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STATOIL
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Returneres etter bruk

statoil

STATOIL

GEOLOGICAL PROGNOSIS & DRILLING PROGRAM

WELL 15/9

Kappa Wildcat

Den norske stats oljeselskap a.s

STATOIL

GEOLOGICAL PROGNOSIS & DRILLING PROGRAM

WELL 15/9

Kappa Wildcat

WELL 15/9-Kappa wildcat

CONTENT

FIGURES

Program Responsibility:
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S T A T O I L

W E L L   P R O G N O S I S

WELL NO. 15/9-Kappa wildcat
PROSPECT (field) 15/9, Kappa structure

General Data:

LOCATION

Country	Norway
Area	North Sea
Licence No.	046
Block No.	15/9

Coordinates 58° 17' 22.9" N, 01° 41' 27.8" E.

Seismic: Shotpoint No. 480 Line No. 510 - 313

23.2 Km south of north Block Boundary
18 Km west of east Block Boundary
238 Km from Norwegian coast, "Jærens Rev"
4.8 Km from N/UK median line
6 Km SW of nearest well 15/9-10

Deviation: 6°W
WATER DEPTH 99 Meters (MSL)

K.B.E. 25 Meters

PROJECTED TOTAL DEPTH 3575 Meters (RKB)

CONTRACTORS

Drilling platform	Deepsea Saga
Drilling Contractor	ODCC
Mudlogging Contractor	The Analyst
Type Logging unit	TC Logging Unit
Electric Logging Contractor	Schlumberger
Mud Contractor	NPS
Cement Contractor	BJ
Rig positioning Contractor	Geoteam and Decca
Bottom Survey Contractor	Geoteam
Helicopter Service	Helikopter Service
Supply Boats	From Statoil "Supply boat pool"
Standby Boat	Strilmøy
Core analysis	GECO (& Corelab)

GEOLOGICAL PROGRAM
WELL 15/9-Kappa wildcat

PURPOSE OF TEST

15/9-Kappa is a wildcat well designed to test possible hydrocarbon accumulations in the Jurassic and Triassic sandstones of the Kappa structure and to give more information about the sand distribution in the area. The well will be drilled to an estimated total depth of 3575 m or through the first water bearing sandstone of Triassic age.

OBJECTIVES

The primary objective of well 15/9-Kappa is sandstones of Upper to Middle Jurassic with a possible secondary objective in the Triassic.

DRILLING HAZARDS

No drilling hazards are anticipated in this well. However, from site survey, a high amplitude is seen at 385 m RKB. This anomaly is not thought to be a gas charged horizon, but precaution should be carried out when drilling this section.

In 15/9-3, 21.5 km north of this location, a high pressure zone occurs at top Jurassic. This local high pressure zone is not expected in this well, but its presence should not be ignored.

SURVEY AND POSITIONING

The rig will be navigated by Pulse 8 and finally positioned by Satnav. Rig location accuracy is requested within a 100 m radius of the proposed location on sp. 480 on seismic line 510-313.

STRATIGRAPHIC PROGNOSIS

UNIT	DEPTH (m)
Top Pliocene	570 m ± 30
Top Utsira Fm.	935 m ± 30
Top Oligocene	1300 m ± 30
Top Eocene	1910 m ± 30
Top Frigg Fm	2080 m ± 30
Top Balder Fm.	2335 m ± 30
Top Heimdal Fm.	2535 m ± 30
Top Ekofisk Fm.	2730 m ± 30
Top Plenus Marl Fm	2950 m ± 40
Top Sola Fm.	3050 m ± 50
Top U. Jurassic	3100 m ± 60
Top Sand	3165 m ± 60
Top Sleipner Fm.	3250 m ± 60
T.D.	3575 m or through the first waterwet sandstone of Triassic age

GEOLOGICAL WELL LOGGING AND SAMPLING PROSEDURES

Mud logging contractor: The Analyst
An Analyst mudlogging unit will be employed to log the well for hydrocarbon shows, collect samples, prepare sample log and conduct certain other services throughout drilling operations.

Sampling interval

5 sets of unwashed samples (½ kg) will be collected at 10 meter intervals down to 2000 meters. Thereafter 3 or 5 meter's intervals will be collected. Over zones of interest, 2 meter sampling intervals may be requested by the wellsite geologist.

2 sets of washed and dried samples will be collected at the same intervals. One composite sample will be canned at 30 meter's intervals from 30" casing to TD.

One set of washed and dried samples will be retained on the rig until the well is finished. The remaining samples will be sent to GECO, Stavanger periodically during drilling. Storage and distribution to partners and government agencies will be handled by GECO as per instructions.

LOGGING PROGRAM

Run	Hole size	Logging program
1	12 1/4"	ISF/SONIC-GR, GR in 30" casing
2	17 ½"	ISF/SONIC-GR, LDT/GR, CST*
3	12 1/4"	ISF/SONIC-GR, LDT/CNL*-GR, DLL/MSFL* RFT*, CST*, HDT*, CBL
4	8 ½"	ISF/SONIC-GR, LDT/CNL*-GR, DLL/MSFL* RFT*, CST, HDT CBL/VDL* Velocity Survey

* Optional

CORING PROGRAM

A minimum of one core will be cut in Jurassic sandstones, additional cores will be cut if significant hydrocarbon shows are encountered. The coring point, and the mumber of cores to be cut, will be at the discretion of the wellsite geologist, subject to review by the Operation Geologist.

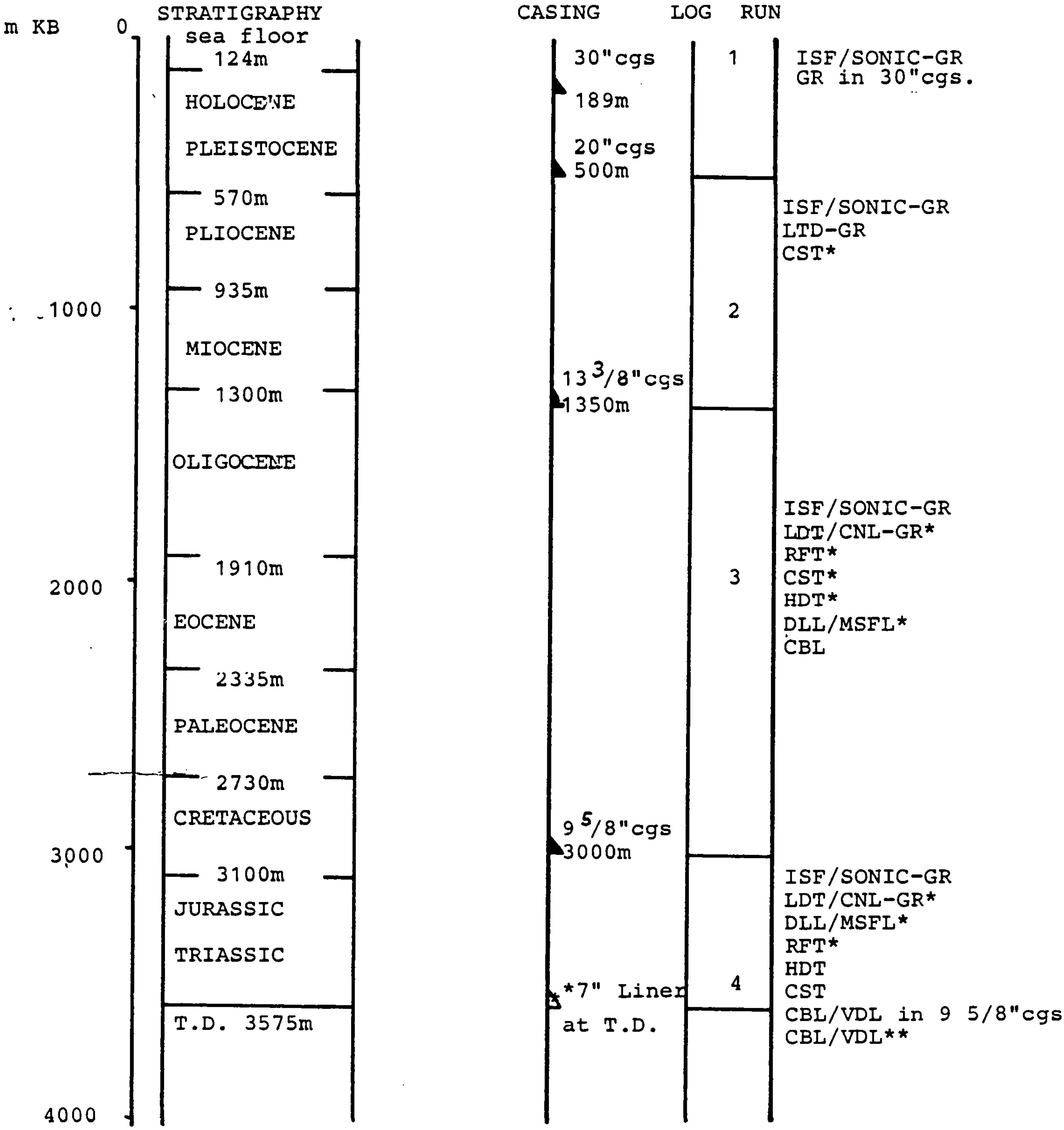
All cores will be sent to GECO, Stavanger, for analysis, distribution and storage.

TESTING PROGRAM

If hydrocarbon accumulations are present, testing will be requested. These tests may be RFT's and/or production tests through casing, depending on analysis of well potential at the time. A supplementary work program will be issued if necessary.

WELL LOGGING PROGRAM

WELL 15/9- KAPPA



*Optional

** Run if 7" liner is set

BASE

Statoil operations base at Dusevik will be utilized for the drilling of this well.

RESPONSIBILITY

a) Drilling Supervisor

The Statoil designated Drilling Supervisor will be immediately responsible for all operations on the rig in accordance with this program and drilling contracts. He will be advised by a Drilling Engineer and a Wellsite Geologist. The Drilling supervisor will report to the Statoil Drilling Superintendent.

b) Drilling Engineer

The Wellsite Drilling Engineer will provide technical assistance to the Drilling Supervisor. He will have special responsibility for pore pressure prediction and will work closely with the Analyst engineer.

c) Wellsite Geologist

The Wellsite Geologist will advise the Drilling Supervisor of any changes in the geological prognosis and of any shows of oil or gas as soon as encountered. He will supervise the mud loggers from Analyst during sampling and coring operations and together with the logging/testing engineer ensure that the Schlumberger logs are run properly and are of acceptable standard. He will recommend coring and testing intervals.

d) Logging and Testing Engineer

The wellsite logging/testing engineer will assist the Drilling Supervisor/Wellsite Geologist in supervising the logging/testing operations. He will perform the necessary quality control of logging/testing/sampling data and ensure optimal data gathering during logging and testing operations.

COMMUNICATION PROCEDURE

Confidentiality

All data are considered confidential and will be released to third parties only by decision of Statoil.

Delivery to participants

A daily well report will be sent by telex by the operator (Statoil) to all partners and to the Norwegian Petroleum Directorate. All other wellsite data, including field prints of logs, will be sent by post or messenger.

A final well report will be prepared for distribution to partners and to the appropriate Norwegian Government agenices not later than six months after completion of the well.

STAFF

Staff of the Explortion and Drilling Department, Statoil, who are involved in the planning and drilling of well 15/9-Kappa wildcat:

		TELEPHONE		
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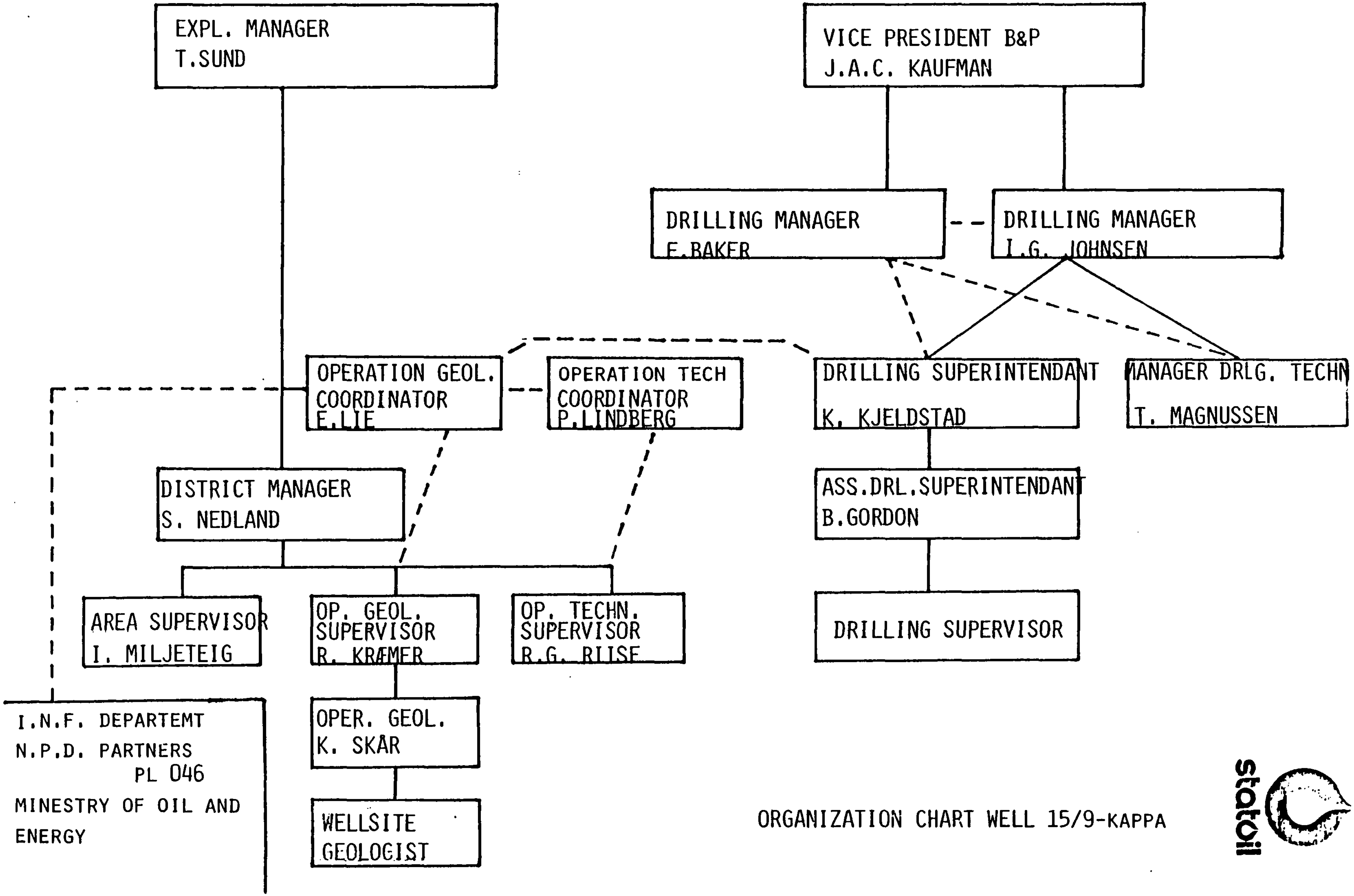
Miljeteig, I.	Area Supervisor	533180	575596	
Skår, K.	Oper. Geologist	533180	591388	



ORGANIZATION CHART WELL 15/9-KAPPA

COMMUNICATION PERSONELL, 15/9-Kappa wildcat

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		TELEPHONE		
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Norsk Hydro Produksjon A/S:

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Leivestad S.I.	Oper. Geol. Manager	(02) 543920	121546	40576

Contact in Norwegian Petroleum Directorate:

Pedersen, T.	533160

DRILLING PROGRAM

Well designation	:	15/9(KAPPA)
Vessel	:	DEEPSEA SAGA
Type drilling rig	:	Aker H-3
Drilling draft	:	21.3 m
RKB to MSL	:	25 m
Air gap	:	15.2 m
Water depth	:	99 m
BOP system	:	18 3/4", 10000 psi single stack system
Wellhead system	:	Vetco 18 3/4",10000 psi, 3-hanger hydraulic set system.

Depths referred to RKB expect where otherwise specified.

I Location

See Geological program

II Mooring

As per general procedure.
Refer to site survey report for information on seabed conditions.

III Geological Prognosis

See Geological Program

IV General drilling

-Drill 36" hole with 26" x 36" H.O. to ± 189 m. Space out so that top of 30" housing will be positioned approx. 1.5 m above the sea bed. Do not use temporary guide base, stab 30" casing blind.

- Drill out cmt + shoe w/26" bit. Run riser w/pin connector and attach diverter. Drill 12 1/4" pilothole to 515 m and log. The hole will be opened to 26" using underreamer or holeopener after having evaluated the possibility of the presence of gasbearing sands (see drilling considerations). 20" casing will be set at 500 m.

- Run BOP and test according to procedure in chapter X. Drill 17½" hole to 1365 m, log and set 13 3/8" casing at 1350 m. This depth should be adjusted to be approx. 50 m below top Oligocene.

- Drill 12 1/4" hole to 3015 m Core and log as programmed. Set 9 5/8" casing at 3000 m. The Upper Cretaceous will be drilled using turbine and diamond bit.

- Drill 8½" hole to T.D. at 3575 m. Core and log as programmed. This section will be drilled using rock bits due to the sharp transition zone and to the secondary objective triassic sandstone.

- If it is decided to test the well, a 7" liner will be run through the test interval w/100 m overlap in 9 5/8" casing.

Drilling considerations

36" hole

After cementing casing, check bulls eye indicator on PGB. If angle is more than 1½^{o} off, consult with operations office before proceeding.

26" hole

The pore pressure is expected to be normal.
For information on shallow gas refer to the site survey report.
Procedure for opening hole to 26":

1) Drill 12 1/4" pilot hole to 515 m and log. If conditions permits displace the entire hole with seawater in 2 stages.
   Stage 1: Displace the hole with seawater from 30" shoe and observe the well for 10 minutes.
   Stage 2: RIH to TD and displace the hole with seawater. Observe the well for 10 minutes.

2) Open hole to 26" using underreamer or holeopener. Holeopener will only be used if no gas is present from the log.
3) Displace the hole with mud, providing an sufficient hydrostatic overbalance at top of highest potential gas sand when the riser is disconnected.
4) Disconnect riser.
5) During clean-up run w/26" bit, circulate w/mud weight as pkt. 3.
6) Before running casing, spot $10m^3$ of 1.25 g/cm^3 mud on bottom.

Remarks

- For information on well control, see "KICK PROCEDURE".
- When drilling this section, there should always be $50m^3$ mud w/density 1.25 g/cm^3 in reserve.

17½" hole

The pore pressure is expected to be normal.

Remarks

- For information on well controll see "KICK PROCEDURE".
- When drilling this section, there should always be $70m^3$ mud w/density 1.25 g/cm^3 in reserve.

12 1/4" hole

The pore pressure is expected to be normal, except for a possible slight increase through the Cretaceous formation. On previous wells on the 15/9 block, tight hole has been experienced down to 2300 - 2400 m. These problems seem to be caused by swelling clays and possibly differential sticking. To reduce the problems, mud weight should be kept at at minimum and a thin filter cake maintained. The hole is expected to stabilize after a few wiper trips.

8½" hole

The pore pressure is expected to increase rapidly from the baseof the Cretaceous and reach a maximum of 1.28 g/cm^3 eq.m.w. in the Jurassic shale. Below this depth the pressure is expected to decrease to approx. 1.23 g/cm^3 eq.m.v. at TD. TD is expected to be at 3575 m. - The upper Jurassic shale is believed to be very tight (low permeability, low productivity).

- On one previous well in the area, the 15/9-3 positioned to the north-west on the 15/9-block, there was encontered a thin, high pressure, low permeability turbidite lens, positioned at the top of upper Jurassic shale. Estimated pore pressure ranging between 1.5-1.92 g/cm^3 eq.m.v. Equal phenomena have been seen in the British sector. The possibility of encountering the turbidite on this well, 15/9-12 , is considered relatively small.
  For information on maximum kick sizes that can be taken before breaking down formation, see "kick limitations".

- The pressure estimate in the Jurassic and Triassic sand is based on pressure communication with 15/9-10.

Directional survey program

Directional surveys will be run every 90 m after setting the 20" casing.

H_2S- check

The mud returns will be monitored continously to detect H_2S. Also check the hole for H_2S-content in 100 m intervals, starting at 2200 m by means of Garret Gas Train (use fresh filtrate from the filter press only).

V. MUD PROGRAM

Interval M RKB	Hole size	Mud Type	Weight (g/cc)	PV	YP	Fluid loss (cc)	pH
124 - 189	36"	Spud mud					
189 - 515	26"	" "					
515 -1365	17½"	Gel/Ligno	1.1		20 - 25	API :10 - 15	9.5 - 10.5
1365 -3015	12¼"	Gyp/Ligno	1.1-1.2		15 - 20	API : 8 - 10	9.0 - 9.5
3015 - TD	8½"	Gel/Ligno	1.2-1.4		12 - 15	HTHP below 15	9.5 - 10.5

REMARKS:
- Rheology properties will be tested and reported at 50°C. Reported mud weight is to be measured using a Pressurized Mud Balance.
- Maintain drill solids content at minimum by means of the desander, desilters/mud cleaner (using 120-150 mesh screens).
- Utilize the centrifuge for viscosity control and for baryte salvage.
- See separate MUD PROGRAM for details.

I: BITS AND HYDRAULICS

EPTH NTERVAL	HOLE SIZE	BIT TYPES	NOZZLES 32 NDS	WOB TONS	RPM	CIRC:RATE (M^3/min)	PUMP PRESSURE (Bars)
124-189	26"x36"H.O.	26" OSC-3AJ + H.O.	3x22	0-5	60-80	-	-
189-515	12 1/4"	X-3, X-3A	3x16	0-5	100-150	3.4	-
189-515	12 1/4"x 17½"x26"	X-3A + SEC.H.O.+ 26"H.O./U.R.	3x18	0-7	120	3.6	-
515-1365	17½"	X-3A, OSC-3AJ	3x18	0-10	120	4.0	-
365-2300	12 1/4"	X-3, SDT, X1G, S 44, J-3	3x15	5-12	150	2.2-2.7	210
300-2750	"	X1G, XDG, XV, XDV,	3x15	10-25	100-120	2.2-2.7	210
750-3015	"	LX-13		10-25	7-800	2.4-2.7	260-290
015-3575	8½"	XDV, X1G, XV, J-4, J-3, J-22	3x11	10-20	80-120	1.2-1.6	200-240

REMARKS:
- Hydraulics and drilling parameters will be optimized on the rig according to actual mud properties and hole conditions.
- Surface pressure is to be monitored at different circulating rates before the bit is pulled.
- Bit types does not necessarily indicate actual make of bit. Equivalent bit types may be used.

VII Well logging program

See geological program.

VIII Casing

Casing program

Size	Depth (m)	Weight (lbs/ft)	Grade	Connection
30"	1jnt 4jnts	1½" th 1" th	B B	VETCO ATD/RB VETCO ATD/RB
20"	124 - 500	94	x 56	VETCO LS
13 3/8"	124 - 1350	68	K-55	BUTTRESS
9 5/8 "	124 - 3000	47	N-80	BUTTRESS
7"(Optional)	2900 - 3575	29	N-80	BUTTRESS

See "Casing design"

Note:

- 20" casing to be run with float collar
- Make up torque (ft-lbs) for Vetco LS connectos:

Min	Opt	Max
14000	19000	24000

Thread lubrication: Machine oil only

Make up speed: 10 RPM

Casing and seal assembly test pressure (see note below)

20" casing	- 55.2	bar	(800 psi)
13 3/8" casing	- 172	bar	(2500 psi)
9 5/8" casing	- 345	bar	(5000 psi)
7" liner	- 345	bar	(5000 psi)

Casing to be tested below shear ram.

The given test pressure should be the pressure measured at surface.

NOTE: - When testing casing: If cement has been brought up inside the previous casing shoe, observe pressure and volume pumped carefully to ensure that the seal assembly is not leaking.

Safety factors:	Collapse:	Burst:
20"	1.30	1.1
13 3/8"	1.30	1.1
9 5/8"	1.25	1.1

IX CEMENTING

As per general procedure. See "cement calculation" for compositions and slurry amounts. A cement bond log will be run to check the top and quality of the cement for the 13 3/8" and 9 5/8" casing strings.

X BOP

BOP test pressures:	Pipe rams	bags	choke and kill valves
1. On surface	690 bar	241 bar	690 bar
2a After initial and subsequent installation on wellhead	517 bar	172 bar	517 bar
2b Weekly test with 20" casing set	103 bar	103 bar	103 bar
3a After 13 3/8" seal assembly is tested with no leak	172 bar	172 bar	172 bar
3b Weekly test with 13 3/8" casing set	172 bar	172 bar	172 bar
4a After 9 5/8" seal assembly is tested	345 bar	172 bar	345 bar
4b Weekly test with 9 5/8" casing set	345 bar	172 bar	345 bar

Shear ram will be tested to 690 bar on surface. After BOP is mounted on wellhead, it will only be tested when testing casing. (Test pressure as given in chapt. VIII).

NOTE: - If the BOP stack must be pulled after initial installation:

a) Pressure test on surface acc. to pt. 1. above.
b) Pressure test after reinstallation acc. to pt. 2a above. During this test, if 13 3/8" csg is set, observe pressure and volume pumped carefully to ensure that the seal assembly is not leaking.

- For more information on BOP testing, refer to general procedures in Statoils Floating Drilling Operation Manual.

- For information on BOP equipment, see "Statoil BOP manual".

XI PRESSURE INTEGRITY TEST

The pressure integrity tests will be performed according to normal procedures.

XII DRILLS

As per general procedures.

XIII ABNORMAL PRESSURE DETECTION

The most effective abnormal pressure detection operation will be the result of team effort involving the Drilling Supervisor, Drilling Engineer, Wellsite Geologist, and Mud Logging Engineer. Pressure indicators will be monitored continuously and any deviation investigated immediately. The reliability of each abnormal pressure indicator will have to be established during the course of operation.

A mud Logging Unit will be utilized below the 30 inch casing shoe to collect and monitor abnormal pressure parameters. This unit will be programmed to record the following parameters relating to abnormal pressure:

1. Mud weight
2. Drilling rate
3. Weight on bit
4. RMP
5. Torque
6. "d" exponent
7. Mud gas
   a) Background gas
   b) Connection gas
   c) Trip gas
8. Mud temperature at flowline
9. Mud flow
10 Pit volume

In addition, shale density and chloride content in the mud will be measured manually.

Manual plots will be recorded and reviewed continuously by the Drilling Engineer and Drilling Supervisor. These plots will include drilling rate, lithology, mud weight, weight on bit, "d" exp., gas units, mud temperature and shale density, together with bit and hydraulics data.

Input parameters (weight on bit, RPM, hydraulics) should be held fairly constant. This is especially important in the pressure transition zone. Abnormal pressure detection data will be forwarded into the Stavanger Operations Office twice daily on a routine basis and more frequently if drilling a suspect transition zone. Any change in abnormal pressure detection parameters will be immediately reported by the rig to the Stavanger Operations Office.

XIV PRODUCTION TEST

As per production test manual. A detailed testing program will be issued prior to a production test.

XV PLUG AND ABONDONMENT

As per general procedures.

Approved 18/3-82

Expl. Manager Statoil

Drilling Manager Statoil

KICK LIMITATION

Drilling below 20" casing:

The general procedure is: Not to shut in a well with only 20" casing set. Consult with the operations office on permission to close the BOP after the leak off test is finished.
Maximum porepressure is expected to be 1.03 s.g. in this interval. A mud weight of 1.10 s.g. should be sufficient to control the well. If the well kicks at 1365m(p.p.=1.10 s.g.) a kick height of approx 190 m can be controlled by closing the BOP. (See figure 1). This is equal to a volume of 25m^3 influx.

Drilling below 13 3/8" casing:

Formation integrity below the 13 3/8" casing shoe is expected to be 1.68 s.g. The maximum considered porepressure is 1.10s.g. in this interval. If the well kicks with a mud weight and porepressure of 1.20 s.g. at 3015m, a kick height of 540 m can be controlled by closing the BOP.(See figure 1). This is equal to a volume of 37m^3 influx.

Drilling below 9 5/8" casing:

Formation integrity below the 9 5/8" shoe at 3000 m is estimated to be 1.85 g/cm^3 eq. The maximum porepressure gradient while drilling is expected to be 1.28 g/cm^3 at 3425 m. Necessary riser margin with additional 7 bars at this depth is 0.05 g/cm^3. A mudweight of 1.40 g/cm^3 should be sufficient to control the well. If the well kicks in this hole section with a p.p. of 1.4 s.g, there is no limit for the kickheight.
(See figure 1).

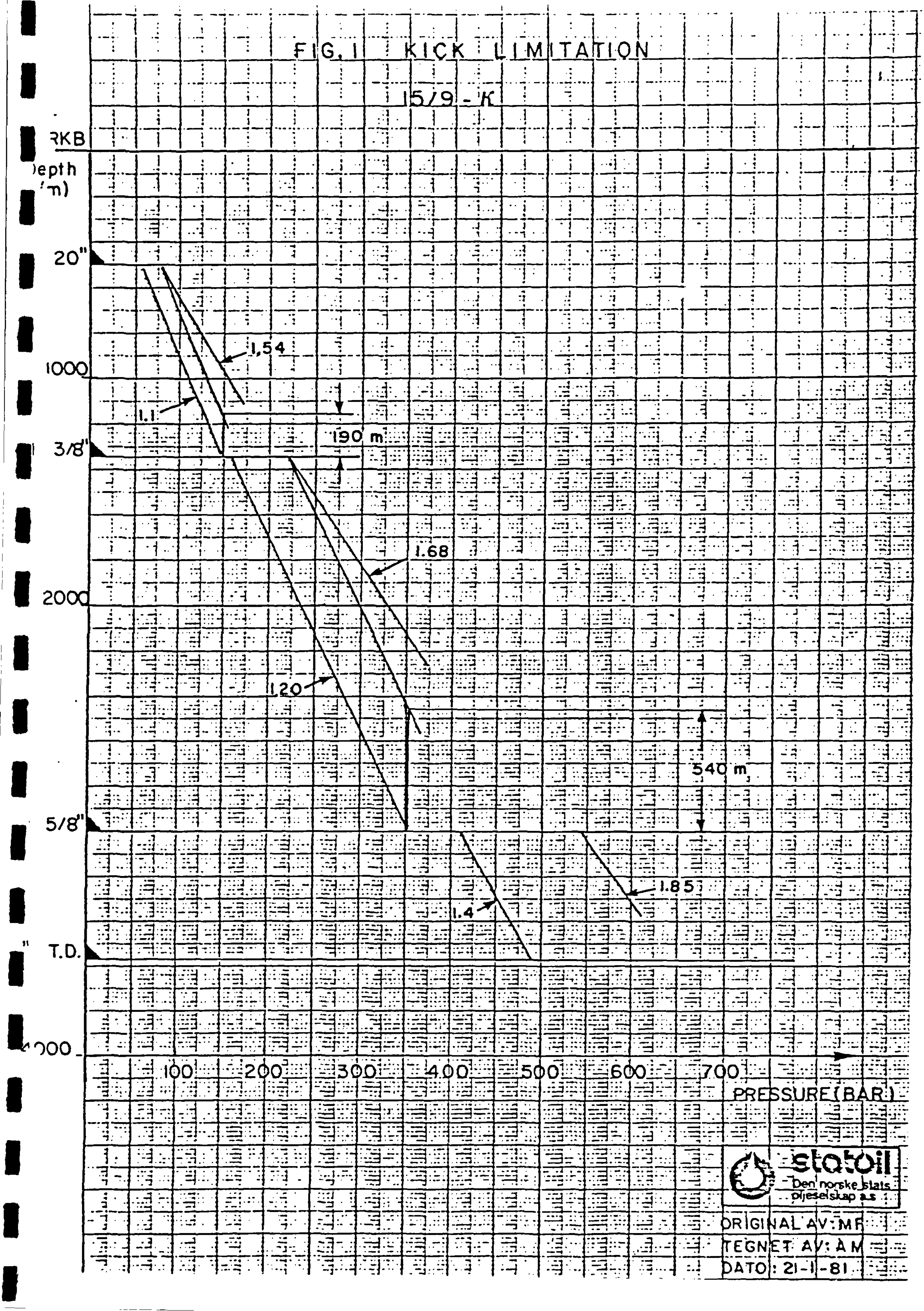
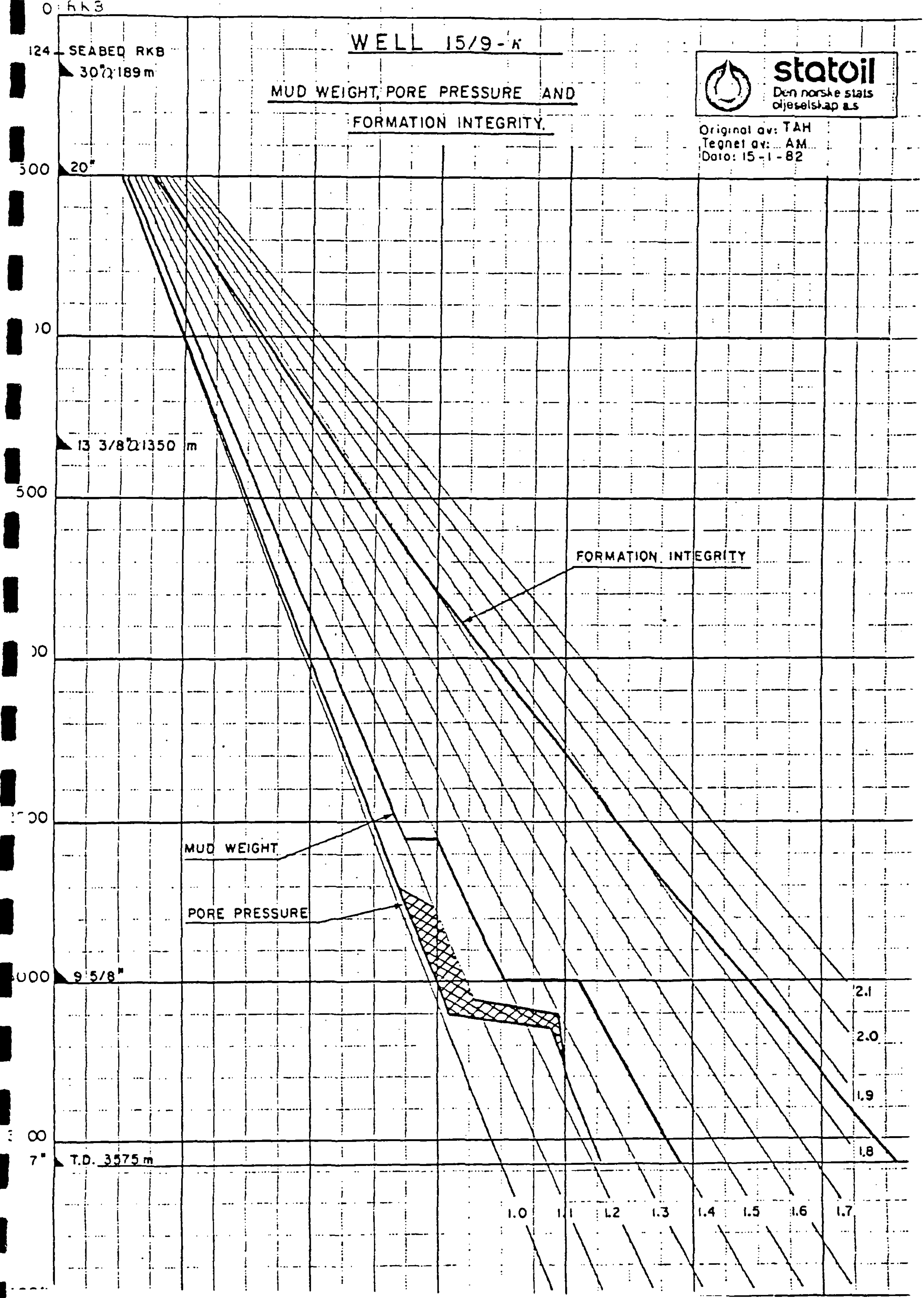


FIG. 1 KICK LIMITATION
15/9 - K
RKB
Depth
(m)
20"
1000
1.54
1.1
190 m
3/8"
1.68
2000
1.20
540 m
5/8"
1.85
1.4
T.D.
100
200
300
400
500
600
700
PRESSURE (BAR)
statoil
Den norske stats oljeselskap a.s
ORIGINAL AV: MF
TEGNET AV: AM
DATO: 21-1-81


WELL 15/9
MUD WEIGHT, PORE PRESSURE AND
FORMATION INTEGRITY.
statoil
Den norske stats oljeselskap a.s
Original av: TAH
Tegnet av: AM
Dato: 15-1-82
124 SEABED RKB
30" @ 189 m
500 20"
13 3/8" @ 1350 m
1500
FORMATION INTEGRITY
MUD WEIGHT
PORE PRESSURE
9 5/8"
7" T.D. 3575 m
2.1
2.0
1.9
1.8
1.0
1.2
1.3
1.4
1.5
1.6
1.7

NOMENCLATURE

X = Casing setting depth (m)

W_D = Drilling depth below X (m)

Z = Depth from RKB to wellhead

Y = Depth from RKB to top of fluid column if mud is lost to a weak zone (m).

G_i = Mud gradient when cementing casing (bar/m)

G'_i = Mud gradient at W_D (bar/m)

G''_i = Mud gradient while testing (bar/m)

G_p = Normal pore pressure gradient (bar/m)

G'_p = Pore pressure gradient at reservoir depth (bar/m)

G''_p = Pore pressure gradient at W_D (bar/m)

G_f = Fracture gradient at casing seat (bar/m)

G_{gas} = Gas gradient (bar/m)

W_W = Water depth (m)

L = Lenght from shoe to float collar (m)

G_{C1} = Lead cement slurry gradient (bar/m)

G_{C2} = Tail in cement slurry gradient (bar/m)

M_C = Casing mass gradient (kg/m)

t = Casing wall thickness (cm)

P_B = Burst load (bar)

P_C = Collapse load (bar)

P_T = Tension load (tons)

RES_B = Burst resistance (bar)

RES_C = Collapse resistance (bar)

RES_T = Tensile resistance (tons)

$S.F._B$ = Safety factor, burst = 1.1

$S.F._C$ = Safety factor, collapse = 1.25 (1.3 for 13 3/8" and larger)

$S.F._T$ = Safety factor, tension = 1.8

20" Casing Design

$X = 500$ m	$G_f = 0.151$ bar/m
$W_D = 1365$ m	$G_i = 0.108$ bar/m
$Z = 124$ m	$G'_i = 0.108$ bar/m
$W_w = 99$ m	$G_{gas} = 0.01$ bar/m
$L = 12$ m	$G_{c1} = 0.153$ bar/m
$G_p = 0.1$ bar/m	$G_{c2} = 0.187$ bar/m

Design Criteria:

BURST: - entire casing filled with light gas.

COLLAPSE: - Collapse load during cementing.

TENSION: - Tension load when bumping plug.

Calculations:

BURST:

If the well is filled with gas (well closed in or flow diverted) the maximum casing pressure will be limited by formation fracture pressure at the casing shoe.
Max. burst load at wellhead:

$$P_{B1} = X \times G_f - (X - Z)G_{gas} - W_w \times G_p$$
$$= 500 \times 0.151-(500-124)\times 0.01 - 99 \times 0.1 = \underline{61.8 \text{ bar}}$$

Max. burst load at casing shoe.

$$P_{B2} = X(G_f - G_p) =$$
$$= 500\ (0.151-0.1) = \underline{25.5 \text{ bar}}$$

COLLAPSE.

Maximum collapse load occur at float collar depth during cementing.

Volume of tail in slurry is : 9.9 m^3
Inside 20 casing : L = 12m eq. to 2.2 m^3
Annular capasity : 0.140 m^3/m which leaves 55m tail in slurry in annulus.

$$P_c = (55-L)G_{c2} + (X - 55 - Z)G_{c1} + W_w \times G_p - (X - L)G_p$$

$$= (55-12)\times 0.187+(500-55-124) \times 0.153+99\times 0.1-(500-12)\times 0.1$$

$$P_c = \underline{18.2 \text{ bar}}$$

Collapse load is zero at wellhead.

Select: 20" , 140kg/m (94lb/ft), X - 56, Vetco LS

RES_B = 152 bar
RES_c = 36 bar
RES_T = 676 tons

Safety factor: Burst:

$$S.F._B = \frac{RES_B}{P_{B1}} = \frac{152}{61.8} = \underline{2.46}$$

Safety factor: Collapse:

$$S.F._c = \frac{RES_c}{P_c} = \frac{36}{19.2} = \underline{1.8}$$

TENSION:

Weight of casing string in air:

$(X - Z) \times M_C = (500-124)m \times 140\ kg/m = \underline{52.6\ tons}$

Casing inside diameter: ID = 48.6 cm

Extra tensile load when bumping plug with 55 bar:

$(55 - P_C) \times (\frac{ID}{2})^2 \times 3.14 \times 0.98\ kg$

$(55 - 18.2) \times (\frac{48,6}{2})^2 \times 3.14 \times 0.98\ kg = \underline{66.9\ tons}$

Total weight load at wellhead : (52,6 + 66.9) tons = 119.5 tons

Safety factor: Tension

$S.F._T = \frac{RES_T}{load} = \frac{676}{119.5} = 5.7$

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Dato: 19-1-82

15/9 - K

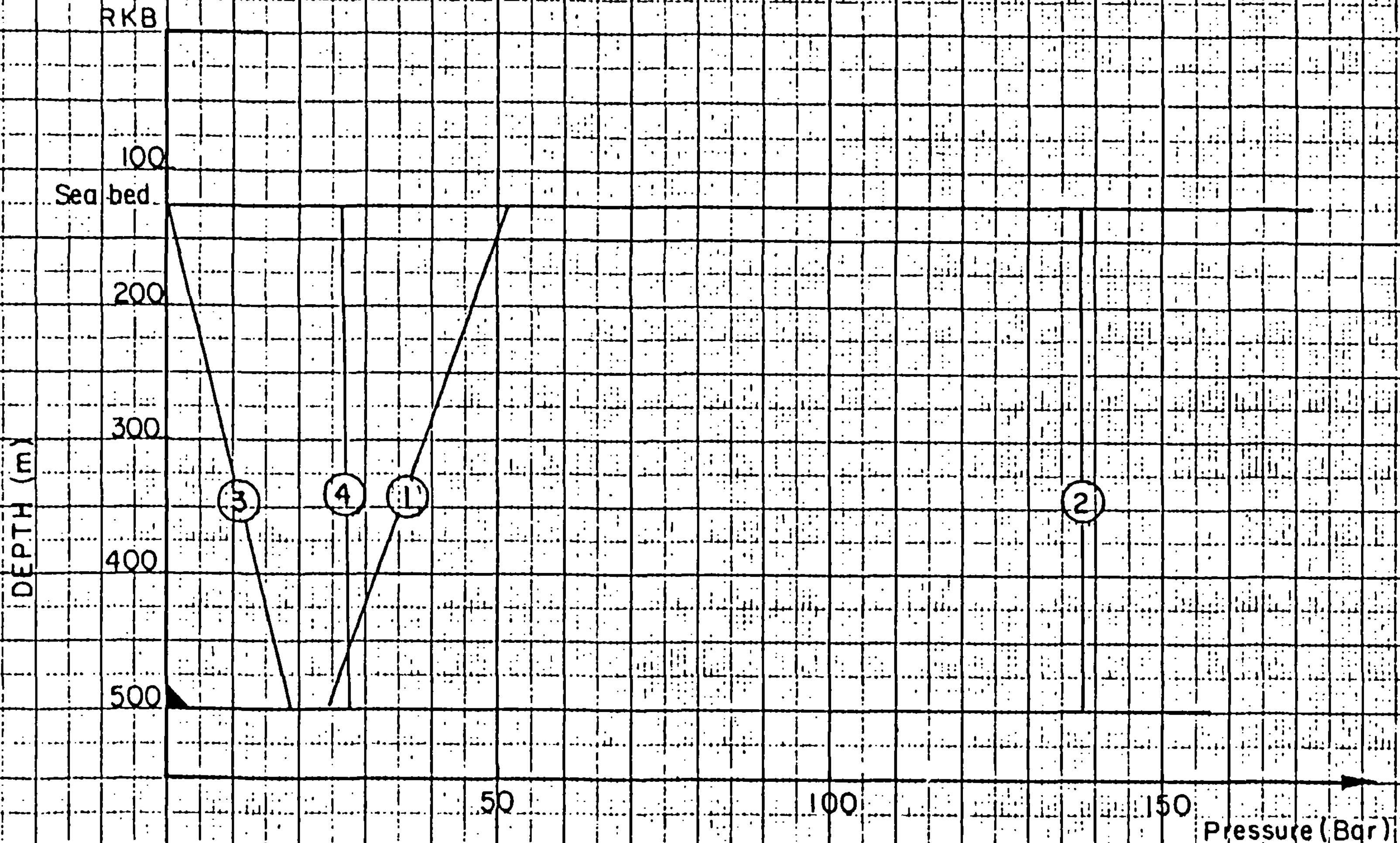
20" CASING DESIGN

124 - 500m : 20", X 56, 94 lb/ft, Vetco LS

RES_B : 152 bar

RES_a : 36 bar

RES_T : $689 \cdot 10^3$ daN



① Burst load, entire csg. filled with gas
② Burst resistance, corrected for S.F. = 1.1
③ Collapse resistance during cementing
④ Collapse resistance, corrected for S.F. = 1.3 and biaxial stress

13 3/8" CASING

W_d	= 3015 m
X	= 1350 m
G_i	= 0.108 bar/m (1.1 g/cm^3)
G'_i	= 0.117 bar/m (1.2 g/cm^3)
G_p	= 0.101 bar/m (1.03 g/cm^3)
G_f	= 0.165 bar/m (1.68 g/cm^3)
G_{gas}	= 0.02 bar/m
$G_{cem}1$	= 0.153 bar/m (1.56 g/cm^3)
$G_{cem}2$	= 0.186 bar/m (1.91 g/cm^3)
L	= 24 m

Design criteria:

1) Entire casing filled with gas
2) Collapse load during cementing
3) Collapse load, lost circulation
4) Tension load, when bumping pliq

BURST:

Max burst load while testing casing:

(172 bar test) : $172 + X (G_i - G_p)$

$$172 + 1350\ (0.108 - 0.1) = \underline{182.8 \text{ bar}}$$

Burst load at wellhead if the entire casing is filled with gas.

$$P_{bw} = (X \times G_f) - (X - Z) \times G_{gas} - Z \times G_p$$

$$= 1350 \times 0.165 - (1350-124) \times 0.02 - 124 \times 0.1 = \underline{185,8 \text{ bar}}$$

Min. burst load (at shoe):

$$X \times G_f - X \times G_p = 1350 \times 0.165 - 1350 \times 0.1 = \underline{87.7 \text{ bar}}$$

<u>COLLAPSE</u>

Max collapse load while cementing:

$$(X - L) \times (G_f - G_i) = (1350 - 24)(0.165 - 0.108) = \underline{75.6 \text{ bar}}$$

Mud level if mud is lost to a low pressure formation (resistance to mud flow into formation = 0.1 bar/m) at 3015 m when drilling with 1.2 sp.gr. mud.

$$Y = W_d - \frac{W_d \times G_p}{G'_i} = 3015 - \frac{3015 \times 0.1}{0.117} = 438 \text{ m}$$

Collapse load: $P_c = G_i \times Y = 0.108 \times 438 = \underline{47.3 \text{ bar}}$

SELECT: 124 - 1350 m: 13 3/8", 68lb/ft,K-55,butress

$RES_C = 134$ bar

$RES_B = 238$ bar

$RES_T = 475 \times 10^3$ daN

<u>Safety factor burst:</u>

$$S.F._B = \frac{RES_B}{185.8} = \frac{238}{185.8} = \underline{1.28 \quad 1.1}$$

Reduced RES_C on top casing due to biaxial stress:

Weight load in air: 108 x 10^3 daN (See TENSION)

$$\frac{\text{Weight load}}{RES_T} = \frac{130 \times 10^3 \text{ daN}}{475 \times 10^3 \text{daN}} = 0.27$$

From the Ellipse of biaxial yield stress, this gives 16% reduction in collapse resistance.

<u>Safety factor collapse:</u>

$$S.F._C = \frac{RES_C \times 0.84}{P_C} = \frac{134 \times 0.84}{47.3} = 2.38$$

<u>TENSION:</u>

Weight load in air (casing used as running string):

1350 m x 98.47 kg/m x 0.98 = 130 x 10^3 daN

Casing inside diameter = 315.3 mm

Differential pressure at shoe due to cement column:

$((G_{cem}{}^1 - G_i) \times 540\text{m} + (G_{cem}{}^2 - G_i) \times 410 \text{ m} =$

((0.153 - 0.108) x 540 + (0.186 - 0.108) x 410m = <u>56.3 bar</u>

Extra tensile load when bumping plug(neglecting steel buoyancy for extra safety) with 172 bar

$(172 \text{ bar} - 56.3) \times 0.01 \times 0.98 \times (\frac{315.3}{2}) \times \pi \text{ daN} = 88.5 \times 10^3 \text{daN}$

Total weight load = (130 + 88.5) x 10^3 daN = 218,5 x 10^3 daN

$$SF_T = \frac{RES_T}{218.5 \times 10^3 \text{daN}} = \frac{475}{218.5} = 2.17 \quad 1.5$$

124 - 1350 m : 13 3/8", K-55, 68 lb/ft, butress.

RES_C : 134 bar
RES_B : 238 bar
RES_T : 475 x 10^3 daN

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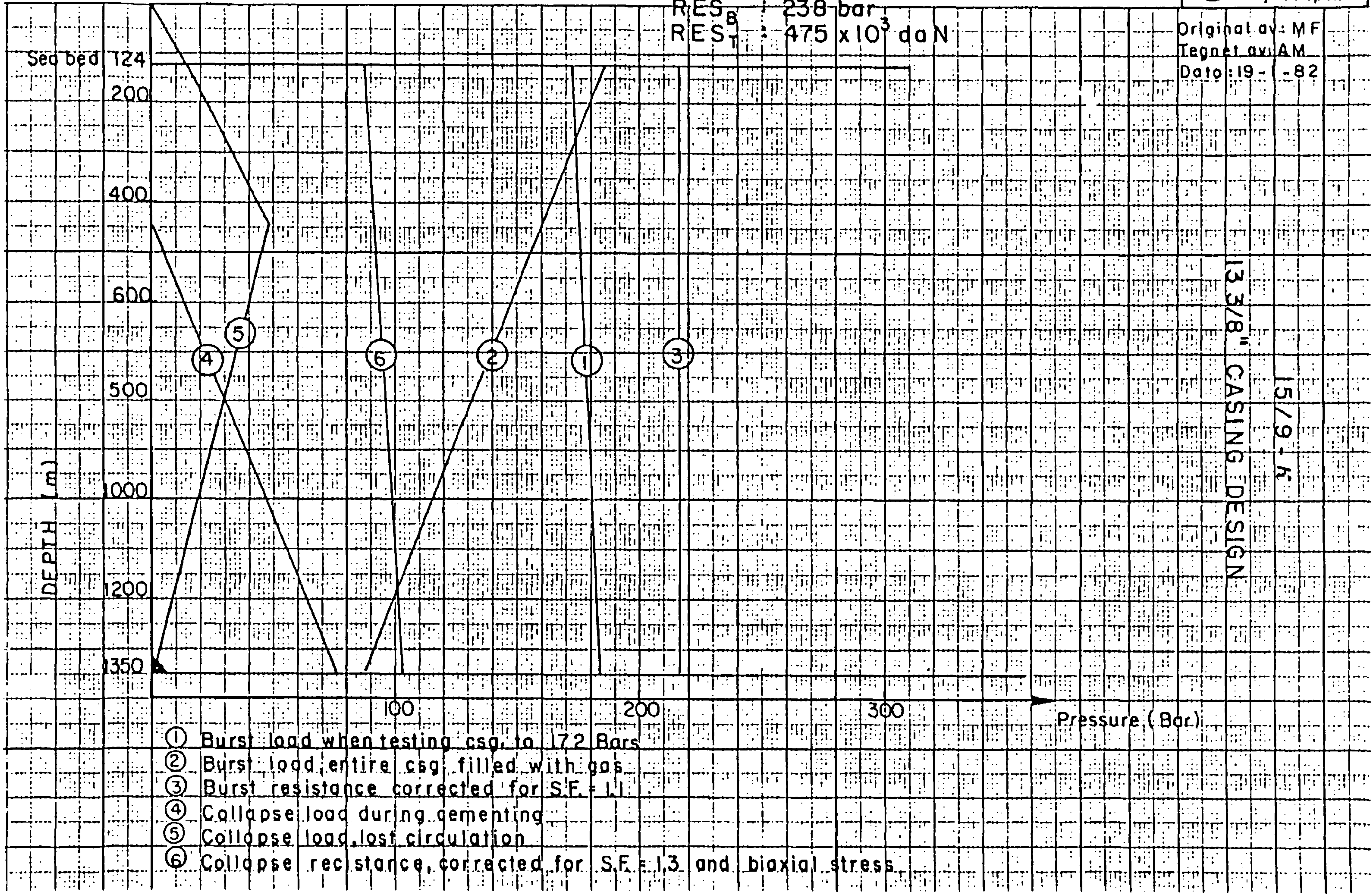


9 5/8" casing design:

W_D = 3575 m
X = 3000 m
W_W = 99 m   Z = 124 m
G_i = 0.118 bar/m (1.2 g/cm^3)
G'_i = 0.137 bar/m (1.4 g/cm^3)
G''_i = 0.132 bar/m (1.35 g/cm^3) (Mudweight while testing)
G_p = 0.1 bar/m (1.03 g/cm^3)
G_{cem} = 0.186 bar/m (1.9 g/cm^3)
G'_p = 0.122 bar/m (1.24 g/cm^3) (Pore pressure at 3425m, Trias sand)
G_f = 0.181 bar/m (1.85 g/cm^3)
G_{gas} = 0.023 bar/m

Design criteria:

1) Tubing leak while testing
2) Collapse load, lost circulation
3) Weight load of casing when bumping plug at 172 bar.

This well will probably be tested from two different sand zones, The Hugin sand and The Trias sand. The casing design is based on testing from the lowest zone. This gives us the worst design criteria for the 9 5/8" casing.

Burst:

Burst load at wellhead if there is a tubing leak just below the wellhead while testing at 3425 m.

$P_{B1} = G'_p \times X - G_{gas}(3425 - z) - W_w \times G_p$
$= 0.122 \times 3425 - 0.023\ (3425-124) - 99 \times 0.1 = 332$ bar

Burst load at 2900 m (7" liner lap) if there is a tubing leak:

$P_{B2} = P_{B1} + (G''_i - G_p)(2900 - Z)$
$= 332 + (0.132-0.1) \times (2900 - 124) = 421$ bar

Max. burst load when testing casing:
(test pressure, 345 bar)

$P_{B4} = 345 + (G_i - G_p) \times X = 345 + (0.118-0.1)3000 \text{ m} = 399 \text{ bar}$

<u>Collapse:</u> During cementing (cement 100m into 13 3/8" casing)

$P_{C1} = (G_{cem} - G_i)(X-(1350-100)) =$

$P_{C1} = (G_{cem} - G_i)(3000-1250) = (0.186-0.118)\times(3000-1250) = 119 \text{ bar}$

If mud is lost to formation at 3575 m

$$Y = W_D - \frac{W_D \times G_p}{G'_i} = 3575 - \frac{3575\times0.1}{0.137} = 965.5 \text{ m}$$

$P_{c2} = Y \times G_p = 965.5 \times 0.1 \text{ bar} = 97 \text{ bar}$

Select: 124 - 3000 m, 9 5/8", N - 80, 47 lb/ft, buttress

$RES_C = 328$ bar

$RES_B = 474$ bar

$RES_T = 482 \times 10^3$ daN

<u>Safety factor burst:</u>

$$S.F._B = \frac{RES_B}{TE_1} = \frac{474}{422} = 1.12$$

<u>Tensile load at 966 m:</u>

$0.98 \times (3000-966)\text{m} \times 70 \text{ kg/m daN} = 142.4 \times 10^3 \text{daN}$ or 29% of RES_T

From the Ellipse of biaxial yield stress, this gives 18% reduction in collapse resistance.

<u>Safety factor collapse:</u>

$$SF._C = \frac{RES_C \times 0.82}{P_c} = \frac{269}{119} = 2.26$$

Tension:

Weight load in air (casing used as running string):

$3000 \times 70 \times 0.98$ daN = 206×10^3 daN

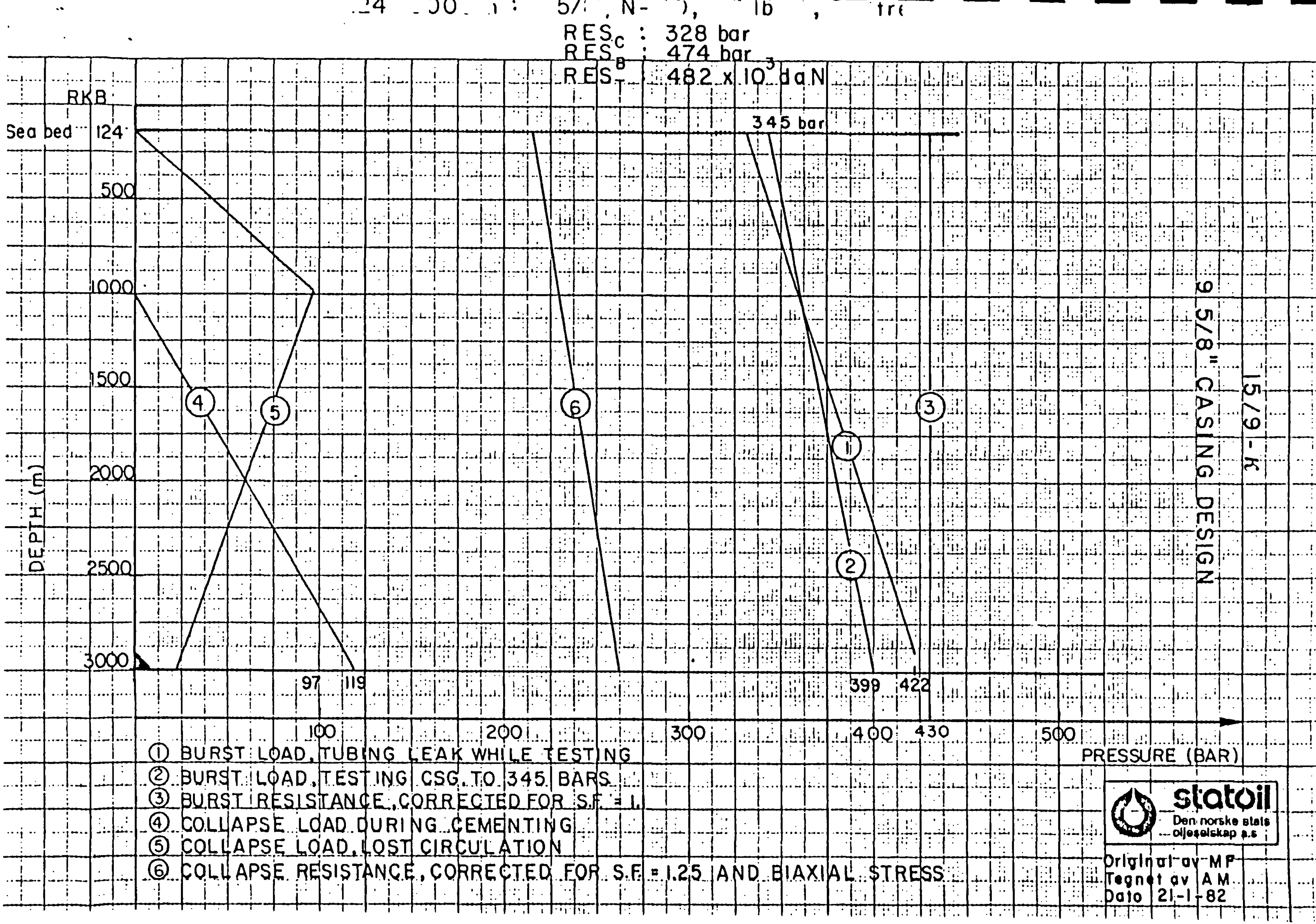
Casing inside diameter= 220.5 mm

Extra tensile load when bumping plug at 172 bar (neglecting buoyancy of steel):

$(172 - 119)\,0.01 \times \left(\frac{220.5}{2}\right)^2 \times \pi \times 0.98$ daN = 20×10^3 daN

Total weight load: $(206 + 20) \times 10^3$ daN = 226×10^3 daN

$$S.F._T = \frac{RES_T}{226} = \frac{482}{226} = 2.13$$


24 00 5/ , N-), lb , tr
RES_C : 328 bar
RES_B : 474 bar
RES_T : 482 x 10^3 daN
15/9-K
9 5/8" CASING DESIGN
RKB
Sea bed 124
500
1000
1500
2000
2500
3000
DEPTH (m)
345 bar
97
119
399
422
100
200
300
400
430
500
PRESSURE (BAR)
① BURST LOAD, TUBING LEAK WHILE TESTING
② BURST LOAD, TESTING CSG. TO 345 BARS
③ BURST RESISTANCE, CORRECTED FOR S.F = 1.
④ COLLAPSE LOAD DURING CEMENTING
⑤ COLLAPSE LOAD, LOST CIRCULATION
⑥ COLLAPSE RESISTANCE, CORRECTED FOR S.F = 1.25 AND BIAXIAL STRESS
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7" Liner:

W_D = 3575 m   Z = 124 m

X = 3575 m

G_i = 0.137 bar/m (1.4 g/cm^3)

G_p = 0.1 bar/m (1.03 g/cm^3)

G'_p = 0.122 bar/m (1.24 g/cm^3) (Pore pressure at 3425 m, TRIAS SAND

G_{gas} = 0.023 bar/m

G_{cem} = 0.186 bar/m (1.9 g/cm^3)

G''_i = 0.132 bar/m (1.35 g/cm^3) (Mudweight while testing)

Design criteria:

1) Tubing leak while testing

2) Tension load while cementing

3) Tension load when bumping plug (at 172 bar)

This well will probably be tested from two different sand zones, The Hugin and The trias sand. The casing design is based on testing from the lowest zone. This gives us the worst design criteria for the 7" liner.

Max burst load (at 3000m) if there is a tubing leak just below the wellhead and the pressure build-up in the annulus is not bled off when testing at 3425 m.

$P_B = G'_p \times 3425 - G_{gas} \times (3425-Z) + (3000-Z) \times (G''_i - G_p)$

$= 0.122 \times 3425 - 0.023 \times 3301 + 2876 \times (0.132-0.1) = 434$ bar

2900 - 3575: 7", 29 lb/ft, N-80 buttress

RES_C = 484 bar
RES_B = 563 bar
RES_T = 300 x 10^3 daN

$S.F._B = \frac{RESB}{434} = \frac{563}{434} = 1.30$

Collapse:

$P_C = (G_{cem} - G_i)\ (W_D - X) = (0.186-0.137)x(3575-2900) =$ 33 bar

Minimum flowing bottom hole pressure when testing at 3425 m

$$P_{WF}\ min = (3425\ xG'_p) - \frac{RES_C}{1.25}$$

$$P_{WF}\ min = 3425\ x\ 0.122 - \frac{484}{1.25} = 31\ bar$$

Tensile load of liner: 28.2×10^3 daN (See TENSION)or 10% of RES_T

From the Ellipse of biaxial yield stress, this gives 4% reduction in collapse resistance.

Safety factor collapse:

$$S.F._C = \frac{RES_C\ x\ 0.96}{P_C} = \frac{484\ x\ 0.96}{33} = 14$$

Tension:

Casing I.D. = 157.1 mm

Extra tensile load when bumping plug with 172 bar:

$(172 - 33)\ x\ 0.01\ x\ (\frac{157.1}{2})^2\ x \pi x (0.98)$ daN $= 26.4 \times 10^3$ daN

Weight load in air:

(3575 - 2900)m x 42.74 kg/m x 0.98 daN = 28.2×10^3 daN

Total tensile load = $(28.2 + 26.4) \times 10^3$ daN = 55×10^3 daN

$$S.F._T = \frac{RES_T}{55} = \frac{300}{55} = 5.45$$

CASING CEMENT DATA AND CALCULATIONS, 30 " CASING.

GENERAL: The cement volume is calculated on the basis of the theoretical hole volume, and the casing to be cemented to sea bed with 150% excess volume in open hole.

WELL DATA:

Depth kb-sea bed.............................:	124	m
Depth kb-last shoe...........................:	-	m
Depth kb-casing set point....................:	189	m
Open hole dia................................:	36	"
Annulus capacity, cased hole.................:	-	l/m
Annulus capacity, open hole..................:	200,6	l/m
Internal capacity, 30 " casing..1".thickness..:	397,2	l/m
Mud weight...................................:	1,1	g/cm^3
Bottom hole hydrostatic pres. (BHHP)........:	-	bar
Est. bottom hole static temp. (BHST)........:	27	^oC
Est. bottom hole circulating temp. (BHCT)...:	27	^oC
Est. formation integrity.....................:	-	bar/m

		FILLER/LEAD SLURRY	TAIL IN SLURRY
CEMENT SLURRY COMPOSITION		CLASS G-cement +3,2 l - D75/100kg cement	CLASS G-cement + 1% $CaCl_2$ (by wt of cement)
Mix water	l/100 kg	93	44,4
Total liquid	l/100 kg	96,2	44,4
Slurry weight	g/cm^3	1,56	1,90
Slurry yield	l/100 kg	128	76,2
TEST DATA @ BHCT			
Thickening time @ BHHP, hr:min		6:20	4:20
Crit. Turb. Flow rate: m/s (l/min)			
Fluid loss, ml/30 min, 70 bar			
TEST DATA @ BHST, BHHP			
Compr. strength, bar hr			
bar hr			
REMARKS:			

Volume calculations: (......30" casing)

Annular volume: ...0,200.....m^3/m x (...189 - 124................)m	=	13,0	m^3
Volume between casings: ....m^3/m x ....m	=		m^3
.......3..... m plug inside casing: .0,397... m^3/m x ......3......... m	=	1,2	m^3
Total volume	=	14,2	m^3
150% excess in open hole	=	19,5	m^3
Total slurry volume	=	33,7	m^3

Lead slurry:

Class G-cement + 3,2 l D-75/100 kg

Cement mixed with seawater at 1,56 kg/liter

......18600...... kg cement equivalent to ......23,8...... m^3 slurry.

Tail-in slurry:

Class G-cement + 1% $CaCl_2$ (by wt of cement)

mixed with seawater at 1,90 kg/liter

......13000...... kg cement equivalent to ......9,9...... m^3 slurry.

Remarks:

Job preparation:

Total liquid lead slurry: ...18600.... kg x ....96,2........... 1/100 kg = 17893 l

Volume of ......D-75......... needed in each mixing tank:

1590 l x (3,2 1/100 kg) / (96,2 1/100 kg) = 53 l

Volume of .... needed in each mixing tank:

1590 l x (1/100 kg) / (1/100 kg) = ______ l

Volume of .... needed in each mixing tank:

1590 l x (1/100 kg) / (1/100 kg) = ______ l

Total liquid tail-in slurry: ...13000............. kg x ...44,4... 1/100 kg = 5798 l

Volume of .... needed in each mixing tank:

1590 l x (1/100 kg) / (1/100 kg) = ______ l

Volume of .... needed in each mixing tank:

1590 l x (1/100 kg) / (1/100 kg) = ______ l

Volume of .... needed in each mixing tank:

1590 l x (1/100 kg) / (1/100 kg) = ______ l

Amount of $CaCl_2$ needed: 13000 kg x 0,01 = 130 kg

Total volume of ......D-75.......................... needed: 18600 kg x 3,2 1/100kg = 595 l

Total volume of .... needed: = ______ l

Total volume of .... needed: = ______ l

CASING CEMENT DATA AND CALCULATIONS, 20 " CASING.

GENERAL: The cement volume is calculated on the basis of the theoretical annulus volume and the casing to be cemented to the sea bed with 100% excess volume in open hole.

WELL DATA:

Depth kb-sea bed...............................:	124	m
Depth kb-last shoe.............................:	189	m
Depth kb-casing set point......................:	500	m
Open hole dia..................................:	26	"
Annulus capacity, cased hole...................:	194	l/m
Annulus capacity, open hole....................:	139,4	l/m
Internal capacity, 20 " casing.94 lbs/ft.......:	185,3	l/m
Mud weight.....................................:	1,1	g/cm^3
Bottom hole hydrostatic pres. (BHHP).........:	54	bar
Est. bottom hole static temp. (BHST).........:	35	°C
Est. bottom hole circulating temp. (BHCT)...:	30	°C
Est. formation integrity......................:	0,15	bar/m

	FILLER/LEAD SLURRY	TAIL IN SLURRY
CEMENT SLURRY COMPOSITION	CLASS G-cement + 3,2 l D-75/100kg cement	CLASS G-cement neat
Mix water 1/100 kg	93,04 sea	44,0 sea
Total liquid 1/100 kg	96,24	44,0
Slurry weight g/cm^3	1,56	1,90
Slurry yield 1/100 kg	128	75,8
TEST DATA @ BHCT		
Thickening time @ BHHP, hr:min	6:00	4:00
Crit. Turb. Flow rate: m/s (l/min)		
Fluid loss, ml/30 min, 70 bar		
TEST DATA @ BHST, BHHP		
Compr. strength, bar hr		
bar hr		
REMARKS:		

Volume calculations: (......20" casing)

Annular volume: 0,1394 m3/m x (500 - 189)m	=	43,35 m3
Volume between casings: 0,194 m3/m x 189-124 m	=	12,61 m3
10 m plug inside casing: 0,1853 m3/m x 10 m	=	1,85 m3
Total volume	=	57,81 m3
100% excess on open hole	=	43,35 m3
Total slurry volume	=	101,16 m3

Lead slurry:

Class G-cement + 3,2 l/100 kg D-75
mixed with seawater at 1,56 kg/cement

71300 kg cement equivalent to 91,3 m3 slurry.

Tail-in slurry:

Class G-cement neat
mixed with sea water at 1,9 kg/l

13000 kg cement equivalent to 9,9 m3 slurry.

Remarks:

Job preparation:

Total liquid lead slurry: 71300 kg x 96,24 l/100 kg = 68619 l

Volume of D-75 needed in each mixing tank:

$$1590\,l \times \frac{3{,}2 \; l/100\,kg}{96{,}24 \; l/100\,kg} = 52{,}87\ l$$

Volume of .... needed in each mixing tank:

$$1590\,l \times \frac{\_\_\_ \; l/100\,kg}{\_\_\_ \; l/100\,kg} = \_\_\_\ l$$

Volume of .... needed in each mixing tank:

$$1590\,l \times \frac{\_\_\_ \; l/100\,kg}{\_\_\_ \; l/100\,kg} = \_\_\_\ l$$

Total liquid tail-in slurry: 13000 kg x 44,0 l/100 kg = 572 l

Volume of .... needed in each mixing tank:

$$1590\,l \times \frac{\_\_\_ \; l/100\,kg}{\_\_\_ \; l/100\,kg} = \_\_\_\ l$$

Volume of .... needed in each mixing tank:

$$1590\,l \times \frac{\_\_\_ \; l/100\,kg}{\_\_\_ \; l/100\,kg} = \_\_\_\ l$$

Volume of .... needed in each mixing tank:

$$1590\,l \times \frac{\_\_\_ \; l/100\,kg}{\_\_\_ \; l/100\,kg} = \_\_\_\ l$$

Total volume of D-75 needed: 68619 kg x 3,2 l/100kg = 2196 l

Total volume of .... needed: = ______ l

Total volume of .... needed: = ______ l

Hydrostatic pressure calculations:

Height of mud: = - m

Height of spacer/preflush: = - m

Height of lead slurry: (500 - 57,7 - 124) m = 318,3 m

Height of tail-in slurry: $(9,9 - 1,85)m^3/0,1394\ m^3/m$ = 57,7 m

Hydrostatic head from spacer/preflush: .... bar/m x .... m = - bar

Hydrostatic head from seawater: $1,025 \cdot \frac{0,981}{10}$ bar/m x 124 - 25 m = 10,0 bar

Hydrostatic head from lead slurry: $1,56 \cdot \frac{0,981}{10}$ bar/m x 3183 m = 48,7 bar

Hydrostatic head from tail-in slurry: $1,9 \cdot \frac{0,981}{10}$ bar/m x 57,7 m = 10,8 bar

Total hydrostatic head at 20" shoe = 69,5 bar

Equivalent pressure gradient at 20" shoe: $\frac{69,5\ \text{bar}}{500\ \text{m}}$ = 0,139 bar/m

Estimated formation integrity at 20" shoe 75 bar/500m = 0,150 bar/m

Hydrostatic head at .... shoe:

.... = ________ bar

Equivalent pressure gradient at .... shoe: $\frac{\text{bar}}{\text{m}}$ = ________ bar/m

Estimated formation inte

Estimated formation integrity at .... shoe = ________ bar/m

CASING CEMENT DATA AND CALCULATIONS, 13 3/8 " CASING.

GENERAL: The cement volume is calculated on the basis of the theoretical annulus volume and the casing to be cemented 100m into the 20" casing.

WELL DATA:

Depth kb-sea bed.............................:	124	m
Depth kb-last shoe...........................:	500	m
Depth kb-casing set point....................:	1350	m
Open hole dia................................:	17½	"
Annulus capacity, cased hole.................:	94,5	l/m
Annulus capacity, open hole..................:	64,4	l/m
Internal capacity,13 3/8"casing.68 lbs/ft......:	78,1	l/m
Mud weight...................................:	1,1	g/cm^3
Bottom hole hydrostatic pres. (BHHP).........:	146	bar
Est. bottom hole static temp. (BHST).........:	58	^oC
Est. bottom hole circulating temp. (BHCT)...:	39	^oC
Est. formation integrity.....................:	0,164	bar/m

	FILLER/LEAD SLURRY	TAIL IN SLURRY
CEMENT SLURRY COMPOSITION	CLASS G-cement 3,20 l/100kg D-75 1,33 l/100kg D-80 0,90 l/100kg D-81	CLASS G-cement 0,09 l/100kg D-81
Mix water l/100 kg	91,72 seawater	43,18 freshwater
Total liquid l/100 kg	97,15	43,27
Slurry weight g/cm^3	1,56	1,91
Slurry yield l/100 kg	128,75	74,87
TEST DATA @ BHCT		
Thickening time @ BHHP, hr:min	5:30	3:30
Crit. Turb.Flow rate: m/s (l/min)		
Fluid loss, ml/30 min, 70 bar		
TEST DATA @ BHST, BHHP		
Compr. strength, bar hr		
bar hr		
REMARKS:		

Volume calculations: (13 3/8" casing)

Annular volume: 0,064 m^3/m x (1350 - 500)m	=	54,74	m^3
Volume between casings: 0,0945 m^3/m x 100 m	=	9,45	m^3
24 m plug inside casing: 0,0781 m^3/m x 24 m	=	1,87	m^3
Total cement slurry volume	=	66,06	m^3

Lead slurry: Class G-cement + 3,20 l/100kg D-75
+ 1,33 l/100kg D-80 + 0,90 l/100kg D-81
mixed with sea water at 1,56 kg/l.

43800 kg cement equivalent to 56,4 m^3 slurry.

Tail-in slurry: Class G-cement + 0,09 l/100kg D-81
mixed with fresh water at 1,9 kg/l.

13000 kg cement equivalent to 9,7 m^3 slurry.

Remarks:

1) Test must be performed by using the actual cement and additives to confirm the thickening time and pumpability.

2) Amount of excess cement should be based on evaluation of the hole conditions and caliper log and discussed with the operational office before a decision is made.

Job preparation:

Total liquid lead slurry: ..43800..... kg x ....97,15......... l/100 kg = 42552 l

Volume of .....D-75.......... needed in each mixing tank:

$$1590\,l \times \frac{3,20\ l/100\,kg}{97,15\ l/100\,kg} = 52,4\ l$$

Volume of .....D-80.......... needed in each mixing tank:

$$1590\,l \times \frac{1,33\ l/100\,kg}{97,15\ l/100\,kg} = 21,8\ l$$

Volume of .....D-81.......... needed in each mixing tank:

$$1590\,l \times \frac{0,9\ l/100\,kg}{97,15\ l/100\,kg} = 14,7\ l$$

Total liquid tail-in slurry: .....13000............ kg x ..43,27 l/100 kg = 5625 l

Volume of .....D-81.......... needed in each mixing tank:

$$1590\,l \times \frac{0,09\ l/100\,kg}{43,27\ l/100\,kg} = 3,3\ l$$

Volume of ....-.................. needed in each mixing tank:

$$1590\,l \times \frac{\_\_\_\ l/100\,kg}{l/100\,kg} = \_\_\_\ l$$

Volume of ....-.................. needed in each mixing tank:

$$1590\,l \times \frac{\_\_\_\ l/100\,kg}{l/100\,kg} = \_\_\_\ l$$

Total volume of ....D-75........................... needed: = 1402 l

Total volume of ....D-80........................... needed: = 583 l

Total volume of ....D-81........................... needed: = 406 l

Hydrostatic pressure calculations:

Height of mud: (500 − 100) m = 400 m

Height of spacer/preflush: = − m

Height of lead slurry: (1350 − 500 + 100 − 125) m = 825 m

Height of tail-in slurry: $(9{,}9 - 1{,}87)\,m^3 / 0{,}0644\ m^3/m$ = 125 m

Hydrostatic head from spacer/preflush: .... bar/m x .... m = − bar

Hydrostatic head from mud: ....1.46/1.350. bar/m x .....400...... m = 43,3 bar

Hydrostatic head from lead slurry: $1{,}56 \cdot \frac{0{,}981}{10}$ bar/m x 825 m = 126,3 bar

Hydrostatic head from tail-in slurry: $1{,}91 \cdot \frac{0{,}981}{10}$ bar/m x 125 m = 23,4 bar

Total hydrostatic head at ..13..3/8" shoe = 193,0 bar

Equivalent pressure gradient at 13..3/8" shoe: $\frac{193\ \text{bar}}{1350\ \text{m}}$ = 0,143 bar/m

Estimated formation integrity at 13 3/8" shoe 221/1350 = 0,164 bar/m

Hydrostatic head at ....20".......... shoe:

0,153 bar/m x 100m + 43,3 bar .... = 58,6 bar

Equivalent pressure gradient at .....20"..... shoe: $\frac{58{,}6\ \text{bar}}{500\ \text{m}}$ = 0,117 bar/m

Estimated formation integrity at ..20"... shoe 75/500 = 0,150 bar/m

CASING CEMENT DATA AND CALCULATIONS, 9 5/8 " CASING.

GENERAL: The cement volume calculation is based on the theoretical hole volume and the casing should be cemented 100m into the 13 3/8" casing.

WELL DATA:

Depth kb-sea bed.................................:	124	m
Depth kb-last shoe...............................:	1350	m
Depth kb-casing set point........................:	3000	m
Open hole dia....................................:	12 1/4	"
Annulus capacity, cased hole.....................:	31	l/m
Annulus capacity, open hole......................:	28,9	l/m
Internal capacity, 9 5/8" casing. 47,0 lbs/ft....:	38,2	l/m
Mud weight.......................................:	1,2	g/cm^3
Bottom hole hydrostatic pres. (BHHP).........:	353	bar
Est. bottom hole static temp. (BHST).........:	98	°C
Est. bottom hole circulating temp. (BHCT)....:	69	°C
Est. formation integrity.........................:	0,181	bar/m

	FILLER/LEAD SLURRY	TAIL IN SLURRY
CEMENT SLURRY COMPOSITION	CLASS G-cement 1,78 l/100kg D-73 1,78 l/100kg D-80 0,36 l/100kg D-81	CLASS G-cement 1,78 l/100kg D-73 1,78 l/100kg D-80 0,27 l/100kg D-81
Mix water l/100 kg	41,00 freshwater	41,06 freshwater
Total liquid l/100 kg	44,92	44,89
Slurry weight g/cm^3	1,90	1,90
Slurry yield l/100 kg	76,52	76,49
TEST DATA @ BHCT		
Thickening time @ BHHP, hr:min	5:20	3:05
Crit. Turb. Flow rate: m/s (l/min)		
Fluid loss, ml/30 min, 70 bar		
TEST DATA @ BHST, BHHP		
Compr. strength, bar hr		
bar hr		
REMARKS:		

Volume calculations: (9 5/8" casing)

Annular volume: 0,0289 m³/m x (3000 - 1350)m	=	47,7	m³
Volume between casings: 0,031 m³/m x 100 m	=	3,1	m³
24 m plug inside casing: 0,0382 m³/m x 24 m	=	0,9	m³
Total cement slurry volume	=	51,7	m³

Lead slurry:

Class G-cement + 1,78 l/100 kg D-73
+ 1,78 l/100 kg D-80 + 0,36 l/100 kg D-81
mixed with fresh water at 1,90 kg/l.

47600 kg cement equivalent to 36,4 m^3 slurry.

Tail-in slurry:

Class G-cement + 1,78 l/100 kg D-73
+ 1,78 l/100 kg D-80 + 0,27 l/100 kg D-81
mixed with fresh water at 1,90 kg/l.

20000 kg cement equivalent to 15,3 m^3 slurry.

Remarks:
1) Pump 2,4m^3 of CW100 preflush as preflush ahead of lead slurry.
2) Tests must be performed by using the actual cement and additives to confirm the thickening time and pumpability.
3) Amount of excess cement should be based on evaluation of the hole conditions and caliper log and discussed with the operational office before a decision is made.

Job preparation:

Total liquid lead slurry: 47600 kg x 44,92 l/100 kg = 21381 l

Volume of D-73 needed in each mixing tank:

$$1590\,l \times \frac{1{,}78\ l/100\,kg}{44{,}92\ l/100\,kg} = 63{,}0\ l$$

Volume of D-80 needed in each mixing tank:

$$1590\,l \times \frac{1{,}78\ l/100\,kg}{44{,}92\ l/100\,kg} = 63{,}0\ l$$

Volume of D-81 needed in each mixing tank:

$$1590\,l \times \frac{0{,}36\ l/100\,kg}{44{,}92\ l/100\,kg} = 12{,}7\ l$$

Total liquid tail-in slurry: 20000 kg x 44,89 l/100 kg = 8978 l

Volume of D-73 needed in each mixing tank:

$$1590\,l \times \frac{1{,}78\ l/100\,kg}{44{,}89\ l/100\,kg} = 63{,}0\ l$$

Volume of D-80 needed in each mixing tank:

$$1590\,l \times \frac{1{,}78\ l/100\,kg}{44{,}89\ l/100\,kg} = 63{,}0\ l$$

Volume of D-81 needed in each mixing tank:

$$1590\,l \times \frac{0{,}27\ l/100\,kg}{44{,}89\ l/100\,kg} = 9{,}6\ l$$

Total volume of D-73 needed: = 1203 l

Total volume of D-80 needed: = 1203 l

Total volume of D-81 needed: = 225 l

Hydrostatic pressure calculations:

Height of mud: (1250 - 77) m = 1173 m

Height of spacer/preflush: 2,4 m^3/0,031 m^3/m = 77 m

Height of lead slurry: (3000 - 1173 - 77 - 498) m = 1252 m

Height of tail-in slurry: (15,3 - 0,9) m^3/0,0289 m^3/m = 498 m

Hydrostatic head from spacer/preflush: $1 \cdot \frac{0,981}{10}$ bar/m x 77 m = 7,6 bar

Hydrostatic head from mud: $1,2 \cdot \frac{0,981}{10}$ bar/m x 1173 m = 138,1 bar

Hydrostatic head from lead slurry: $1,90 \cdot \frac{0,981}{10}$ bar/m x 1252 m = 233,3 bar

Hydrostatic head from tail-in slurry: $1,9 \cdot \frac{0,981}{10}$ bar/m x 498 m = 92,8 bar

Total hydrostatic head at 9 5/8" shoe = 471,8 bar

Equivalent pressure gradient at 9 5/8" shoe: $\frac{471,8 \text{ bar}}{3000 \text{ m}}$ = 0,157 bar/m

Estimated formation integrity at 9 5/8" shoe 544 bar/3000m = 0,181 bar/m

Hydrostatic head at 13 3/8" shoe:

$1,9 \cdot \frac{0,981}{10}$ bar/m $\cdot$ 100m + 7,6m + 138,1m = 164,3 bar

Equivalent pressure gradient at 13 3/8" shoe: $\frac{164,3 \text{ bar}}{1350 \text{ m}}$ = 0,122 bar/m

Estimated formation integrity at 13 3/8" shoe 222/1350 bar/m = 0,164 bar/m

CASING CEMENT DATA AND CALCULATIONS, 7 " LINER.

GENERAL: The cement volume calculation is based on the theoretical hole volume and the liner should be cemented 150m into 9 5/8" casing.

WELL DATA:

Depth kb-sea bed.............................:	124	m
Depth kb-last shoe...........................:	3000	m
Depth kb-casing set point....................:	3575	m
Open hole dia................................:	8½	"
Annulus capacity, cased hole.................:	13,3	l/m
Annulus capacity, open hole..................:	11,7	l/m
Internal capacity, 7" liner.. 29 lbs/ft.....:	19,4	l/m
Mud weight...................................:	1,4	g/cm^3
Bottom hole hydrostatic pres. (BHHP)........:	491	bar
Est. bottom hole static temp. (BHST)........:	111	^oC
Est. bottom hole circulating temp. (BHCT)...:	82	^oC
Est. formation integrity.....................:	0,184	bar/m

	CEMENT SLURRY	TAIL IN SLURRY
CEMENT SLURRY COMPOSITION	CLASS G-cement 2,22 l/100kg D-73 1,78 l/100kg D-80 0,13 l/100kg D-109	CLASS
Mix water l/100 kg	40,79 freshwater	
Total liquid l/100 kg	44,92	
Slurry weight g/cm^3	1,9	
Slurry yield l/100 kg	76,52	
TEST DATA @ BHCT		
Thickening time @ BHHP, hr:min	5:45	
Crit. Turb. Flow rate: m/s (l/min)		
Fluid loss, ml/30 min, 70 bar		
TEST DATA @ BHST, BHHP		
Compr. strength, bar hr		
bar hr		
REMARKS:		

Volume calculations: (.......7" liner)

Annular volume: 0,0117 m³/m x (3575 - 3000)m = 6,7 m³

Volume between casings: 0,0133 m³/m x 150 m = 2,0 m³

24 m plug inside casing: 0,0194 m³/m x 24 m = 0,5 m³

Total cement slurry volume = 9,2 m³

Cmt slurry: Class G-cement + 2,22 l/100kg D-73
+ 1,78 l/100kg D-80 + 0,13 l/100kg D-109
mixed with fresh water at 1,90 kg/l.

12000 kg cement equivalent to 9,2 m³ slurry.

Remarks:

1) Pump 1,6m³ of CW 100 preflush ahead of cement slurry.

2) Test must be performed by using the actual cement and additives to confirm the thickening time and pumpability.

3) Amount of excess cement should be based on evaluation of the hole conditions and caliper log and discussed with the operational office before a decision is made.

Job preparation:

Total liquid ~~cmt~~ slurry: 12000 kg x 44,92 l/100 kg = 5390 l

Volume of D-73 needed in each mixing tank:

$$1590\,l \times \frac{2{,}22\ l/100\,kg}{44{,}92\ l/100\,kg} = 78{,}6\ l$$

Volume of D-80 needed in each mixing tank:

$$1590\,l \times \frac{1{,}78\ l/100\,kg}{44{,}92\ l/100\,kg} = 63{,}0\ l$$

Volume of D-81 needed in each mixing tank:

$$1590\,l \times \frac{0{,}13\ l/100\,kg}{44{,}92\ l/100\,kg} = 4{,}60\ l$$

Total liquid tail-in slurry: .... kg x .... l/100 kg = ______ l

Volume of .... needed in each mixing tank:

$$1590\,l \times \frac{\ \ l/100\,kg}{l/100\,kg} = \_\_\_\_\ l$$

Volume of .... needed in each mixing tank:

$$1590\,l \times \frac{\ \ l/100\,kg}{l/100\,kg} = \_\_\_\_\ l$$

Volume of .... needed in each mixing tank:

$$1590\,l \times \frac{\ \ l/100\,kg}{l/100\,kg} = \_\_\_\_\ l$$

Total volume of D-73 needed: = 267 l

Total volume of D-80 needed: = 214 l

Total volume of D-109 needed: = 16 l

Hydrostatic pressure calculations:

Height of mud: (3000 - 150 - 64) m = 2786 m

Height of spacer/preflush: 1,6 m^3/0,0249 m^3/m = 64 m

Height of ~~cmt~~ slurry: (3575 - 3000 + 150) m = 725 m

~~Height of tail-in slurry~~: = - m

Hydrostatic head from spacer/preflush: 0,098 bar/m x 64 m = 6,3 bar

Hydrostatic head from mud: 0,137 bar/m x 2786 m = 381,7 bar

Hydrostatic head from cmt slurry: 0,186 bar/m x 725 m = 134,9 bar

Hydrostatic head from tail-in slurry: .... bar/m x .... m = bar

Total hydrostatic head at 7" shoe = 522,9 bar

Equivalent pressure gradient at 7" shoe: $\frac{522,9 \text{ bar}}{3575 \text{ m}}$ = 0,146 bar/m

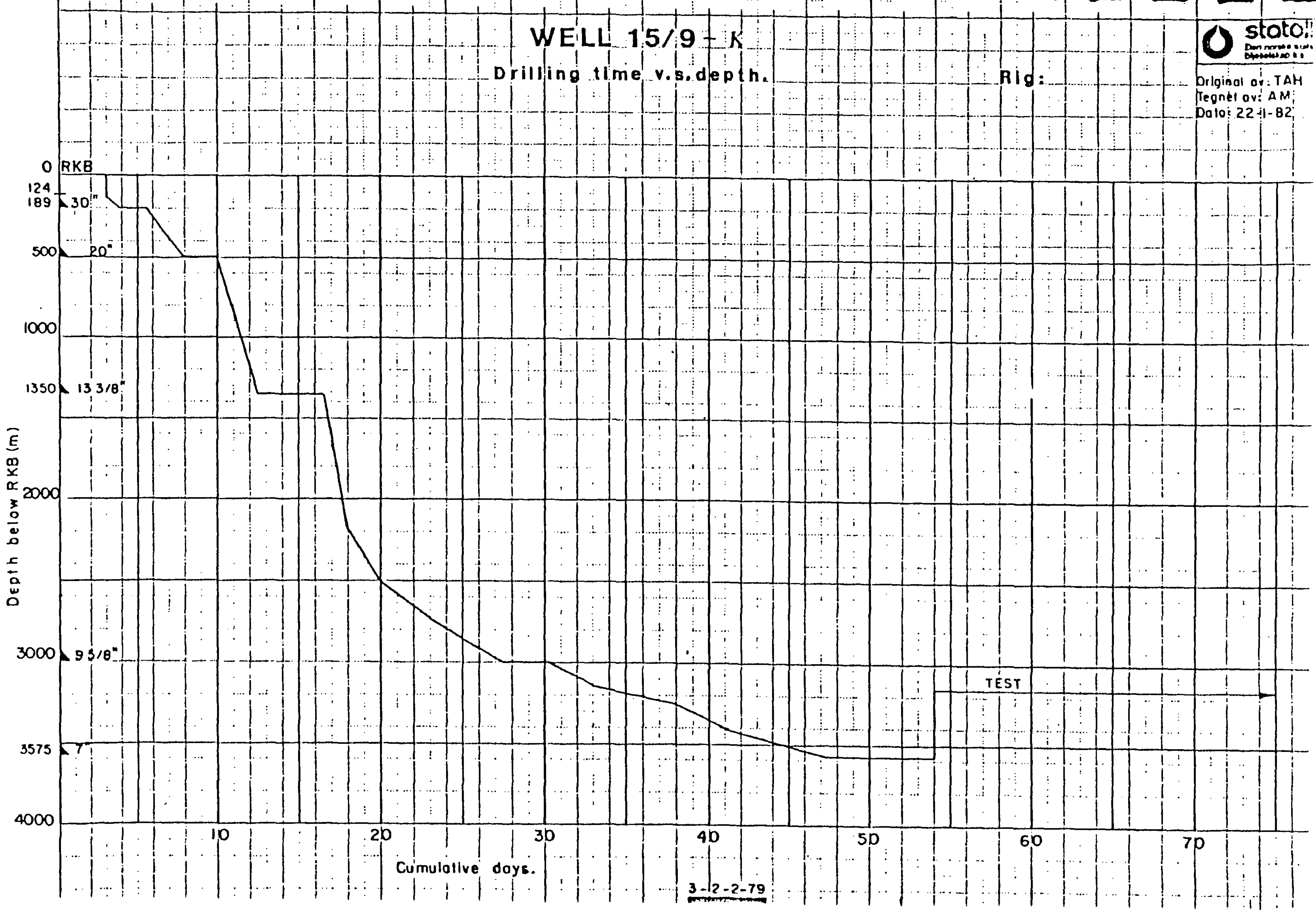
Estimated formation integrity at 7" shoe 658/3575 = 0,184 bar/m

Hydrostatic head at 9 5/8" shoe:

(6,3 + 381,7) bar + 0,186 bar/m · 150m = 415,9 bar

Equivalent pressure gradient at 9 5/8" shoe: $\frac{415,9 \text{ bar}}{3000 \text{ m}}$ = 0,139 bar/m

Estimated formation integrity at 9 5/8" shoe 544/3000 = 0,181 bar/m



WELL 15/9 - K
Drilling time v.s. depth.
Rig:
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Den norske stats oljeselskap a.s
Original av: TAH
Tegnet av: AM
Dato: 22-1-82
0 RKB
124
189
30"
500
20"
1000
1350
13 3/8"
2000
3000
9 5/8"
3575
7"
4000
Depth below RKB (m)
10
20
30
40
50
60
70
Cumulative days.
TEST
3-12-2-79

WELL NO. 15/9-K

(Not to scale)

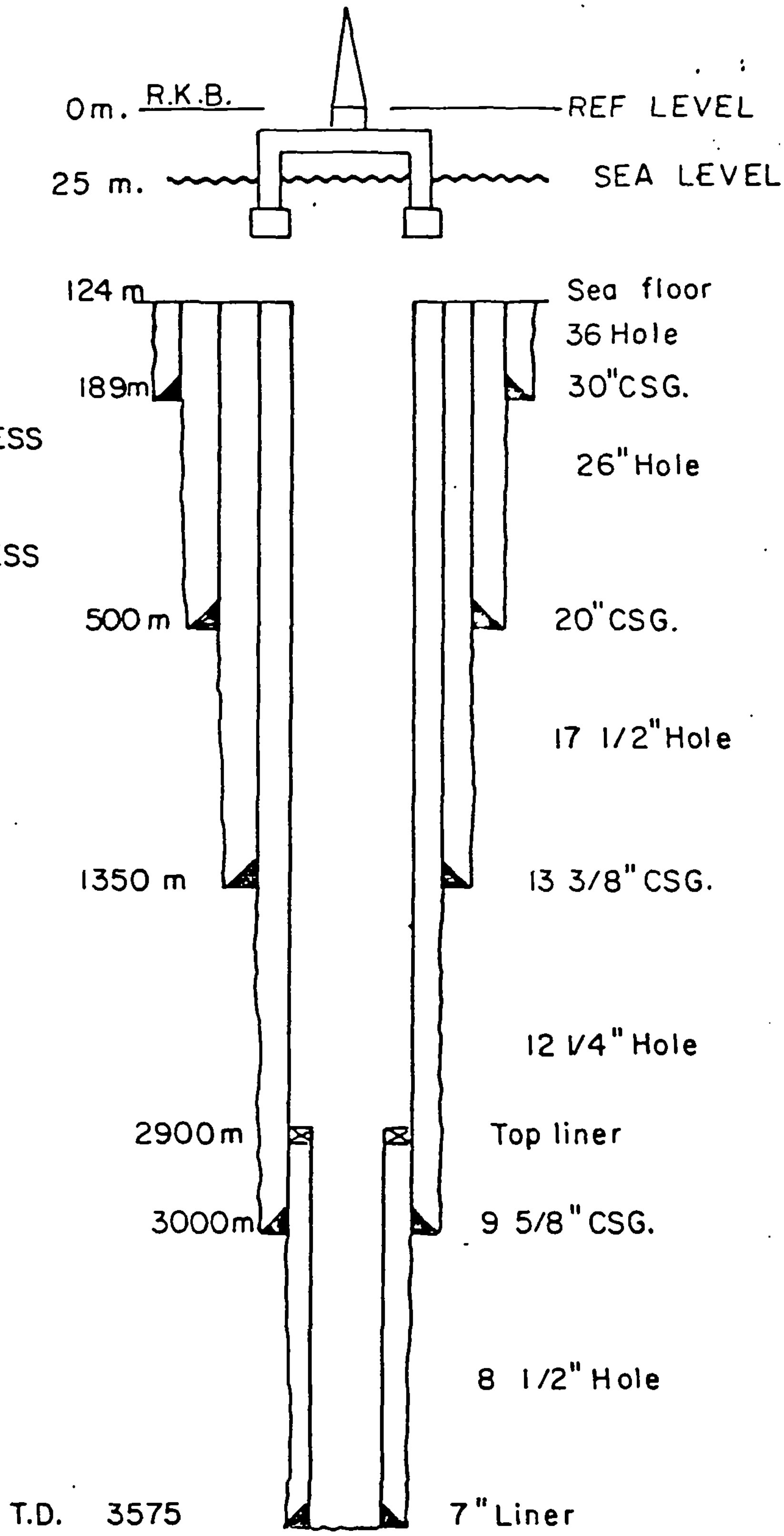
30", GRADE B, VETCO ATD/RB
1 jt. 1 1/2" TH.
4 jt. 1" TH
CEMENT TO SEA BED + 150% EXCESS

20", X-56, 94 lb/ft, VETCO LS
CEMENT TO SEA BED + 100% EXCESS

13 3/8", K-55, 68 lb/ft, BUTTRESS
CEMENT TO 400 m

9 5/8", N-80, 47 lb/ft, BUTTRESS
CEMENT TO 1250 m

7", N-80, 29 lb/ft, BUTTRESS
CEMENT TO FULL LENGTH



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Den norske stats oljeselskap a.s

ORIGINAL AV: MF
TEGNET AV: AM
DATO: 21-1-82

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Att: T.S. Ølberg

Deres ref Your ref	Deres brev av Your letter of	Vår ref. Our ref.	Dato Date
		BOR/TMa/GEB	21.4.82

ENDRINGER I 9 5/8" FORINGSRØRSVALG I BOREPROGRAM FOR BRØNN 15/9-14

Etter nærmere vurderinger har Statoil funnet det riktig å forandre nedre del av 9 5/8" foringsrør slik at det forsterkes.

Dette betyr at de nederste 800 m (2200-3000 m) med 47 lbs/ft, N-80 byttes ut med rør av kvalitet 47 lbs/ft, P110.

Beregningene som viser styrkeforholdet til det nye røret finnes vedlagt.

Eventuelle spørsmål eller kommentarer kan rettes til undertegnede.

Med hilsen
for Den norske stats oljeselskap a.s

A.Ø. Håland
A.Ø. Håland

AMMENDMENT TO 15/9-K DRILLING PROGRAM

15/9-K (14), 9 5/8" casing design

The following change will be done in the composition of the 9 5/8" casing string due to too low SF_B at 3000 m.

124-2200 m: 9 5/8", 47 lb/ft, N-80, BUTTRESS

RES_C = 328 bar

RES_B = 474 bar

RES_T = $482 \cdot 10^3$ daN

2200-3000: 9 5/8", 47 lb/ft, P110, BUTTRESS

RES_C = 366 bar

RES_B = 651 bar

RES_T = $659 \cdot 10^3$ daN

Consequently the safetyfactors for burst will be, if there is a tubing leak just below the wellhead while testing:

- at 2200 m:

$332 \text{ bar} + (0.132-0.1) \cdot (2200\text{m} - 99\text{m}) = 399 \text{ bar}$

$$SF_B = \frac{474}{399} = 1.19$$

- at 3000 m:

$332 \text{ bar} + (0.132-0.1) \cdot (3000-99) = 425 \text{ bar}$

$$SF_B = \frac{651}{425} = 1.53$$

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LET-SVG
RKr/THd
29.4.82.

To all receivers of
the Geological Prognosis
and Drilling Program
15/9-14 (KAPPA)

Please replace the original cementing program in the Geological Prognosis and Drilling Program 15/9-14 (KAPPA) with the cementing program enclosed.

Yours faithfully

Roar Kræmer

Enclosure

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30" CASING CEMENT DATA AND CALCULATIONS, 15/9-KAPPA:

GENERAL: The cement volume is calculated at the basis of the theoretical hole volume and the casing to be cemented to sea bed with 150% excess volume in open hole.

WELL DATA:

Depth kb-sea bed............................:	124 m
Depth kb-last shoe..........................:	
Depth kb-casing set point...................:	189 m
Open hole dia...............................:	36"
Annulus capacity, cased hole.. ....:	- l/m
Annulus capacity, open hole...... ......:	200.0 l/m
Internal capacity, 30" casing 1.0"thickness	397.0 l/m
Mud weight..................................:	1.10 g/cm^3
Bottom hole hydrostatic pres. (BHHP).......:	bar
Est. bottom hole static temp. (BHST).......:	27 °C
Est. bottom hole circulating temp. (BHCT).:	27 °C
Est. formation integrity...................:	- bar/m

		LEAD SLURRY	TAIL-IN SLURRY
CEMENT SLURRY COMPOSITION		CLASS "G"cement + 3.55 l/100kg A-3L	CLASS G-cement +1.33 l/100kg A-7L
Mix water	l/100 kg	93.5 <u>sea</u>	42.8 <u>sea</u>
Total liquid	l/100 kg	97.1	44.1
Slurry weight	g/cm^3	1.56	1.92
Slurry yield	l/100 kg	128.8	75.9
TEST DATA AT BHCT			
Thickening time at BHHP, hr:min		5:11	3:30
Crit. Turb.Flow rate:m/s (l/min)			
Fluid loss, ml/30 min, 70 bar			
TEST DATA AT BHST, BHHP			
Compr. strength,	bar 12 hr	30	117
	bar 24 hr	70	207

REMARKS:

Fann VG Readings 600/300/200/100	43/33/29/25	147/113/93/74

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Volume calculations (30" casing):

Annular volume	: 0.200 m^3/m x (189-124)m	= 13.0 m^3
3 m plug at shoe	: 0.397 m^3/m x 3 m	= 1.2 m^3
150% excess in open hole :		= 19.5 m^3
Total volume		= 33.7 m^3

Lead slurry : Class G-cement + 3.55 l A-3L/100 kg cement mixed with seawater at 1.56 g/cm^3

18400 kg cement equivalent to 23.7 m^3 slurry

Tail-in slurry : Class G-cement + 1.33 l A-7L/100kg cement mixed with seawater at 1.92 g/cm^3.

13200 kg equivalent to 10.0 m^3 slurry.

Chemicals needed: Total volume of A-3L needed: 653 l

Total volume of A-7L needed: 176 l

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20" CASING CEMENT DATA AND CALCULATIONS, 15/9-KAPPA:

GENERAL: The cement volume is calculated at the basis of the theoretical annulus volume and the casing to be cemented to the sea bed with 100% excess volume in open hole.

WELL DATA:

Depth kb-sea bed	124 m
Depth kb-last shoe	189 m
Depth kb-casing set point	500 m
Open hole dia	26"
Annulus capacity, cased hole	194.0 l/m
Annulus capacity, open hole	139.4 l/m
Internal capacity, 20" casing 94 lb/ft	185.3 l/m
Mud weight	1.10 g/cm^3
Bottom hole hydrostatic pres. (BHHP)	54 bar
Est. bottom hole static temp. (BHST)	31 °C
Est. bottom hole circulating temp. (BHCT)	29 °C
Est. formation integrity	0.150 bar/m

		LEAD SLURRY	TAIL IN SLURRY
CEMENT SLURRY COMPOSITION		CLASS "G"cement + 3.55 l/100 kg A-3L + 0.22 l/100 kg R-15L	CLASS "G"-cement neat
Mix water	l/100 kg	92.50 sea	44.0 sea
Total liquid	l/100 kg	96.27	44.0
Slurry weight	g/cm^3	1.56	1.91
Slurry yield	l/100 kg	128.1	75.8
TEST DATA AT BHCT			
Thickening time at BHHP, hr:min		5:20	4:00
Crit. Turb.Flow rate:m/s (l/min)			
Fluid loss, ml/30 min, 70 bar			
TEST DATA AT BHST, BHHP			
Compr. strength, bar 12 hr		12	273
bar 24 hr		55	319

REMARKS:

Fann VG Readings 600/300/200/100 41/33/29/25/ 130/98/82/61

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Volume calculations (20" casing):

Annular volume	: 0.1394 m^3/m x (500-189)m	= 43.4 m^3
Volume between csg's:	0.194 m^3/m x (189-124)m	= 12.6 m^3
12 m plug at shoe	: 0.1853 m^3/m x 12	= 2,2 m^3
100" exces: in open hole:		= 43.4 m^3
Total volume		= 101.6 m^3

Lead slurry : Class "G"-cement + 3.55 1/100 kg A-3L + 0.22 1/100 kg R-15L mixed with seawater at 1.56 g/cm^3

71600 kg cement equivalent to 91.6 m^3 slurry

Tail-in slurry : Class "G"-cement mixed with seawater at 1.91 g/cm^3.

13200 kg equivalent to 10.0 m^3 slurry.

Chemicals needed: Total volume of A-3L needed: 2542 l

Total volume of R-15L needed: 158 l

Hydrostatic pressure at 20" csg. shoe

Height of tail-in slurry : $(10.0-2.2)m^3/0.1394\ m^3/m=$ 56 m

Hydrostatic head of lead slurry :

0.153 bar/m x (500-124-56)m 49.0 bar

Hydrostatic head of tail-in slurry :

0.187 bar/m x 56 m 10.5 bar

Hydrostatic head of sea-water :

0.101 bar/m x (124 - 25)m 10.0 bar

Total hydrostatic pressure 69.5 bar

Equivalent pressure gradient at 20" shoe :

$$\frac{69.5\ \text{bar}}{500\ \text{m}} = 0.139\ \frac{\text{bar}}{\text{m}}$$

Estimated formation integrity : 0.150 bar/m

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13 3/8" CASING CEMENT DATA AND CALCULATIONS, 15/9-KAPPA:

GENERAL: The cement volume is calculated at the basis of the theoretical annulus volume and the casing to be cemented 100 m into the 20" casing.

WELL DATA:

Depth kb-sea bed.........................:	124 m
Depth kb-last shoe.......................:	500 m
Depth kb-casing set point................:	1350 m
Open hole dia............................:	17½"
Annulus capacity, cased hole.. ....:	94.5 l/m
Annulus capacity, open hole...... ....:	64.4 l/m
Internal capacity, 13 3/8"casing 68 lb/ft :	78.1 l/m
Mud weight...............................:	1.10 g/cm^3
Bottom hole hydrostatic pres. (BHHP)......:	146 bar
Est. bottom hole static temp. (BHST)......:	44 °C
Est. bottom hole circulating temp. (BHCT).:	38 °C
Est. formation integrity.................:	0.164 bar/m

		LEAD SLURRY	TAIL IN SLURRY
CEMENT SLURRY COMPOSITION		CLASS "G"cement + 3.55 l/100 kg A-3L + 0.44 l/100 kg R-15L	CLASS "G" cement
Mix water	l/100 kg	92.4 sea	44.0 fresh
Total liquid	l/100 kg	96.4	44.0
Slurry weight	g/cm^3	1.56	1.90
Slurry yield	l/100 kg	128.2	75.8
TEST DATA AT BHCT			
Thickening time at BHHP, hr:min		5:00	3:50
Crit. Turb.Flow rate:m/s (l/min)			
Fluid loss, ml/30 min, 70 bar			
TEST DATA AT BHST, BHHP			
Compr. strength,	bar 12 hr	20	138
	bar 24 hr	50	230
REMARKS:			
Fann VG Readings 600/300/200/100		42/29/26/27	97/59/47/35

Volume calculations (13 3/8" casing):

Annular volume	: 0.0644 m^3/m x (1350-500)m	= 54.7 m^3
Volume between csg's:	0.0945 m^3/m x 100 m	= 9.5 m^3
24 m plug inside casing	: 0.0781 m^3/m x 24m	= 1.9 m^3
Total cement slurry volume		= 66.1 m^3

Lead slurry : Class G-cement + 3.55 1/100 kg A-3L + 0.71 1/100 kg R-15L mixed with seawater at 1.56 g/cm^3

43800 kg cement equivalent to 56.1m^3 slurry

Tail-in slurry : Class G-cement mixed with fresh water at 1.90 g/cm^3.

13200 kg equivalent to 10.0 m^3 slurry.

NOTE: Amount of excess cement should be based on evaluation of the hole conditions and caliper log to give the top of cement 100 m into 20" csg. The amount of excess should be discussed with the operation office before any decision are made.

Chemicals needed:

Total volume of A-3L needed : = 1555 l
Total volume of R-15L needed : = 311 l

Remarks: Adequate samples of cement, additives and drillwater should be forwarded to Statoil's Mud and Cement Lab, Forus, for testing prior to the cement job.

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Hydrostatic pressure calculations: Height of mud :
(500-100)m = 400 m

Height of lead slurry : (1350-500- 126 + 100)m = 824 m
Height of tail-in slurry : (10.0 - 1.9) $m^3/0.0644\ m^3/m$ = 126 m
Hydrostatic head from mud: 0.108 bar/m x 400 m = 43.2 bar

Hydrostatic head from lead slurry : 0.153 bar/m x 824 m = 126.1 bar

Hydrostatic head from tail-in slurry: 0.187 bar/mx126 m = 23.6 bar

Total hydrostatic head at 13 3/8" shoe = 192.9 bar

Equivalent pressure gradient at 13 3/8" shoe :

$$\frac{192.9\ \text{bar}}{1350\ \text{m}} = 0.143\ \text{bar/m}$$

Estimated formation integrity at 13 3/8" shoe : = 0.164 bar/m

Hydrostatic head at 20" shoe:

43.2 bar + 0.153 bar/m x 100 m = 58.5 bar

Equivalent pressure gradient at 20" shoe : $\frac{58.5\ \text{bar}}{500\ \text{m}}$ = 0.117 bar/m

Estimated formation integrity at 20" shoe = 0.150 bar/m

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9 5/8" CASING CEMENT DATA AND CALCULATIONS, 15/9-KAPPA:

GENERAL: The cement volume is calculated at the basis of the theoretical annulus volume and the casing should be cemented 100m into the 13 3/8"csg.

WELL DATA:

Depth kb-sea bed.........................:	124 m
Depth kb-last shoe.......................:	1350 m
Depth kb-casing set point................:	3000 m
Open hole dia............................:	12 1/4 m
Annulus capacity, cased hole.. ....:	31.0 l/m
Annulus capacity, open hole...... ....:	28.9 l/m
Internal capacity, 9 5/8" casing 47 lbs/ft:	38.2 l/m
Mud weight...............................:	1.20 g/cm^3
Bottom hole hydrostatic pres. (BHHP)......:	353 bar
Est. bottom hole static temp. (BHST)......:	90 °C
Est. bottom hole circulating temp. (BHCT).:	66 °C
Est. formation integrity.................:	0.181 bar/m

		SLURRY
CEMENT SLURRY COMPOSITION		CLASS "G"cement + 1.78 l/100 kg D-19LN + 0.89 l/100 kg D31LN + 0.53 l/100 kg R-12L
Mix water	l/100 kg	41.6 fresh
Total liquid	l/100 kg	44.8
Slurry weight	g/cm^3	1.90
Slurry yield	l/100 kg	76.4

TEST DATA AT BHCT

Thickening time at BHHP, hr:min	5:20
Crit. Turb.Flow rate:m/s (l/min)	
Fluid loss, ml/30 min, 70 bar	

TEST DATA AT BHST, BHHP

Compr. strength, bar 12 hr	285
bar 24 hr	427

REMARKS: K/N	6.700.10-5/1.2781
Fann VG Readings 600/300/200/100	48/19/11/5

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Volume calculations (9 5/8" casing):

Annular volume	: 0.0289 m^3/m x (3000-1350)m	= 47.7 m^3
Volume between csg's:	0.0310 m^3/m x 100 m	= 3.1 m^3
24 m plug inside casing	: 0.0382 m^3/m x 24	= 0.9 m^3
Total cement slurry volume		= 51.7 m^3

Slurry : Class G-cement + 1.78 1/100 kg D-19LN +0.89 1/100 kg D-31 LN + 0.53 1/100 kg R-12L mixed with fresh water at 1.90 g/cm^3

67700 kg cement equivalent to 51.7 m^3 slurry

NOTE : Amount of excess cement should be based on evaluation of the hole conditions and caliper logg to give the top of cement 100 m into 13 3/8" csg. The amount of excess should be discussed with the operation office before any dicision are made.

Chemicals needed: Total volume of D-19LN needed: 1205 l
Total volume of D-31LN needed: 603 l
Total volume of R-12L needed: 359 l

Remarks: Pump 3.2 m^3 of BJ's mud sweeps ahead of slurry. Spacer weight of 1.60 g/cm^3.

Adequate samples of cement, additives and drillwater should be forwarded to Statoil's Mud and Cement Lab, Forus, for testing prior to each cement job.

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Hydrostatic pressure calculations:

Height of mud : (1350 - 100 - 103)m =1147 m

Height of spacer/preflush: 3.2 m^3 /0.031 m^3/m = 103m

Height of slurry :(3000-1350+100)m =1750 m

Hydrostatic head from spacer/preflush:
0.157 bar/m x 103 m = 16.2 bar

Hydrostatic head from mud : 0.118 bar/m x 1147 m = 135.3 bar

Hydrostatic head from slurry : 0.186 bar/m x 1750 m = 325.5 bar

Total hydrostatic head at 9 5/8" shoe = 477.0 bar

Equivalent pressure gradient at 9 5/8"shoe:

$$\frac{477.0\ \text{bar}}{3000\ \text{m}} = 0.159\ \text{bar/m}$$

Estimated formation integrity at 9 5/8" shoe = 0.181 bar/m

Hydrostatic head at 13 3/8" shoe:
(16.2 + 135.3) bar + 0.186 bar/m x 100 m = 170.1 bar

Equivalent pressure gradient at 13 3/8" shoe :

$$\frac{170.1\ \text{bar}}{1350\text{m}} = 0.126\ \text{bar/m}$$

Estimated formation integrity at 13 3/8" shoe 0.164 bar/m

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7" LINER CEMENT DATA AND CALCULATIONS, 15/9- KAPPA

GENERAL: The cement volume calculations is based on the theoretical hole volume and the liner should be cemented 100m into the 9 5/8" casing.

WELL DATA:

Depth kb-sea bed	124 m
Depth kb-last shoe	3000 m
Depth kb-casing set point	3575 m
Open hole dia	8 ½"
Annulus capacity, cased hole	13.3 l/m
Annulus capacity, open hole	11.7 l/m
Internal capacity, 7" liner 29 lbs/ft	19.4 l/m
Mud weight	1.40 g/cm³
Bottom hole hydrostatic pres. (BHHP)	491 bar
Est. bottom hole static temp. (BHST)	107 °C
Est. bottom hole circulating temp. (BHCT)	80 °C
Est. formation integrity	0.184 bar/m

		SLURRY
CEMENT SLURRY COMPOSITION		CLASS "G" + 1.78 l/100 kg D-19LN + 0.89 l/100 kg D-31LN + 0.40 l/100 kg R-12L
Mix water	l/100 kg	41.7
Total liquid	l/100 kg	44.8
Slurry weight	g/cm³	1.90
Slurry yield	l/100 kg	76.5
TEST DATA AT BHCT		
Thickening time at BHHP, hr:min		4:30
Crit. Turb.Flow rate:m/s (l/min)		
Fluid loss, ml/30 min, 70 bar		
TEST DATA AT BHST, BHHP		
Compr. strength, bar 12 hr		448
bar 24 hr		572
REMARKS: K/N		$1.070 \cdot 10^{-4}$/1.1927
Fann VG Readings 600/300/200/100		42/18/11/5

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Volume calculations (7 " liner)

Annular volume	: 0.0117 m^3/m x (3575-3000)m	= 6.7 m^3
Volume between csg's:	0.0133 m^3/m x 100 m	= 1.3 m^3
24 m plug inside casing	: 0.0194 m^3/m x 24m	= 0.5 m^3
Total cement slurry volume		= 8.5 m^3

Slurry : Class G-cement + 1.78 l/100kg D-19LN + 0.89 l/100kg D-31LN + 0.40 l/100kg R-12 l mixed with fresh water at 1.90 g/cm^3

11200 kg cement equivalent to 8.5 m^3 slurry

NOTE : Amount of excess cement should be based on evaluation of the hole conditions and the caliper log to give the top of cement at the liner hanger (100 m into 9 5/8" csg.) The amount of excess should be discussed with the operation office before any dicision are made.

Chemicals needed:	Total volume of D-19LN needed:	199 l
	Total volume of D-31LN needed:	100 l
	Total volume of R-12L needed :	45 l

Remarks: Pump 1.6 m^3 of BJ's mudsweep ahead of slurry. Spacer weight 1.50 g/cm^3.

The Statoil supervisor is responsible for sending in cement,drillwater and additives from the rig. The operation office is responsible for making arrangements to have the slurry composition tested before the cement job.

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Hydrostatic pressure calculations:

Height of mud : (3000-100-64)m	=2836m
Height of spacer/preflush: 1.6 m^3/0.0249 m^3/m	= 64 m
Height of slurry :(3575-3000+100)m	= 675 m
Hydrostatic head from spacer/preflush: 0.147 bar/mx64m	= 9.4 bar
Hydrostatic head from mud : 0.128 bar/m x 2836m	= 363.0 bar
Hydrostatic head from slurry : 0.186 bar/m x 675 m	= 125.6 bar
Total hydrostatic head at 7" shoe	= 498.0 bar

Equivalent pressure gradient at 7"shoe :

$$\frac{498.0 \text{ bar}}{3575 \text{ m}} = 0.139 \text{ bar/m}$$

Estimated formation integrity at 7"shoe = 0.184 bar/m

Hydrostatic head at 9 5/8" shoe:
(9.4+363.0) bar + 0.186 bar/m x 100 m = 391.0 bar

Equivalent pressure gradient at 9 5/8"shoe :

$$\frac{391.0 \text{ bar}}{3000} = 0.130 \text{ bar/m}$$

Estimated formation integrity at 9 5/8"shoe 0.181 bar/m

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LET-SVG
KS/THd
10.5.82.

To all receivers of
the Geological Prognosis
and Drilling Program
15/9-14 (Kappa)

Please find the enclosed ammendment to
15/9-K drilling program.

Yours faithfully
for Den norske stats oljeselskap a.s

Kåre Skår

Enclosure

9.00.03