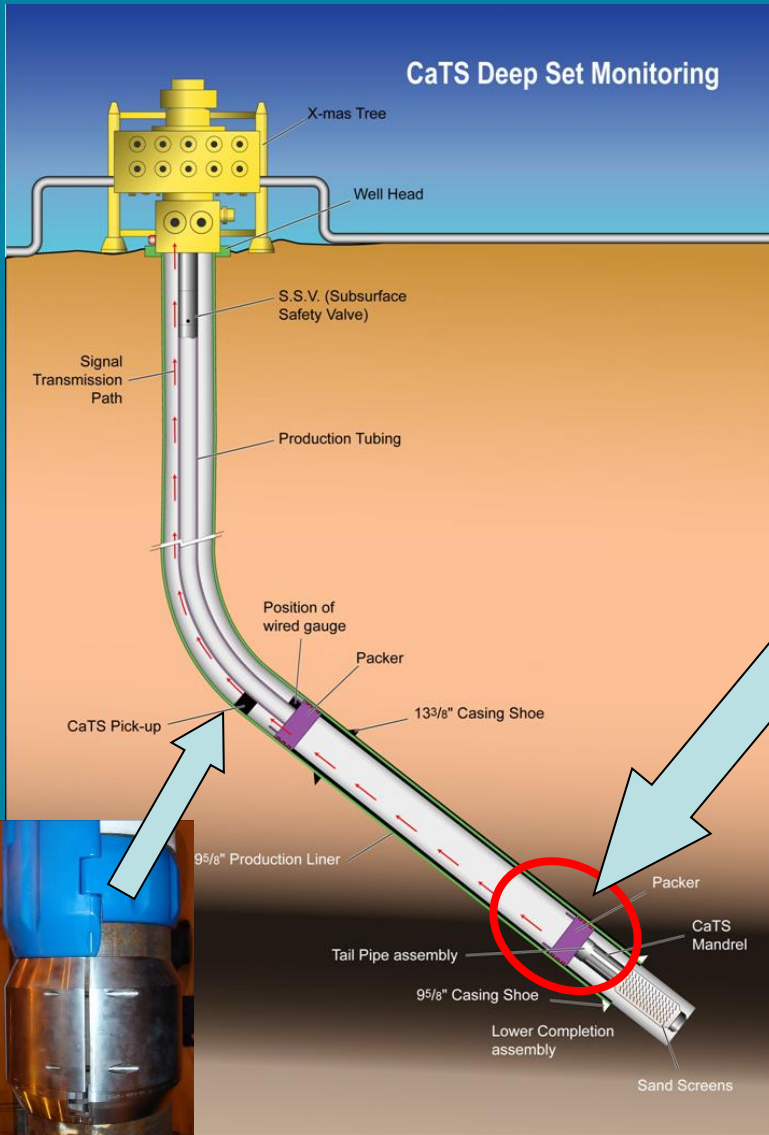
## Ormen Lange Big Bore Completion Design



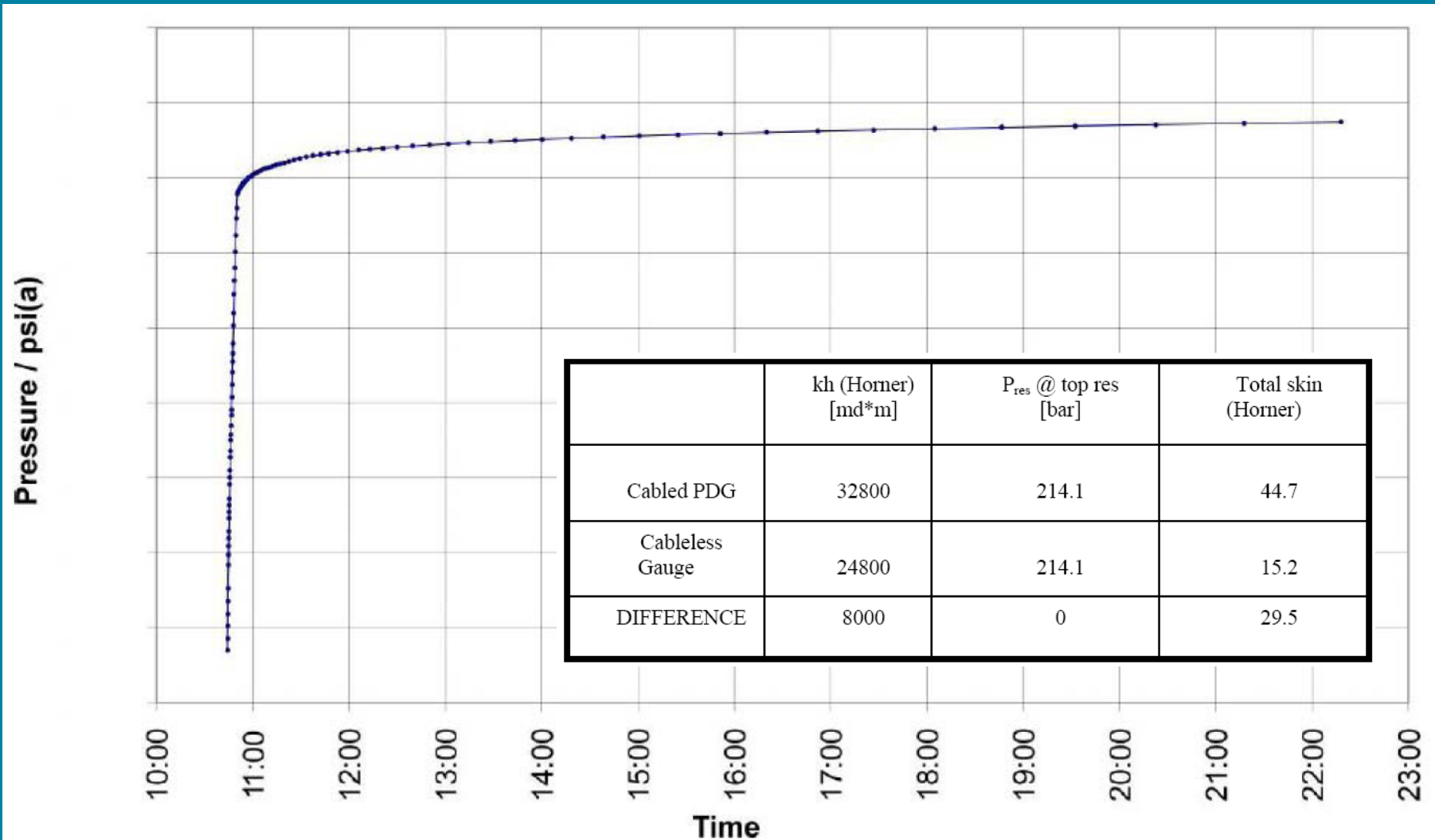
- 7" lower completion with gravel pack
- 9 5/8" production liner
- High set production packer with cabled PDG 1000m -1200m above the producing sandface
- Cableless gauge mandrel located at the top of the sand screens



# Cableless Gauge System For Ormen Lange



# Results – Pressure Build-up in A-5H (Ref. SPE 145581)

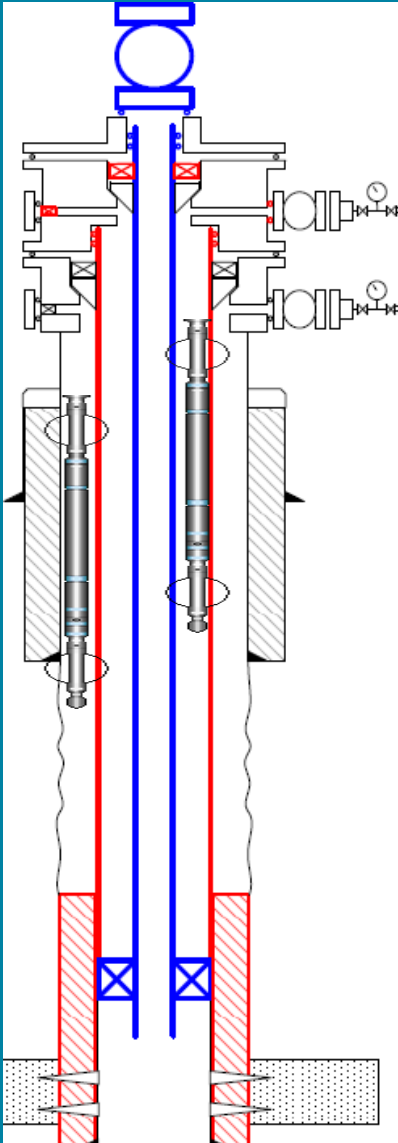


# Conclusions for Wireless Technology in Ormen Lange



- In drawdown constrained wells, having access to high accuracy flowing pressure measurements at the producing sandface enables the drawdown to be optimised and the flow rate to be maximised.
- The cabled PDG data can be correlated with the cableless gauge data across a range of flow rates to reflect sandface flowing conditions.
- The CaTS data collected from 6 Ormen Lange wells has been used to fine tune the lift curve correlations across the wider Ormen Lange Field, even in those wells having no cableless gauge system installed.
- Pressure transient analysis performed on PBU data collected by the cableless gauge located at the reservoir provides more representative values for permeability and skin than the remotely located cabled PDG.

# Annulus Integrity Monitoring



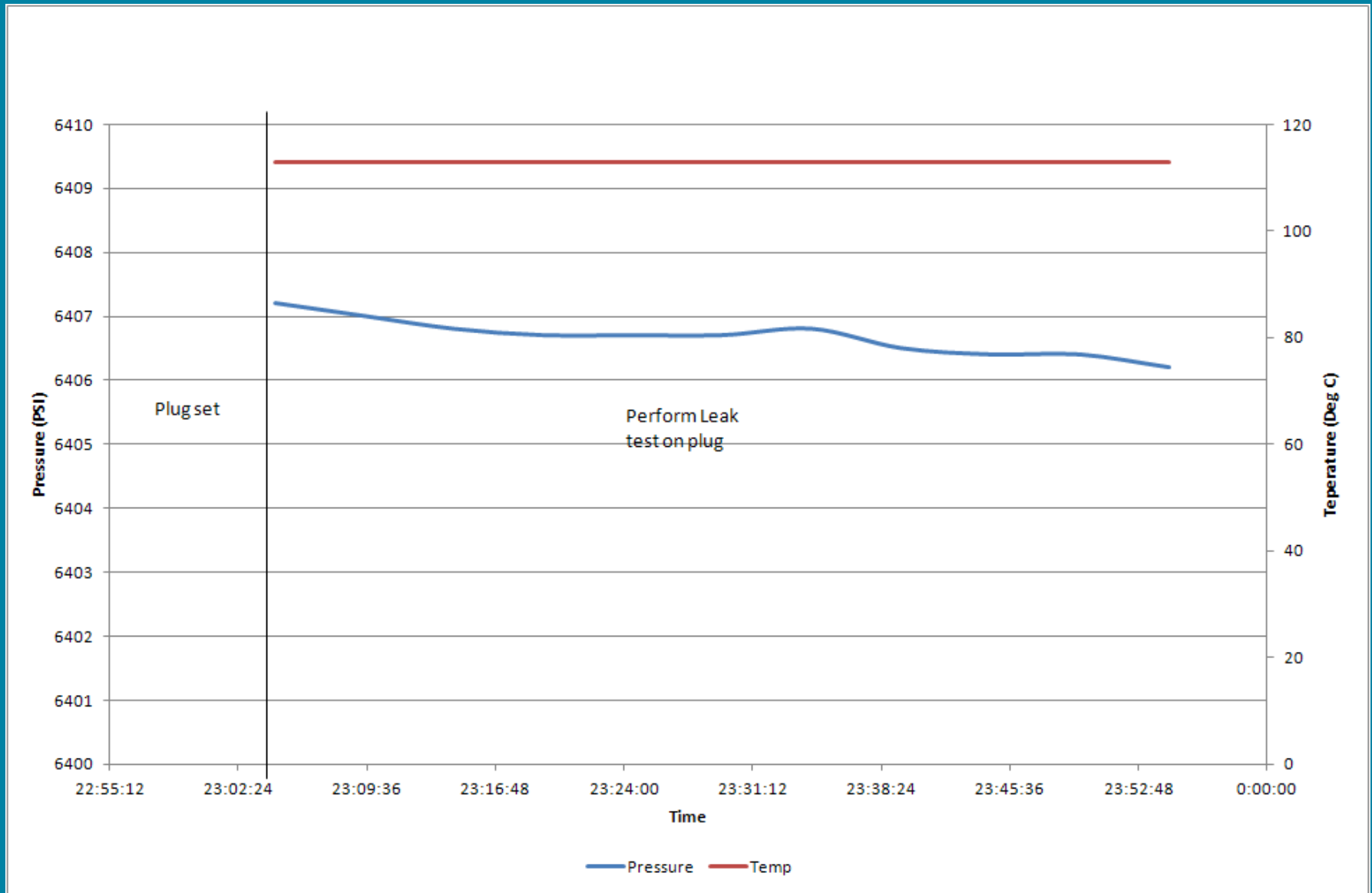
- Flexibility in placement location for Annulus Monitoring applications
- Gauge can be used for monitoring the pressure and temperature in the A, B, C, or any annulus, with no penetrations required
- Failing to adequately monitor and control thermally induced annulus pressure variations can result in serious consequences!



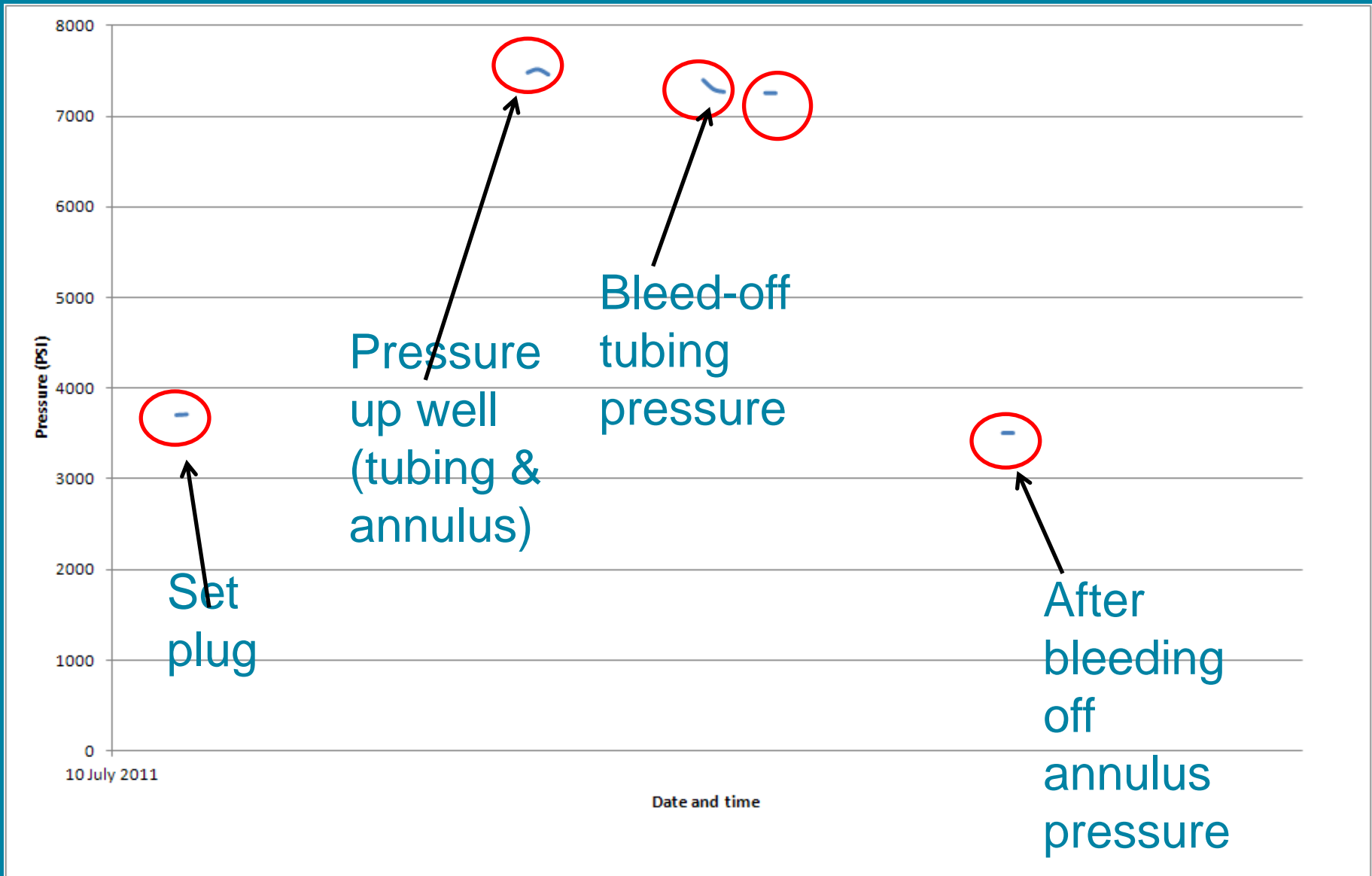
- Light Well Intervention campaigns were performed on 13 wells on the Norwegian and UK Continental Shelf during the period 2011 to 2014
- Objective of the interventions was either to prepare the wells for a rig workover or to permanently abandon the well
- Operational programme called for the installation of 2 deep-set plugs
- Verifying deep-set dual barriers located close together, using surface pressure measurements can be inconclusive
- EM Wireless gauge technology was used to verify the upper barrier



# Results – Well no. 1 – Upper Barrier Verified OK



# Results – Well no. 3 – Upper Barrier Failed Verification





- Reservoir connectivity and compartmentalization are key uncertainties when planning any new field development; reducing reservoir uncertainty carries significant value
- Advances in wireless monitoring technology using EM communications now enables abandoned or suspended wells to be cost effectively converted into high value, long term monitoring assets post-final abandonment
- Post-abandonment data is being used for far-boundary investigation, inter-well connectivity and vertical transmissibility determination
- Advanced Reservoir Testing using EM wireless monitoring technology is being used to reduce reservoir uncertainties, resulting in an optimised field development plan
- The technology has applications throughout the well life cycle for production optimisation in new completions, or retrofit by LWI in existing wells, and by verifying barriers, it is enhancing well safety



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# Thank You for Your Attention

## Any Questions?

Contact for further information: [brian.champion@exprogroup.com](mailto:brian.champion@exprogroup.com)

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