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GEOLOGICAL PROGNOSIS & DRILLING PROGRAM

WELL 30/2-1

DEC. 1981

CONTENTS

FIGURES

STATOIL WELL PROGNOSIS

WELL NO.	30/2-1, North (Wildcat)
PROSPECT	Block 30/2, Alpha structure

GENERAL DATA :

Location :

Country	Norway
Area	North Sea
Licence No.	051
Block No.	30/2
Coordinates	60° 53' 10,2" N, 02° 38' 52,3" E

Seismic shotpoint No. 435   Line No.702 164

13 km of S Block Boundary
16 km of W Block Boundary
110 km from Norwegian Coast
43 km from N/UK median Line
5 km of nearest well 30/3-1
49 km E of nearest field Brent

Water depth : 125 m MSL
KBE 27 m
Projected total depth : 4610 m KB

CONTRACTORS

Drilling Platform :	Dyvi Delta
Drilling Contractor	Dyvi Drilling
Mudlogging Contractor	Exploration Logging
Type Logging Unit	Ex-Log unit (Gemdas)
Electric Logging Contractor	Schlumberger
Rig Positioning Contractor	Decca
Bottom Survey Contractor	Geoteam
Helicopter Service	Helikopter Service A/S
Supply Boats	Statoil supply-boat pool

GEOLOGICAL PROGRAM

Well No.30/2-1, North (Wildcat)

Purpose.

30/2-1, is a wildcat well designed to test possible hydrocarbon accumulations in the 30/2 Alpha-structure. Total depth is estimated to 4610 m (KB)(in Triassic).

Objectives.

The primary objective of the well is sandstone of Middle Jurassic age. Secondary objectives are sandstones of Upper/Lower Jurassic age.

DRILLING HAZARDS

No particular drilling hazards are anticipated.

SURVEY AND POSITIONING

The rig will be navigated by Pulse 8 and finally positioned by Satnav. Rig location accuracy is requested within 100 m radius off the proposed location at sp 435 on seismic line 702 164.

STRATIGRAPHIC PROGNOSIS 30/2-1 NORTH

UNIT	DEPTH (m KB)
Top Tertiary	354
Top Miocene-Pliocene	762
Top Ogligocene	952
Top Eocene	1402
Top Paleocene	1952
Top Cretaceous (Maastrichtian)	2185
Top Lower Campanian	2310
Top Turonian	3440
Top Albian	3615
Top Jurassic (Humber Gr.)	3640
Top Brent	3735
Top Dunlin - Drake Fm.	3920
Top Cook Fm.	4105
Top Burton/Amundsen Fm.	4160
Top Statfjord	4290
Top Trias	4560
TD	4610

The above structural depths have been derived from seismic line 702 164 which crosses the well location and from correlations with 30/3-1, Phase I and 30/3-2.

GEOLOGICAL WELL LOGGING AND SAMPLING PROCEDURE

Mud logging contractor : Exploration Logging.

The Exploration Logging unit will be employed to log the well for hydrocarbon shows, collect samples, prepare sample log and conduct other services throughout drilling operations.

Sampling interval.

Samples will be collected at 10 meters intervals down to approximately 1900 m, thereafter at 3 meters intervals. Sampling intervals might be changed on the well-site geologist's discretion.

2 sets of washed and dried samples will be collected at each interval.

6 sets of unwashed samples (½ kg) will be collected at each interval.

One canned mud sample to be taken at 100 m intervals for total section.

One composite sample of unwashed cuttings will be canned at 15 meters sampling interval.

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, washing and distribution will be handles by GECO as per instructions.

LOGGING PROGRAM

RUN	HOLE SIZE	TYPE LOGS
1	26"	ISF/SONIC-MSFL-GR, FDC/CNL-GR*
2	17½"	ISF/SONIC-MSFL-GR, FDC/CNL-GR
3	17½"	ISF/SONIC-MSFL-GR, FDC/CNL-GR RFT*, CST*
4	12 1/4"	ISF/SONIC-MSFL-GR, FDC/CNL-GR DLL/MSFL*, CST
5	8½"	ISF/SONIC-MSLF-GR, FDC/CNL-GR, DLL/MSFL-GR*, HDT, RFT, CST, WSS

*OPTIONAL

CORING PROGRAM

A minimum of one core will be taken in Middle Jurassic sandstone for reservoir analysis. Additional cores may be requested if significant hydrocarbon shows are encountered during drilling. This will be at the discretion of the wellsite geologist, subject to review by 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 or production tests through casing depending on analysis of well potential at the time.

A supplementary work program will be issued if necessary.

BASE

Statoil's operation base at Ågotnes 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 Analysts engineer.

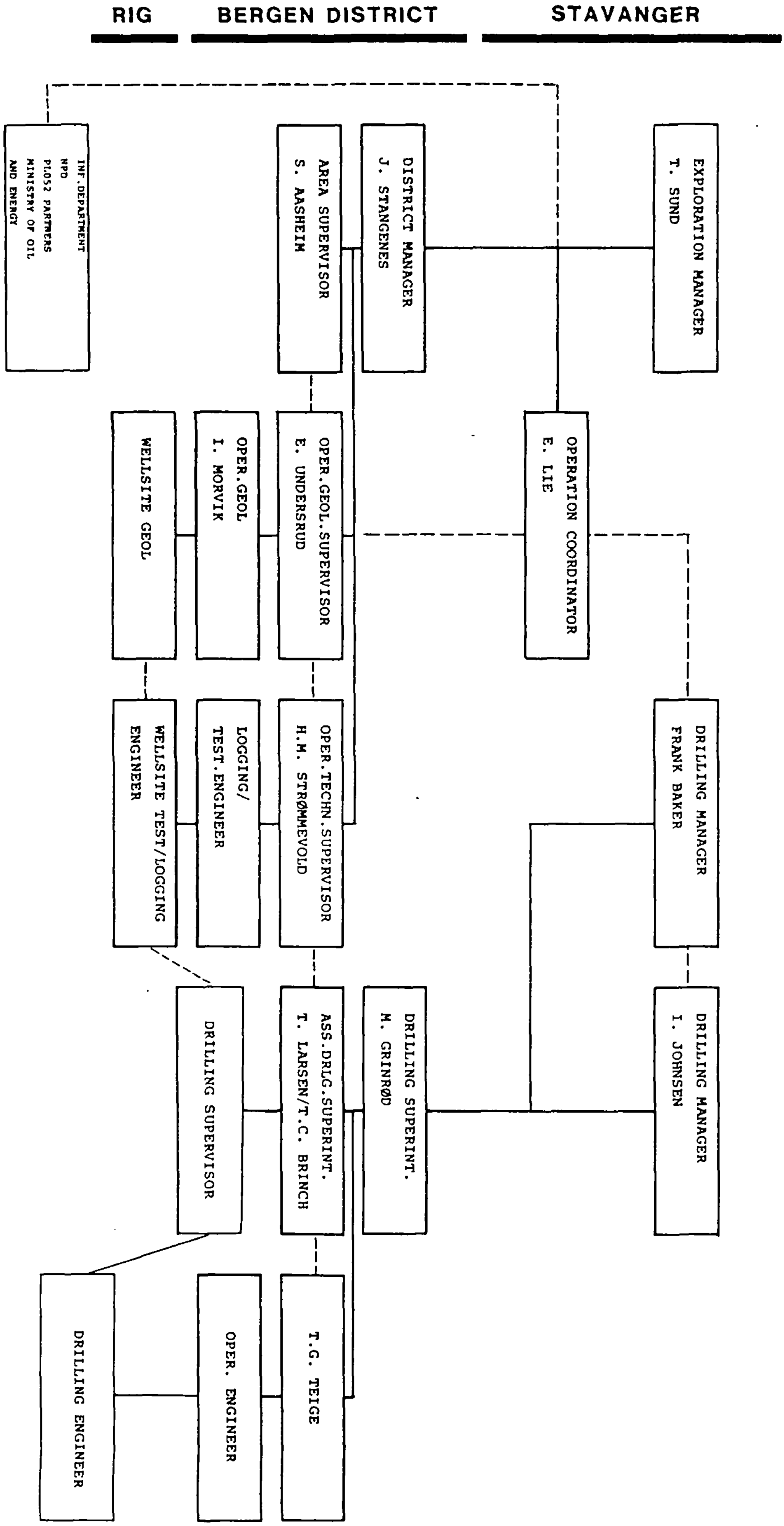
c) Wellsite Geologist.

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 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 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 data gathering during logging and testing operations.

ORGANIZATION CHART WELL 30/2 - 1



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 agencies no later than six months after completion of the well.

STAFF

Staff of Exploration Department, Statoil, who are involved in the planning and drilling of well 30/2-1 North :

NAME	TITLE	OFFICE TELEPHONE	PRIVAT TELEPHONE	MOBIL TELEPHONE
T. Sund	Expl.Manager	04-533180	04-560235	
E. Lie	Operation Coordinator	04-533180	04-667411	04-57916
S. Aasheim	Area Superv.	05-344711	05-284214	
E. Undersrud	Op.Geol.Superv.	05-344711		57908
I. Morvik	Op.Geologist	05-344711		23317
H.M.Strommevold	Petroph. Supervisor	05-344711		57914

COMMUNICATION PERSONNEL DURING THE DRILLING OF WELL 30/2-1.

Unionoil

Vernon E. Roe	Manager of Operations	04-663040	71285
Keith Lindsell	Chief Geophys.	04-663040	

Tenneco

H.S. Bratlie	Man.Director	04-666891
W.T. Spurlock	Expl.Manager	04-666891

DRILLING PROGRAM

Well Designation	:	30/2-1
Drilling Platform	:	DYVI DELTA
Drilling Draft	:	23.2 m (76 ft)
Distance RKB to MSL	:	27 m
Water Depth	:	125 m
Depths	:	Referred to RKB except where specified otherwise.

I LOCATION

See Geological Program.

II MOORING

As per general procedure.

III GENERAL DRILLING

Estimated total depth; 4610 m.

Operation Phase

A temporary guide base is not required.

- Drill 36" hole with 26" x 36" hole opener to ± 210 m. Stab 30" casing blind. (5 joints)

- Drill 12 1/4" pilot hole to 615 m. Log and open the hole to 26" using holeopener or underreamer. Run 20" casing.

- Drill 17½" pilot hole to 1395 m. Log and open the hole to 22" using underreamer. Run 16" liner.

- Drill 14 3/4" pilot hole to 2295 m. Log and open the hole to 17½" using underreamer. Run 13 3/8" casing.

- Drill 12 1/4" hole to 3565 m. Log and run 9 5/8" casing.

- Drill 8½" hole to an estimated total depth of 4610 m. If hydrocarbons are present in the lower Jurassic sandstones; then log and run a 7" liner. If hydrocarbons are present only in the middle Jurassic sandstones; then log and plug back. Run the 7" liner 50 m into the Dunlin shale.

DRILLING CONSIDERATIONS

The closest well with respect to geology is 30/3-1, This well, however, was temporary abandoned after setting 9 5/8" casing in lower Cretaceous.

Other nearby wells are drilled on 30/4 and 30/7 and data from these are used in programming this well.

The Alpha structure on 30/2 - 30/3 has an extremely high porepressure in Jurassic. Leak-off data from 30/4 - 30/7 and 31/3 are used for fracture gradient prediction.

It is of the utmost importance that all the casings below the 20" are set as deep as possible, to be able to reach to TD.

SEA BED CONDITION

The seabed in the vicinity of the location is fairly smooth and even. It is thought to consist of firm, dense sand, possibly with occational patches of coarser gravel and pebbles.

The seabed is free from any obstructions to the siting of a semisubmersible drilling rig.

SHALLOW GAS

A site survey has been carried out. Based on data from this survey, no drilling hazards are anticipated in this well.

CASING PROGRAM

36" HOLE

5 joints of 30" casing will be run.

26" HOLE

In order to obtain the desired formation integrity, the 20" casing should be set at 600 m.

Porepressures are expected to be normal. Weight of return mud should be checked regularly to prevent the annulus from overloading and breaking down the formation. The drilling rate should be controlled.

A 12 1/4" pilot hole will be drilled. Indications of shallow gas sands obtained while drilling, may dictate intermediate logging.

Before deciding how to enlarge the 12 1/4" pilot hole, all the drilling data and logs should be carefully reviewed and discussed with the Operations Office.

If the presence of gas bearing sands cannot be excluded, the hole should be underreamed.

If it is decided to enlarge the hole with a holeopener, the procedure will be as follows.

- Displace the hole with sea water in three steps.
- Check for flow after each step.
- Displace the hole with mud.
- Pull the riser.

When pulling the riser, the hydrostatic pressure in the hole should exceed the minimum pressure the hole earlier has been exposed to with sufficient safety margin over any gas bearing sand.

22" HOLE

A 22" hole is programmed to be drilled to 1395 m. It is planned to first drill a 17½" pilot hole, and then open up to 22" using a under reamer. The hole should not be under reamed faster than 20 m/hr.
Porepressures are expected to be normal through this section.

The objective of the 16" liner is to get adequate formation strength to drill the 17½" hole deep into the transition zone.

The 16" liner will be set on bottom, and will have a 150 m overlap into the 20" casing.

17½" HOLE

The 17½" hole is programmed to be drilled to about 2295 m. The porepressure is expected to increase in Early Eocene. There are uncertainties to the pressure build up in this section, but depending on the previous leak off, the hole should be drilled to a porepressure equivalent to 1,5 gr/cc.

The objective of the 13 3/8" casing is to get adequate penetration into the pressure transition zone and obtain satisfactory formation integrity to carry the mudweight necessary to allow for drilling and cementing the 9 5/8" casing.

When approaching the Early Eocene transition zone, drilling parameters should be kept as uniform as possible. The mud weight should not be raised until the transition zone is recognized. Drilling should cease when weighing up the mudsystem in steps to minimize the effect on the "d"-eksponent.

To reduce the drilling problems in the Early Eocene clays, a good bentonite/lignosulphonate mud system will be utilized, using high quality bentonite for this section of hole. Mud weight should be kept at a minimum and drilling rate should be controlled to avoid excessive build up of cuttings in the annulus.

12 1/4" HOLE

Porepressures are expected to increase to 1,65 gr/cc in the upper part of Cretaceous. There will be a slight regression through the Cretaceous before the porepressure again increases rapidly in Upper Jurassic.

The objective of the 9 5/8" casing is to get adequate penetration to obtain satisfactory formation integrity to carry the mudweight necessary to allow for drilling and cementing the 7" casing.

The 9 5/8" casing is programmed to be set at 3550 m in the Turonian group. The leak off below the 9 5/8" casing will dictate if the well can be drilled to TD. It is therefore of the utmost importance that the correct setting depth of the 9 5/8" casing is chosen.

The casing should be set in the lower part of Turonian group, but prior to drilling into the upper Jurassic. To choose the right setting depth, an intermediate logging run including RFT may be run.

8½" HOLE

Porepressures are expected to increase below the 9 5/8" shoe, and reach a maximum of 2,03 gr/cc in the top of Brent. A 8½" hole will be drilled through the Brent, Dunlin and Statfjord sands. If hydrocarbons are found in the lower Jurassic sandstones, a 7" liner will be set at TD.
However, if hydrocarbons only are found in Brent, the lower part of the hole will be plugged back leaving 50 m rathole in Dunlin, to improve the liner cementing.

DIRECTIONAL SURVEY

Directional surveys will be run every 90 m after setting the 20" casing. Magnetic multishots will be considered run at 13 3/8" and 9 5/8" casing depths, and also at TD if a 7" liner is to be run.

H_2S - CHECKS

H_2S checks shall be performed on mud filtrate at 100 m intervals below the 13 3/8" casing shoe.

IV HYDRAULICS / BITS

INTERVAL M RKB	HOLE SIZE	BIT TYPE	NOZZLES (32 nds)	WOB (tons)	RPM	PUMP OUTPUT (cu.m/min)	PUMP PRESSURE (bar)
152 - 210	26" x 36"	OSC-3AJ + 36" H.O.	3 x 20	0 - 5	40 - 60	4.5	-
210 - 615	12 1/4"	X3A	3 x 16 3 x 18	Controlled drill. rate	120 - 150	2.5	-
210 - 615	12 1/4"x17½" 26"	X3A + H.O./U.R. or X3A + H.O. + U.R.	3 x 24 or 3x15 + 3x18	Controlled drill. rate	-	3.6	-
615 - 1395	17½"	OSC-3AJ, X3A	3 x 18 3 x 20	Controlled drill rate	120 - 150	3.5 - 3.8	207
615 - 1395	17½" x 22"	OSC-3AJ + U.R	3 x 24	Controlled drill. rate	-	3.6	-
1395 - 2295	14 3/4"	DSJ, DS, OSC-3AJ, MSDTC,OSC-1GJ	3 x 15 3 x 16	5 - 20	100 - 150	2.8 - 3.0	207
1395 - 2295	14 3/4"x17½"	DSJ or MSDTC + U.R.	3 x 24	Controlled drill. rate	-	3.6	-
2295 - 3000	12 1/4"	X3A, S33SF, XIG, SDS	3 x 14	10 - 20	80 - 130	2.0 - 2.2	220
3000 - 3565	12 1/4"	S33SF, XIG	3 x 15	10 - 20	80 - 130	2.0 - 2.2	220
2295 - 3565	12 1/4"	LX-13 ON TURBINE	-	10 - 15	-	2.0 - 2.1	280-290
3565 - 4000	8½"	SDGH, S33SF, J3	2 x 11 1 x 12	15 - 20	80 - 130	1.25	220
4000 - 4610	8½"	SDGH, S33SF, J3	1 x 11 2 x 12	15 - 20	80 - 130	1.25	220
CORING	8 15/32"	C-20, CB303 (9 SPC)					

V

MUD PROGRAM

Interval m RKB	Hole size	Mud type	Weight (g/cm^3)	PV	YP	HTHP w.1.	pH
152-210	26" x 36"	Seawater w/gel slugs	-				
210-615	12 1/4"	Seawater w/gel slugs	1.03-1.10				
210-615	26"	Seawater w/gel slugs	1.03-1.10				
615-1395	17½"	Seawater/fresh water lignosulfonate	1.03-1.10				
615-1395	22"	Seawater/fresh water lignosulfonate	1.03-1.10				
1395-2295	14 3/4"	Sea-/freshwater, chromelignosulfonate	1.10-1.55	low	15-20	25 or less	9.5-10.5
1395-2295	17½"	Sea-/freshwater, chromelignosulfonate	1.10-1.55	low	15-20	25 or less	9.5-10.5
2295-3565	12 1/4"	Sea-/freshwater, chromelignosulfonate	1.55-1.69	low	10-15	15 or less	10.0-11.0
3565-4610	8½"	Sea-/freshwater, chromelignosulfonate	1.69-2.08	low	10-15	15 or less	10.0-11.0

REMARKS:
- Rheology properties will be tested and reported at 50^{o}C. Reported mud weight is to be measured using a Pressurized Mud Balance.
- Maintain drill solids content at a minimum by utilizing the desander, desilters/mud cleaners.
- Utilize the centrifuge for viscosity control and for barite salvage.
- See separate Mud Program for details.

X PRESSURE INTEGRITY TESTS

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

XI 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. Thereliability 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 and plot the following parameters relating to abnormal pressure:

a) On a depth scale:
1. Drillability
2. ROP
3. "d" exponent

b) On a time scale:
1. Rotary torque
2. Mud temperature in
3. Mud temperature out
4. Lagged differential temperature
5. Mud flow in
6. Mud flow out
7. Mud weight in

8. Mud weight out
9. Pit volume
10. Pit volume total change
11. Mud gas

In addition, below the 20" casing shoe, manual plots will be recorded and reviewed continuosly by the Drilling Engineer and Drilling Supervisor. These plots will include ROP, "d"-exp., Gas Units and Shale Density.

Abnormal pressure detection data will be forwarded into the Bergen 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 Bergen Operations Office.

XIII PRODUCTION TESTS

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

XIV PLUG AND ABANDONMENT

A separate program will be submitted.

Approved:

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34/10 Exploration Manager, Statoil

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for Drilling Manager, Statoil

KICK LIMITATION

Drilling below the 20" casing shoe:

Formation integrity below the 20" casing shoe at 600 m is estimated to be 1.35 gr/cm^3. The maximum porepressure is prognosed to be 1.03 gr/cm^3.

The section will be drilled with a mudweight of 1.10 gr/cm^3.

If the well kicks at 1395 m, a kick height of approx. 200 m can be controlled by closing the BOP. (See figure 1.)
Annular capacity (12 1/4" - 8") = 0.0436 m^3/m DC length-150 m
Annular capacity (12 1/4" - 5") = 0.0627 m^3/m

This is equal to a volume of: 10.9 m^3

The general procedure is; Not to shut in the well with only the 20" casing set.

Drilling below the 16" shoe:

Formation integrity below the 16" shoe at 1395 m is estimated to be 1.58 gr/cm^3. The maximum porepressure gradient while drilling is expected to be 1.50 gr/cm^3 at 2295 m. Necessary riser margin at this depth is 0.05 gr/cm^3. A mudweight of 1.55 gr/cm^3 should be sufficient to control the well.

If the well kicks at 2295 m, a kickheight of approx. 65 m can be controlled by closing the BOP. (See figure 1.)

Annular capacity: (14 3/4" - 9½") : 0.0645 m^3/m.

This is equal to a volume of 4.2 m^3.

Drilling below the 13 3/8" shoe:

Formation integrity below the 13 3/8" shoe at 2280 m is estimated to be 1.77 gr/cm^3. The maximum porepressure gradient while drilling is expected to be 1.65 gr/cm^3 at 3565 m. Necessary riser margin at this depth is 0.04 gr/cm^3. A mudweight of 1.69 gr/cm^3 should be sufficient to control the well.

If the well kicks at 3565 m, a kickheight of 115 m can be controlled by closing the BOP. (See figure 1.)

Annular capacity (12 1/4"-8") : 0.0436 m^3/m (DC-length 190 m)

This is equal to 5.0 m^3.

Drilling below the 9 5/8" shoe:

Formation integrity below the 9 5/8" shoe at 3550 m is estimated to be 2.11 gr/cm^3. The maximum porepressure gradient while drilling is expected to be 2.03 gr/cm^3. Necessary riser margin at this depth is 0.05 gr/cm^3. A mudweight of 2.08 gr/cm^3 should be sufficient to control the well.

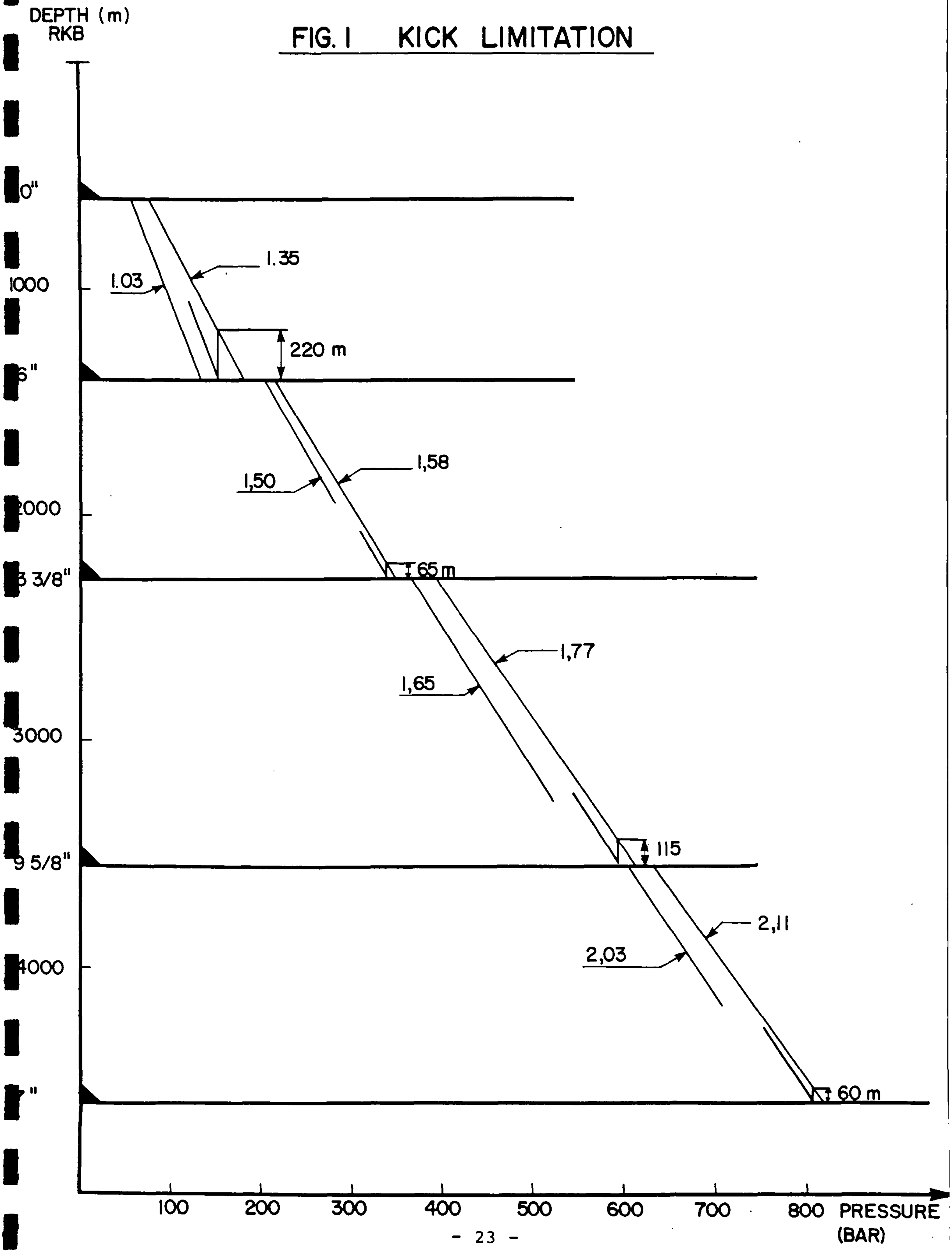
If the well kicks in this hole section, a kickheight of approx 50 m can be controlled by closing the BOP. (See figure 1.)

Annular capacity (8½" x 6½") = 0.0152 m^3/m (DC-length 180 m)

This is equal to a volume of 0.9 m^3.

Comments

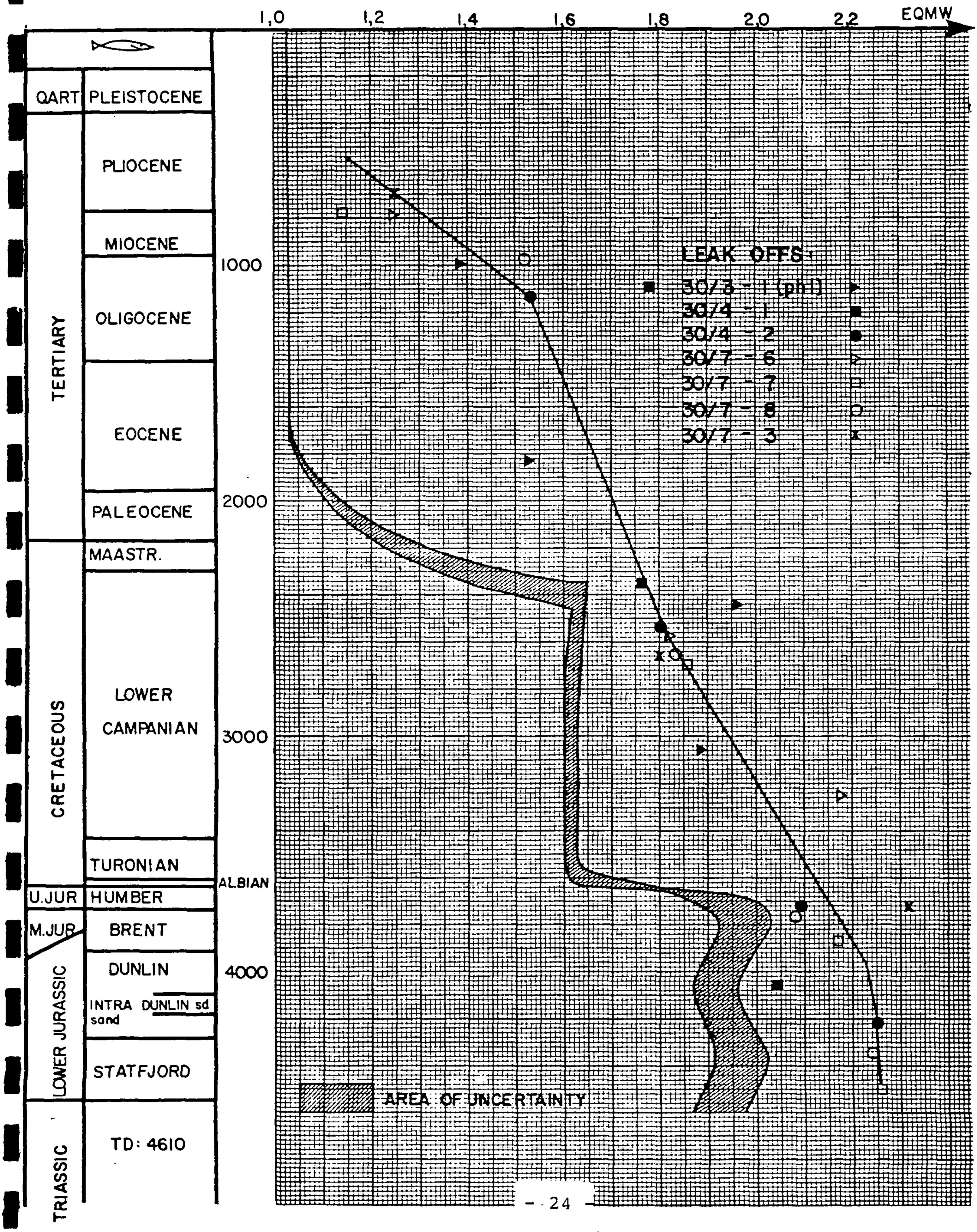
The above estimated volumes are the maximum shut in volumes. However, the volumes that safely can be circulated out will be of approximately the same size. The expansion effect of a possible gas influx will be cancelled by the reduction in temperature and the increase in annular capacity as the influx enters the drillpipe annulus.

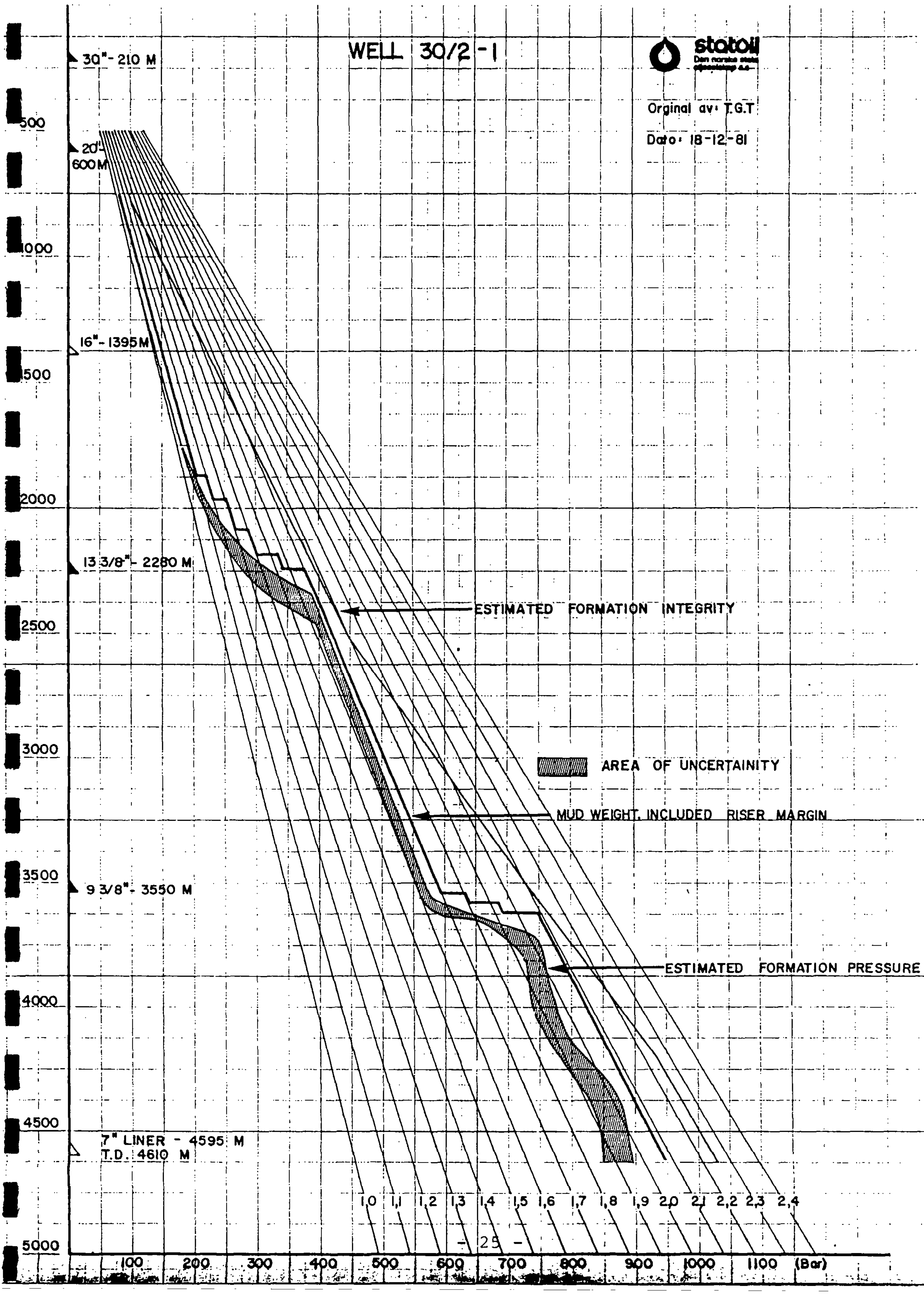


DEPTH (m)
RKB
FIG. 1 KICK LIMITATION
0"
1000
6"
2000
3 3/8"
3000
9 5/8"
4000
7"
1.35
1.03
220 m
1,58
1,50
65 m
1,77
1,65
115
2,11
2,03
60 m
100
200
300
400
500
600
700
800
PRESSURE
(BAR)

PREDICTED PORE PRESSURE AND FRACTURE GRADIENTS

30/2 - 1




WELL 30/2-1
statoil
Orginal av: T.G.T
Dato: 18-12-81
30"- 210 M
20" 600 M
16"- 1395 M
13 3/8"- 2280 M
9 3/8"- 3550 M
7" LINER - 4595 M
T.D. 4610 M
ESTIMATED FORMATION INTEGRITY
AREA OF UNCERTAINITY
MUD WEIGHT, INCLUDED RISER MARGIN
ESTIMATED FORMATION PRESSURE
1,0 1,1 1,2 1,3 1,4 1,5 1,6 1,7 1,8 1,9 2,0 2,1 2,2 2,3 2,4
500 1000 1500 2000 2500 3000 3500 4000 4500 5000
100 200 300 400 500 600 700 800 900 1000 1100 (Bar)

CASING CALCULATIONS

All depths measured from RKB.

W_D = Well depth (m)

X = Casing setting depth (m)

Y = Depth (m) to top of fluid column if mud is lost to a low-pressure zone.

Z = Depth (m) from RKB to wellhead

G_F = Fracture gradient (bar/m)

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

G_{c1} = Lead slurry gradient (bar/m)

G_{c2} = Tail slurry gradient (bar/m)

G_i = Mud gradient at casing setting depth (bar/m)

G'_i = Mud gradient below shoe (bar/m)

G''_i = Mud gradient below shoe (bar/m)

G_p = Normal pore pressure gradient

G'_p = Actual pore pressure gradient

G''_p = Actual pore pressure gradient

G'''_p = Actual pore pressure gradient

X-area= Casing cross-sectional area (cm^2)

RES_C = Collapse resistance (bar)

RES_B = Burst resistance (bar)

RES_T = Tensile resistance (10^3 daN)

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

$S.F._B$ = Safety factor, burst = 1.10

$S.F._T$ = Safety factor, tension = 1.5

20" CASING DESIGN

W_D = 1395 m

W'_D = 2295 m (well depth below 16" liner)

X = 600 m

X' = 1395 m (setting depth 16" liner)

G_F = 0.142 bar/m

G_i = 0.108 bar/m

G_{gas} = 0.01 bar/m ($\bar{P}$ = 112 bar, $\bar{T}$ = 20°C, γ = 0.6)

G_p = 0.1 bar/m

G_{c1} = 0.186 bar/m

G_{c2} = 0.153 bar/m

Z = 152 m

DESIGN CRITERIA

A 16" liner will be set from 450 m - 1395 m. The 13 3/8" casing will be set at 2280 m. The 20" casing will therefore be design to withstand pressure from 2280 m.

BURST : - Burst load if entire casing is filled with gas.
COLLAPSE: - Collapse load during cementing.
TENSION : - Weight load while bumping plug with 35 bar.

BURST

If the well is filled with gas (well closed in or flow diverted) the maximum casing pressure will be limited by fracture pressure at the 16" casing shoe. (G_F=0.155 bar/m). Maximum burst load at wellhead.

$P_{B1} = X \times G_F - (X-Z) \times G_{gas} - (Z-27) \times G_p =$

$1395 \times 0.155 \text{ bar} - (1395-152) \times 0.01 \text{ bar} - (152-27) \times 0.1 \text{ bar} =$

191.3 bar

Burst load at shoe:

P_{B2} = 1395 x 0.155 bar - (1395-600) x 0.01 bar - (600-27) x 0.1 bar = 151.0 bar

Safety factor, burst:

$$S.F._B = \frac{RES_B}{P_{B1}} = \frac{211 \text{ bar}}{191.3 \text{ bar}} = 1.10$$

COLLAPSE

Collapse load during cementing. Maximum collapse load will be at float collar at 588 m.
Volume of tail in slurry is 9.9 m^3, which leaves the tail in cement 55 m up in annulus.

P_C = (55 m - 12 m) x G_{c1} + (X - 55 m - Z) x G_{c1} + (Z - 27 m) x G_p - (X - 12 m - 27 m) x G_p = 43 m x 0.186 bar/m + 393 m x 0.153 bar/m + 125 m x 0.101 bar/m - 561 m x 0.101 bar/m = = 24.1 bar

Safety factor, collapse:

$$S.F = \frac{RES_C}{P_C} = \frac{103 \text{ bar}}{24.1 \text{ bar}} = 4.3 > 1.3$$

TENSION

Weight load at wellhead:

(600 - 152) x 198 x 0.981 daN = 87 x 10^3 daN

Extra tensile load when bumping plug (neglecting boyancy of steel):

$$35 \times \left(\frac{485.7}{2}\right)^2 \times 3.14 \times 0.01 \times 0.981 \text{ daN} = \underline{63.6 \times 10^3 \text{ daN}}$$

$$\underline{S.F._T} = \frac{RES_T}{(87+63.6) \times 10^3 \text{ daN}} = \frac{945 \times 10^3 \text{ daN}}{150.6 \times 10^3 \text{ daN}} = \underline{6.3 > 1.5}$$

Select: 152 m - 600 m: 20", K55, 133 lbs/ft, Buttress

RES_C = 103 bar

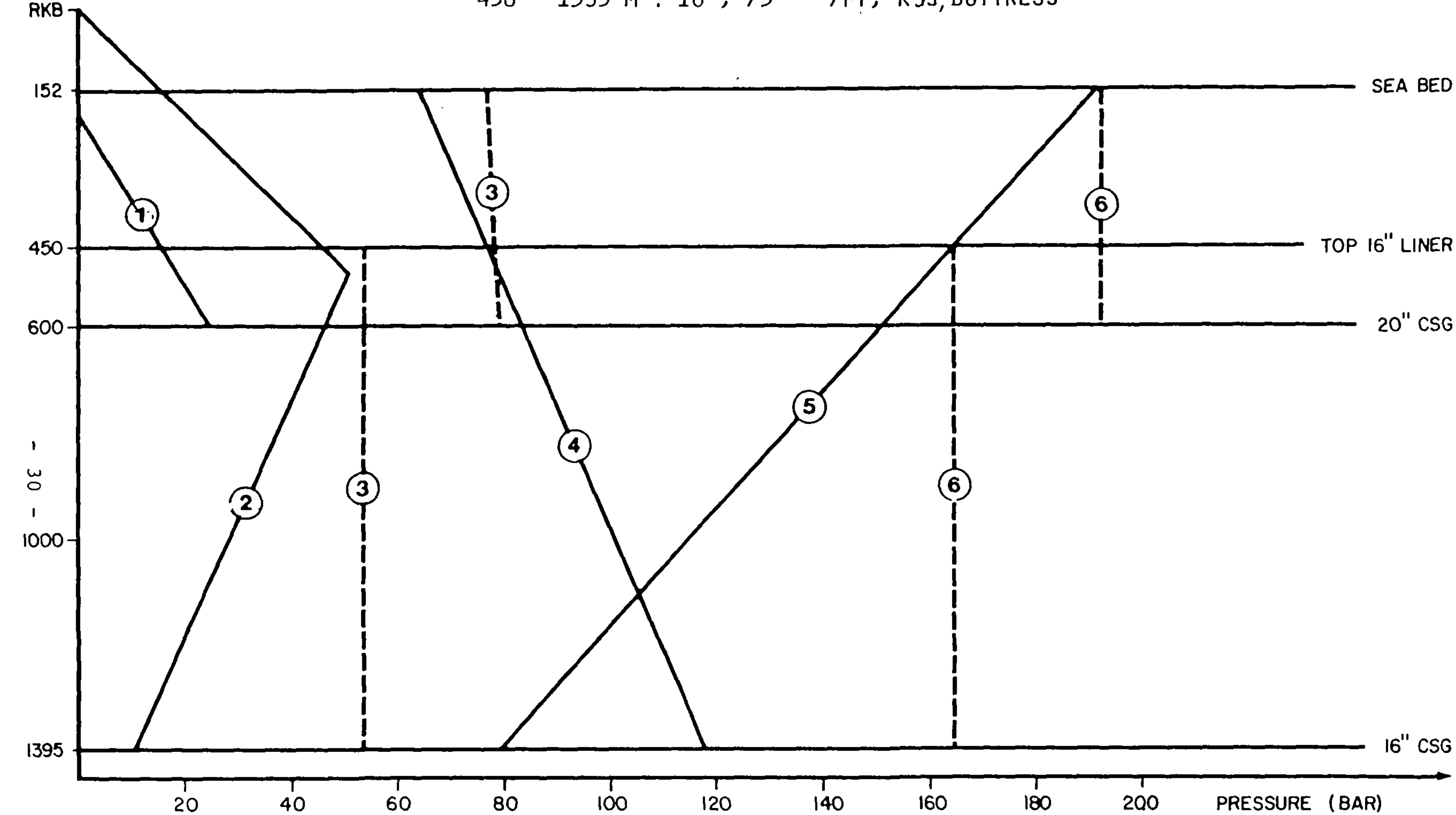
RES_B = 211 bar

RES_T = 945×10^3 daN

20" AND 16" CASING DESIGN

152 - 600 M : 20", 133 LBS/FT, K-55, BUTTRESS

450 - 1395 M : 16", 75 LBS/FT, K-55, BUTTRESS



1. COLLAPSE LOAD WHILE CEMENTING 20" CASING
2. COLLAPSE LOAD, LOST CIRCULATION WHILE DRILLING BELOW 16" LINER
3. COLLAPSE RESISTANCE, CORRECTED FOR SAFETY FACTOR 1.3 AND BIAXIAL STRESS
4. BURST LOAD WHILE CIRCULATING A 15 M^3 KICK
5. BURST LOAD, UNDERGROUND BLOW OUT
6. BURST RESISTANCE, CORRECTED FOR SAFETY FACTOR 1.1.

16" CASING DESIGN

W_D = 2295 m

X = 1395 m - 450 m

G_F = 0.155 bar/m

G_{gas} = 0.02 bar/m

G_p = 0.1 bar/m

G'_p = 0.147 bar/m

G_i = 0.108 bar/m

G'_i = 0.152 bar/m

Z = 152 m

DESIGN CRITERIA

BURST : - Underground blowout.
- Circulating a 15 m^3 kick.

COLLAPSE: - Lost circulation.
- Cementing.

TENSION : - Weight load

BURST

Burst load in case of an underground blowout:
Maximum burst load at wellhead and at 600 m : See 20" casing design.

Burst load at 16" casing shoe:

$P_B = 1395 \times G_F - (1395 - 27) \times G_p =$

$P_B = 1395 \times 0.155 \text{ bar} - 1368 \times 0.1 \text{ bar} =$

$\underline{P_B = 79.4 \text{ bar}}$

Kick consideration

BHA approx 220 m.

Annular capacity : 14 3/4" - 8" = 0.0778 m^3/m

Height of kick : $\dfrac{15\ m^3}{0.0778\ m^3/m} = \underline{193\ m}$

BHA after kick at 2295 m : 2295 m x (0.147 + 0.01)bar/m =

= 360.3 bar

1) $P_g + (W_D - Z - H_g) \times G'_i = P_p$

2) $\dfrac{P_p \times V_1}{T_1 \times Z_1} = \dfrac{P_g \times V_g}{T_2 \times Z_2}$

P_g = Pressure of gas at wellhead

V_g = Volume of gas at wellhead

V_1 = Volume of influx = 15 m^3

T_1 = Bottom hole temperature 82°C

T_2 = Wellhead temperature 25°C

Z_1 = Gas compr. factor at bottom = 1.1

Z_2 = Gas compr. factor at surface = 0.8

Capacity 5" DP - 16" csg 84 lbs/ft = 0.1009 m^3/m

V_g = $H_g \times 0.1009\ m^3/m$

$$H_g = \frac{360.3 \times 15 \times 298 \times 0.8}{355 \times 1.1 \times 0.1009 \times P_g} = \frac{32700}{P_g}$$

Substitute in eq. 1):

$\Rightarrow$ $\underline{P_g = 76.6\ bar}$

Max burst load while circulating out kick:

$$P_{Bmax} = P_g + \frac{(P_p - P_g)(X-Z)}{(W_D - H_g - Z)} - (X \times G_p) =$$

$$76.6 + \frac{(360.3 - 76.6)(1395 - 152)}{(2295 - 193 - 152)} - (1395 \times 0.1) =$$

$$76.6 + 180.84 - 139.5 = \underline{117.94 \text{ bar}}$$

The maximum burst load is based on 257.5 bar internal pressure at the 16" shoe. The formation at this depth is expected to fracture at 216 bar.

Burst load at wellhead:

$$\underline{P_B} = P_g - (Z-27) \times G_p = 76.6 \text{ bar} - (152-27) \times 0.101 \text{ bar} = \underline{64 \text{ bar}}$$

Safety factor, burst:

$$\underline{S.F._B} = \frac{RES_B}{151 \text{ bar}} = \frac{181 \text{ bar}}{151 \text{ bar}} = \underline{1.20 > 1.1}$$

COLLAPSE

Lost circulation:

Collapse load if mud is lost to a low pressure zone at 2295 m and the mud level drops to 500 m:

Collapse load at 500 m: $\underline{P_C} = (500-152) \times 0.108 \text{ bar} + 0.101 \times 125 \text{ bar} = \underline{50.2 \text{ bar}}$

Collapse load at 1395 m: $\underline{P_C} = (1395-152) \times 0.108 \text{ bar} + 0.101 \times 125 \text{ bar} - (1395-500) \times 0.152 \text{ bar} = \underline{10.8 \text{ bar}}$

Cementing:

P_C = $(GF-G_i)$ (X-450 m) = (0.155-0.108) (1395-450) bar =

P_C = <u>44.4 bar</u>

Safety factor, collapse :

$$S.F._C = \frac{RES_C}{50.2 \text{ bar}} = \frac{70 \text{ bar}}{50.2 \text{ bar}} = \underline{1.39 > 1.3}$$

TENSION:

Weight load at 450 m:

(1395-450) 110.05 x 0.981 daN = $\underline{102 \times 10^3 \text{ daN}}$

Safety factor, tension:

$$S.F._T = \frac{RES_T}{102 \times 10^3 \text{ daN}} = \frac{524 \times 10^3 \text{ daN}}{102 \times 10^3 \text{ daN}} = \underline{5.1 > 1.5}$$

Select: 450 m - 1395 m: 75 lbs/ft, K55, Buttress

RES_C = 70

RES_B = 181

RES_T = 524×10^3 daN

13 3/8" CASING DESIGN

W_D = 3565 m

X = 2280 m

G_F = 0.174 bar/m

G_i = 0.152 bar/m

G'_i = 0.166 bar/m

G_p = 0.101 bar/m

G'_p = 0.162 bar/m

G_{gas} = 0.026 bar/m

Z = 152 m

DESIGN CRITERIA

BURST : - Burst load, underground blow out.
- Burst load while testing casing.
- Circulating a 15 m^3 kick.

COLLAPSE: - Collapse load, lost circulation.
- Collapse load while cementing.

TENSION : - Weight load.

BURST

Burst load at wellhead in case of an underground blowout:

$\underline{P_{B1}} = G_F \times X - G_{gas} \times (X-Z) - (Z-27)\ G_p =$

0.174×2280 bar $- 0.026\ (2280-152)$ bar $- (152-27)\ 0.101$ bar =

= <u>328.8 bar</u>

Burst load while testing casing to 172 bar:

P_{B2} = 2280 x 0.152 bar + 172 bar - (2280-27) x 0.101 bar =

P_{B2} = 291 bar

Kick considerations

BHA-length approx. 220 m.
Annular capacity 8" x 12 1/4" = 0.0436 m^3/m
Annular capacity 5" x 12 1/4" = 0.0627 m^3/m
Kick volume : 15 m^3
Height of kick:

$$220 \text{ m} + \frac{15 \text{ m}^3 - 0.0436 \text{ m}^3/\text{m} \times 220 \text{ m}}{0.0627 \text{ m}^3/\text{m}} = \underline{306 \text{ m}}$$

Mud weight increase necessary to balance pore pressure = 0.01 bar/m

BHP pressure after kick at 3665 m:

3565 x (0.162 + 0.01) bar = 613.2 bar

$$P_g + (W_D - Z - H_g) \times G'_i = P_p \qquad 1)$$

$$\frac{P_p \times V_1}{T_1 \times Z_1} = \frac{P_g \times V_g}{T_2 \times Z_2} \qquad 2)$$

P_g = Pressure of gas at wellhead
V_g = Volume of gas at wellhead
V_1 = Volume of influx = 15 m^3
T_1 = Bottom hole temperature = 150°C
Z_1 = Gas compr. factor at bottom : 1.25
T_2 = Wellhead temperature 25°C (298°K)
Z_2 = Gas compr. factor at wellhead = 0.8
H_g = Height of gas bubble at wellhead
P_p = Porepressure at 3665 m

Equation 2

$$\frac{613.2 \times 15}{423 \times 1.25} = \frac{P_g \times V_g}{298 \times 0.8}$$

$$V_g = H_g \times 0.0648 \quad ==> \quad H_g = \frac{63999}{P_g}$$

Subst. in eq. 1:

$$P_g + (3565 - 152 - \frac{63999}{P_g})\, 0.166 = 613.2$$

$$==> \underline{P_g = 129 \text{ bar}}$$

Max burst load while circulating out kick:

$$P_{Bmax} = P_g + \frac{(P_p - P_g)(X-Z)}{(W_D - H_g - Z)} - (X \times G_p)$$

$$P_{Bmax} = (129 + \frac{(613.2-129)(2280-152)}{(3565-306-152)}) - 2280 \times 0.101 =$$

$$P_{Bmax} = 129 \text{ bar} + 331.6 \text{ bar} - 230.3 \text{ bar} =$$

$$\underline{P_{Bmax} = 230.3 \text{ bar}}$$

The maximum burst load is based on 460.6 bar internal pressure at 13 3/8" shoe.
The formation at this depth is expected to fracture at 396.7 bar.

Burst load at wellhead:

$$P_B = P_g - (Z-27) \times G_p = 129 \text{ bar} - (152-27) \times 0.101 \text{ bar} =$$

$$\underline{P_B = 116.4 \text{ bar}}$$

Safety factor, burst:

$$\underline{S.F._B} = \frac{RES_B}{328.8 \text{ bar}} = \frac{371 \text{ bar}}{328.8 \text{ bar}} = \underline{1.13 > 1.1}$$

COLLAPSE

If circulation is lost to a low pressure formation and the mud level drops to 800 m:

Burst load at 800 m : $\underline{P_C} = 800 \times 0.152 \text{ bar} = \underline{121.6 \text{ bar}}$

Burst load at 2280 m:

$$P_C = (2280-152)\ 0.152 \text{ bar} + (152-27) \times 0.101 \text{ bar} - (2280-800) \times 0.166 \text{ bar}$$

$\underline{P_C = 90.4 \text{ bar}}$

Collapse load while cementing:

$$P_C = (G_F-G_i)(X-27) = (0.174-0.152)(2280-27) \text{ bar}$$

$\underline{P_C = 49.6 \text{ bar}}$

Safety factor, collapse

$$\underline{S.F._C} = \frac{RES_C}{121.6 \text{ bar}} = \frac{184 \text{ bar}}{121.6 \text{ bar}} = \underline{1.51 > 1.3}$$

TENSION

Weight load at wellhead:

$$106.3 \times (2280-152)\ 0.981 \text{ daN} = \underline{221.9 \times 10^3 \text{ daN}}$$

Safety factor, tension

$$\underline{S.F._T} = \frac{RES_T}{221.9 \times 10^3} = \frac{738 \times 10^3 \text{ daN}}{221.9 \times 10^3 \text{ daN}} = \underline{3.3 > 1.5}$$

Select: 13 3/8", 72 lbs/ft, N80, Buttress

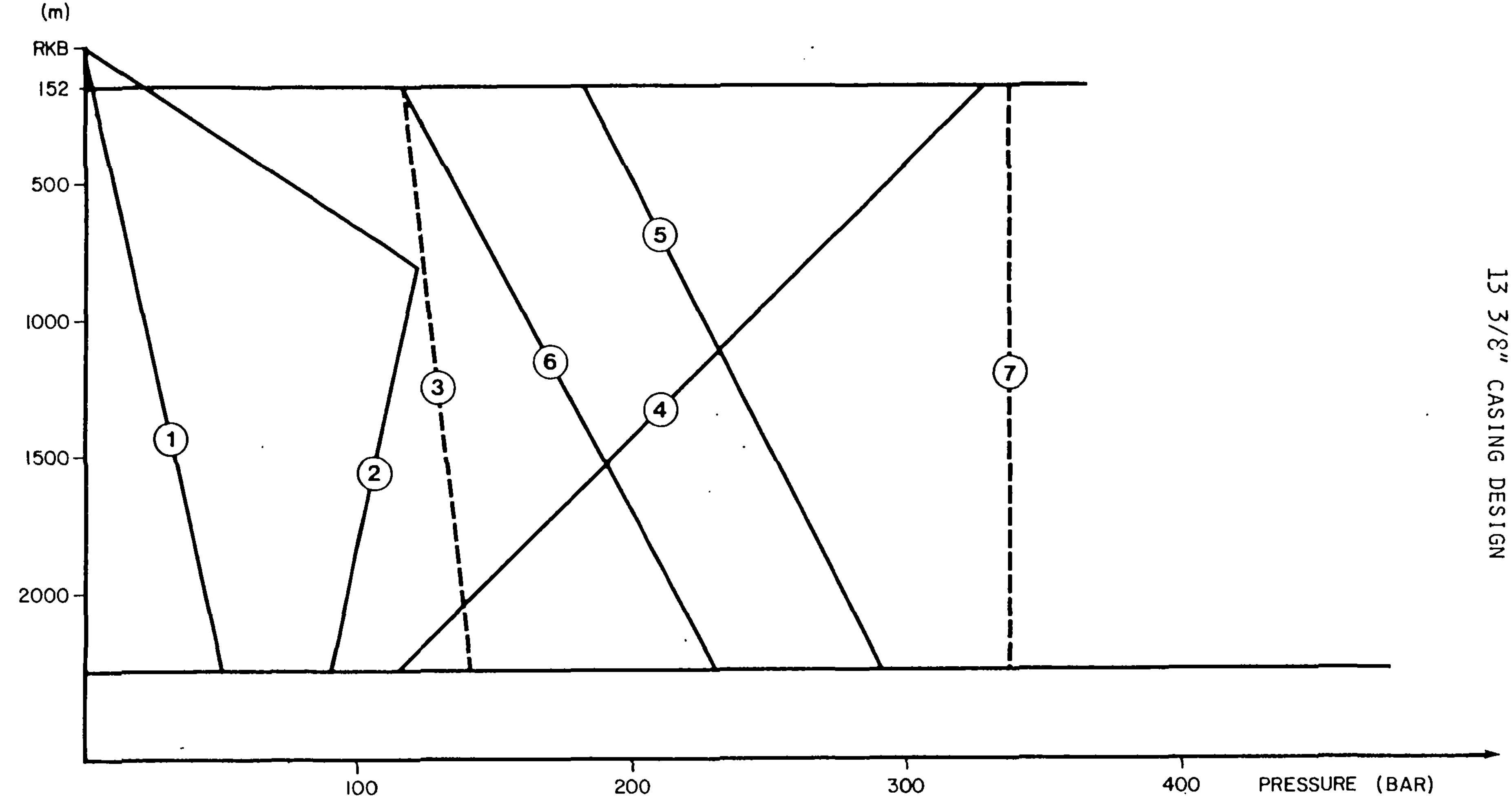
RES_C = 184 bar

RES_B = 371 bar

RES_T = 738×10^3 daN

13 3/8" CASING DESIGN

152 - 2280 M : 13 3/8", 72 LBS/FT, N80, BUTTRESS



1. COLLAPSE LOAD DURING CEMENTING
2. COLLAPSE LOAD, LOST CIRCULATION
3. COLLAPSE RESISTANCE, CORRECTED FOR S.F. 1.3. AND BIAXIAL STRESS
4. BURST LOAD, UNDERGROUND BLOWOUT
5. BURST LOAD, TESTING CASING
6. BURST LOAD, CIRCULATING A 15 M^3 KICK
7. BURST RESISTANCE, CORRECTED FOR S.F. 1.1.

9 5/8" CASING DESIGN

W_D = 4610 m

X = 3550 m

G_F = 0.207 bar/m

G_i = 0.166 bar/m

G'_i = 0.204 bar/m

G_p = 0.101 bar/m

G'_p = 0.199 bar/m

G_{gas} = 0.03 bar/m

Z = 152 m

DESIGN CRITERIA

BURST : - Underground blow out and the entire casing filled with gas.
- Testing casing.

COLLAPSE: - Lost circulation.
- Cementing.

TENSION : - Weight load of casing.

BURST

Burst load at wellhead in case of an underground blowout:

$P_{B1} = G_F \times X - G_{gas}\ (X-Z) - (Z-27) \times G_p =$

$P_{B1} = 0.207 \times 3550$ bar $- 0.03\ (3550-152)$bar $(152-27)\ 0.101$ bar $=$

$\underline{P_{B1} = 620.3 \text{ bar}}$

At wellhead:

$\underline{P_{B2}}$ = 620.3 bar - (3550-152) 0.101 bar = $\underline{277.1 \text{ bar}}$

Burst load while testing casing to 345 bar:

P_{B3} = 345 bar + 0.166 x 3550 bar - (3550-27) 0.101 bar =

$\underline{P_{B3} = 578.5 \text{ bar}}$

Safety factor, burst: $S.F._B = \frac{RES_B}{620.3 \text{ bar}} = \frac{752 \text{ bar}}{620.3 \text{ bar}} = \underline{1.21 > 1.1}$

COLLAPSE

If circulation is lost to a lowpressure formation and mud level drops to 1500 m.

Collapse pressure at 1500 m:

$\underline{P_{c1}}$ = 1500 x 0.166 bar/m = $\underline{249 \text{ bar}}$

Collapse pressure at shoe:

P_{c2} = (3550-152) x 0.166 bar + (152-27) x 0.101 bar -

(3550-1500) x 0.204 bar = $\underline{158.5 \text{ bar}}$

Collapse load during cementing:

$P_{c3} = (G_F-G_i)(X-27)$ = (0.207-0.166)(3550-27) bar =

$\underline{P_{c3} = 144.4 \text{ bar}}$

Safety factor, collapse:

$S.F._C = \frac{RES_C}{249 \text{ bar}} = \frac{366 \text{ bar}}{249 \text{ bar}} = \underline{1.47 > 1.25}$

TENSION

Weight load at wellhead:

(3550-152) 79.9 x 0.981 daN = 266.4 X 10^3 daN

Safety factor, tension:

$$S.F._T = \frac{RES_T}{266.4 \times 10^3 \text{ daN}} = \frac{759 \times 10^3 \text{ daN}}{266.4 \times 10^3 \text{ daN}} = 2.8 > 1.5$$

Select: 152 m - 600 m : 53.5 lbs/ft, P110, Buttress

RES_C = 547 bar

RES_B = 752 bar

RES_T = 759 x 10^3 daN

600 m - 3550 m: 47 lbs/ft, P110, Buttress

RES_C = 366 bar

RES_B = 651 bar

RES_T = 659 x 10^3 daN

7" CASING DESIGN

W_D = 4610 m

X = 4595 m

G_i = 0.204 bar/m

G'_p = 0.199 bar/m

G_{gas} = 0.03 bar/m

G_F = 0.221 bar/m

Z = 152 m

DESIGN CRITERIA

BURST : - Tubing leak just below wellhead while testing.
TENSION : - Weight load.

BURST

Burst load at shoe if there is a tubing leak while resting in Statfjord at 4500 m.

P_B = 0.199 x 4530 bar - 0.03 (4530-152)bar + (4530-3550) x

(0.204 - 0.101)bar - (152-27) 0.101 bar =

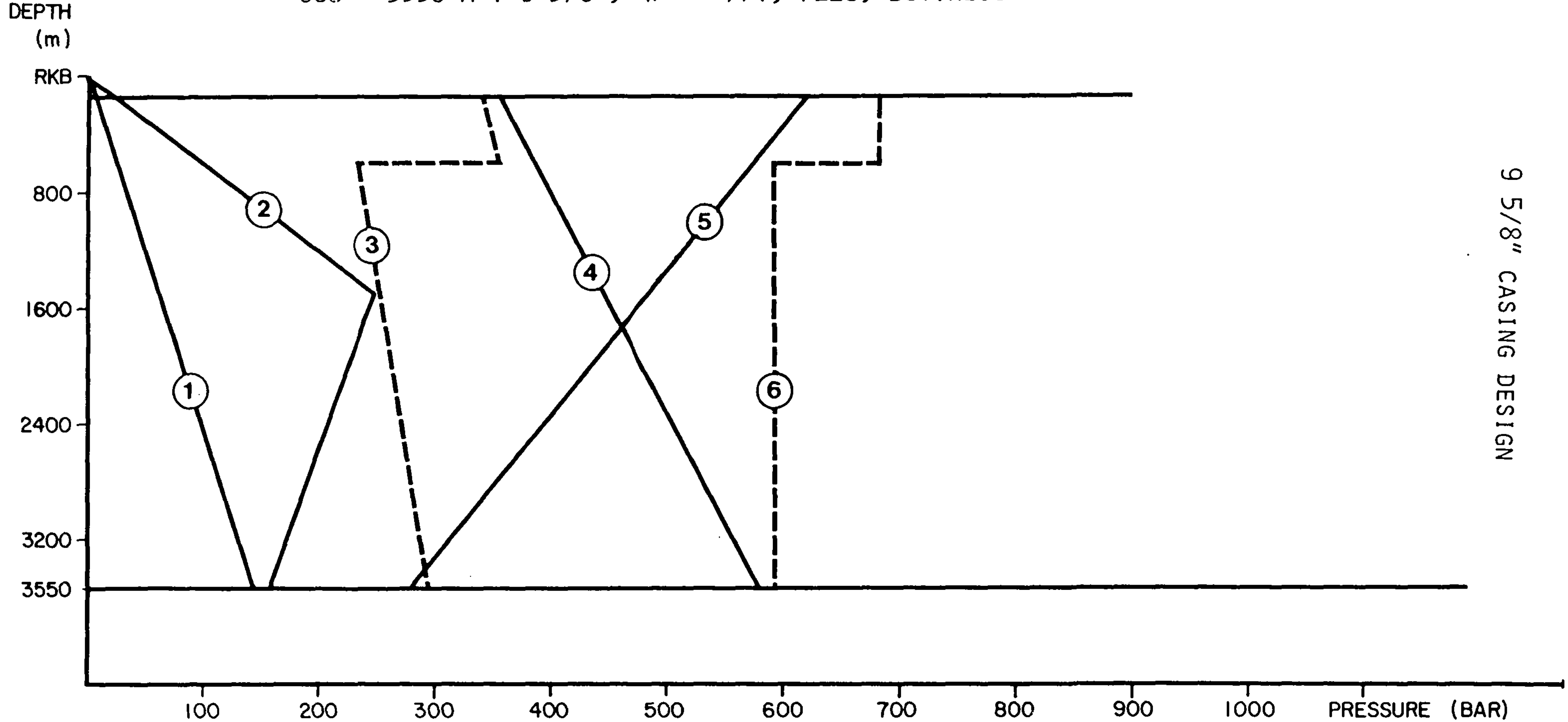
P_B = 858.3 bar

From wellhead and down to the 9 5/8" shoe it is used the same pressure gradient inside and outside the casing. From 9 5/8" shoe and down to 7" shoe a normal pressure gradient is used outside the casing and mud weight inside the casing.

9 5/8" CASING DESIGN

152 - 600 M : 9 5/8", 53,5 LBS/FT, P110, BUTTRESS

600 - 3550 M : 9 5/8", 47 LBS/FT, P110, BUTTRESS



1. COLLAPSE LOAD WHILE CEMENTING
2. COLLAPSE LOAD, LOST CIRCULATION
3. COLLAPSE RESISTANCE, CORRECTED FOR S.F. 1.25 AND BIAXIAL STRESS
4. BURST LOAD, TESTING CASING TO 345 BAR
5. BURST LOAD, UNDERGROUND BLOW OUT
6. BURST RESISTANCE, CORRECTED FOR SAFETY FACTOR 1.1.

Burst load at wellhead and down to 9 5/8" shoe:

P_B = 0.199 x 4530 bar - 0.03 (4530-152)bar - (152-27) 0.101 bar =

$\underline{P_B = 757.5 \text{ bar}}$

Safety factor:

$$\underline{S.F._B} = \frac{RES_B}{858.3 \text{ bar}} = \frac{976 \text{ bar}}{858.3 \text{ bar}} = \underline{1.14 > 1.1}$$

TENSION

Weight load:

(4595-3700) x 47.5 x 0.981 daN + (3700-152) x 47.5 x 0.981 daN =

41.7×10^3 daN + 165.4×10^3 daN = $\underline{207.1 \times 10^3 \text{ daN}}$

Safety factor, tension :

$$\underline{S.F._T} = \frac{RES_T}{207.1 \times 10^3 \text{ daN}} = \frac{455 \times 10^3 \text{ daN}}{207.1 \times 10^3 \text{ daN}} = \underline{2.2 > 1.5}$$

Select: 152 m - 3700 m : 7", 32 lbs/ft, P110, Buttress

RES_C = 742 bar
RES_B = 859 bar
RES_T = 455×10^3 daN

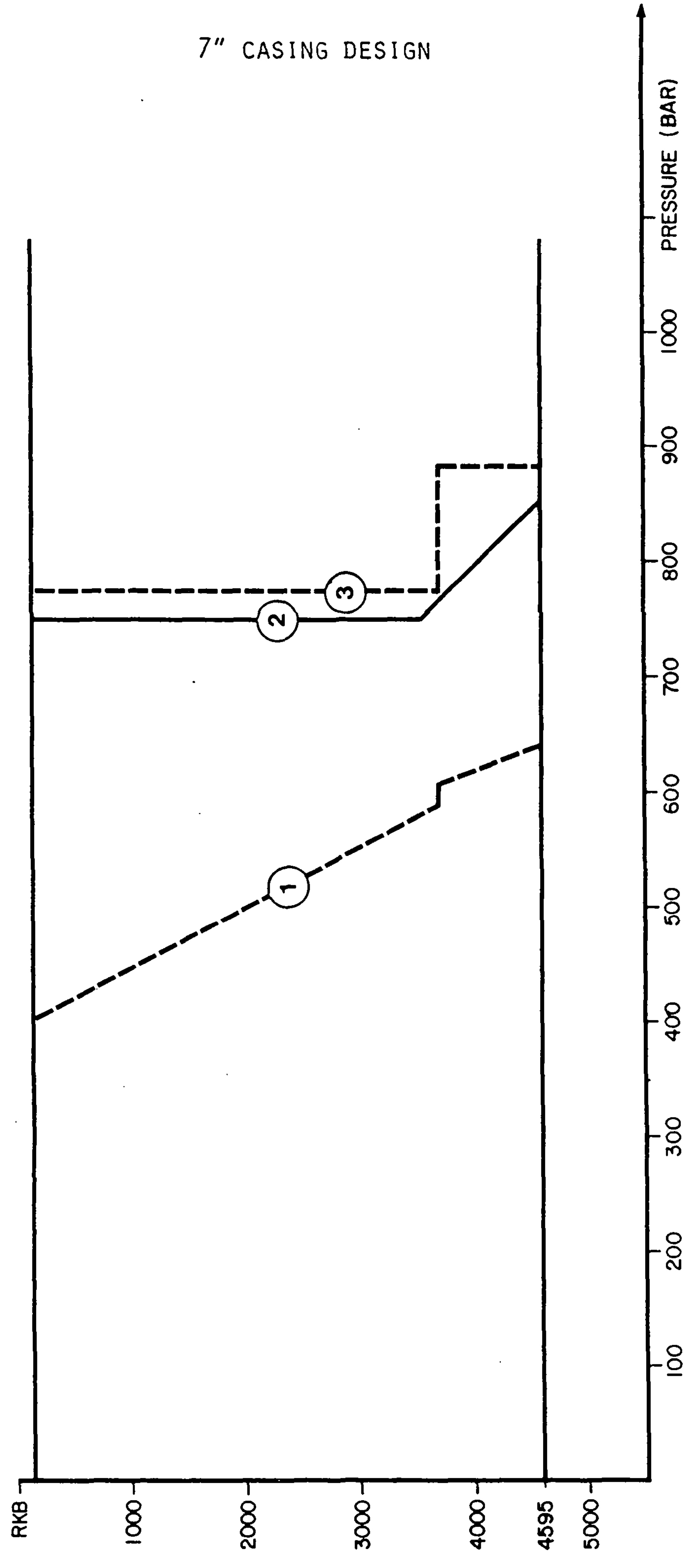
3700 m - 4595 m : 7", 32 lbs/ft, MW 125, Buttress

RES_C = 808 bar
RES_B = 976 bar
RES_T = 517×10^3 daN

7" CASING DESIGN

152 - 3700 M : 7", 32 LBS/FT, P110, BUTTRESS

3700 - 4595 M : 7", 32 LBS/FT, MW - 125, BUTTRESS



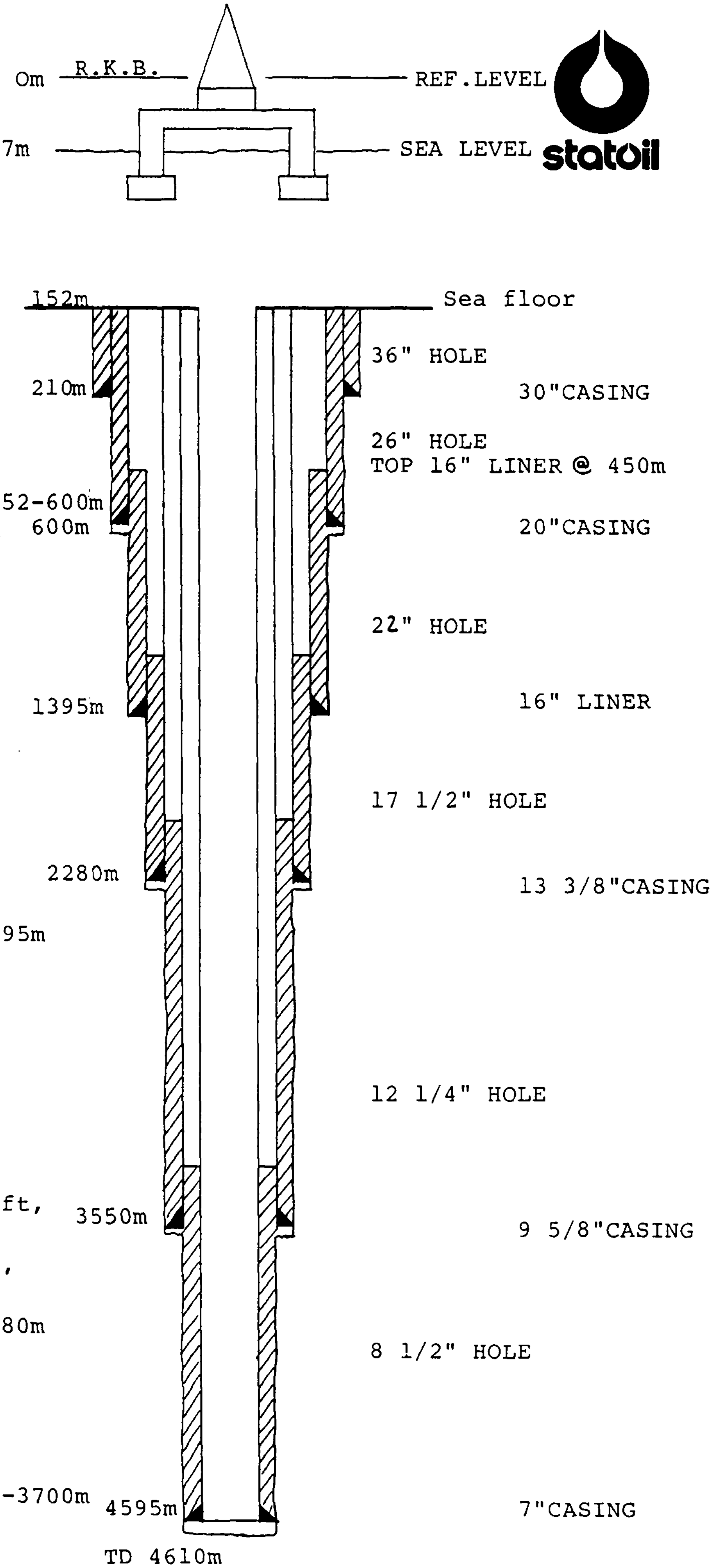
1. COLLAPSE RESISTANCE, CORRECTED FOR SAFETY FACTOR 1,25 AND BIAXIAL STRESS.
2. BURST LOAD, TUBING LEAK WHILE RESTING
3. BURST RESISTANCE, CORRECTED FOR SF 1.1.

CASING CEMENT DATA AND CALCULATION.

A complete program will be submitted at a later date, prior to spudding the well.

WELL 30/2-1

(Not to scale)



30" 1 jt. 1.5" wall
4 jt. 1" wall
Cement to sea floor

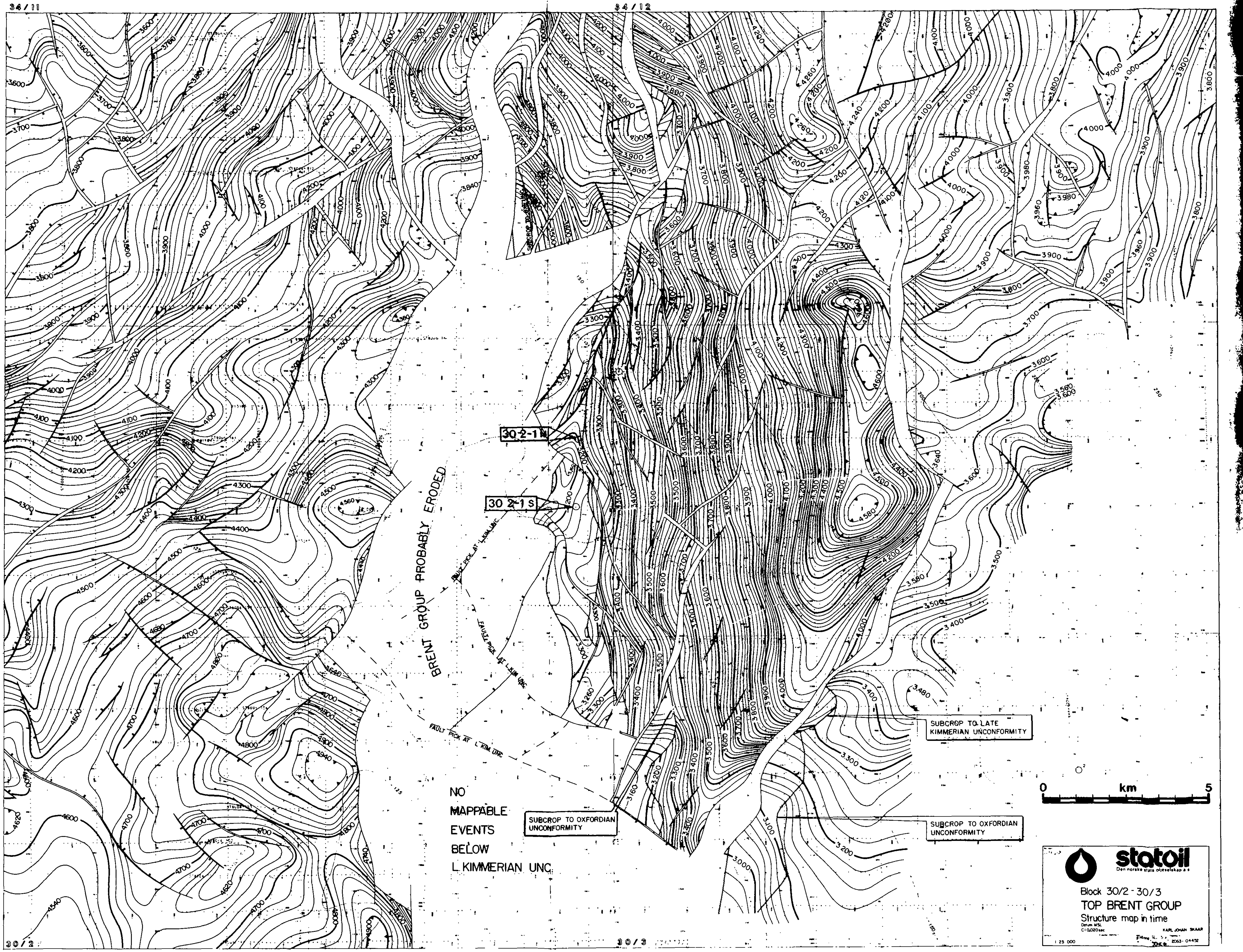
20" K-55, 133 lbs/ft, 152-600m
Cement to sea floor

16" K-55,75 lbs/ft, 450-1350m
Cement: 1395-450m

13 3/8" N-80,72 lbs/ft, 152-2280m
Cement: 2280-1295m

9 5/8" P-110,53.5 lbs/ft, 152-600 m
P-110,47 lbs/ft, 600-3550m
Cement: 3550-2180m

7" P-110,32 lbs/ft, 152-3700m
MW-125, 32 lbs/ft, 3700-4595m
Cement


34/11
34/12
30/2
30/3
BRENT GROUP PROBABLY ERODED
NO MAPPABLE EVENTS BELOW L.KIMMERIAN UNC
FAULT PICK AT L.KIM.UNC
30/2-1S
30/2-1N
SUBCROP TO LATE KIMMERIAN UNCONFORMITY
SUBCROP TO OXFORDIAN UNCONFORMITY
SUBCROP TO OXFORDIAN UNCONFORMITY
0 km 5
statoil
Den norske stats oljeselskap a.s
Block 30/2 - 30/3
TOP BRENT GROUP
Structure map in time
1:25 000