



# Water Injectors - K28 Case Study and More

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# Agenda:

1. Introduction to water injectors on Ekofisk
2. Diagnostics and Evaluation
3. K-28 - The value of built in DTS - how to save a well
4. Alternative technologies being tested
5. K-11 - decisions...
6. Questions?

# Introduction to Water Injectors on Ekofisk:

	Platform	Red	Orange	Yellow	Green
2010 RNNP Submission	Ekofisk Kilo	1 (TA)	14 (I) 5 (S)	5 (I)	4 (I) 1 (S)
	Tor		4 (I)		
	Eldfisk Alpha		3 (I)		1 (I)
	Eldfisk Bravo		1 (I)	1 (I)	
2011 RNNP Submission	Ekofisk Kilo	1 (TA)	13 (I) 3 (S) 2(TA)	6 (I) 1(S)	4 (I)
	Tor		1 (I)		
	Eldfisk Alpha		4 (I)		
	Eldfisk Bravo		1 (I)	1 (I)	2 (I)
	Ekofisk VA			2 (I)	6 (I)

Water Injection critical for subsidence management - if well integrity turn off all problematic water injectors.....

How to assess - risk to personnel on platforms vs risk of cross injection vs risk of subsidence

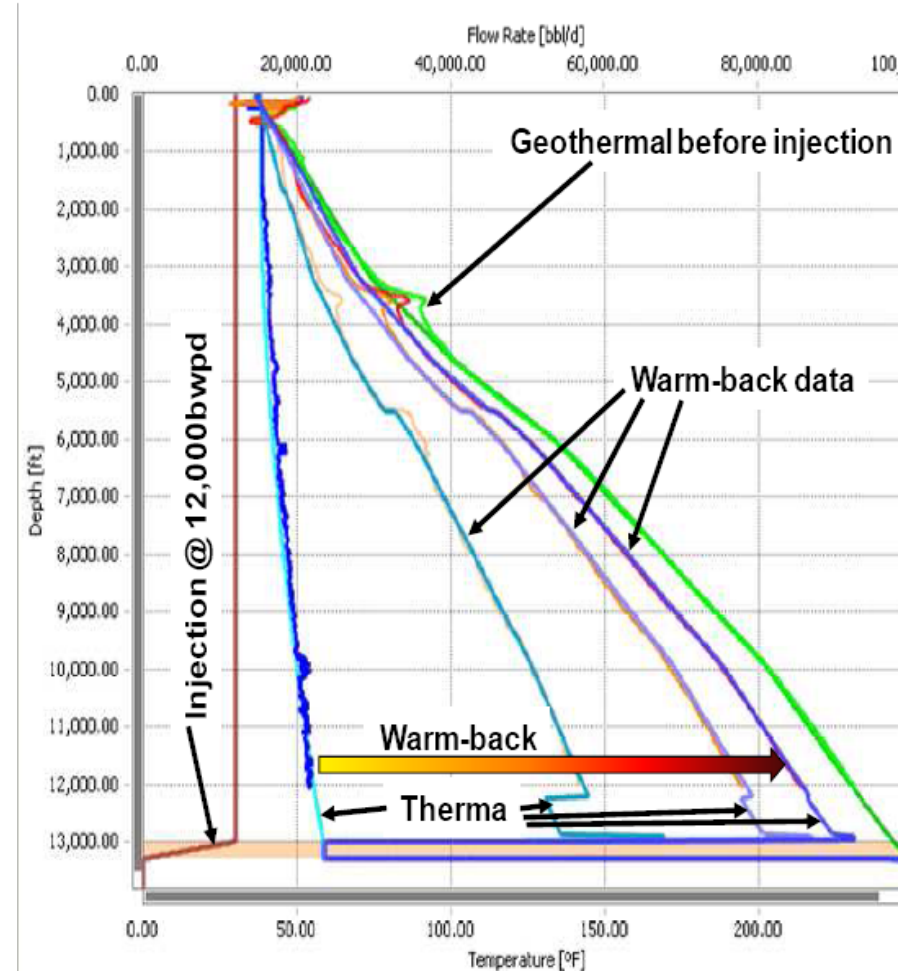
# Diagnostics:

To address personnel exposure  
Annulus and tubing pressure monitoring.  
Fluid rates and types  
Wellhead and Tree Evaluation  
Tubular condition  
Barriers against reservoir (tubing)  
Barriers against reservoir (annuli)

To allow subsidence management  
*Priority of wells on rig sequences.*  
VA wells support south portion of Ekofisk,  
Kilo wells northern and COMPLEX

To prevent cross flow  
Reservoir Fall off testing.  
Time-lapsed temperature logging

**Frustration!**



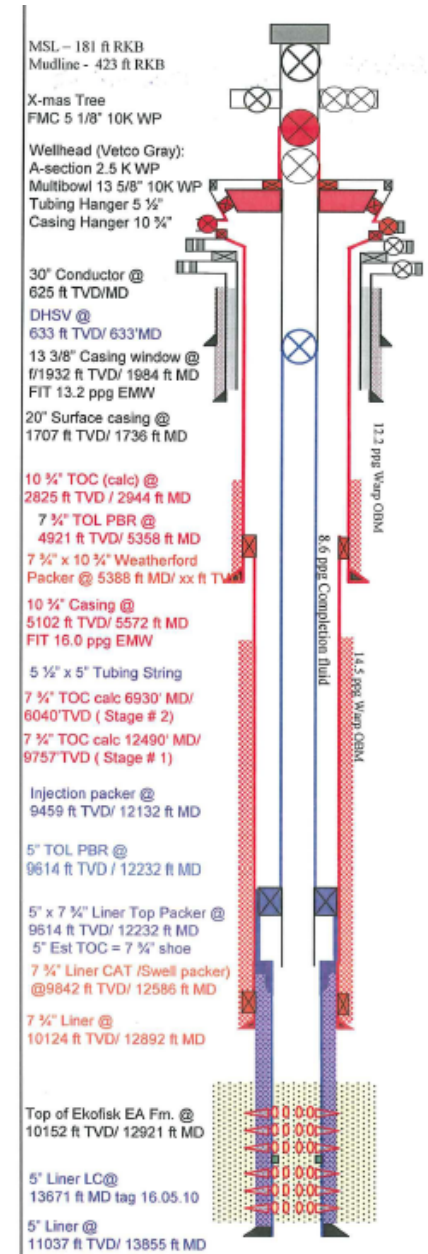
## RESULTS

Reservoir securing - B annuli flows cease in 50-70% of cases  
**Rig shut down for 2-3months to log wells!**  
DTS cables & improved cementation in all new wells

# K-28 - a newly delivered well that was looking bad!



- K28A was sidetracked and completed in May 2010. No faults detected in construction phase
- After few months of injection and Summer SD, annulus pressure came up.
- One annulus bleed off test produced "crude looking" fluid.
- There was no leak detected in the tubing.
- Due to B annulus problem, the well was considered as P&A candidate.

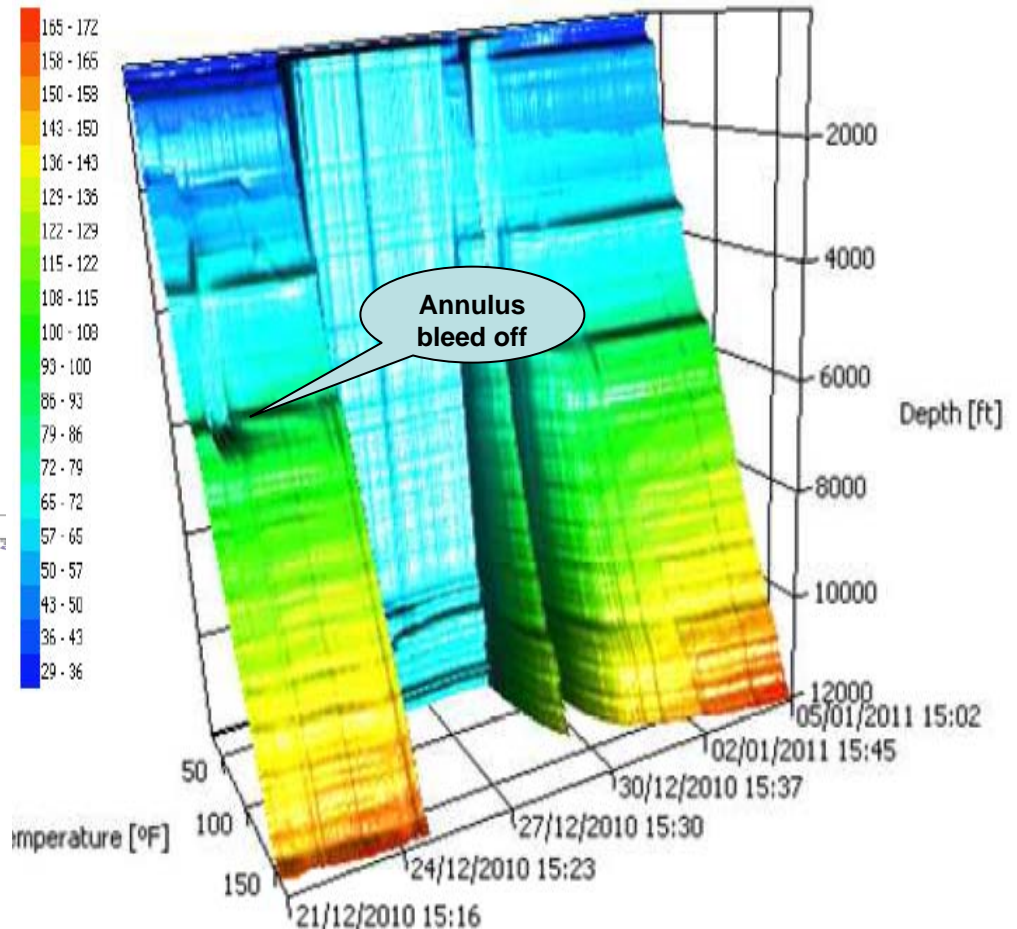
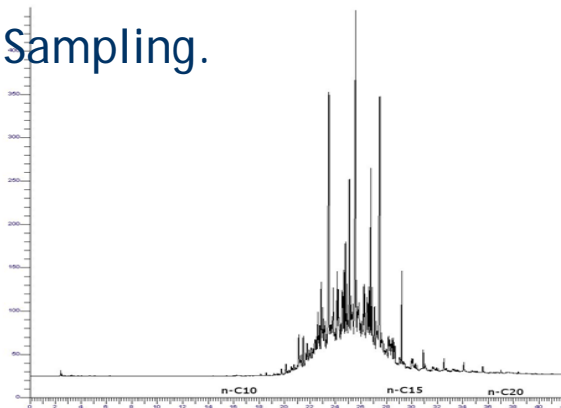




# K-28 - a newly delivered well that was looking bad!

Detailed diagnostic program.

Annulus Sampling.



Distributed Temperature System

- Behaviour under injection,
- Behaviour during bleed off

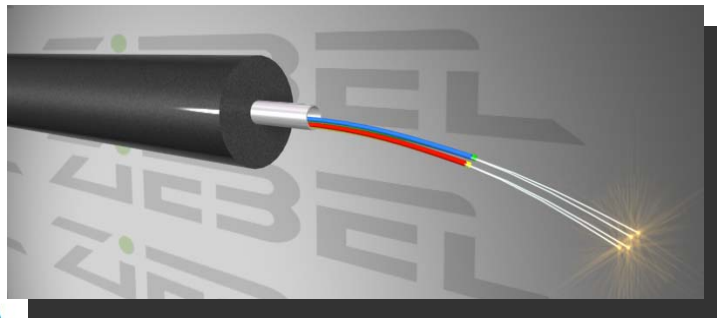
Thanks to DTS survey, root cause of annulus leak has been diagnosed to be result of expansion of trapped drilling fluid (OBM) at the liner lap.

Fluid moves downwards during bleed-off.

# Alternative Techniques (CoP/DeepWell and Ziebel)

- Provides a step change in downhole intervention & horizontal well logging
  - Similar to coiled tubing intervention, but utilizing much smaller footprint equipment
  - Requires 6-8 field crew vs. other solutions requiring 10+ engineers for 24hr operation.
- A 20,000 ft. injectable semi-stiff, continuous, carbon “rod” with Fibers
  - Significantly less choke effect compared with using CT or “tractor”
  - Doesn’t require any up-down movements to log entire wellbore

DTS & DAS measurements along the complete length of the “rod” with point pressure, temperature & vibration sensors housed in a “bullnose” BHA.



# K-11 - An older well (supports main complex)

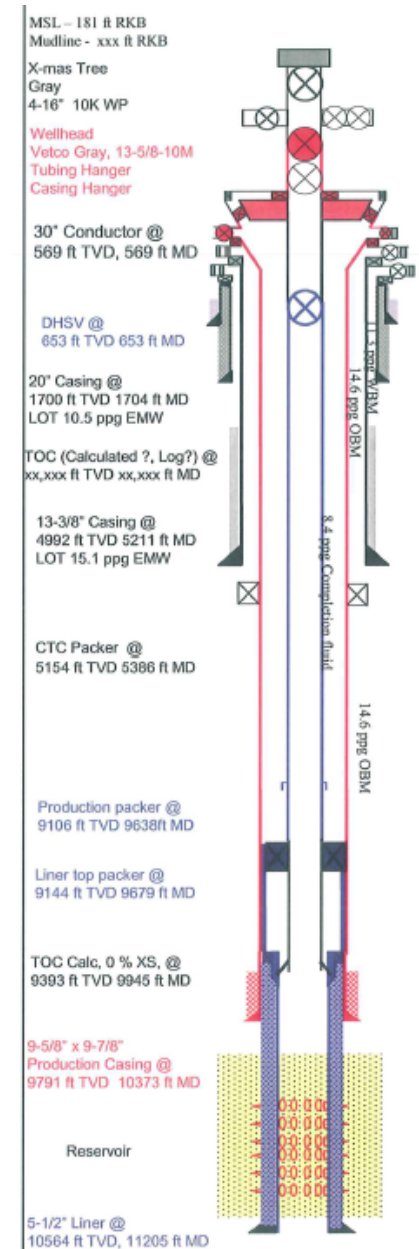
- Built in the years when we did not cement the production casing (to improve well integrity).
- Some material specification issues on wellhead caused corrosion.
- CTC packer in open hole on a water injection in a subsiding field.

B annulus pressure - with wellhead concerns!  
 Traditional solution - cement the reservoir and sidetrack the well.

**But.....**

Ziebel logging identified main flow into B was NOT from the reservoir.

**Workover.....**





Questions?