



Successful Completion of Geothermal Well de Lier and the Future of Geothermal Energy

KCA Deutag Drilling GmbH
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Quick Overview and Operations



CELEBRATING
125 Years
Our legacy. Our future.

KCA DEUTAG
Operating safely, succeeding globally.

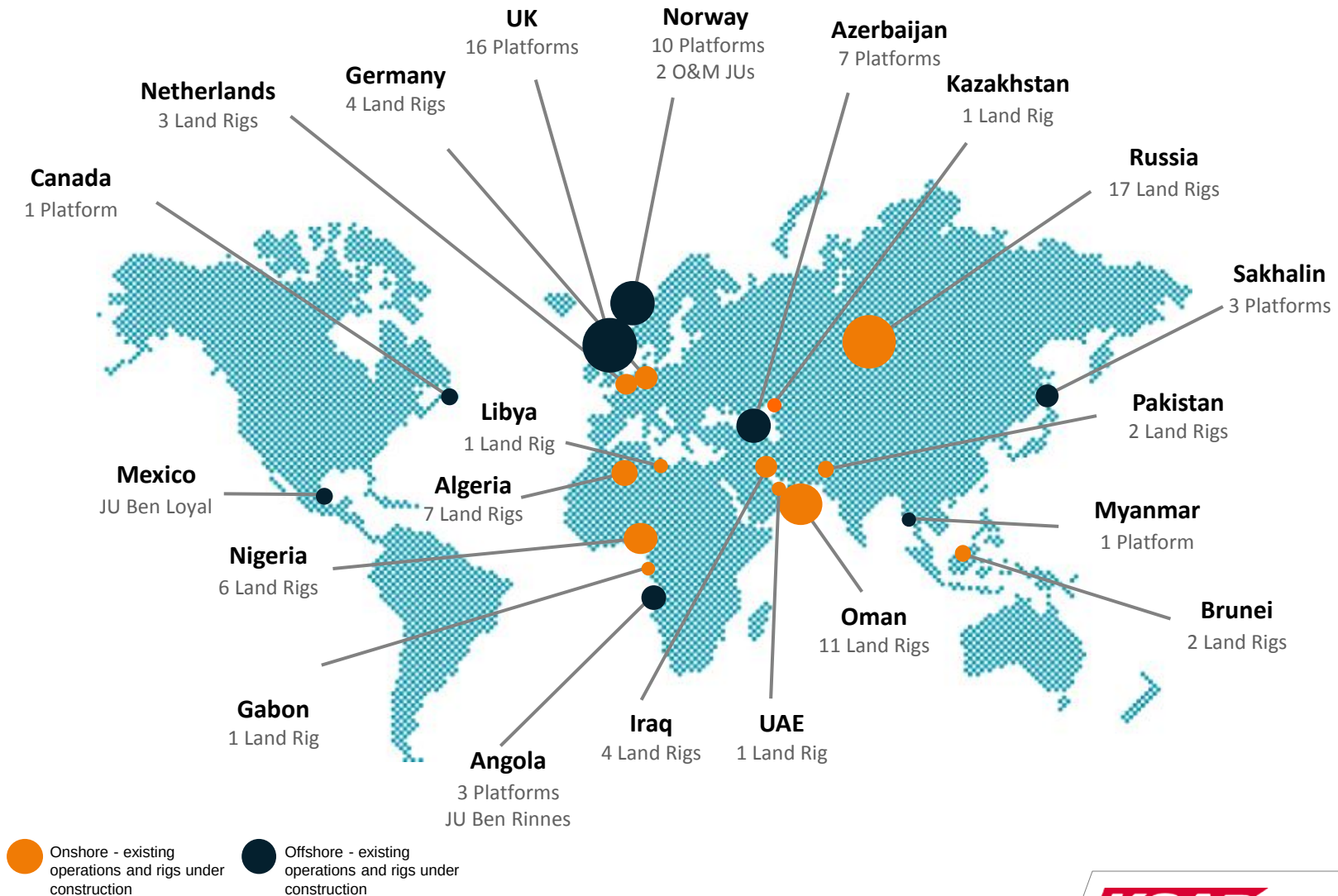
KCA Deutag Vision & Business Overview

To be recognised as the world's most successful drilling and engineering contractor through measurable performance improvement, delivering safe, effective, trouble-free operations

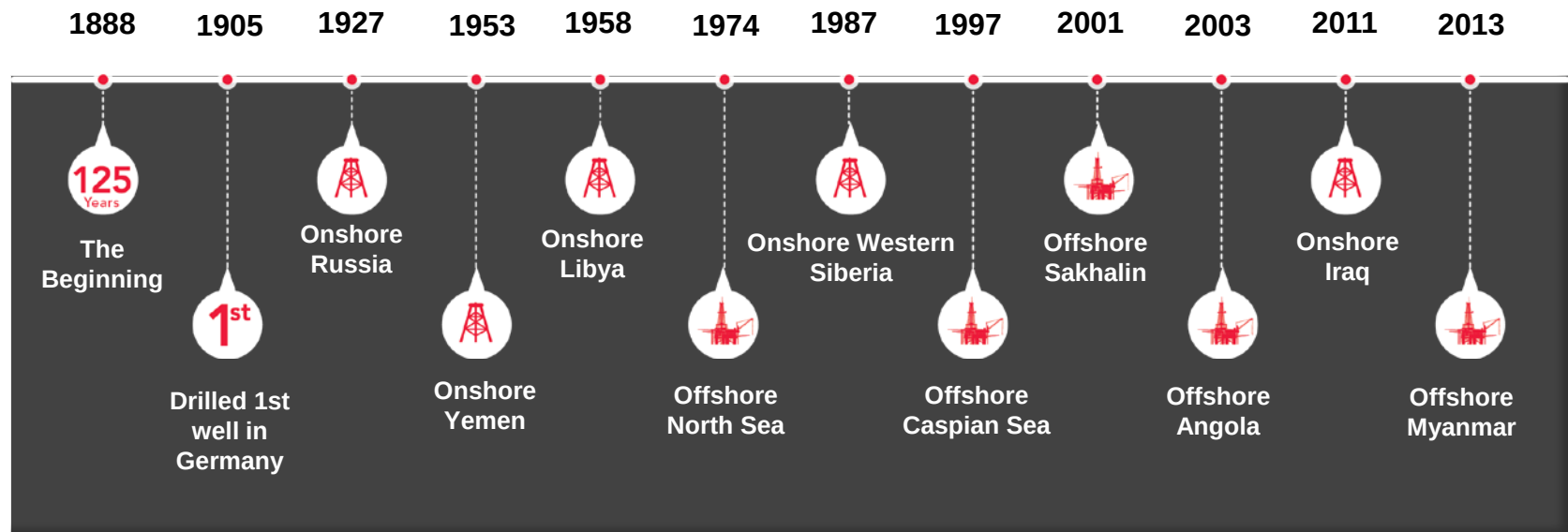
- More than 9,300 staff in 21 countries
- Onshore fleet of 60 rigs
- 41 offshore platform drilling contracts
- Owner and operator of 2 jack-ups
- Engineering division of 900+ drilling facilities design professionals (RDS)
- Leading land rig builder and equipment manufacturer (Bentec)



Onshore and Offshore Locations



125 years supporting the Drilling Industry globally



Onshore – Europe & Kazakhstan

- **Currently** operating in the Netherlands and Kazakhstan
- **Previously** worked in:
 - Albania
 - Austria
 - Belgium
 - Denmark
 - France
 - Germany
 - Greece
 - Poland
 - Portugal
 - Spain
 - Sweden
 - Switzerland
 - Turkey
 - UK
- European new-builds include:
T-207 and T-208 1,500 HP EuroRigs,
highly automated T-700 rig
- Market opportunities: Geothermal (Europe, Africa),
conventional oil and gas, shale gas (UK, Poland and
Ukraine)



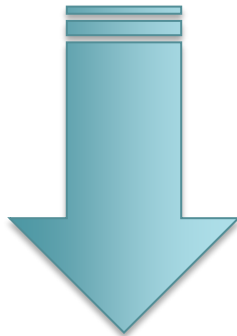
Major Clients in Europe



Operating in The Netherlands since the 50ies



Rig Name	Client	Start	End	Scope	Location/Well	Total Meters Drilling
T-22	Staatsmijnen in Limburg	1953	1953	Drilling	Neer/Holland	706 m
T-4	Staatsmijnen in Limburg	1954	1954	Drilling	Maalbrock/Holland	456 m
T-4	Staatsmijnen in Limburg	1954	1954	Drilling	Beesel/Holland	1.234 m
T-22	Staatsmijnen in Limburg	1954	1954	Drilling	Swalmen/Holland	1.331 m
T-22	Staatsmijnen in Limburg	1954	1954	Drilling	Neer/Holland	586 m
T-4		1955	1955	Drilling	Maalbrock	985 m
T-22		1955	1955	Drilling	Helden	1.352 m
T-22		1956	1956	Drilling	Reuver	1.104 m
T-7	Staatsmijnen in Limburg	1958	1958	Drilling	Elmpt 2	1.026 m
T-7	Staatsmijnen in Limburg	1958	1958	Drilling	Elmpt 1 (deviasion)	15 m
T-7	Staatsmijnen in Limburg	1958	1958	Drilling	Elmpt 1	1.215 m
T-7	Staatsmijnen in Limburg	1959	1959	Drilling	Elmpt 2	101 m
T-41		1959	1959	Drilling	Hengelo 5	452 m
T-41		1959	1959	Drilling	Hengelo 4	454 m
T-41		1959	1959	Drilling	Hengelo 3	442 m
T-41		1959	1959	Drilling	Hengelo 2	443 m
T-41		1959	1959	Drilling	Hengelo 1	452 m



Location Ameland 2, beginning of 60ies

T 700 Project



Rig Name	Client	Start	End	Scope	Location/Well	Total Meters Drilling
T-700	NAM	2015	2015	Drilling	Coevorden 59	ongoing
T-700	NAM	2014	2014	Drilling	Anjum 6	5.335 m
T-700	NAM	2014	2014	Drilling	Krabburen 5	5.493 m
T-700	NAM	2014	2014	Drilling	Enwierum 3	4.423 m
T-700	NAM	2014	2014	Drilling	Norg 41	3.141 m
T-700	NAM	2014	2014	Drilling	Norg 43	2.936 m
T-700	NAM	2014	2014	Drilling	Norg 41	2.920 m
T-700	NAM	2014	2014	Drilling	Norg 43	2.289 m
T-700	NAM	2014	2014	Drilling	Norg 41	905 m
T-700	NAM	2013	2013	Drilling	Anjum 6	1.396 m
T-700	NAM	2013	2013	Drilling	Blijham 7 a	5.036 m
T-700	NAM	2013	2013	Drilling	Blijham 7	2.994 m
T-700	NAM	2013	2013	Drilling	Borgsweer 5	3.268 m
T-700	NAM	2013	2013	Drilling	Bedum 5	4.979 m
T-700	NAM	2012	2013	Drilling	Munnekezijl 7	5.229 m
T-700	NAM	2012	2012	Drilling	Spijkenisse Oost (1 B)	2.770 m
T-700	NAM	2012	2012	Drilling	Norg 416	4.808 m
T-700	NAM	2012	2012	Drilling	Moddergat (MGT) 3	3.914 m



T45 Project Bergermeer



Start	End	Scope	Location/Well	Total Meters Drilling
2015	2015	Drilling	Bergermeer (BGM) 03	ongoing
2014	2015	Drilling	Bergermeer (BGM) 17	2.801 m
2014	2014	Drilling	Bergermeer (BGM) 18	4.030 m
2014	2014	Drilling	Bergermeer (BGM) 19	2.378 m
2014	2014	Drilling	Bergermeer (BGM) 23	2.453 m
2014	2014	Drilling	Bergermeer (BGM) 19	2.210 m
2014	2014	Drilling	Bergermeer (BGM) 18	3.238 m
2014	2014	Drilling	Bergermeer (BGM) 17	2.732 m
2014	2014	Drilling	Bergermeer (BGM) 18	2.733 m
2014	2014	Drilling	Bergermeer (BGM) 19	1.779 m
2014	2014	Drilling	Bergermeer (BGM) 23	1.790 m
2014	2014	Drilling	Bergermeer (BGM) 19	1.009 m
2014	2014	Drilling	Bergermeer (BGM) 18	1.020 m
2014	2014	Drilling	Bergermeer (BGM) 17	1.020 m
2014	2014	Drilling	Bergermeer (BGM) 10	3.492 m
2014	2014	Drilling	Bergermeer (BGM) 11	2.351 m
2014	2014	Drilling	Bergermeer (BGM) 14	2.431 m
2014	2014	Drilling	Bergermeer (BGM) 15	2.675 m
2014	2014	Drilling	Bergermeer (BGM) 16	2.911 m
2014	2014	Drilling	Bergermeer (BGM) 15	2.565 m
2014	2014	Drilling	Bergermeer (BGM) 14	2.246 m
2014	2014	Drilling	Bergermeer (BGM) 11	2.166 m
2014	2014	Drilling	Bergermeer (BGM) 10	2.866 m
2014	2014	Drilling	Bergermeer (BGM) 16	2.033 m
2014	2014	Drilling	Bergermeer (BGM) 15	2.007 m
2014	2014	Drilling	Bergermeer (BGM) 14	1.753 m
2014	2014	Drilling	Bergermeer (BGM) 11	1.767 m



Start	End	Scope	Location/Well	Total Meters Drilling
2013	2014	Drilling	Bergermeer (BGM) 10	1.664 m
2013	2013	Drilling	Bergermeer (BGM) 11	1.033 m
2013	2013	Drilling	Bergermeer (BGM) 14	975 m
2013	2013	Drilling	Bergermeer (BGM) 15	1.020 m
2013	2013	Drilling	Bergermeer (BGM) 16	1.020 m
2013	2013	Drilling	Bergermeer (BGM) 25	3.417 m
2013	2013	Drilling	Bergermeer (BGM) 27	2.480 m
2013	2013	Drilling	Bergermeer (BGM) 28	2.217 m
2013	2013	Drilling	Bergermeer (BGM) 27	2.379 m
2013	2013	Drilling	Bergermeer (BGM) 25	2.882 m
2013	2013	Drilling	Bergermeer (BGM) 27	2.089 m
2013	2013	Drilling	Bergermeer (BGM) 28	1.791 m
2013	2013	Drilling	Bergermeer (BGM) 29	3.944 m
2013	2013	Drilling	Bergermeer (BGM) 24	2.201 m
2013	2013	Drilling	Bergermeer (BGM) 29	3.377 m
2013	2013	Drilling	Bergermeer (BGM) 24	2.072 m
2013	2013	Drilling	Bergermeer (BGM) 25	971 m
2013	2013	Drilling	Bergermeer (BGM) 27	1.001 m
2013	2013	Drilling	Bergermeer (BGM) 28	995 m
2013	2013	Drilling	Bergermeer (BGM) 29	1.027 m
2012	2012	Drilling	Warmenhuizen 2	1.615 m
2012	2012	Drilling	Zuidwijk	3.300 m
2012	2012	Drilling	Groet Oost 01S1	3.596 m

Operating in The Netherlands



Rig Name	Client	Start	End	Scope	Location/Well	Total Meters Drilling
T-49	DE LIER	2014	2014	Drilling	LIR-GT-02	TD
T-49	DE LIER	2014	2014	Drilling	LIR-GT-01	2.897 m
T-49	VERMILION	2014	2014	Drilling	Havelte HVE-01	3.938 m
T-46	NAM	2007	2007	Workover	Lauwersoog LWO1	Workover
T-46	NAM	2007	2007	Workover	Lauwersoog LWO2	Workover
T-46	NAM	2007	2007	Workover	Vierhuizen VHN-1 / NL	Workover
T-46	NAM	2006	2006	Workover	Moddergat MGT1	Workover
T-46	NAM	2006	2006	Workover	Moddergat MGT2	Workover
T-46	NAM	2006	2006	Drilling	Oud Beijerland Zuid OBLZ-2	4.640 m
T-46	NAM	2006	2006	Workover	Tussenklappen TUS 5	Workover
T-46	NAM	2006	2006	Workover	Tussenklappen TUS 2	Workover
T-46	NAM	2006	2006	Workover	Tussenklappen TUS 3	Workover
T-46	NAM	2006	2006	Workover	Tussenklappen TUS 4	Workover
T-46	NAM	2006	2006	Drilling	Grijpskerk GRK-43	3.449 m
T-46	NAM	2006	2006	Workover	Uiterburen 4	Workover
T-46	NAM	2006	2006	Drilling	Spijkenisse SPKO-3	4.520 m
T-46	NAM	2005	2006	Drilling	's Gravenzande SGZ-4	7.119 m
T-46	NAM	2005	2005	Workover	Sappemeer SAP-15 A	Workover
T-46	NAM	2005	2005	Drilling	Eemskanaal EKL-13	4.648 m
T-46	NAM	2005	2005	Workover	Borgsweer BRW-4	Workover
T-46	NAM	2005	2005	Drilling	Grisjperk GRK-17	3.749 m
T-46	WIAG	2004	2005	Drilling	Waalwijk Zuid 02	4.850 m
T-45	BP	2006	2006	Drilling	Boekel 1 (Alkmaar 1)	3.440 m
T-45	BP	2005	2006	Drilling	Groet Oost 1	3.680 m
T-45	TOTAL	2005	2005	Workover	Luttelgeest	Workover
T-207	FRISIA	2014	2015	Drilling	Barradeel BAS 3 O	4.724 m



Working in sensitive areas

Germany – Bavaria (The Alps)

Touristically high influenced region



The Netherlands

Noise reduction in urban area



East of Germany

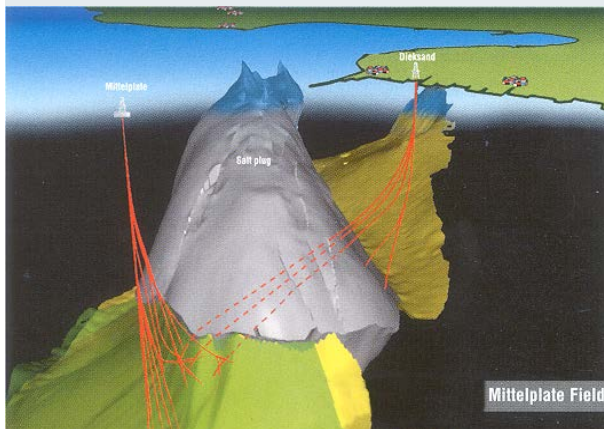
Coastline of Baltic Sea



Working in sensitive areas

Germany

In the Wadden Sea
World Heritage



The Netherlands

Minimise Noise at Source



What differentiates KCA Deutag?



- **The KCA Deutag Way**

HSE: Superior culture and performance, Safe2Lead programme

Drilling Performance: Non-Productive Time of 1.9% in 2014 across more than 100 onshore/offshore rigs

Corporate Operations Function: Accountability for global operations as per KCAD worldwide standard, policies, procedures and technical integrity

Performance Services: Commitment to performance improvement

- **International Experience:** Worked in more than 30 countries in last 10 years
- **Drilling and Advance Rig Training:** Surface equipment and down-hole drilling operations training services worldwide, competency system for crews
- **Drilling Facilities Engineering Design:** 900+ professionals, 60+ major drilling facility projects, conceptual studies etc.
- **Rig Building and Drilling Equipment Manufacturing:** Bentec, German engineering for world class drilling equipment

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Execution of de Lier project



Our Drilling Rig T49



BENTEC E-1250-DC

TECHNICAL OVERVIEW

Rating	1,250 HP	933 kW
Hook load	612,000 lbs @ 12 lines	277 t
Drilling depth theoretical	14,000 ft	Approx. 4,250 m
Refurbished in 2008		

ADDITIONAL INFORMATION

Soundproofed Equipment

- Rig Floor, Generators, Mud Pumps, Helical gear for TDS, Top Drive Sound protection

Drawworks features

- Disk brake, 4-Q-System with Joystick operation, Anti Collision System (ACS), Automatic Driller System

Power Supply

- Diesel Engine Driven and / or Grid-Power Supply with Transformer

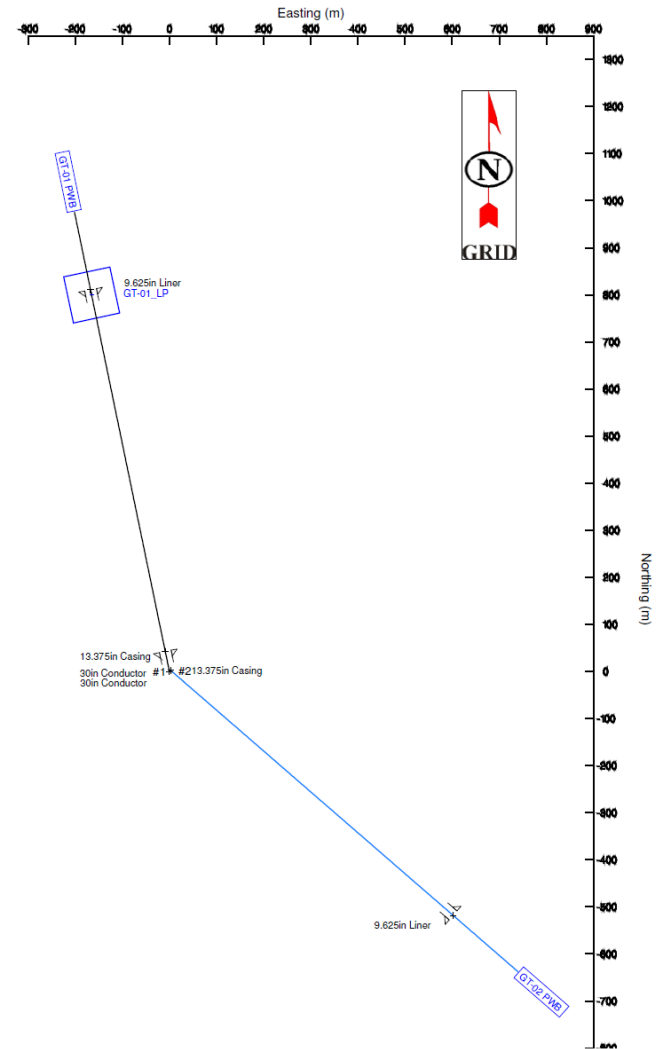
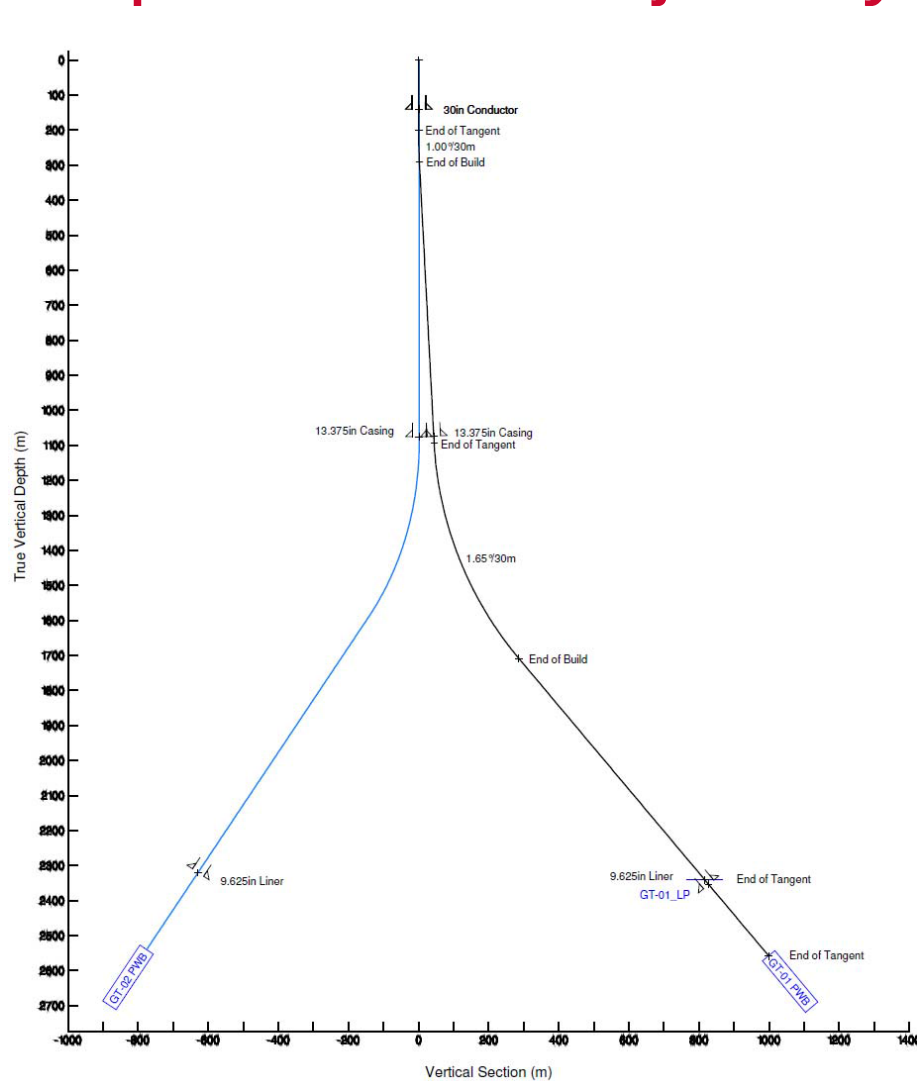
Certification

- ATEX & CE, including local requirements

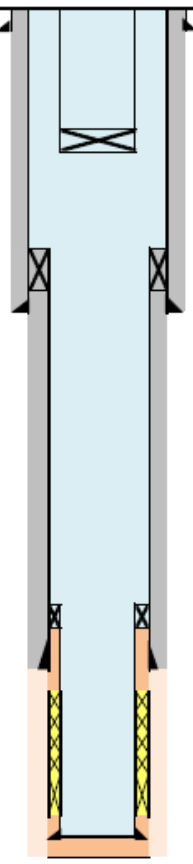
Miscellaneous

- Air Conditioned Driller Cabin with InfoDrill (computerized) & CCTV
- Skidding System

Proposed well trajectory



LIR-GT-01 Well Diagram

Formations	Member	Formation top depths (m RT)		Wellhead and Xmastree LIR-GT-01	Nr.	Item Description	Depth	Depth	Hole ID	Pipe OD	Collar OD	Pipe ID	Pipe ID
		m	m				m	m	in	in	in	in	in
		TVD	AH				tvd	ah		(nom)		(drift)	
	Superficial deposits	6.7	6.7		1	24" welded conductor / stove pipe	140	140		24.000	welded		22.000
	Maassluis	105	105			Kick off Point	200	200					
Upper North Sea	Oosterhout	255	255			End of Built (EOB) to 3-	290	290					
	Breda					for testing:							
Middle North Sea	Rupel	430	430			ESP on 8 5/8" 32# L80 Polseal product	500	500					
Lower North Sea	Dongen	450	450										
	Landen												
Chalk	Ekofisk	705	705										
	Ommelanden					13 3/8 x 9 5/8" Liner Hanger + Packer	975			Top of liner (100 m liner lap)			
	Texel Marl Stone	1068	1069		2	13 3/8" 68ppf L80 Premium GT (gas tig	1075	1075	17.5"	13 3/8"	14.175	12.415	12.259
	Texel Greensand	1097	1098				1080	1080		section TD			
Rijnland	Holland	1110	1111			Kick off Point	1096	1096					
	Vlieland	1677	1726										
						End of Built (EOB) to 40"	1708	1766					
Schieland	Rodenrijs Claystone	2242	2483										
	Delft Sandstone	2341	2592		3	9 5/8" x 6 5/8" Liner Hanger + Packer	2326	2574	12.25"	9 5/8"	10.396	8.681	8.525
						9 5/8" 47ppf L80 Premium GT (gas tight)	2330	2579		section TD			
	Alblasserdam	2481	2775		4	6 5/8" 24ppf L80 Basepipe w/ 7" OD WWS w/ Bullnose	2555	2872	8.500	7.000	7.191	5.921	5.796
	Pijnacker Zandsteen	2558	2876		5	Open hole 8 1/2" (TD)	2558	2876	8.500				

LIR-GT-01 Common Drilling hazards

Stratigraphic Column De Lier				Total gas detection ppm				Common		
Group	Formation	Member	Source rock or Reservoir rock	VLN-01	HON-GT-01	HON-GT-02	GAG-01	Drilling hazard		
Upper North Sea NU	"Diverse"			No data		0	0	<50	Mudstones in sandy topholes, sand cavings. Swelling clays.	
	Maassluis NME								Chalks, overpulls, stuck pipes, swabbing.	
	Oosterhout NUCOT								Sand cavings, Swelling Clays.	
	Breda NUBA								Pyrite, Swelling clays.	
Middle North Sea NM	Rupel NMRP	Rupel Clay NMRP							Coarse chert. Trace pyrite.	
Lower North Sea NL	Dongen NLF	Aase NLFBS			0 - 150	0 - 100		<50	Slightly to very swelling clays. Washouts.	
		Brussels Sand NLFBS								
		Ieper NLFPI								
		Basal Dongen Tuffite NLFDT								
Chalk OK	Landen NLF	Landen Clay NLFCL			100 - 800	100 - 400	Trace pyrite			
		Ekofisk OKIK			40 - 100	± 150				
		Ommelanden OKOR			0 - 3000	100 - 2000	Chert (top section): chert 5-30%. Trace pyrite. Mudstones.			
		Texel OKTX			± 250	± 250	Trace pyrite			
Rijnland RN	Holland RNL	Plenus Marl OKTRP			200 - 2000	400 - 3000	100 - 400	Trace pyrite		
		Texel Marlstone OKTRM			200 - 2000	800 - 2000		Trace pyrite		
		Texel Greensand OKTRG			200 - 1500	200 - 2000				
		Middle Holland Claystone RNLMI			200 - 1500	400 - 4000		Swelling clays		
	Holland RNL	Holland Greensand RNLG			no oil shows detected	800 - 4000				
		Lower Holland Marl RNLML			300 - 5000	100 - 6000		800 - 3000		
	Vlieland Sandstone RNL	De Lier Sandstone RNL			800 - 10000; TRG (trip gas): 88400 & 134400 (no natural fluorescence)	800 - 8000		1500 - 5000	100 - 400	Pyrite. Cavings (5-10%)
		Vlieland Clay RNLMI			200 - 4000 TRG: 13321 & 36400 well swabbed gas while POCOL circulated gas out max 931676 ppm	200 - 10,000 CG up to 77,000		1000 - 6000 CG up to 29,000	± 100	"Plastic clays": clay balls, overpulls, swabbing.
Schieland SL	Nieuwerkerk SLN	Berkel Sandstone RNLBS			500 - 4500	1000 - 10,000 CG up to 51,000	3000 - 7000 CG up to 43,000	± 120	Mud Losses	
		Berkel Sand/Claystone RNLCC			2000 - 4000	0 - 5000 CG up to 40,000	1500 - 7000 CG up to 45,000	60 - 120	Swelling clays	
		Rijswijk Sandstone RNLRS			800 - 3000 Two peaks TRG of 16270 & 12051	0 - 5000 CG up to 22,000	2000 - 6000 CG up to 34,000	70 - 80	Swelling clays	
		Rodenrijs Claystone SLNR			1000 - 3300	0 - 2000 CG up to 15,000	150 - 6000 CG up to 11,000		Pyrite	
		Deift Sandstone SLND			200 - 2000	200 - 2700	150 - 3400	60 - 800	Mudstones and/or influx of formation water. Pyrite.	
		Alblasendam SLDA			200 - 3000	200 - 7400				
		Pijnacker Zandveen (submember)			One peak of TRG 7000 (Fair yellow/orange natural fluorescence, yellow solvent cut, milky white cut fluorescence)	200 - 22,000 Generally between 400 - 800	150 - 17,000		Pyrite. Cavings.	

Brief overview of Project



Project Brief

- Drilling a geothermal doublet (LIR-GT-01 & -02) for V.O.F. Geothermie De Lier
- Target depth: 2,341 m; maximum inclination of 40 degree
- Reservoir pressure: 243 bar; mid aquifer level temperature: 82° C

Commencement & Duration

- 1st well: start: 19.05.2014; end: 30.06.2014 (planned: 37.5 days; actual: 42 days)
- 2nd well: start: 07.07.2014; end: 05.08.2014 (planned: 36.5 days; actual: 29 days)

Highlights

- Skidding of T-49 within 21 hrs from rig release to spud; planned for 1.5 days
- Good lessons learnt from 1st well implemented to drill 2nd well faster
- Well LIR-GT-02 was drilled in a 7 days shorter period than planned
- Post Activity Review within KCA Deutag to capture lessons learnt for us

Lowlights

- Rig up took longer than expected due to small location (planned: 9 days, actual: 11 days, LL for us)
- Duration of LIR-GT-01 took 4.5 days longer due to pull out of 9-5/8" casing again (resistance RIH casing)

V.O.F. Geothermie De Lier



3

The future of Geothermal Energy



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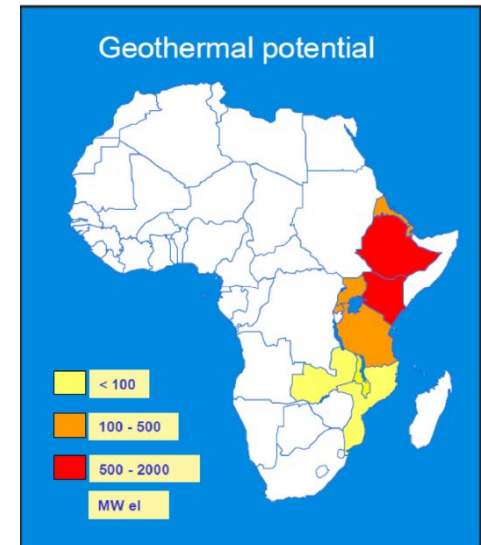
Geothermal Future



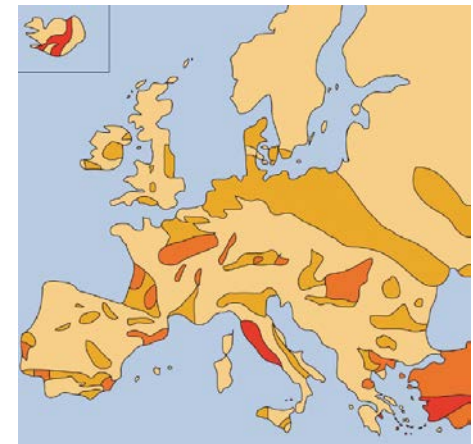
Source: www.mbmsystems.de

Geothermal Future

- Complex constructions require reputable and mature players
- Risk management taken serious in all aspects
- Market is sharing learnings well, but maturing still
- Geothermal heat mainly for big heat consumers
- Geothermal energy for new industrial zones
- Geothermal heat & energy for new residential areas
- Share and receive lessons learnt with O&G industry, SodM, Science



Source: BGR 2013



Geothermal Future

- Share lessons learnt and experience internationally
- Consider restructuring subsidising of geothermal projects (SDE+)
- Demonstrate performance by improving track record, success rate
- Potentially efficient investment rather than wind energy, biomass
- Cooperation with University to explore (deeper) energy potential
- Deep geothermal projects (Trias)

Geothermal Energy is...

- a renewable source of energy: the use of hot steam or water under high pressure
- mostly located close to boundaries of tectonic plates
- Environmentally friendly due to its fossil-fuel-free nature
- A stable source of base-load power
- competitive in terms of cost per kilowatt hour
- a longterm project with high upfront costs

4

Risk Management & Process safety

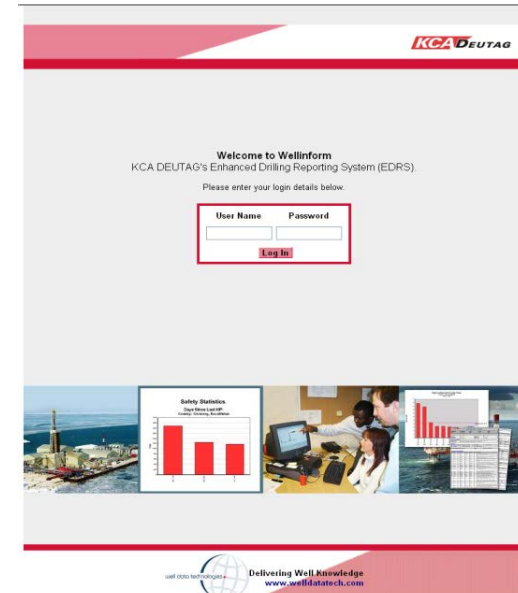


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Enhanced Drilling Reporting System (EDRS)

- Web-based reporting systems introduced 2004
- Systems provide tools necessary to enhance KCA Deutag operations performance
- Operational in more than 90% of KCA Deutag locations
- All KCA Deutag operational reporting completed using this system
- Ease of input and review by wellsite and base personnel
- Data input on a daily basis at rig-site and final report approved at the rig for issue
- Flexible query system allows a large range of on-line performance graphs
- Raises awareness, e.g. Traffic Light NPT Table.



Operational Integrity (our process safety)

Policies



Procedures



World Wide Standards



Bridging Documents



Drilling Programme



Well Control Manual



Rig Conditional Field Guide



Security Plans

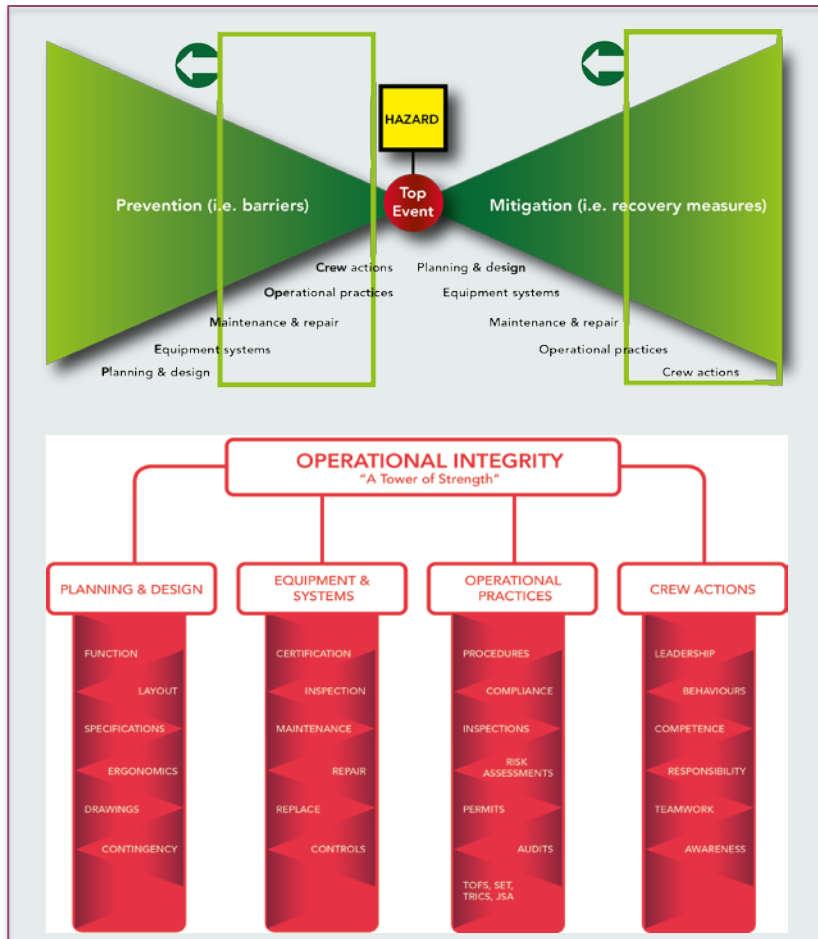


E R P



Operational Integrity (OI) at KCA Deutag

The KCA Deutag IO Approach



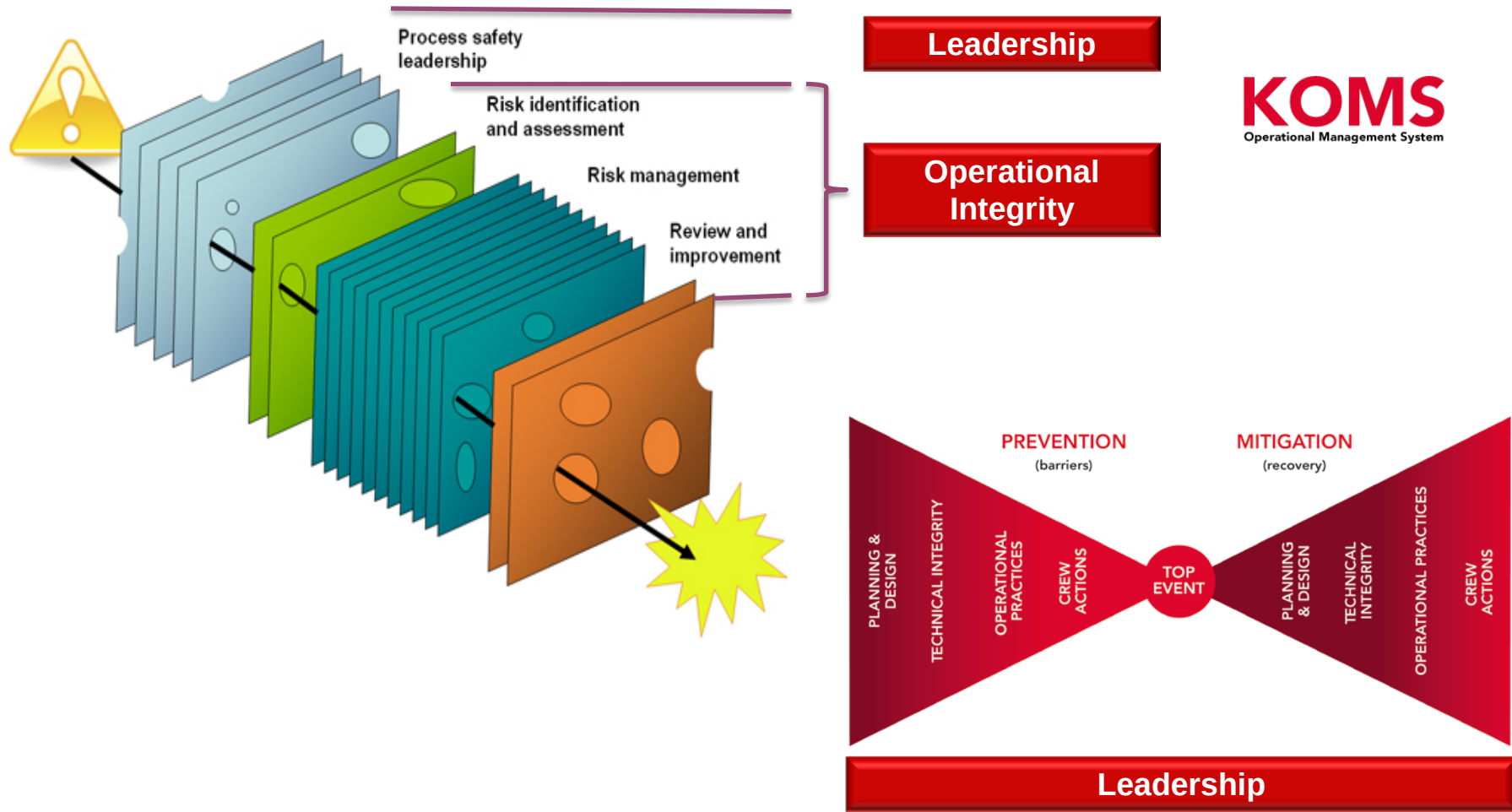
The Practical Application

At the rig site – **“The Tower of Strength”**. What building blocks of OI are in the crew's sphere of influence? What can be done to sustain the 'Tower of Strength' and avoid an incident?



At the engineering design office our **“Intrinsically Safe Design (ISD) philosophy”** has the objective to design drilling facilities that eliminate unnecessary complexity, consider operability from the early stages of design and minimise the use/impact of hazardous materials

Operational Integrity



Risk Management

Risks are scored and ranked in a **Risk Register**

Risk Management in the Organisation



- Major Risk Workshops undertaken annually at all levels including identifying risks and assigning mitigating actions
- Risk registers consolidated at each level on the basis of criticality score (risk ranking)
- Risk register kept live by reviewing as part of company meeting cycles
- Board of Directors formally review quarterly
- Internal training programme for risk workshop facilitators

Risk		Probability				
		5	4	3	2	1
Hazard Effect	5	25	20	15	10	5
	4	20	16	12	8	4
	3	15	12	9	6	3
	2	10	8	6	4	2
	1	5	4	3	2	1

KCA DEUTAG

Thanks for your attention!



Reference

<http://geothermie.nl/actueel/nieuws/nieuws-single-display/article/boringen-de-lier-voorspoedig-verlopen/>

Boringen De Lier voorspoedig verlopen.

16 september 2014 - 15:26

De boringen bij De Lier (Westland) zijn voorspoedig verlopen. De twee putten van V.o.f. Geothermie De Lier (waarvan de tuinbouwbedrijven Harting Holland BV en A. de Bruijn en Zn BV de initiatiefnemers zijn) zijn in 86 dagen geboord door KCA Deutag met de T49. Voor geothermische boringen in Nederland op vergelijkbare diepte is dit tot nu toe de kortste tijd voor de realisatie van een doublet. Met name de tweede boring verliep zeer voorspoedig. De doorlooptijd is ook in financiële zin relevant, want de boring is in regie uitgevoerd (dit i.t.t. een vaste prijsafspraken). Bij de eerste testen bleek de temperatuur conform de verwachting. Het maximale debiet kan pas na afbouw van de bovengrondse installaties worden vastgesteld. Deze afbouw is inmiddels begonnen.