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STATOIL

GEOLOGICAL PROGNOSIS & DRILLING PROGRAM

WELL 31/3-1

TROLL

Den norske stats oljeselskap a.s

STATOIL

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TROLL

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CONTENT

FIGURES

Program Responsibility:
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UND: P. Furmyr

INTRODUCTION

Block 31/3 is one of the four "Troll-blocks", 31/2, 31/3, 31/5 and 31/6. While block 31/2 is operated by Norske Shell, the three others are operated jointly by Statoil, Norsk Hydro and Saga Petroleum. It is agreed that Saga will concentrate on exploring northern part of block 31/5, while Statoil and Norsk Hydro will jointly explore the eastern part of the "Troll- field" i.e. blocks 31/3, 31/6 and the eastern part of 31/5.

Lateral extension of the Troll-field as mapped today is mainly based on the extension of the seismic flatspot in the area. This seismic event is regarded as a direct hydrocarbon indicator and represents a gas-liquid contact. A verification and calibration of this seismic event is provided by data from the 31/2 wells.

So far only block 31/2 is drilled; since 1979 ten wells have been completed on the Troll Field in 31/2. Each of the wells, except for well 31/2-10, which was water bearing, found gas underlain by an oil rim in sandstones of upper to middle Jurassic age.

PURPOSE OF TEST

31/3-1 is the first well to be drilled outside block 31/2 on the Troll-field. It is a wildcat well designed to test possible gas and oil accumulations in sandstones of upper to middle Jurassic age.

The well will be drilled approximately 200 m into the Triassic to an estimated total depth of 2375 m (RKB). This should be sufficient to penetrate all interesting seismic horizons, test the complete reservoir sequence of upper to middle Jurassic age and also to test possible hydrocarbon accumulations on Brent, Statfjord and upper Triassic levels.

OBJECTIVES

The primary objective of well 31/3-1 is the sandstone sequence of upper to middle Jurassic age. Secondary objectives are sandstones of middle to lower Jurassic and also upper Triassic age.

31/3-1 LOCATION CONSIDERATIONS

Well 31/3-1 is located in an area where the seismic flatspot is recognized. It is believed that a communication to the reservoir in block 31/2 exists both in the gas- and liquid phase. However, a break in communication may be present, and this is one of the main questions to be answered by well 31/3-1.

The well is located near the top of a yet untested fault block, which is tilted to the east. In this location the reservoir will be penetrated in a position close to the structurally highest level expected in the eastern part of the Troll-field. The gas column is estimated to be approximately 190 m and an approximately 10 m thick oil rim is expected to be found underneath. Gas-oil contact is expected at 1570 m (RKB), and the OWC at 1580 m (RKB), both in Fens Fm. (reservoir zone 3*), and this will enable gas-production tests from three different reservoir zones.

Well 31/3-1 is also located on a cross point between seismic lines from different surveys. This to enable seismic calibration for both surveys.

* Reservoir zonation is expected to be similar to block 31/2, where four different, main zones are present.

DRILLING HAZARDS

The water depth at the planned drilling location is 335 m (MSL).

Seismic data from the site survey show no abnormal high reflection amplitudes at this location, and no debris were seen on the sea floor. In surrounding areas, however, weak reflection anomalies may be caused by gas in the interval 455 - 565 m (RKB). Boulders are probably present in the zone between 425 and 475 m (RKB).

SURVEY AND POSITIONING

The rig will be navigated by Syledis and finally positioned by Satnav. Rig location accuracy is requested within a 100 m radius of the proposed location on s.p. 491 of seismic line ST8116-138.

STRATIGRAPHIC PROGNOSIS 31/3-1

UNIT	DEPTH (m) RKB
Top Nordland Gr.	360 m ± 5
Top Hordaland Gr.	540 m ± 10
Top Eocene	710 m ± 10
Top Balder Fm.	945 m ± 20
Top Sele Fm.	1050 m ± 20
Top Lista Fm.	1125 m ± 20
Top Upper Cretaceous	1250 m ± 20
Top Lower Cretaceous	1315 m ± 20
Top Kimm. Clay Fm.	1365 m ± 20
Top Sogn Fm. (Zone 1)	1380 m ± 20
Top Middle Heather Fm. (Zone 2)	1465 m ± 40
GOC	1570 m ± 20
Top Brent Coal	1795 m ± 40
Top Cook Fm.	1915 m ± 40
Top Statfjord Coal	2095 m ± 40
Top Cormorant Fm.	2145 m ± 40
T.D.	Approximately 200 m into Triassic, estimated at 2375 m.

LITHOLOGY

Tertiary

The sediments of the Nordland Gr. consist of grey soft clay interbedded with silt sand and gravel.

The Hordaland Gr. is dominated by grey and brown clay with some sandy and calcareous layers.

The Balder Fm. consists of multicoloured tuffaceous claystone while the Sele and Lista Fm. are dominated by uniform grey to brown, occasionally marly claystone.

Cretaceous

The Upper Cretaceous interval consist of grey, marly claystone at the top and glauconitic, chalky limestone at the base. These sediments are all believed to belong to the Shetland Group, but there is a possibility for a thin Maureen Formation at the top of the Shetland Group.

The lower Cretaceous Cromer Knoll Group has a chalky limestone at the top and a red to brown glauconitic marl at the base.

Jurassic

The Kimmeridge Clay Formation is believed to be thin and consists of black to dark brown, bitumenous shale.

It is thought that as in block 31/2, the reservoir sequence may be divided in four main zones:

Zone 1, Sogn Formation consists of a grey, weakly consolidated sand with some bands of consolidated, micaceous sandstone and occasionally carbonate cemented bands.

Zone 2, Middle Heather Formation consists of a grey strongly micaceous and fine grained sandstone/siltstone.

Zone 3, Fens Formation (top not prognosed) is a sequence of grey sandstone with interbeds of micaceous sandstone/siltstone and carbonate cemented bands.

Zone 4, Kross and Lower Heather Formation (top not prognosed) is dominated by fairly coarse sand with interbeds of fine sands and silts and some carbonate bands.

The Brent Group is composed of fine to coarse sandstones. Grey-green, micaceous siltstones and claystones and thin coals are interbedded with the sand.

The Dunlin Group consists of grey, silty claystones with some argillaceous sandstone intervals.

The Statfjord Formation is relatively thin and consists of white sandstones with coaly claystone and siltstone beds.

Triassic

The Upper Triassic is dominated by reddish claystone and sandstones of continental origin.

GEOLOGICAL WELL LOGGING AND SAMPLING PROSEDURES

Mud logging contractor: Exploration Logging
The Gemdas-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

Samples will be collected at 10 meters intervals down to 900 meters. Thereafter at 3 meters intervals. Sampling intervals might be changed on request by the wellsite geologist.

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

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

One composite sample of unwashed cuttings will be canned at 30 meters intervals.

One or more mudsamples of 3 litres will be collected from the active pits when drilling through any hydrocarbon bearing interval. The number of samples will be at the discresion of the wellsite geologist. The sample should be properly marked with depth and sent to Statoil Laboratories, Forus.

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 handled by GECO as per instructions.

WELL LOGGING PROGRAM 31/3-1

STRATIGRAPHY (mRKB)		CASING		LOG RUN
360m	SEA FLOOR			
QUATERNARY		30"csg. 420m		GR TO SEA FLOOR
520m			1	DIFL/BHC ACCUSTIC-GR-SP-CAL CDL -GR-CAL*
TERTIARY		20"csg. 850m		
1000			2	DIFL/BHC ACCUSTIC-GR-SP-CAL CDL-GR-CAL(CNL*) HRDIP*
1240m		13 3/8"csg. 1285m		
CRETACEOUS				
1370m				
UPPER/MIDDLE JURASSIC		9 5/8"csg. 1820m	3	DIFL/BHC ACCUSTIC-GR-SP-CAL CDL/CNL-GR-CAL DLL/MLL-GR* SPECTRALOG* HRDIP COREGUN FMT* CBL IN 13 3/8" CSG.
1850m				
LOWER JURASSIC			4	DIFL/BHC ACCUSTIC-GR-SP-CAL CDL/CNL-GR-CAL DLL/MLL-GR* SPECTRALOG COREGUN FMT* CBL IN 9 5/8" CSG. VELOCITY SURVEY
2000				
2165m				
TRIASSIC		7" LINER AT TD IF SET		
TD: 2375m OR APPROX.200m INTO TRI-ASSIC				* OPTIONAL

COMPANY : DRESSER ATLAS

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 points, and the number 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, storage and distribution.

TESTING PROGRAM

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

BASE

Statoil operations base at Agotnes 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) 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 be responsible for that the electrical logs are run properly and are of acceptable standard. He will recommend coring intervals. The Wellsite Geologist will report to the Statoil Operations Geologist.

c) Logging and Testing Engineer

The Wellsite Logging/Testing Engineer will assist the Drilling Supervisor 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.

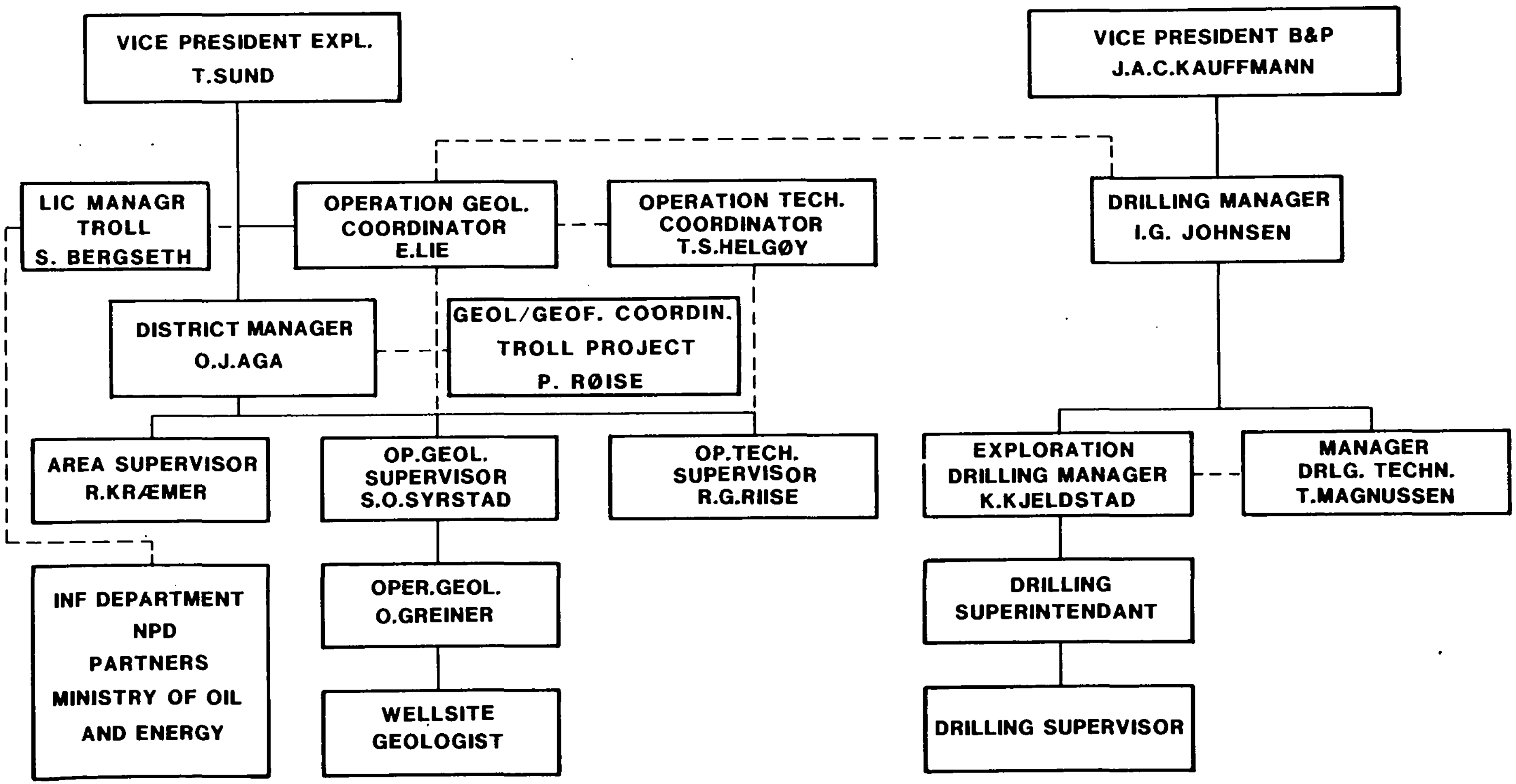
A final well report will be prepared for distribution to partners and to the appropriate Norwegian Government agencies not later than six months after completion of the well.

STAFF

Staff of the Exploration and Drilling Department, Statoil, who are involved in the planning and drilling of the well:

		TELEPHONE		
NAME	TITLE	OFFICE	HOME	MOBIL
Sund, T.	Vice President Expl.	04-578178	04-560235	
Bergseth, S.	Licence Manager, Troll	04-578180	04-559322	
Johnsen, I.	Drlg. Mngr.	04-541099	04-576125	
Røise, P.	Geol./Geof. Coordinator Troll project	04-578168	04-550369	4314
Lie, E.	Oper. Coord. Geol.	04-578162	04-667411	57916
Kjeldstad, K.	Expl. Drlg. Mngr.	04-541099	04-591437	
Helgøy, T.S.	Op.Tech.Coord.	04-577297	04-661757	
Aga, O.J.	District Manager	04-533180	04-534739	
Kræmer, R.	Area Supervisor	04-533180	04-620039	
Riise, R.G.	Oper.Techn.Supervisor	04-533180	04-591401	
Syrstad, S.O.	Oper.Geol.Supervisor	04-533180	04-587429	

ORGANIZATION CHART WELL 31/3-1



COMMUNICATION PERSONNEL, 31/3-1 TROLL

Norsk Hydro Produksjon A/S:

NAME	TITLE	TELEPHONE OFFICE	TELEPHONE HOME	TELEPHONE MOBIL
Oppebøen, K.A.	Expl. Manager	02-543920	02-170206	16274
Sæbøe, A.	Area Expl. Manager	02-543920	02-543805	
Egeberg, T.	Area Geologist	02-543920		
Leivestad, S.I.	Oper.Geol.Manager	02-543920	02-121546	16272
Davies, A.	Oper. Geol.	02-543920	02-563441	33928

Saga Petroleum A/S:

NAME	TITLE	TELEPHONE OFFICE	TELEPHONE HOME	TELEPHONE MOBIL
Nysæther, E.	Expl. Manager	02-120111	02-570154 05-282563	
Høisæter, T.	Area Manager	02-120111	02-792651	
Olsen, J.	Area Geologist	02-120111	032-66409	
Gustavsen, B.	Oper.Geol.Supervisor	02-120111	02-789640	

Contact in Norwegian Petroleum Directorate:

NAME	TITLE	TELEPHONE OFFICE	TELEPHONE HOME	TELEPHONE MOBIL
Aamodt, F.R.	Section Manager	05-533160		

DRILLING PROGRAM

Well designation	:	31/3-1
Vessel	:	Deep Sea Bergen
Type drilling rig	:	Aker H-3.2
Drilling draft	:	22 m maximum
RKB to MSL	:	25 m
Air gap	:	15,2 m
Water depth	:	330 m
BOP system	:	NL-Schäffer 18-3/4", 10 000 psi stack.
Wellhead system	:	Vetco 18-3/4", 10 000 psi, 3 hanger torque set system.

Depth are referred to RKB except were otherwise specified.
The first following pages refers to Statoil's "Floating Drilling Operations Manual" and should be used as additional information.

2.0. General procedure

2.1.1. Location survey:

The water depth at the planned drilling location is approximately 330 m (MSL).
The seabed at location is flat.
The seabed is even, but number of pockmarks are distributed over the survey area. Pockmarks up to 6 m deep and 25-30 m across have been recorded.

The sequence from seabed to approximately 380 m (MSL) probably consists of soft and laminated clay and silt.
The sequence between 380-390 m probably consists of silt and sand is followed by sand and gravel down to 430 m MSL.

Seismic data from the site survey show no abnormal high aplitudes at this location, and no debris were seen on the sea floor.

In surronding areas, however, weak reflection anomalies may be caused by gas in the interval 540-600 m (RKB). Boulders are probably present in the zone between 430-475 (RKB).

2.2.1. Mooring

Rig heading 180 Deg.

3.0. General drilling

3.1.1. Drilling 36" hole

Drill 36" hole with 26" bit and 36" H.O. to +/- 420 m. A temporary guide base will be used if needed.

3.2.1. Drilling pilot hole and logging:

Prior to drill out 30" shoe, there should always be 50 m^3 mud with density 1.23 g/cm^3 in reserve.
Drill 12 1/4" pilot hole to 865 m.
Quart/Tertiary will probably be normally pressured down to 1040 m where the top of the abnormal pressured transition zone may start.

Before deciding how to enlarge the pilot hole to 26", all the drilling data and logs should be carefully reviewed and discussed with the operations office. If the presence of gas bearing sand can't be excluded the hole should be underreamed.

3.2.5. Running 20" casing and cementing:

Fill 20" casing every joint after shoe has reached sealevel. After 1st stand of landing string has been run, attach circulation head and fill 20" casing and landing string. Make sure not to exceed the pressure necessary to release sub sea plug. The landing string shall be filled every second stand using the mudhose. 20" casing shoe will be set at 850 m.

3.4.1. Drilling 17 1/2" and 12 1/4" hole:

17 1/2" hole: 865 - 1300 m

The abnormal pressured zones may start at +/- 1040 m and increase to approximately 1.25 S.G. at 1160 m. The maximum pressure gradient is probably present in the lower Tertiary and Cretaceous formation.

The 13 3/8" casing should be set through the peak of the pore pressure in order to drill the reservoir sand without too much overbalance.

Drill into the top of limestone in Cretac, log and set casing. Mudweight should be as the well dictates, but the pressure prognosis indicates a mudweight from 1.13 to 1.45 S.G. including risermargin and a safety margin.

13 3/8" casing will be set at approximately 1285 m.

When drilling this section, there should always be 70 m^3 mud with density 1.5 g/cc in reserve.

12 1/4" hole: 1300 - 1835 m:

Porepressures are expected to decrease continously below the 13 3/8" shoe, and may reach normally pressured at 1550 m.

The 12 1/4" hole will be drilled through Upper and Middle Jurassic. The 9 5/8" casing will be set after drilling into Brent coal, approximately at 1820 m.

The primary objectives are sandstones of Upper to Middle Jurassic age.

Mudweight used should be dictated by well conditions, but the pressure prognosis indicates a mudweight from 1.18 - 1.32 S.G. including risermargin and a safety margin.

8 1/2" hole: 1835 - 2350 m:

The pressure gradient in this section is believed to be normal.
The 8 1/2" hole is planned to be drilled 200 m into Triassic, and drilled with a mudweight of 1.1 S.G.

If it is decided to test Lower Jurassic/Triassic sandstones a 7" liner will be set at TD.

4.0 MUD PROGRAM

Interval M RKB	Hole size	Mud type	Weight (g/cc)	PV	YP	Fluid loss API/HTHP	PH
355- 420	36"	spud mud					
420- 865	26"	Bent./ligno			+ 20	N/C	9,5-10,5
865-1300	17-1/2"	KCL-polymer	1,13-1,45	ALAP	15-30	6-8	8,5-9,5
1300-1835	12-1/4"	Bent./ligno	1,18-1,32	"	15-20	6-10/20	9,5-10,5
1835-2350	8-1/2"	Bent./ligno	1,1	"	12-15	4-6/15	9,5-10,5

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 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.

4.4.1. BOP TESTING

	BOP test pressures:	Pipe rams	Bags	Choke and kill valves
1.	On surface	690 bar	241 bar	690 bar
2a.	Initial and subsequent installation on wellhead.	172 bar	172 bar	172 bar
	Close shear ram with the accoustic system and test shear ram against casing.			
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	150 bar	150 bar	150 bar
3b.	Weekly test with 13 3/8" casing set	150 bar	150 bar	150 bar
4a.	After 9 5/8" seal assembly is tested	172 bar	172 bar	172 bar
4b.	Weekly test with 9 5/8" casing set	172 bar	172 bar	172 bar

Casing and seal assembly test pressure (see note below)

20" casing	- 90 bar
13 3/8" casing	- 150 bar
9 5/8" casing	- 172 bar
7" liner	- 172 bar

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	1.18
13 3/8"	1.30	1.18
9 5/8"	1.25	1.18
7"	1.25	1.18

CASING PROGRAM

SIZE	DEPTH (m)	WEIGHT	GRADE	CONNECTION
30"	355- 420	1jnt 1½" wt. 4 " 1" wt.	B B	Vetco ATD/RB
20"	355- 850	133	K-55	Vetco LS
13 3/8"	355-1285	68	K-55	Buttress
9 5/8" "	355- 820 820-1820	47 43.5	N-80 "	Buttress "
7" +	1670-2350	29	N-80	Buttress

See "Casing program"

+ optional

4.8.1. 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 continously and any deviation investigated immediately. The reliavility 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" 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. RPM
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 continously by the Drilling Engineer and Drilling Supervisor. These plots will include drilling rate, lithology, mud 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 hold fairly constant. This is especially important in the pressure transition zone. Abnormal pressure detection data will be forwarded to the Stavanger Operation Office twice daily on 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 Operation Office.

4.9.1. Formation evaluation:

The mud returns will be monitored continously to detect H_2S. Also check the hole for H_2S-content in 100 m intervals, (or when background gas exceed 1%) by means of Garret Gas Train (use fresh filtrate from the filter press only).

A detailed testing program will be issued prior to test.

4.11.1 Plug and Abandonment:

A detailed P and A program will be issued prior to P and A.

Approved

for Vice President Exploration Statoil

Drilling Manager Statoil

statoil

KICK LIMITATION 31/3-1

Drilling below 20" casing:

The genral 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 1.25 S.G. in this interval. Formation integrity below 20" casing shoe is expected to be 1.49 S.G. A mud weight of 1.45 should be sufficient to control the well. If the well kicks with a mudweight and porepressure of 1.25 S.G. at 1300 m a kick height of approx.
163 m can be controlled by closing the BOP. (See fig. 1). This is equal to a volume of 20m^3 influx.

Drilling below 13 3/8" casing:

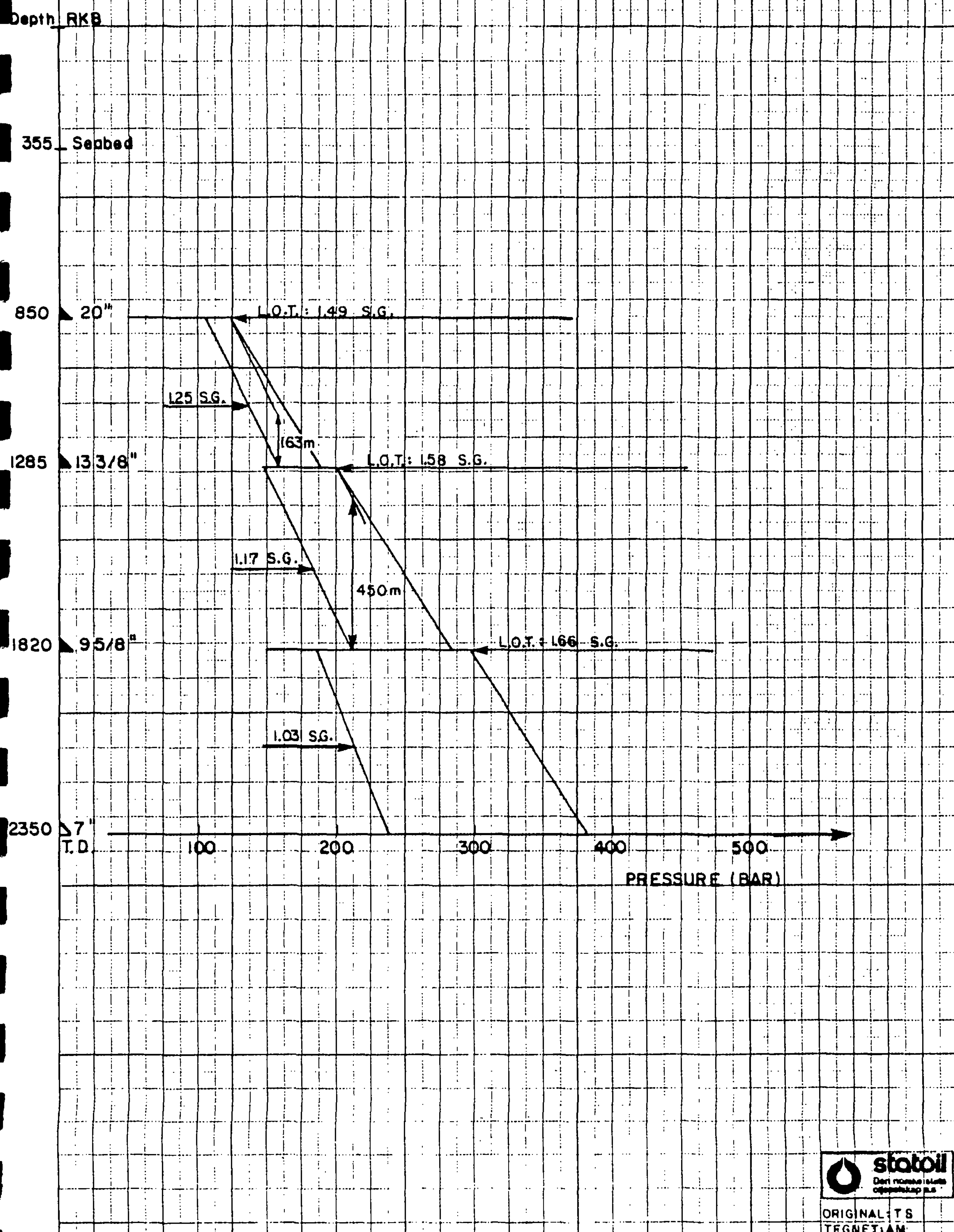
Formation integrity below the 13 3/8" casing shoe is expected to be 1.58 S.G. The maximum considered porepressure is 1.17 S.G. in this interval. If the well kicks with a mudweight and porepressure of 1.17 at 35 m, a kick height of 450 m can be controlled by closing BOP. (See fig. 1). This is equal to a volume of 25 m^3 influx.

Drilling below 9 5/8" casing:

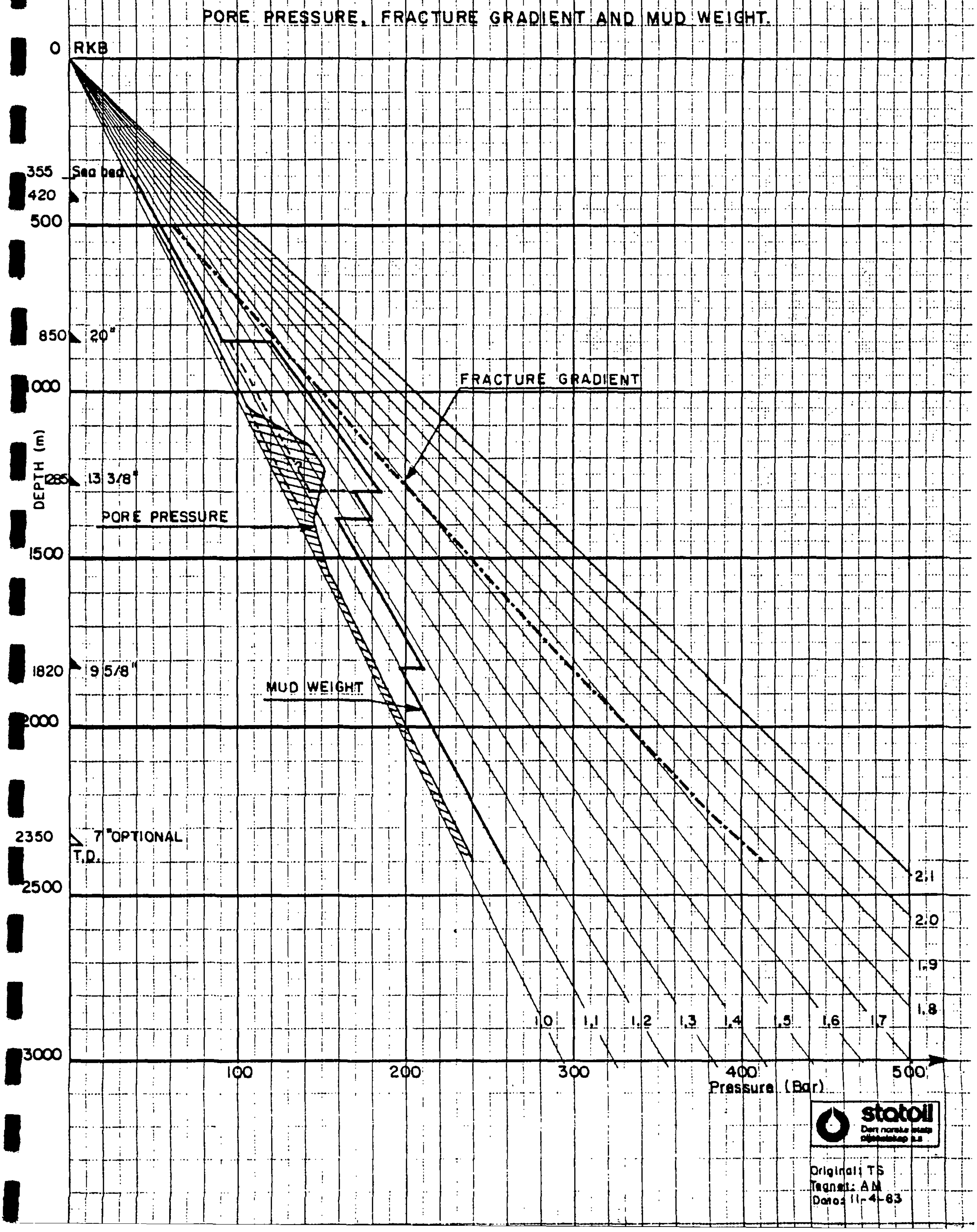
Formation integrity below the 9 5/8" shoe at 1820 m is estimated to be 1.66 S.G. The porepressure gradient at TD is expected to be 1.03 S.G. A mudweight of 1.1 S.G. should be sufficient to control the well.

If the well kicks at 2350 m with a mudweight and porepressure equivalent to 1.03 S.G., there is no limit for the kickheight. (See fig. 1).

KICK LIMITATIONS 31/3-1



WELL 31/3-1


PORE PRESSURE, FRACTURE GRADIENT AND MUD WEIGHT.
0 RKB
355 Sea bed
420
500
850 20"
1000
DEPTH (m)
1285 13 3/8"
PORE PRESSURE
1500
1820 9 5/8"
MUD WEIGHT
2000
2350 7" OPTIONAL
T.D.
2500
3000
FRACTURE GRADIENT
2.1
2.0
1.9
1.8
1.0
1.1
1.2
1.3
1.4
1.5
1.6
1.7
100
200
300
400
500
Pressure (Bar)
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Original: TS
Tegnet: AM
Dato: 11-4-83

NOMENCLATURE

X	=	Casing setting depth (m)
W_d	=	Drilling depth for next section (m)
G_i	=	Mudweight when cementing casing (bar/m)
G'_i	=	Mudweight at W_d bar/m)
G''_i	=	Mudweight while testing (bar/m)
G_p	=	Seawater (normal) gradient (bar/m)
G'_p	=	Porepressure, reservoir (bar/m)
G''_p	=	Porepressure at W_d (bar/m)
G_f	=	Fracture gradient (bar/m)
G_{gas}	=	Gas gradient (bar/m)
G_{c1}	=	Lead cement slurry (bar/m)
G_{c2}	=	Tail in cement slurry (bar/m)
L	=	Length from shoe to float collar (m)
Z	=	Length from RKB to wellhead (m)
Z_1	=	Length from mean sea level to wellhead (m)
Y	=	Length RKB - Mudlevel in csg. (m)
M_c	=	Casing mass gradient (kg/m)
P_C	=	Collapse load (bar)
P_B	=	Burst load (bar)
RES_B	=	Burst resistance (bar)
RES_C	=	Collapse resistance (bar)
RES_T	=	Tension strength (tons)
$S.F._C$	=	Safety factor, collapse
$S.F._B$	=	Safety factor, burst
$S.F._T$	=	Safety factor, tension

20" Casing Design 31/3-1

X	=	850 m	G_f	=	0,146 bar/m
W_d	=	1300 m	G_i	=	0,108 bar/m
Z	=	355 m	G'_i	=	0,142 bar/m
Z_1	=	330 m	G_{gas}	=	0.01 bar/m
L	=	12 m	G_{c1}	=	0,153 bar/m
G_p	=	0,101 bar/m	G_{c2}	=	0,187 bar/m

Design Criteria:

BURST : Entire casing filled with light gas.
Burst load when testing casing.

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:

$$P_{B1} = X \times G_f - (X - Z) G_{gas} - Z_1 \times G_p$$

$$= 850 \times 0{,}146 - (850 - 355) \times 0{,}01 - 330 \times 0{,}101 = \underline{85.8 \text{ bar}}$$

Burst load at casing shoe.

$$P_{B2} = X \times (G_f - G_p) + (Z - Z_1) \times G_p$$

$$= 850 \times (0.146 - 0.101) + (355 - 330) \times 0.101 = \underline{40.8 \text{ bar}}$$

Max burst load while testing casing:

(90 bar test)

P_{B3} = 90 + (X-L) x G_i - (X - Z + Z_1 - L) x G_p
= 90 + (850-12) x 0.108 - (850-355+330-12) x 0.101 = <u>98.4 bar</u>

<u>COLLAPSE:</u>

Maximum collapse load at float collar depth during cementing
Volume of tail in slurry is : 10 m^3
Inside 20 casing : L = 12 m eq. to 2.2 m^3
Annular capasity : 0.140 m^3/m which leaves 55 m in annulus.

P_C = (55-L)G_{c2} + (X - 55 - Z)G_{c1} + Z_1 x G_p - (X - L)G_p
=(55-12) x 0,187 + (850-55-355) x 0,153+330x0,101-(850-12)x0,101
= <u>24.1 bar</u>

Collapse load is zero at wellhead.

Select: 355 - 850 m : 20", 197.5 kg/m (133 lb/ft), K - 55, Vetco LS

RES_B = 211 bar
RES_C = 103 bar
RES_T = 926 tons

<u>Safety factor: Collapse:</u>

$$S.F._C = \frac{RES_C}{P_C} = \frac{103}{24.1} = \underline{4,27}$$

<u>Safety factor: Burst:</u>

$$S.F._B = \frac{RES_B}{P_{B3}} = \frac{211}{98.4} = \underline{2,14}$$

TENSION:

Weight of casing string in air:

$$(X - Z) \times M_c = (850 - 355) \times 197.5 \times 10^{-3} = \underline{97.8 \text{ tons}}$$

Casing inside diameter: ID = 47.6cm

Extra tensile load when bumping plug with 55 bar:
(neglecting steel buoyancy for extra safety)

$$(55 - P_c) \times 0{,}98 \times \left(\frac{ID}{2}\right)^2 \times 3.14 \times 10^{-3}$$

$$(55 - 24.1)\ 0.98 \times \left(\frac{47{,}6}{2}\right)^2 \times 3{,}14 \times 10^{-3} = \underline{53.9 \text{ tons}}$$

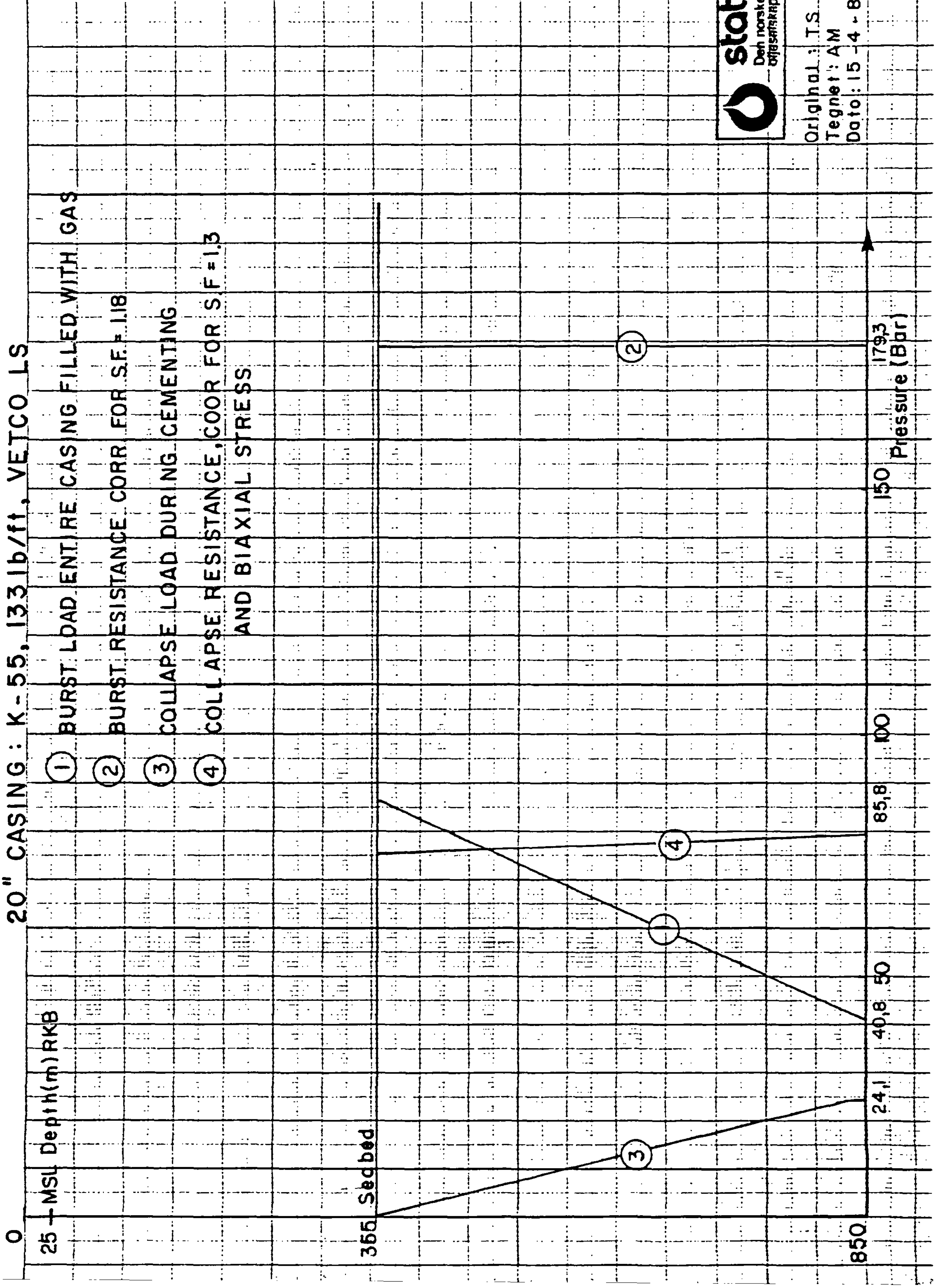
Total weight load at wellhead : (97.8 + 53.9) tons = 151.7 tons

Safety factor: Tension

$$S.F._T = \frac{RES}{load}\ T = \frac{926}{151.7} = \underline{6.10}$$

20" CASING DESIGN

WELL 31/3-1



13 3/8" Casing Design 31/3-1

W_d = 1835 m	G_p = 0,101 bar/m
X = 1285 m	G_f = 0,155 bar/m
L = 24 m	G_{gas} = 0,02 bar/m
Z = 355 m	G_c = 0.187 bar/m
Z_1 = 330 m	G'_p = 0.101 bar/m (1.03 S.G. at 1835m)
G_i = 0,142 bar/m	
G'_i = 0,130 bar/m	

Design Criteria:

BURST : Entire casing filled with gas.
Burst load when testing casing

COLLAPSE: Collapse load during cementing.

TENSION : Tension load, when bumping plug.

BURST:

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

$$P_{B1} = W_d \times G'_p - (1835 - Z) \times G_{gas} - Z_1 \times G_p$$

$$= 1835 \times 0{,}101 - (1835 - 355) \times 0{,}02 - 330 \times 0{,}101 = \underline{122.4 \text{ bar}}$$

Burst load (at shoe):

$$P_{B2} = P_{B1} + (X-Z) \times G_{gas} - (X-850) \times G_p - (850-Z) \times G_i$$

$$P_{B2} = 122.4 + (1285-355) \times 0.02 - (1285-850) \times 0.101 - (850-355) \times 0.142 = \underline{26.8 \text{bar}}$$

Max burst load at shoe while testing casing: (150 bar test):

$$P_{B3} = 150 + X \times G_i - (X-850 + Z_1) \times G_p - (850-Z) \times G_i$$

$$= 150 + 1285 \times 0.142 - (1285-850 + 330) \times 0.101 - (850-355) \times 0.142 = \underline{184.9 \text{bar}}$$

COLLAPSE

Max allowable load while cementing:

$P_C = (X-L) x (G_f - G_i) = (1285 - 24) x (0,155-0,142) = \underline{16.4\ bar}$

Max. collapse load at float collar during cementing. (cement 100m into 20" casing).

$P_C = (G_C - G_i) \times (X - 850 - L + 100) =$

$(0.187 - 0.142) \times (1285 - 850 - 24 + 100) = \underline{23\ bar}$

SELECT: 355 - 1285 m: 13 3/8", 68 lb/ft, K-55 , buttress.

$RES_C = 134$ bar
$RES_B = 238$ bar
$RES_T = 466$ tons

Safety factor burst:

$S.F._B = \frac{RES_B}{P_{B3}} = \frac{238}{184.9} = \underline{1.29}$

Reduced RES_C on top casing due to biaxial stress:

Weight load in air: $(X-Z) \times Mc = (1285-355)m \times$
100.0 kg/m = 93 tons

$\frac{\text{Weight load}}{RES_T} = \frac{93 \text{ tons}}{466 \text{ tons}} = \underline{0,20}$

From the Ellipse of biaxial yield stress, this gives 12 % reduction in collapse resistance.

Safety factor collapse:

$$S.F._C = \frac{RES_C}{P_C} \times 0,88 = \frac{134x0.88}{23} = 5.13$$

TENSION:

Extra tensile load when bumping plug (neglecting steel buoyancy for extra safety) with 150 bar. Casing inside diameter:
ID = 31,53 cm.

$$(150 - P_C) \times 0.98 \times \left(\frac{ID}{2}\right)^2 \times 3.14 \times 10^{-3}$$

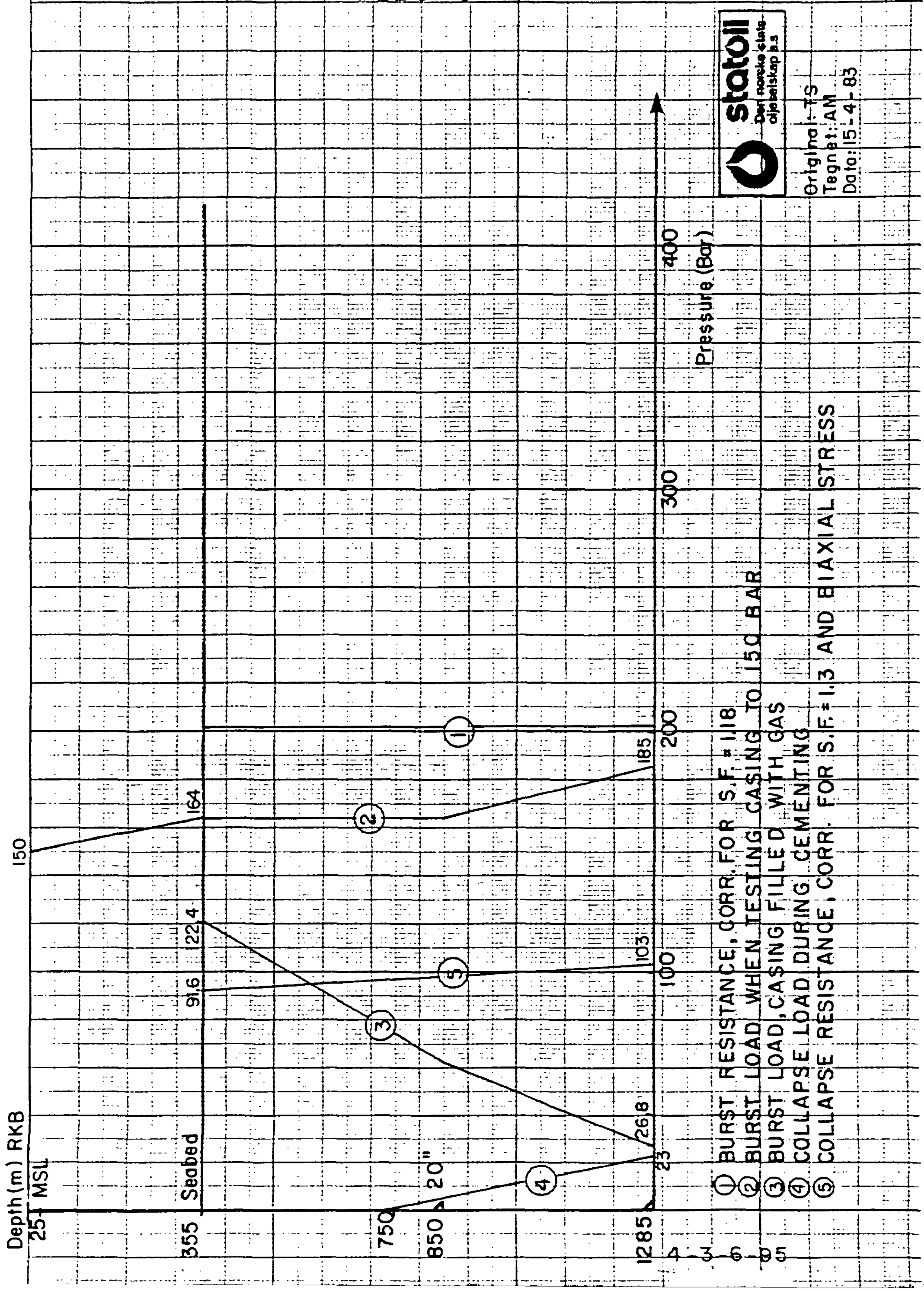
$$= (150-23) \times 0.98 \times \left(\frac{31,53}{2}\right)^2 \times 3,14 \times 10^{-3} = \underline{97.1 \text{ tons}}$$

Total weight load = (93 + 97.1) tons = 190.1 tons

$$S.F._T = \frac{RES_T}{load} = \frac{466}{190.1} = \underline{2.45}$$

13 3/8" CASING DESIGN

WELL 31/3-1



13 3/8" CASING: 68 lb/ft, K-55, BUTTRESS

9 5/8" Casing Design 31/3-1

X =	1820 m	G_f =	0.163 bar/m
W_d =	2350 m	G_i =	0.129 bar/m
Z =	355 m	G'_i =	0.108 bar/m
Z_1 =	330 m	G''_i =	0.113 bar/m
L =	24 m	G_{gas} =	0.023 bar/m
G_p =	0.101 bar/m	G_c =	0.187 bar/m
G'_p =	0.101 bar/m (1.03 S.G. at 2350m)		

Design Criteria:

BURST : Tubing leak while testing.
Burst load when testing casing

COLLAPSE : Collapse load during cementing.

TENSION : Tension load when bumping plug.

Burst:
Burst load at wellhead if there is a tubing leak just below the wellhead while testing at 2350 m.

$$P_{B1} = G'_p \times 2350 - G_{gas} \times (2350 - Z) - Z_1 \times G_p$$

$$= 0.101 \times 2350 - 0.023 \times (2350 - 355) - 330 \times 0.101 = \underline{158.1 \text{ bar}}$$

Burst load at 7" liner top depth if tubing leak at wellhead. (liner top 150 m above 9 5/8" shoe depth)

$$P_{B2} = P_{B1} + (1670 - Z) \times G''_i - (1285 - Z) \times G_i$$

$$- (1670 - 1285) \times G_p = 158.1 + (1670 - 355) \times 0.113$$
$$- (1285-355) \times 0.129 - (1670-1285) \times 0.101 = \underline{147.8 \text{ bar}}$$

Max. burst load at shoe while testing casing:
(172 bar test)

$P_{B3} = 172 + X \times G_i - (X-1285 + Z_1) \times G_p - (1285-Z) \times G_i$

$= 172 + 1820 \times 0.129 - (1820-1285 + 330) \times 0.101 - (1285-355) \times 0.129 = \underline{199.45 \text{ bar}}$

<u>Collapse:</u>

During cementing (cement 100 m into 13 3/8" casing)

$P_C = (G_c - G_i) \times (X-(1285 - 100)- L)$

$= (0.187-0.129) \times (1820 - (1285-100)-24) = \underline{35.4 \text{ bar}}$

Select: 355-820 m, 9 5/8",N-80, 47 lb/ft, buttress

$RES_C = 328$ bar
$RES_B = 474$ bar
$RES_T = 472$ tons

Burst loaded at 820 m when testing casing:
(Test pressure, 172 bar).

$P_{B3'} = 172 + 820 \times G_i - (820-Z) \times G_i - 355 \times G_p$

$P_{B3'} = 172 + 820 \times 0.129 - (820-355) \times 0.129 - 355 \times 0.101$
$= \underline{181,9 \text{ bar}}$

<u>Safety factor burst</u>

$S.F._B = \frac{RES_B}{P_{B3'}} = \frac{474}{181,9} = \underline{2.61}$

Select: 820 - 1820 m, 9 5/8", N-80, 43,5 lb/ft, buttress

$RES_C = 263$ bar
$RES_B = 436$ bar
$RES_T = 436$ tons

Safety factor burst:

$$S.F._B = \frac{RES_B}{P_{B3}} = \frac{436}{199,45} = \underline{2,19}$$

Tensile load at wellhead

$W = W_1 + W_2 = (X-Z) \times Mc$

$= (820-355)m \times 70\ kg/m + (1820-820)m \times 64,8\ kg/m$

$= (32,6 + 64,8)tons$

$= \underline{97,4\ tons}$

$$\frac{\text{Weight load}}{RES_T} = \frac{W}{RES_T} = \frac{97,4}{472} = \underline{0,21}$$

From the Ellipse of biacial yield stress, this gives 12% reduction in collapse resistance.

$$\frac{\text{Weight load}}{RES_T} = \frac{W_2}{RES_T} = \frac{64,8}{436} = 0.15$$

From the Ellipse of biaxial yield stress, this gives 8% reduction in collapse resitance.

Safety factor collapse:

$$S.F._C = \frac{RES_C}{P_C} \times 0,88 = \frac{328 \times 0,88}{35.4} = \underline{8.2}$$

$$S.F._C = \frac{RES_C}{P_C} \times \underline{0,92} = \frac{263 \times 0,92}{35,4} = \underline{6,8}$$

Tension:

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

$X \times M_c = 820\ m \times 70\ kg/m + 1000\ m \times 64,8\ kg/m = \underline{122,2\ tons}$

Extra tensile load when bumping plug at 172 bar (neglecting buoyancy of steel): Casing inside diameter : ID = 22,24 cm

$$(172 - P_C)0.98 \times (\frac{ID}{2})^2 \times 3,14 \times 10^{-3}$$

$$= (172-35,4)\ 0,98 \times (\frac{22,24}{2})^2 \times 3,14 \times 10^{-3} = \underline{52\ \text{tons}}$$

Weight load of 7" liner: $(W_d - X + 150) \times M_c$

= (2350-1820 + 150)m x 43,15 kg/m = 29,3 tons

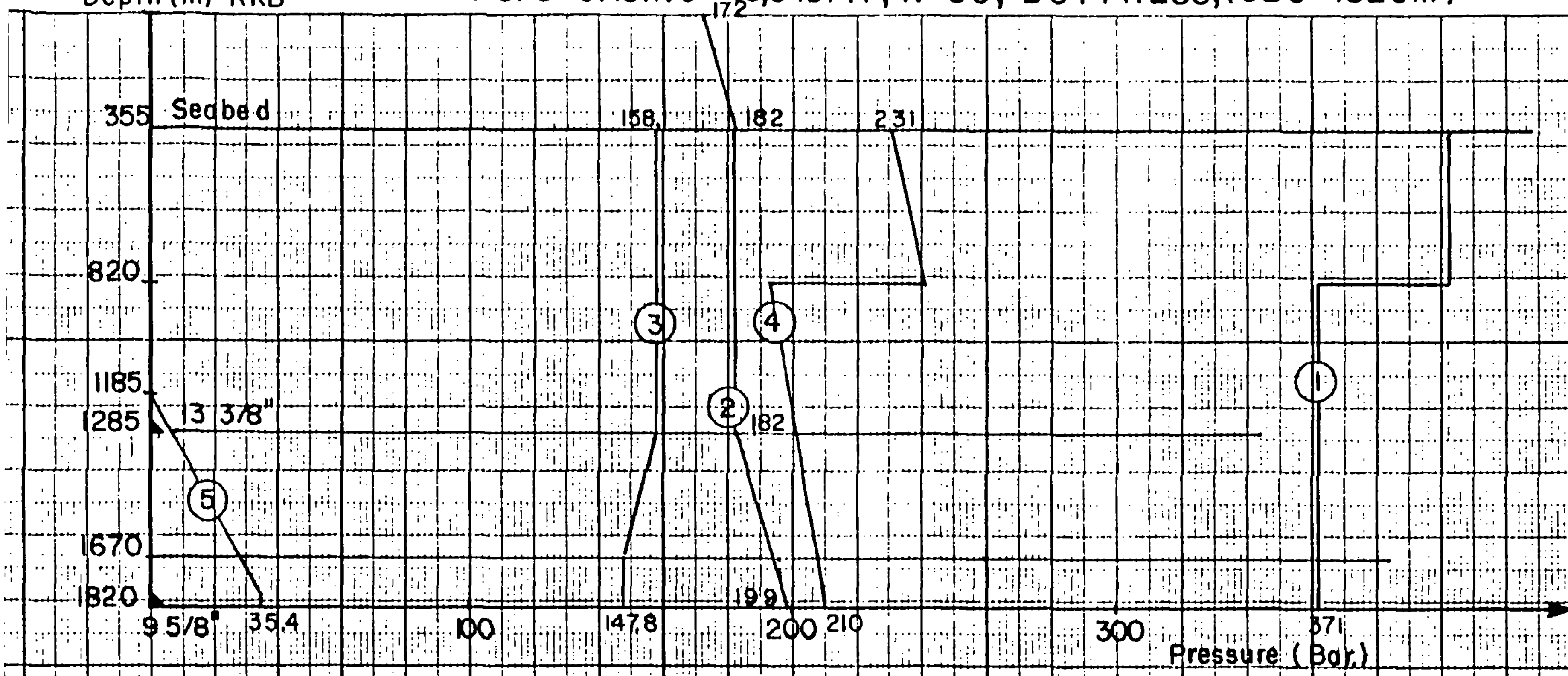
Total weight load: (122,2 + 52 + 29.3) = 203,5 tons

$$S.F._T = \frac{RES_T}{203,5} = \frac{436}{203,5} = \underline{2,14}$$

9 5/8" CASING DESIGN

WELL 31/3-1

9 5/8" CASING : 47 lb/ft, N-80, BUTTRESS,(355 - 820m)
43,5 lb/ft, N-80, BUTTRESS,(820-1820m)



(1) BURST RESISTANCE CORRECTED FOR S.F. = 1,18

(2) BURST LOAD PRESSURE TEST CASING TO 172 BAR

(3) BURST LOAD, TUBING LEAK WHILE TESTING

(4) COLLAPSE RESISTANCE CORRECTED FOR S.F = 1,25 AND BIAXIAL STRESS

(5) COLLAPSE LOAD DURING CEMENTING

statoil
Den norske stats oljeselskap a.s

Original TS
Tegnet AM
5-4-83

7" liner 31/3-1

W_d	= 2350m	G_p	= 0.101 bar/m
X	= 2350 m	G'_p	= 0.101 bar/m
Z	= 355 m		(Test at 2350m)
Z_1	= 330 m	G_{gas}	= 0.023 bar/m
G_i	= 0.108 bar/m	G_c	= 0.187 bar/m
G'_i	= 0.108 bar/m	$G"_i$	= 0.113 bar/m

Design criteria:

BURST : Tubing leak while testing
Testing liner
COLLAPSE: Collapse load while cementing
TENSION : Tension load when bumping plug

Burst:

Max burst load at packer setting depth 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 2350 m. (Packer at 2320 m).

$$P_B = G'_p x\ 2350 + (2350-Z)x(G"_i - G_{gas}) - (1285-Z)x0.142$$

$$-(2320-1285+Z_1)x\ G_p$$

$$= 0.101x2350+(2350-355)(0.113-0.023)-(1285-355)x0.142$$

$$-\ (2320-1285+330)x0.101$$

$$= \underline{147\ bar}$$

Max burst load when testing 7" liner/9 5/8" casing to 172 bar:

$$P_{B2} = 172+G_i \times X - (1285-Z)\times 0.142-(X-1285+Z_1)\times G_p$$

$$= 172+2350\times 0.108-(1285-355)\times 0.142-(2350-1285+330)\times 0.101$$

$$= \underline{152.8 \text{ bar}}$$

From 1670 - 2350 m select : 7", 29 lb/ft, N-80, Buttress

RES_C = 484 bar
RES_B = 563 bar
RES_T = 294 tons

$$S.F._B = \frac{RES_B}{P_{B2}} = \frac{563}{152.8} = \underline{3.68}$$

Collapse:

7" liner is set at bottom with 150 m overlap in 9 5/8" casing.

Collapse load during cementing:

$$P_C = (G_c-G_i)\times(X-1670) = (0.187-0.108) \times (2350-1670)$$

$$= \underline{53.7 \text{ bar}}$$

Minimum flowing bottom hole pressure when testing at 2350 m

$$P_{WF}\ min = 2350 \times G'_p - \frac{RES_C}{1.25}$$

$$P_{WF}\ min = 2350 \times 0.101 - \frac{484}{1.25} = \underline{< 0}$$

Tension:

Weight load in air:

$(X-1670) \times M_c = (2350-1670)\text{m} \times 43{,}15\text{kg/m} = \underline{29.3 \text{ tons}}$

Liner I.D. = 15,71 cm

Extra tensile load when bumping plug with 172 bar:

$(172 - 53.7) \times 0.98 \times \left(\frac{15.71}{2}\right)^2 \times 3.14 \times 10^{-3} = \underline{22.5 \text{ tons}}$

Total tensile load = (22.5 + 29.3) tons = 51.8 tons

$= S.F._T = \frac{RES_T}{51.8} = \frac{294}{51.8} = \underline{5.68}$

30" CASING CEMENT DATA AND CALCULATIONS, 31/3-1:

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..........................:	355 m
Depth kb-last shoe........................:	
Depth kb-casing set point.................:	420 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 + 3.2 l/100kg econolite	CLASS "G"-cement
Mix water	l/100 kg	93.2 sea	46.1 sea
Total liquid	l/100 kg	96.4	46.1
Slurry weight	g/cm^3	1.56	1.90
Slurry yield	l/100 kg	127.9	77.7
TEST DATA AT BHCT			
Thickening time at BHHP, hr:min		5:00	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 16 hr		
	bar 24 hr	28	62

REMARKS:

Fann VG Readings
600/300/200/100

Volume calculations (30" casing):

Annular volume	: 0.200 m^3/m x (420-355)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 + 3.2L econolite/100 kg cement mixed with seawater at 1.56 g/cm^3

18500 kg cement equivalent to 23.7 m^3 slurry

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

13000 kg equivalent to 10.0 m^3 slurry.

Chemicals needed: Total volume of econolite needed: 590L

20" CASING CEMENT DATA AND CALCULATIONS, 31/3-1:

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	355 m
Depth kb-last shoe	420 m
Depth kb-casing set point	850 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 133 lbs/ft	177.8 l/m
Mud weight	1.10 g/cm^3
Bottom hole hydrostatic pres. (BHHP)	92 bar
Est. bottom hole static temp. (BHST)	41 °C
Est. bottom hole circulating temp. (BHCT)	34 °C
Est. formation integrity	0.146 bar/m

		FILLER/LEAD SLURRY	TAIL IN SLURRY
CEMENT SLURRY COMPOSITION		CLASS "G"cement + 2.7 kg prehydrated bentonite/100 kg cement	CLASS "G"cement
Mix water	l/100 kg	93.6 fresh	45.0 fresh
Total liquid	l/100 kg	94.8	45.0
Slurry weight	g/cm^3	1.55	1.90
Slurry yield	l/100 kg	126.5	76.5
TEST DATA AT BHCT			
Thickening time at BHHP, hr:min		6:00	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		
	bar 24 hr	24	93

REMARKS: 2.7 kg prehydrated bentonite/100 kg cmt.
2.7% by weight of cmt, corresponds to
28.8 kg bentonite pr 1000 liter mixingwater

Volume calculations (20" casing):

Annular volume	: 0.1394 m^3/m x (850-420)m	= 59.9 m^3
Volume between csg's:	0.194 m^3/m x(420-355) m	= 12.6 m^3
12 m plug at shoe	: 0.1778 m^3/m x 12m	= 2.1 m^3
100% excess in open hole:		= 59.9 m^3
Total volume		= 134.5 m^3

Lead slurry : Class "G"-cement + 2.7 kg prehydrated bentonite/ 100 kg cmt mixed with fresh water at 1.55 g/cm^3

98500 kg cement equivalent to 124.5 m^3 slurry

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

13100 kg equivalent to 10.0 m^3 slurry.

Bentonite needed: 2660 kg

Hydrostatic pressure at 20" csg. shoe

Height of tail-in slurry : $(10.0-2.1) m^3 / 0.1394\ m^3/m$ = 57 m

Hydrostatic head of lead slurry :

0.152 bar/m x (850-355-57)m 66.6 bar

Hydrostatic head of tail-in slurry :

0.187 bar/m x 57 m 10.7 bar

Hydrostatic head of sea-water :

0.101 bar/m x (355 - 25)m 33.3 bar

Total hydrostatic pressure 110.6 bar

Equivalent pressure gradient at 20" shoe :

$$\frac{110.6\ \text{bar}}{850\ \text{m}} = 0.130\ \text{bar}$$

Estimated formation integrity : 0.146 bar/m

13 3/8" CASING CEMENT DATA AND CALCULATIONS, 31/3-1:

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...........................:	355 m
Depth kb-last shoe.........................:	850 m
Depth kb-casing set point..................:	1285 m
Open hole dia..............................:	17½"
Annulus capacity, cased hole.. ....:	87.0 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.................................:	1.45 g/cm^3
Bottom hole hydrostatic pres. (BHHP)......:	183 bar
Est. bottom hole static temp. (BHST)......:	48 °C
Est. bottom hole circulating temp. (BHCT).:	38 °C
Est. formation integrity...................:	0.155 bar/m

		LEAD SLURRY	TAIL IN SLURRY
CEMENT SLURRY COMPOSITION		CLASS "G" cement 2.7 kg prehydrated bentonite/ pr 100 kg cement	CLASS "G" cement
Mix water	1/100 kg	93.6 fresh	45.0 fresh
Total liquid	1/100 kg	94.8	45.0
Slurry weight	g/cm^3	1.55	1.90
Slurry yield	1/100 kg	126.5	76.5
TEST DATA AT BHCT			
Thickening time at BHHP, hr:min		5:00 +	3:26
Crit. Turb.Flow rate:m/s (1/min)			
Fluid loss, ml/30 min, 70 bar			
TEST DATA AT BHST, BHHP			
Compr. strength, bar 16 hr			107
bar 24 hr		24	

REMARKS:

Fann VG Readings 600/300/200/100	68/60/55/50	111/68/55/11

Remarks: 2.7 kg prehydrated bentonite per 100 kg cmt or 2.7% by weight of cmt, corresponds to 28.8 kg bentonite per 1000 liter mixing water.

Volume calculations (13 3/8" casing):

Annular volume	: 0.0644 m^3/m x (1258-850)m	= 28.0 m^3
Volume between csg's:	0.0870 m^3/m x 100 m	= 8.7 m^3
24 m plug inside casing	: 0.0781 m^3/m x 24m	= 1.9 m^3
Total cement slurry volume		= 38.6 m^3

Lead Slurry : Class G-cement + 2.7 kg perhydrated bentonite per 100 kg cement mixed with fresh water at 1.55 g/cm

22600 kg cement equivalent to 28.6 m^3 slurry

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

13100 kg cement equivalent to 10 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:

Bentonite needed : 610 kg

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.

Hydrostatic pressure calculations:

Height of mud: (850-100)m = 750 m

Height of lead slurry : (1285-850-126 + 100)m = 409 m

Height of tail-in slurry : $(10.0 - 1.9)m^3/0.644m^3/m$ = 126 m

Hydrostatic head from mud: 0.142 bar/m x 750m = 106.5 bar

Hydrostatic head from lead slurry : 0.152 bar/m x 409 m = 62.2 bar

Hydrostatic head from tail-in slurry : 0.187 bar/m x 126m = 23.6 bar

Total hydrostatic head at 13 3/8" shoe = 192.3 bar

Equivalent pressure gradient at 13 3/8" shoe :

$$\frac{192.3 \text{ bar}}{1285 \text{ m}} = 0.150 \text{ bar/m}$$

Estimated formation integrity at 13 3/8" shoe : = 0.155 bar/m

Hydrostatic head at 20" shoe:

106.5 bar + 0.152 bar/m x 100 m = 121.7 bar

Equivalent pressure gradient at 20" shoe : $\frac{121.7 \text{ bar}}{850 \text{ m}}$ = 0.143 bar/m

Estimated formation integrity at 20" shoe = 0.146 bar/m

9 5/8" CASING CEMENT DATA AND CALCULATIONS, 31/3-1:

GENERAL: The cement volume calculations 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.........................:	355 m
Depth kb-last shoe.......................:	1285 m
Depth kb-casing set point................:	1820 m
Open hole dia............................:	12 1/4"
Annulus capacity, cased hole.. ....:	31.0 l/m
Annulus capacity, open hole...... ......:	28.9 l/m
Internal capacity, 9 5/8"casing 43.5 lbs/ft:	39.0 l/m
Mud weight...............................:	1.32 g/cm^3
Bottom hole hydrostatic pres. (BHHP)......:	236 bar
Est. bottom hole static temp. (BHST)......:	70 °C
Est. bottom hole circulating temp. (BHCT).:	47 °C
Est. formation integrity.................:	0.163 bar/m

		LEAD SLURRY	TAIL-IN SLURRY
CEMENT SLURRY COMPOSITION		Class "G" cement + 1.33 l/100 kg CFR-2L + 2.7 kg prehydrated bentonite per 100 kg cement	Class "G" cement + 1.95 l/100 kg CFR-2L + 1.78 l/100 kg Halad-10L
Mix water	l/100 kg	93.5 fresh	41.8 fresh
Total liquid	l/100 kg	96.0	45.5
Slurry weight	g/cm^3	1.55	1.90
Slurry yield	l/100 kg	127.7	77.07
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 16 hr		
	bar 24 hr	49	474
REMARKS:			
Fann VG-readings 600/300/200/100		20/14/12/10	51/23/16/9

REMARKS: 2.7 kg prehydrated bentonite per 100 kg cement or 2.7% by weight of cmt, corresponds to 28.8 kg bentonite per 1000 liter mising water.

Volume calculations (9 5/8" casing):

Annular volume	: 0.0289 m^3/m x (1820-1285)m	= 15.5 m^3
Volume between csg's:	0.0301 m^3/m x 100 m	= 3.1 m^3
24 m plug inside casing	: 0.0390 m^3/m x 24m	= 0.9 m^3
Total cement slurry volume		= 19.5 m^3

Cement Slurry : Class G-cement + 1.33 1/100 kg CFR-2L + 2.7 kg prehydrated bentonite per 100 kg cmt mixed with fresh water at 1.55 g/cm^3

7500 kg cement equivalent to 9.5 m^3 slurry

Tail-in slurry: Class G-cement + 1.95 1/100 kg CFR-2L + 1.78 1/100 kg Halad 10L mixed with fresh water at 1.90 g/cm^3

13000 kg cement equivated to 10 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 100 into 13 3/8" csg. The amount of excess should be discussed with t operation office before any dicision are made.

Chemicals needed:

Total volume of CRF-2L needed:		355 1
Total volume of HR-10L needed:		230 1
Bentonite	:	203 kg

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.

Hydrostatic pressure calculations:

Height of mud : (1285-100) m = 1185 m

Height of lead slurry :(1820-1285-315 + 100))m = 320 m

Height of tail-in slurry: (10.0-0.9)m^3/0.0289 m^3/m = 315 m

Hydrostatic head from mud : 0.130 bar/m x 1185 m = 154.1 bar

Hydrostatic head from lead slurry : 0.152 bar/m x 320 m = 48.6 bar

Hydrostatic head from tail-in slurry: 0.187 bar/m x 315m = 58.9 bar

Total hydrostatic head at 9 5/8" shoe = 261.6 bar

Equivalent pressure gradient at 9 5/8" shoe :

$$\frac{261.6 \text{ bar}}{1820 \text{ m}} = \underline{0.144 \text{ bar/m}}$$

Estimated formation integrity at 9 5/8" shoe = 0.163 bar/m

Hydrostatic head at 13 3/8" shoe:
154.1 bar + 0.152 bar/m x 100 m = 169.3 bar

Equivalent pressure gradient at 13 3/8" shoe :

$$\frac{169.3 \text{ bar}}{1285 \text{ m}} = 0.132 \text{ bar/m}$$

Estimated formation integrity at 13 3/8" shoe = 0.155 bar/m

7" LINER CEMENT DATA AND CALCULATIONS, 31/3-1:

GENERAL: The cement volume is calculated at the basis of the theoretical annulus volume and the liner to be cemented 150 m into the 9 5/8" casing.

WELL DATA:

Depth kb-sea bed.........................:	355 m
Depth kb-last shoe.......................:	1820 m
Depth kb-casing set point................:	2350 m
Open hole dia............................:	8½"
Annulus capacity, cased hole.. ....:	14.1 l/m
Annulus capacity, open hole...... ......:	11.7 l/m
Internal capacity, 30" casing 1.0"thickness	19.4 l/m
Mud weight...............................:	1.1 g/cm^3
Bottom hole hydrostatic pres. (BHHP)......:	254 bar
Est. bottom hole static temp. (BHST).......:	82 °C
Est. bottom hole circulating temp. (BHCT).:	56 °C
Est. formation integrity.................:	

		SLURRY
		CLASS "G"
COMPOSITION		+ 1.95 l/100kg CFR-2L + 3.55 l/100 kg Halad-10L
Mix water	l/100 kg	40.0 fresh
Total liquid	l/100 kg	45.5
Slurry weight	g/cm^3	1.90
Slurry yield	l/100 kg	77.1

TEST DATA AT BHCT

Thickening time at BHHP, hr:min	4:34
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	
bar 16 hr	365

REMARKS:

Volume calculations (7" liner):

Annular volume	: 0.0117 m^3/m x (2350-1820)	=	6.2 m^3
Volume between csg's	: 0.0133 m^3/m x 150	=	2.1 m^3
24 m plug inside casing	: 0.194 m^3/m x 24 m	=	0.5 m^3
Total cement slurry volume		=	8.8 m^3

Slurry : Class G-cement + 1.95 l/100kg CFR-2L + 3.55 l/100kg Halad-10L mixed with fresh water at 1.90 g/cm

11500 kg cement equivalent to 8.8 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 at the liner hanger (150 m into 9 5/8" csg). The amount of excess should be discussed with the operation office before before any decision are made.

Chemicals needed:

Total volume of CFR-2 needed : = 225
Total volume of Halad-10L needed : = 408

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

Hydrostatic pressure calculations:

Height of mud : (1820-150) m = 1670 m

Height of slurry : (2350-1820 + 150) m = 680 m

Hydrostatic head from mud : 0.108 bar/m x 1620 m = 180.4 bar
Hydrostatic head from slurry : 0.187 bar/m x 680 m = 127.2 bar

Total hydrostatic head at 7" shoe : = 307.6 bar

Equivalent pressure gradient at 7" shoe :

$\frac{307.6 \text{ bar}}{2350} \doteq 0.131$ bar/m

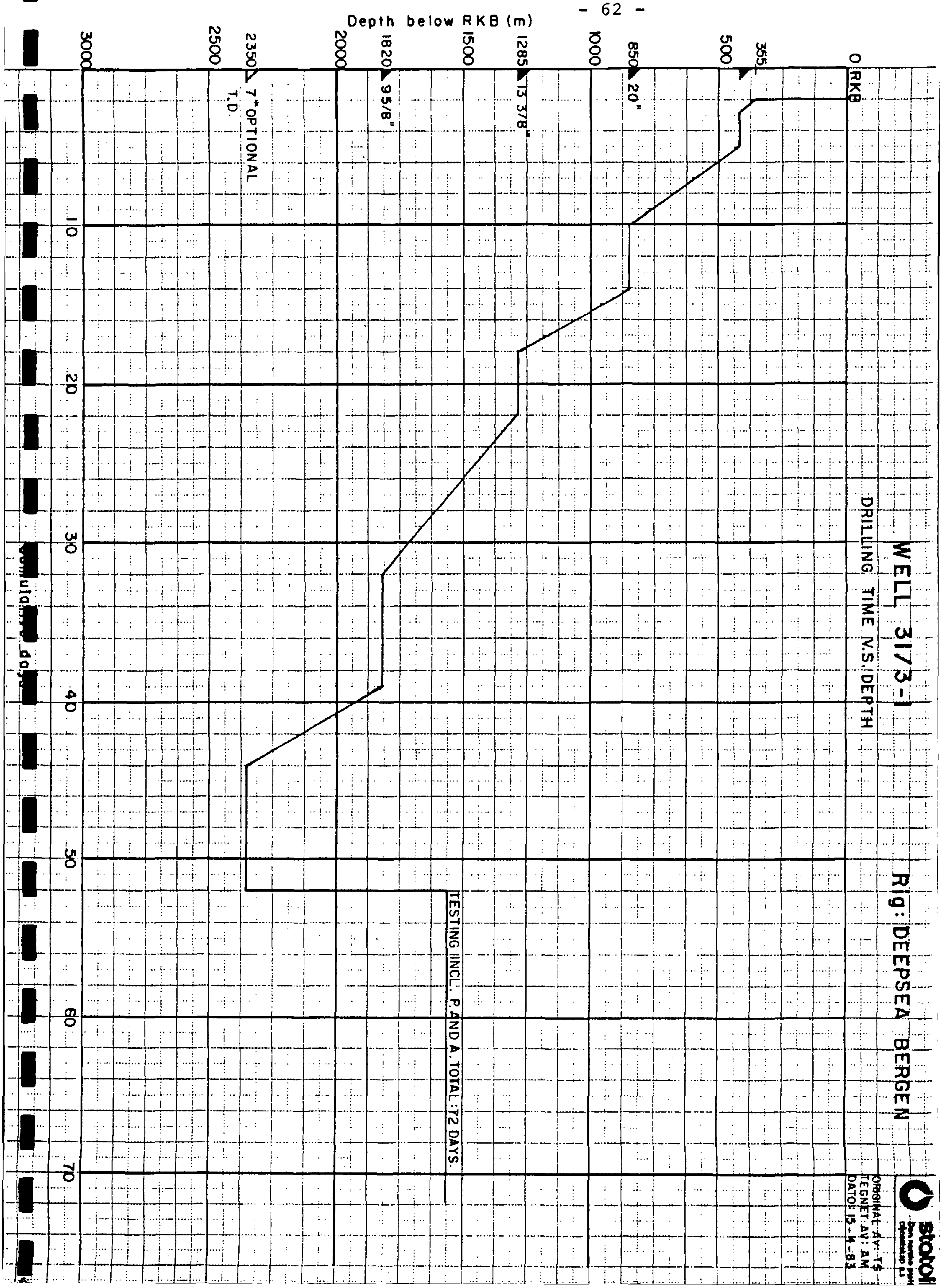
Estimated formation integrity at 7" shoe : = 0.171 bar/m

Hydrostatic head at 9 5/8" shoe :
180.4 bar + 0.187 bar/m x 150 m = 208.5 bar

Equivalent pressure gradient at 9 5/8" shoe :

$\frac{208.5 \text{ bar}}{1820} = 0.115$ bar/m

Estimated formation integrity at 9 5/8" shoe = 0.163 bar/m



WELL 31/3-1
Rig: DEEPSEA BERGEN
DRILLING TIME V.S. DEPTH
Depth below RKB (m)
0 RKB
355
500
850
1000
1285
1500
1820
2000
2350
2500
3000
20"
13 3/8"
9 5/8"
7" OPTIONAL
T.D.
10
20
30
40
50
60
70
TESTING INCL. P. AND A. TOTAL: 72 DAYS.
Statoil
ORIGINAL AV: TS
TEGNET AV: AM
DATO: 15-4-83

WELL NO. 31/3-1

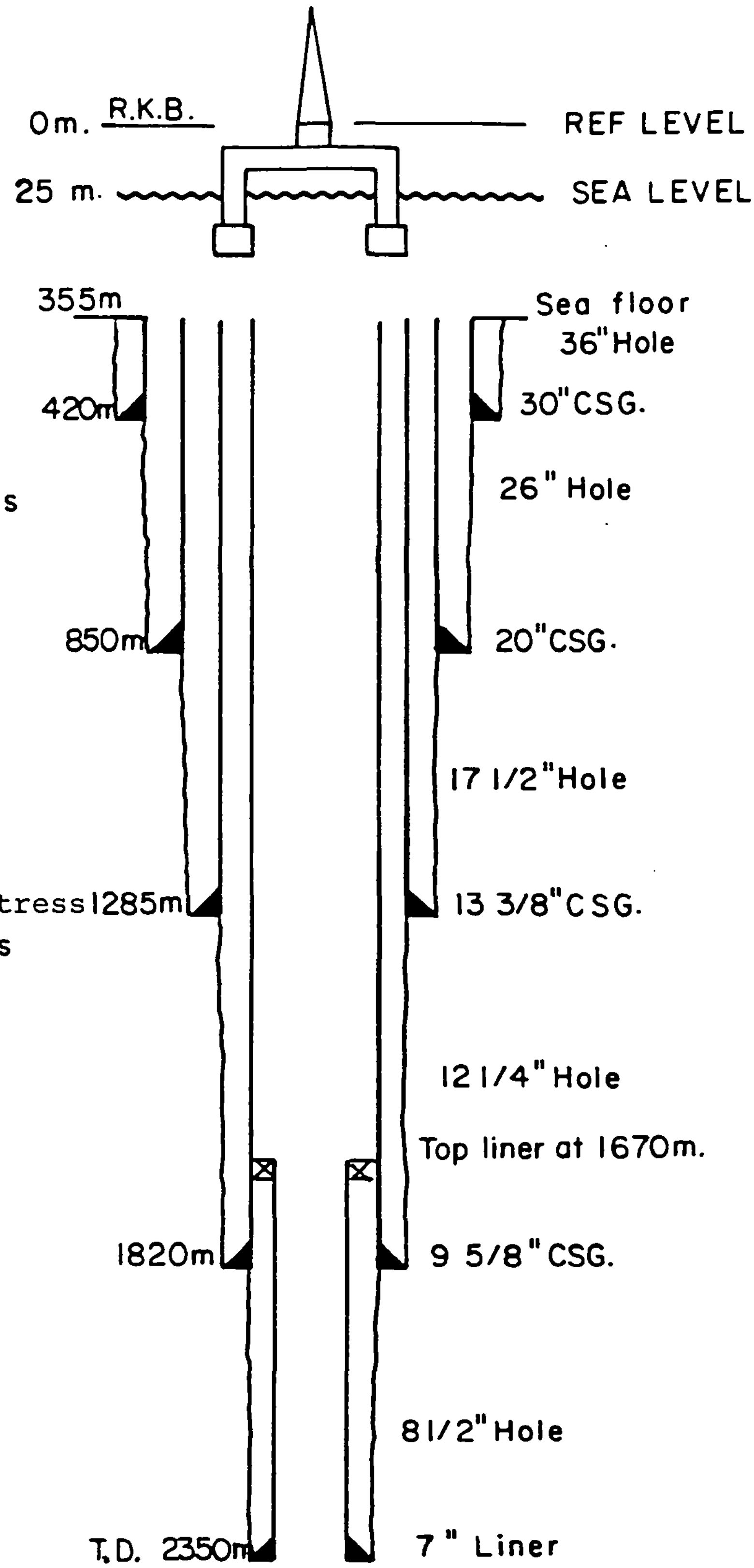
(Not to scale)

30" grade "B" Vetco ATD/RB
1 jt 1.5 " wall th.
4 jts 1" wall th.
Cement to seabed + 150 % excess
20", K-55, 133 lb/ft

13 3/8", K-55, 68 lb/ft, buttress
cement to minimum 750 m.

9 5/8" N-80, 43,5 lb/ft, buttress
9 5/8", N-80, 47 lb/ft, buttress
Cement to minimum 1185m.

7", N-80, 29 lb/ft, buttress
Cement to full length.



statoil
Den norske stats oljeselskap a.s

Original av: TS
Tegnet av: AM
Dato: 14-4-83