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STOI
P5.10.02-01
15/12-4

STATOIL

GEOLOGICAL PROGNOSIS, PRESSURE PREDICTION & DRILLING PROGRAM

WELL 15/12-4

Revised July 1984

WELL 15/12-4

CONTENT

Program Responsibility:
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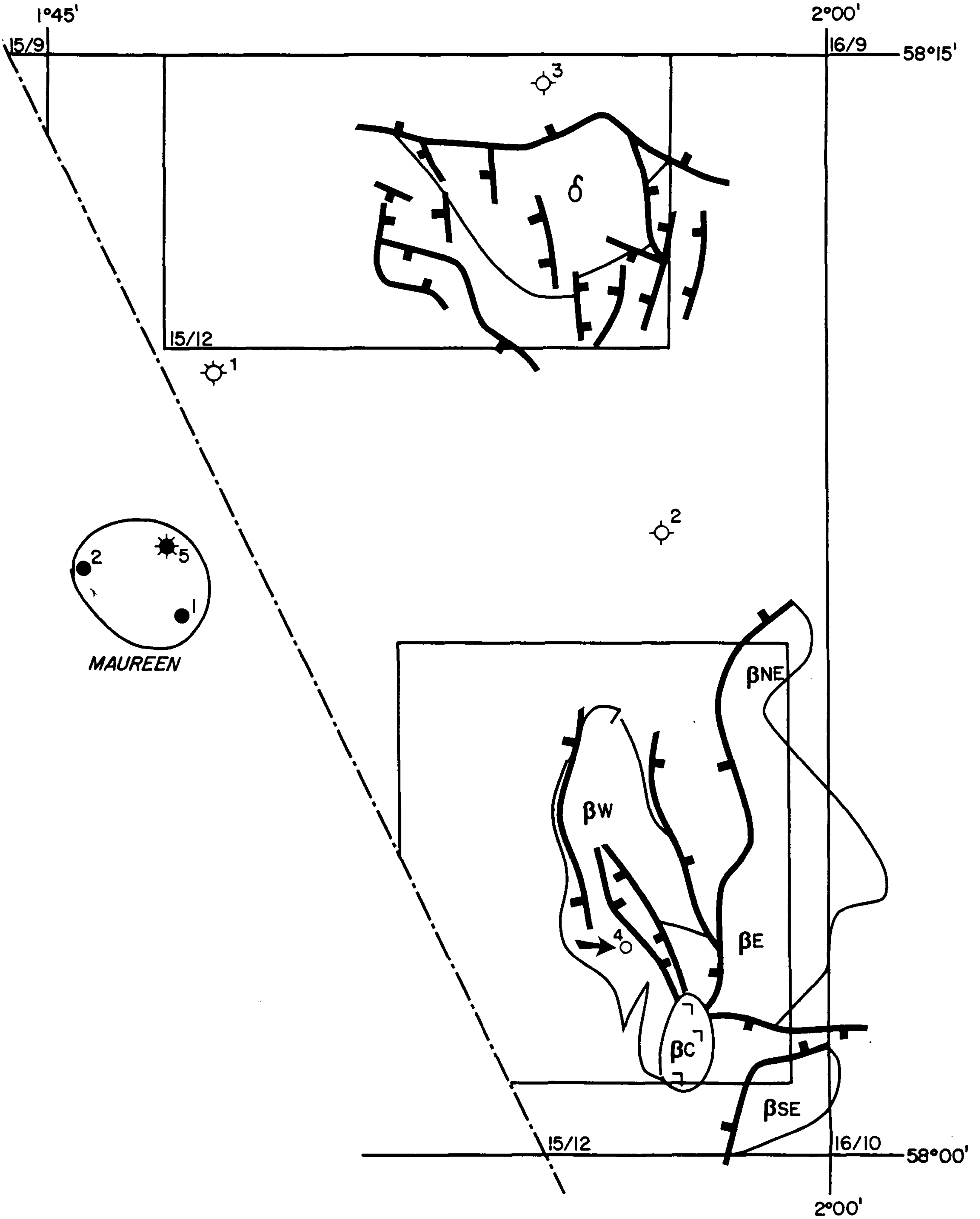
FIG. 1

LISENCE PL 038,BLOCK 15/12
PROSPECT MAP JURASSIC



S T A T O I L

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

WELL NO.	15/12-4
PROSPECT (field)	Beta-Structure

General Data:

LOCATION

Country	Norway
Area	North Sea
Licence No.	038
Block No.	15/12

Coordinates 58° 03' 08.5" N, 01° 54' 13.8" E.

Seismic: Shotpoint No. 2105 Line No. ST 8315/106

5.6 Km west of east block Boundary
5.7 Km north of south block Boundary
230 Km from Norwegian coast, "Jærens Rev"
3.8 Km from N/UK median line
10 Km NE of nearest well UK 22/5b-3

WATER DEPTH 87 Meters (MSL)

K.B.E. 23 Meters

PROJECTED TOTAL DEPTH : IF DRY: 150 m into Triassic red beds (approx. 3125 m RKB)
IF DISCOVERY: 50 m into salt or max. 3600 m RKB

CONTRACTORS

Drilling platform	Deepsea Bergen
Drilling Contractor	Odfjell Drilling and Cons. Co.
Mud logging Contractor	Exploration Logging
Type Logging unit	Ex.log unit (Gemdas)
Electric Logging Contractor	Dresser Atlas
Mud Contractor	NPS
Cement Contractor	Halliburton
Rig positioning Contractor	Geoteam and Decca
Bottom Survey Contractor	Geoteam/Odin
Helicopter Service	Helikopter Service
Supply Boats	From Statoil "Supply boat pool"
Standby Boat	Geo Boy
Core analysis	GECO

INTRODUCTION

Block 15/12 was awarded in 1975 to Statoil as operator and Esso with fifty percent each.

Parts of the block were relinquished in 1981, after fulfillment of a work program of three wells. Two discrete areas were retained, one in the north and one in the southern part of the block.

The southern area covers the Beta structural complex where the 15/12-4 well will be drilled.

This area has been under continuous evaluation in light of the recent promising development in nearby British waters.

A first detailed mapping (late 1982) showed a highly segmented Jurassic/Triassic positive structural complex underlying a possible Paleocene submarine fan lobe with additional reserve potential in the Heimdal Fm. Renewed mapping in connection with the 8th Norwegian License Round and based on some new seismic data basically confirmed the earlier results. It did, however, indicate increased reserves, both in Beta E, Beta SE, Beta SW and in the Paleocene.

Either oil or gas (or both) are possible in this area.

RESULTS OF EARLIER WELLS

Three wells have been drilled so far in 15/12:

- 1) Was drilled on the extension of the Maureen Field. Good reservoir sands were found both in the Jurassic and in the Heimdal Fm. Good oilshows were encountered in the Jurassic, but the reservoirs were both largely water wet.

  Later mapping has shown that the Maureen Field is not filled to spillpoint, and consequently, does not extend onto the Norwegian side.

- 2) Was drilled on a discrete salt structure in the east-central part of the block. Good reservoir sands were found in the Jurassic, but no shows were seen, and the reservoir was water wet.

- 3) Was drilled to test a rotated fault block in the northern part of the block. No reservoir sands were found. Later mapping also showed that the well was drilled off-structure.

In addition several wells have been drilled in nearby British waters, both in 16/29 (Maureen, Mable and Andrew) and in 22/5.

Either oil or gas or both have been found in the majority of the wells.

Especially the discoveries in 22/5 seem to spill directly into the Beta Complex of 15/12.

PURPOSE OF TEST AND OBJECTIVES

15/12-4 is designed to test both a thin Heimdal Fm. (stratigraphic trap) and sandstones of Jurassic/Triassic age (structural trap) on Beta West.

Possible sands of the Frigg Fm. and fractured limestones in Cretaceous form secondary speculative prospects of unknown potential.

The well is a rank wildcat, and located 85 kilometers from the nearest well, UK 22/5a-1 (Amoco).

The Heimdal play has a high potential, but a high risk of not finding any reservoir sand. The Jurassic/Triassic has a moderately low risk. The uncertainties are mainly restricted to hydrocarbon type and column, although there is a chance that the reservoir section is partly or fully eroded. The potential is low for the Jurassic/Triassic on Beta West alone (unless sealing faults occur), but the total potential of Jurassic/Triassic on the Beta Complex is moderately high.

The total depth of the well is dependent on the hydrocarbon results.

If the well is dry, it will be completed at approximately 3125 m (i.e. 150 meters into Triassic redbeds).

In case of a discovery the well will be drilled 50 m into Zechstein salt or maximum 3600 m.

15/12-4 LOCATION CONSIDERATIONS

The main reason for choosing the location on Beta West is the proximity to the mature source rocks and the oil- and gas discoveries to the west in British waters.

The location is on the south flank of a north-south trending salt-feature (saltwall) which probably penetrates most of the Jurassic only 1.5 kilometers to the north of the location.

DRILLING HAZARDS

The 15/12-4 loaction is in an area which is quite complicated both structurally due to salt tectonics and otherwise.

The following points should be emphasized:

1) The presence of the Frigg Fm. Sands is highly questionable, but a possible gas charge should be taken into consideration during drilling of this sequence.

2) The chalks and limestones of the Cretaceous may be strongly fractured, and possibly hydrocarbon charged. This could lead to either kick or lost circulation problems dependent on the pore pressure development between the nearly normally pressured lower Tertiary sequence and the overpressured Jurassic/Triassic.

3) The Upper Jurassic shales may be absent. Therefore sandstones should be taken into account from 2815 m (RKB).

4) The location is located only slightly more than 100 meters from a major fault to the east of the location. This should be taken into account for the rig-positioning. It is also important with a good control on the direction during drilling.

The sidescan sonar shows a typical North Sea sandy seafloor free from man-made debris. The sand coverage is generally less than 1 m thick. Below the sand there are glaciomarine deposits.

At 262 m (RKB) there is a glacially controlled surface.

Below 262 m (RKB) there is a thick deposit of clay.

At 492 m (RKB) a strong reflector is observed. This is believed to be associated with stiff (overconsolidated ?) clay.

There are no significant geological hazards at the location. At 492 m (RKB) immediately south of location there is an area of high amplitude reflection below the clay layer. There is, however, no conclusive evidence of gas.

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.

Water depth from site survey is 87 m, which is 6 m more than used in the drilling program.

STRATIGRAPHIC PROGNOSIS

UNIT	DEPTH (m) RKB
Top Utsira Fm.	915 m ± 30
Base Utsira Fm.	995 m ± 30
Top Mid Oligocene	1365 m ± 30
Top Eocene	1890 m ± 30
Top Frigg Fm. ??	2290 m ± 50
Top Balder Fm.	2340 m ± 50
Top Heimdal Fm.	2485 m ± 50
Top Cretaceous	2535 m ± 50
Top Lower Cretaceous	2725 m ± 50
Top Draupne Fm.	2815 m ± 70
Top Hugin Fm.	2870 m ± 100
Top Smith Bank Fm.	2975 m ± 150
Top Salt	3360 m ± 200

T.D. (if dry): 150 m into Triassic red beds (approx. 3125 m)
T.D. (if discovery): 50 m into salt or max. 3600 m

LITHOLOGY

Tertiary

The sediments of the Nordland Gr. consist of grey soft clay interbedded with silt, sand and gravel. The Utsira Fm. is composed of sand with beds of clay of variable thickness.

The Hordaland Gr. is dominated by grey and brown claystone and shale. Downward the colour changes and the sediments become more grey to green. Thin limestone and dolomite stringers occur. The Frigg Fm., if present, is a more sandy development in the lower part of the Hordaland Gr.

The Rogaland Gr. consists mainly of shale with traces of tuff, dolomite and anhydrite. If present, the Heimdal Fm. is developed as a sandy sequence in the lowermost part of the Tertiary.

Cretaceous

The Upper Cretaceous is mainly composed of limestones and chalky limestones, while the Lower Cretaceous consists of a mixture of limestone, marl, claystone and siltstone.

Jurassic

The Draupne Fm., consists typically of a brown to black carbonaceous shale, occasionally silty and with traces of limestone.

The Heather Fm. consists of shale and claystone similar to the Draupne Fm. above. The sequence is distinguished from the Draupne Fm. on log response characteristics, mainly an increase in sonic velocity.

The Hugin Fm. is usually represented by sandstone interbedded with shale, limestone and some coal beds.

Triassic

The Smith Bank Fm. is dominated by reddish claystones and sandstones of continental origin.

Permian

The Zechstein Fm., if reached, is composed of salt.

GEOLOGICAL WELL LOGGING AND SAMPLING PROSEDURES

Mud logging contractor is Exploration Logging.
A Gemdas unit will be employed to log the well for hydrocarbon shows, collect samples, prepare sample log and conduct certain other services throughout the drilling operation.

Sampling interval

Samples will be collected at 10 meter intervals down to 2000 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.

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

One composite sample of unwashed cuttings will be canned at 15 meters intervals. Each can should be 3/4 filled and covered with water and a full dropper of bactericide, leaving a 2 - 3 cm air space. The cans should be stored inverted.

One or more mudsamples of 3 liters will be collected from the active pits when drilling through any hydrocarbon bearing interval. The number of samples will be at the discretion of the wellsite geologist (approximately one sample every 50 m). 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.

CORING PROGRAM

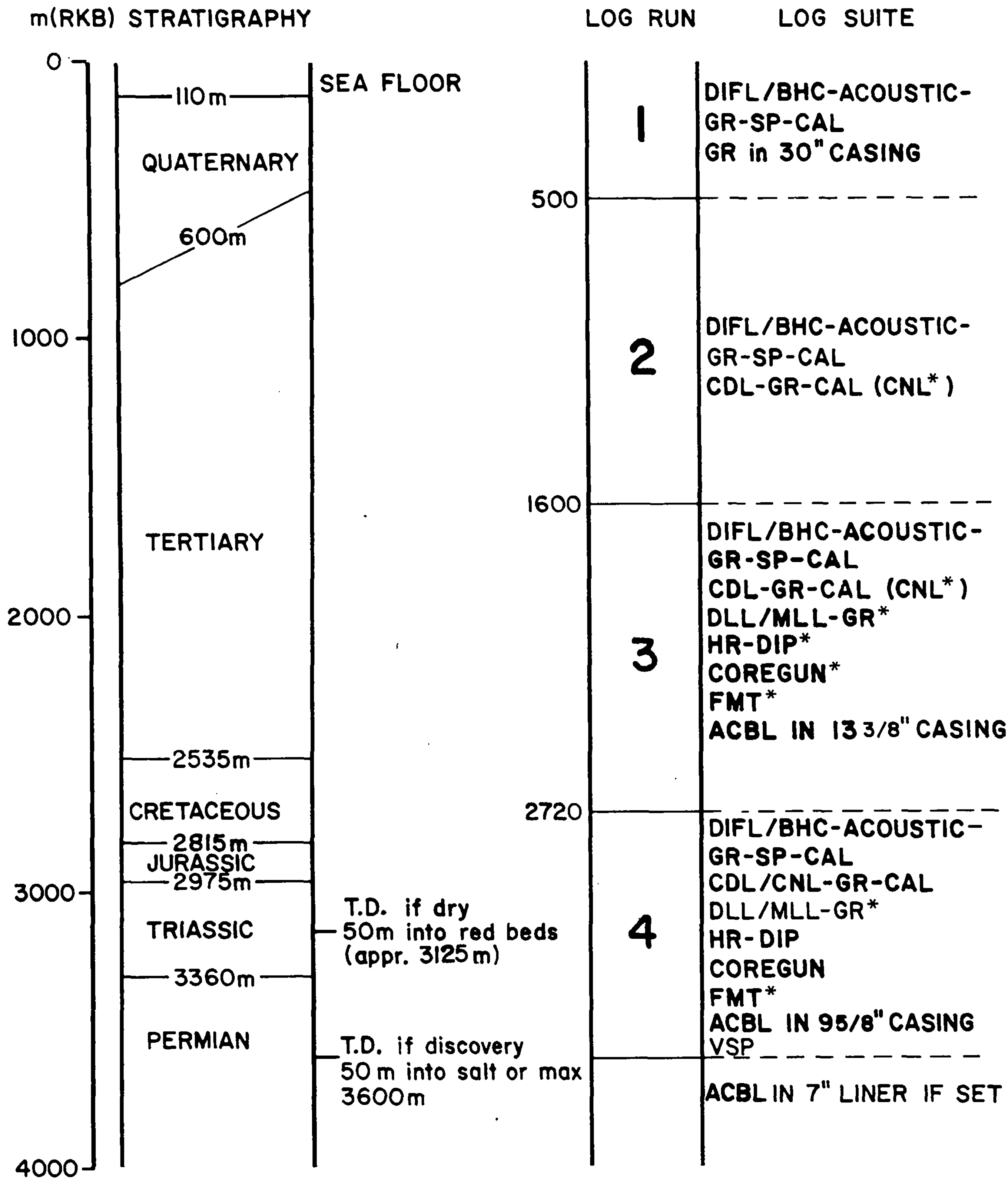
A minimum of one core will be cut in Paleocene and Jurassic sandstones. Additional cores will be cut if significant hydrocarbon shows are encountered. The coring points, and the number of cores to be cut, will be at the discretion of the wellsite geologist, subject to review by the Operation Geologist.

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

TESTING PROGRAM

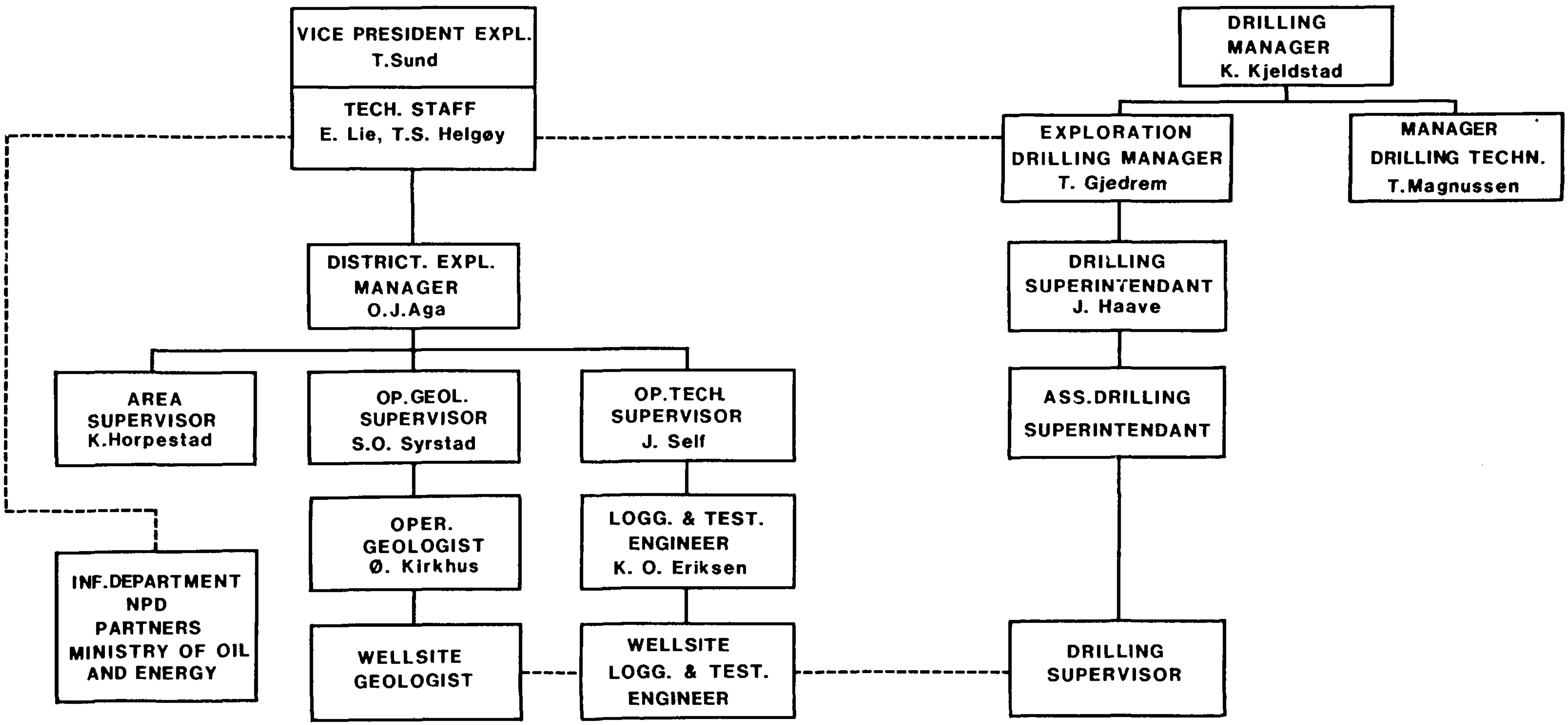
If hydrocarbon accumulations are present, testing will be requested. These tests may be FMT's and/or production tests through casing, depending on analysis of well potential at the time. A supplementary work program will be issued if necessary.

WELL LOGGING PROGRAM-WELL 15/12-4



* OPTIONAL
COMPANY: DRESSER ATLAS

ORGANIZATION CHART WELL 15/12-4



BASE

Statoil operations base at Dusavik 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 NPS 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 NPS 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.

c) 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 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 well 15/12-4:

		TELEPHONE		
NAME	TITLE	OFFICE	HOME	MOBIL
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Kjeldstad, K.	Drilling Manager	541099	591437	
Gjedrem, T.	Expl. Drlg. Manager	541099	620032	
Haave, J.	Drlg. Superintendant	541099	558139	73314
Hellstrand, T.A.	Ops. Engineer	541099	533218	
Sorsell, T.	Ops. Engineer	541099	592404	
Helgøy, T.S.	Oper. Coord. Op.Techn.	577297	661757	
Lie, E.	Oper. Coord. Geol.	578162	620918	57916
Aga, O.J.	Distr. Expl. Manager	533180	534739	
Self, J.C.	Oper. Techn. Supervisor	533180	550824	
Syrstad, S.O.	Oper. Geol. Supervisor	533180	587429	
Horpestad, K.	Area Supervisor	533180	591400	
Kirkhus, Ø.	Oper.Geologist	533180	549579	

COMMUNICATION PERSONNEL, 15/12-4

Esso Exploration and Production Norway Inc.:

NAME	TITLE	TELEPHONE OFFICE	TELEPHONE HOME	TELEPHONE NIGHT
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Thomas, J.	Chief Geologist	606060	560729	
Purdy, E.	Geol. Supervisor	606060	606575	
Macduff-Duncan, C.R.	Oper.Geol.Manager	606060	550100	

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Lysholm, S.		533160
	Faximile	532861

PRESSURE PREDICTION

Overburden gradient

The overburden pressure gradient is based on density logs from the wells 15/12-1 and 15/12-3. Data from 15/12-3 is used down to top Jurassic, and data from 15/12-1 to TD at 3460 m RKB. Fig. 2 shows the prediction pressure gradients for the well.

Pore Pressure

Pressurewise this well must be considered to be a rank wildcat. It will be located on top of a narrow horst formed by salt movements. These have obviously resulted in variable degrees of tectonic stresses over and around the structure, and the stresses may in turn have resulted in abnormal pore pressure. Also note that there is only around 100 - 150 m to a major fault in the east from the location. The fault zone must be avoided and is considered a potential drilling hazard.

The Quaternary and most of the Tertiary is unaffected by the salt movements. It is therefore fairly safe to assume normal pressure through these sections as seen in the correlation wells.

Sandstone may be present in Paleocene from around 2485 m. This is considered a potential prospect and may contain gas. Assuming a gas/water contact 200 m below top sand, the pore pressure gradient will be approximately 1.08 g/cc at the top of the sandstone. In that case a transition zone in the shale above should be expected. If the Paleocene sand is waterfilled, the pressure is probably normal hydrostatic.

The Cretaceous section is the most uncertain. The chalk may be fractured and normally pressured. However, if it is not fractured it is probably overpressured due to the deformation caused by the salt. The degree of overpressure is hard to predict, and it is suggested in Fig. 2 that there is a gradual transition from the higher Jurassic pressure to the lower Paleocene pressure. Particular care should be taken when drilling through this zone.

The Jurassic may also be affected by the salt movements but pressure communication with neighbour structures is assumed. Also a gas column of 150 is assumed. This results in a pressure gradient of around 1.43 g/cc at the top of the reservoir at 2870 m. It should be noted that the prognosed upper Jurassic shale is uncertain and the sandstone may be encountered higher. This will result in slightly higher pressure gradient.

The Triassic is thought to be within the same pressure regime as the lower part of the Jurassic, because of the high sand/shale ratio.

The well is planned drilled to a maximum of 3600 m or 50 m into the salt. The pressure is believed to be no higher than in the Triassic above.

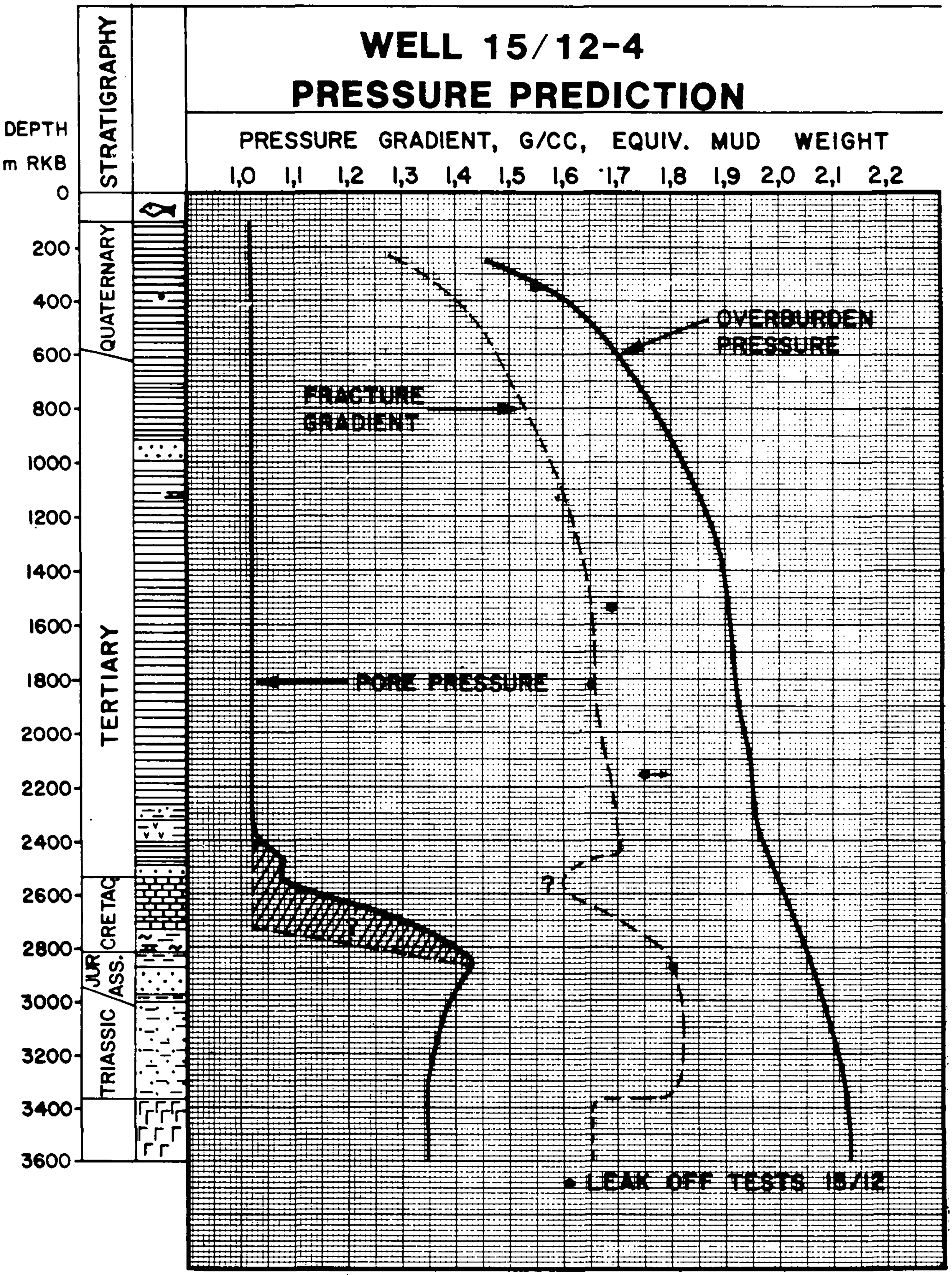
Fracture Pressure

The predicted fracture pressure gradient is based on different theoretical approaches and correlated to the leak-offs obtained in the correlation wells. The estimate is probably fairly good down to top Paleocene. Through Paleocene and Cretaceous there are great uncertainties as to the existence of sand in Paleocene and fractures in the Chalk section. A decrease in formation integrity is suggested for these sequences, but the minimum value of 1.6 g/cc at top of the Cretaceous (Fig. 2) is still very uncertain. This may be a potential lost circulation zone.

Through the Jurassic and Triassic the formation integrity is probably higher and should be sufficient to safely drill and complete the well.

The salt will probably have a lower integrity based on a leak-off test taken in one of the offset wells. The fracture pressure gradient is here estimated to around 1.65 g/cc.

FIG. 2


WELL 15/12-4
PRESSURE PREDICTION
PRESSURE GRADIENT, G/CC, EQUIV. MUD WEIGHT
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
DEPTH
m RKB
0
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
2600
2800
3000
3200
3400
3600
STRATIGRAPHY
QUATERNARY
TERTIARY
CRETAC
JUR ASS.
TRIASSIC
OVERBURDEN PRESSURE
FRACTURE GRADIENT
PORE PRESSURE
?
• LEAK OFF TESTS 15/12

DRILLING PROGRAM

Well designation	:	15/12-4
Vessel	:	Deepsea Bergen
Type drilling rig	:	Aker H-3.2
Drilling draft	:	22 m maximum
RKB to MSL	:	23 m
Air gap	:	15.2 m
Water depth	:	87 m (site survey)
BOP system	:	NL- Schaffer 18 3/4", 690 bar, (10000 psi) stack
Wellhead system	:	Vetco 18 3/4", 690 bar (10 000psi) 3 hanger torque set system.

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

3.0 RIG MOVE AND MOORING PROCEDURE

3.1. Location survey

The water depth at the planned location is approximately 87m. At 492 m RKB there is a strong reflector possibly assosiated with stiff (overconsolidated?) clay layers. However, immediately south of the proposed location there is an area of high amplitude reflection below stiff clay layer, but there is no conclusive evidence of gas.

If logs in the pilothole (or drilling parameters) shows gas, then the pilot hole will be plugged back and the 20" casing set above any potential gas zone.

3.2 Mooring

As per general procedure. Rig heading 315 DEG.

NOTE: There is a major fault 100-150m to the east of the proposed drilling location. Therefore, the rig must not be positioned to the east of the planned location. See drilling hazards and pore pressure prediction.

4.0 GENERAL DRILLING

- Drill 36" hole with 26" x 36" H.O. to ± 175 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 520 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 chapter 7.1. Drill 17 1/2" hole to 1620 m, log and set 13 3/8" casing at 1600 m.

- Drill 12 1/4" hole with rockbit through Ekofisk Chalk Fm. Core as required. Log as programmed. Set 9 5/8" casing with 20 m rathole with shoe in the bottom of the Ekofisk Chalk Formation.

- Drill 8 1/2" hole to T.D. at 3600 m. Core as required. Log as programmed.

- If it is decided to test the Jurassic sandstone, a 7" liner will be run through the test interval w/150 m overlap in 9 5/8" casing.

Drilling considerations

4.1 Drilling 36" hole

After cementing casing, check bulls eye indicator on PGB. If angle is more than 1 1/2° off, consult with operations office before proceeding.

4.2 Running 30" conductors.

On this well 30" casing with Vetco ST-2 connectors will be run.

4.4 Drilling pilot hole and logging

Prior to drilling out 30" shoe, there should always be 50 m^3 1.23 S.G. mud in reserve pit.

In order to obtain the desired formation integrity, the 20" casing should be set at approx 500 m.

Check regularly the density of return mud to prevent the annulus from overloading and breaking down the formation.

While drilling the 12 1/4" pilot hole, all the drilling data should be carefully observed and interpreted. Indication of shallow gas sands may dictate intermediate logging.

Before deciding how to enlarge the 12 1/4" pilot hole, all the drilling data and logs should be carfully 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 from TD to wellhead 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 possible gas bearing sand.

4.6 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 500 m.

4.8 Drilling 17 1/2", 12 1/4" and 8 1/2" hole:

17 1/2" hole: 520-1620 m

The pore pressure is expected to be normal.

Remarks

- For information on well control see "KICK PROCEDURE".
- When drilling this section, there should always be 70m^3 1.25 S.G. mud in reserve.

12 1/4" hole: 1615-2735 m

The pore pressure is expected to be normal down to 2350 m. A pore pressure increase is expected through lower Tertiary to approx. 1.08 S.G. if the Heimdal sand is filled with gas. The Cretaceous may be overpressured due to the deformation caused by the salt. The pore pressure is believed to be maximum 1.33 S.G. at 2735 m. The 9 5/8" casing will be set after drilling through Upper Cretaceous and into Top Plenus Marl. Primary objective is sandstone of Paleocene age. Secondary objectives are Frigg sand and the fractured chalk in Upper Cretaceous.

NOTE: The Upper Cretaceous Chalk may be fractured and normally pressured. However, if it is not fractured, it is probably overpressured due to the deformation caused by the salt. Also note that there is a major fault 100-150 m to the east of the drilling location. The fault zone must be avoided as it is considered as a potential drilling hazard. The hole should be kept as straight as possible.

8 1/2" hole: 2740-3600 m

The pore pressure is expected to increase to approx. 1.43 S.G. at the top of the reservoir. The prognosed Upper Jurrasic shale is uncertain and the sandstone may be encountered higher. This will result in a slightly higher pressure gradient. At T.D. the pressure declines to approx. 1.34 S.G. The well is planned drilled 50 m into Zechstein salt, or to maximum 3600 m.

If hydrocarbons are encountered in this section, and it is decided to test the zones, a 7" liner will be run. Otherwise the hole will be plugged with open hole cement plugs 50 m into 9 5/8" casing.

For information on maximum kick sizes that can be taken before breaking down formation, see "Kick Limitations". The predicted pore pressure of 15/12-4 is based on the results from 15/12-1 and 15/12-3.

Directional survey program

Directional surveys will normaly be run every 100 m after setting the 20" casing.

A MWD tool shall be run in the 12 1/4" and 8 1/2" hole section to have better control of the direction.

When running a MWD tool surveys shall be taken at least every third joint and single shot surveys can be left out. MWD surveys can be checked by dropping single shot on trips. When a survey is being taken the depth of the survey tool, and not the depth of the well at that particular time, should be reported.

4.11 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.

NOTE: A measurement while drilling tool will be used in the 12 1/4" and 8 1/2" section.

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 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 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.

4.12 Formation evaluation:

The mud returns will be monitiored continuously to detect H_2S. Also check the hole for H_2S-content in 100 m intervals below 1600m (or when background gas exceeds 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.

5. CASING PROGRAM

SIZE	DEPTH	WEIGHT	GRADE	CONNECTION
30"	110 - 175	1jnt 1.5"wt	B	Vetco ST-2
		4jnt 1" wt	B	" "
20"	110 - 500	94	X-56	Vetco LS
13 3/8"	110 - 1600	72	N-80	Buttress
9 5/8"	110 - 2000	47	N-80	Buttress
	2000- 2720	47	P-110	"
7"+	2570 - 3600	29	N-80	Buttress

See "Casing Design"
+ optional.

6.0 MUD PROGRAM 15/12-4

Interval M RKB	Hole size	Mud type	Weight (g/cm^3)	PV	YP	HTHP w.l	pH
110 - 175	36"	Spud mud					
175 - 520	26"	Spud mud					
520 - 1620	17 1/2"	Gyp polymer	1.1	As low	20 - 25	API: 10 - 15	9.5 - 10.3
1620 - 2740	12 1/4"	Gyp polymer	1.1 - 1.38	as	15 - 20	API: 5 - 10	9.5 - 10.3
2740 - 3600	8 1/2"	Gel/ligno	1.48	possible	12 - 16	API: 4 - 6	10.0 - 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 (150 - 120 mesh screens).
- Utilize the centrifuge for viscosity control and for barite salvage.
- See separate Mud Program for details.

7.1 BOP TESTING

BOP test pressures:	Pipe rams	Bags	Choke and kill valves
1. On surface	690bar	241bar	690bar
2a Initial and subsequent installation on wellhead	385bar	241bar	385bar
Close shear ram with the accoustic system and test shear ram against casing.			
2b Weekly test with 20" casing set	60bar	60bar	60bar
3 Weekly test with 13 3/8" casing set	242bar	241bar	242bar
4 Weekly test with 9 5/8" casing set	385bar	241bar	385bar
5. Weekly test with 7" liner set	345bar	241bar	345bar

Shear ram will be tested to 690 bar on surface. After BOP is mounted on wellhead, it will only be tested when testing casings.

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 according to point 2a above. During this test, if 13 3/8" casing 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.

Casing and seal assembly test pressure (see note below)

20" casing	-	60 bar
13 3/8" casing	-	241 bar
9 5/8" casing	-	385 bar
7" liner	-	345 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:	Tension:
20"	1.30	1.18	1.5
13 3/8"	1.30	1.18	1.5
9 5/8"	1.25	1.18	1.5
7"	1.25	1.18	1.5

8. PLUG AND ABANDONMENT

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

Approved

------------------------------	------------------------------
Vice President Exploration	Drilling Manager Statoil

KICK LIMITATION 15/12-4

Drilling below 20" casing:

The general procedure is: Not to shut in a well with only 20" casing set. Consult with the office on permission to close the BOP after the leak off test is finished. Maximum porepressure is expected to be 1.02 S.G. in this interval. Formation integrity below 20" casing shoe is expected to be 1.44 S.G. A mud weight of 1.10 S.G. should be sufficient to control the well. If the well kicks at 1615m (p.p. = 1.10 S.G.) a kick height of approx 154 m can be controlled by closing the BOP. (See fig. 1). This is equal to a volume of 18.4 m^3 influx.

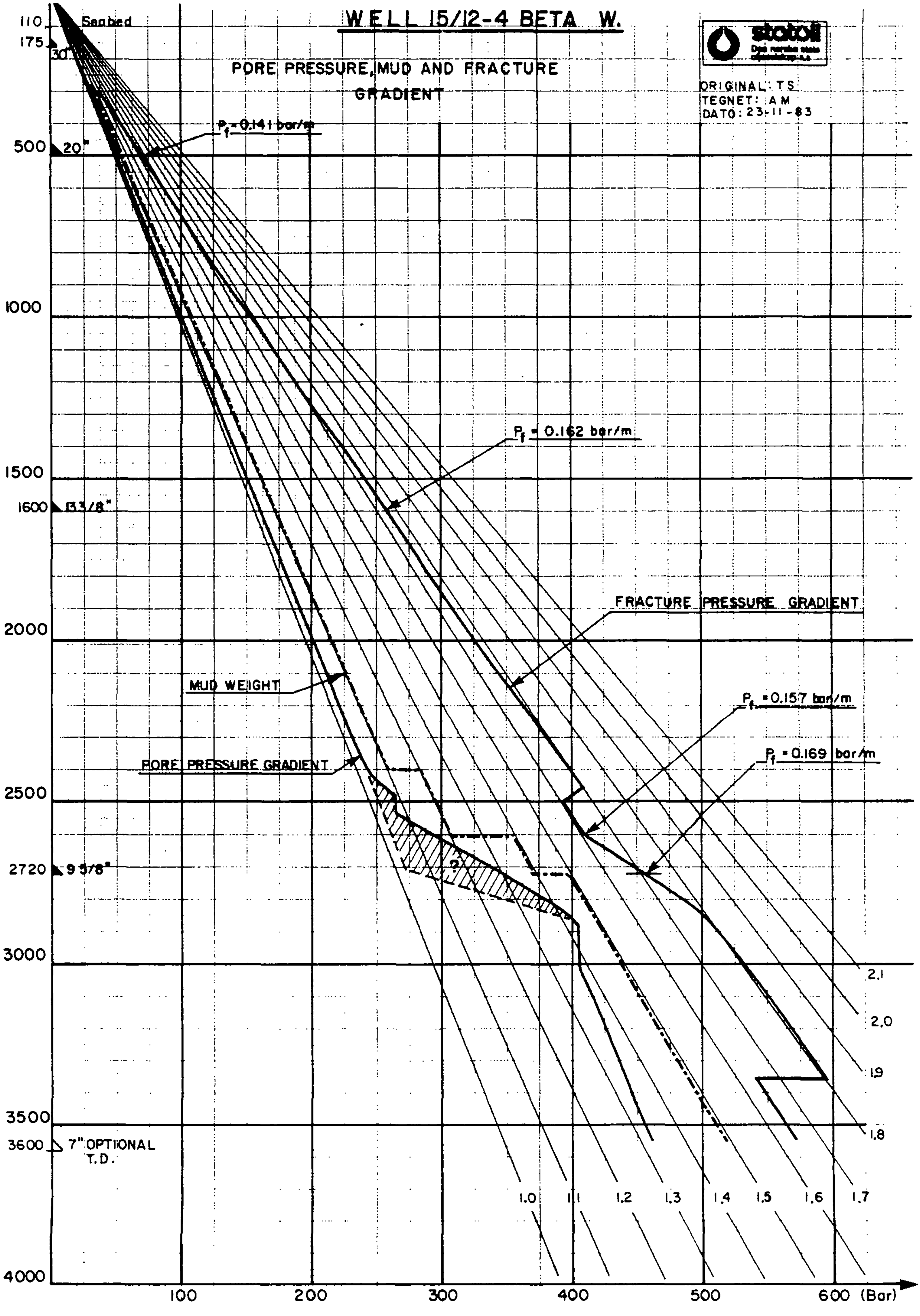
Drilling below 13 3/8" casing:

Formation integrity below the 13 3/8" casing shoe is expected to be 1.65 S.G. The maximum considered porepressure is 1.33 S.G. at 2735m, a kick height of 385m can be controlled by closed BOP. (See fig.1). This os equal to a volume of 21.3m^3 influx.

Drilling below 9 5/8" casing:

Formation integrity below the 9 5/8" shoe at 2720 is estimated to be 1.72 S.G The maximum porepressure gradient while drilling is expected to be 1.43 S.G. at 2870m. Necessary riser margin with additional 7 bars at this depth es 0.05 g/cm^3. A mudweight of 1.48 S.G. should be sufficient to control the well.

If the well kicks at 2870 m with a porepressure equivalent to 1.43 S.G. there is no limit for the kickheight (see fig. 1) If the well kicks at T.D. with a porepressure of 1.34 S.G., a kick height of 771 m can be controlled by closed BOP. (See fig. 1). This is equal to a volume of 16.3m^3 influx.


WELL 15/12-4 BETA W.
statoil
PORE PRESSURE, MUD AND FRACTURE GRADIENT
ORIGINAL: TS
TEGNET: AM
DATO: 23-11-83
110 Seabed
175 30"
P_f = 0.141 bar/m
500 20"
1000
P_f = 0.162 bar/m
1500
1600 13 3/8"
FRACTURE PRESSURE GRADIENT
2000
MUD WEIGHT
P_f = 0.157 bar/m
P_f = 0.169 bar/m
PORE PRESSURE GRADIENT
2500
2720 9 5/8"
3000
2.1
2.0
1.9
1.8
3500
3600 7" OPTIONAL T.D.
1.0
1.1
1.2
1.3
1.4
1.5
1.6
1.7
4000
100
200
300
400
500
600 (Bar)

3-4-1-84

KICK LIMITATIONS 15/12-4

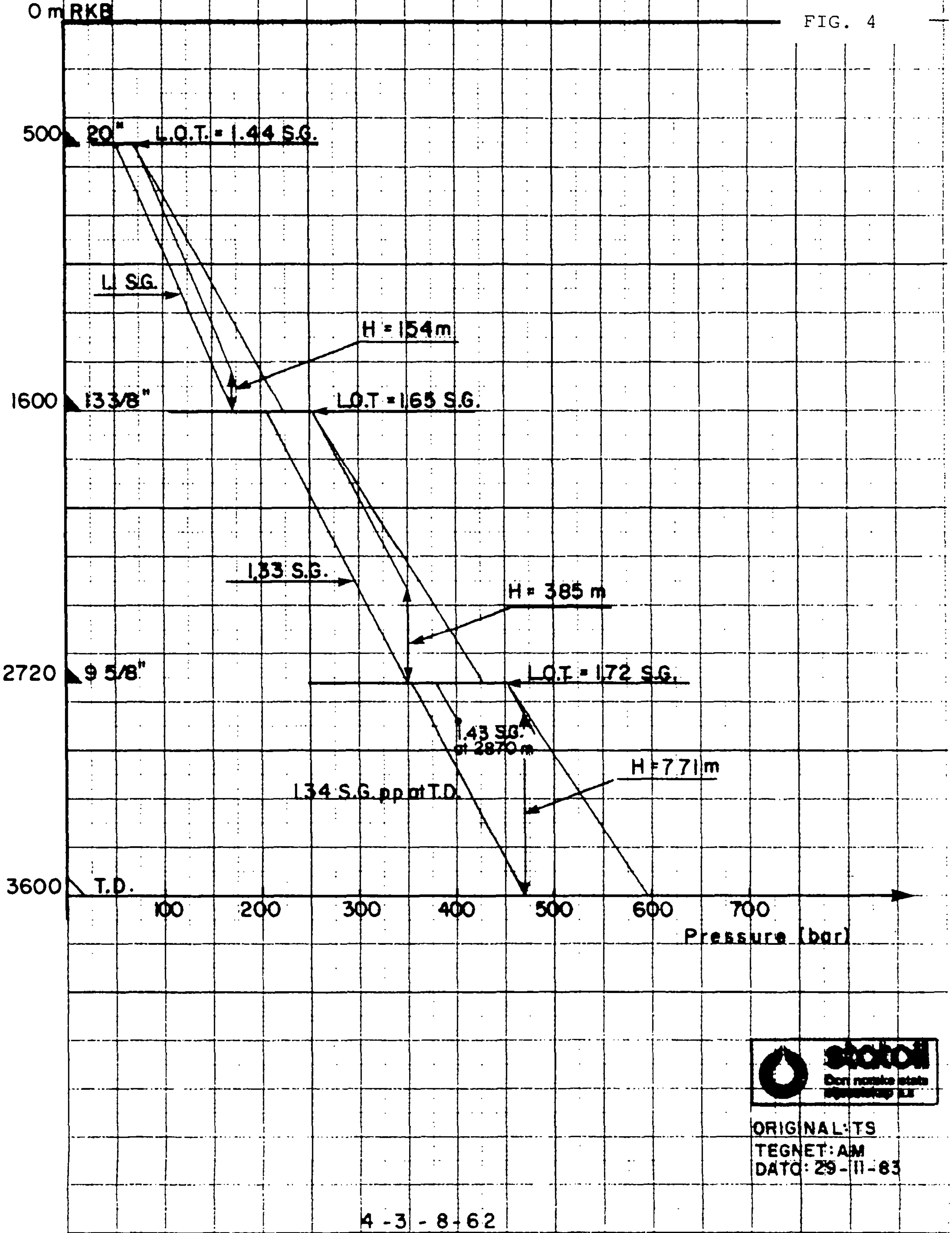


FIG. 4

4 - 3 - 8 - 62

Nomenclature

X	= Casing setting depth (m)
W_D	= Drilling depth below X (m)
Z	= Depth from RKB to seabed (m)
Z_1	= Water depth (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)
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)
P_B	= Burst load (bar)
P_C	= Collapse load (bar)
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 = 1.18
$S.F._C$	= Safety factor, collapse = 1.25 (1.3 for 13 3/8" and larger
$S.F._T$	= Safety factor, tension = 1.5

20" Casing Design 15/12-4

X	=	500 m	G_f	=	0.141 bar/m
W_D	=	1 620 m	G_i	=	0.108 bar/m
Z	=	110 m	G'_i	=	0.108 bar/m
Z_1	=	87 m	G_{gas}	=	0.01 bar/m
L	=	12 m	G_{c1}	=	0.153 bar/m
M_c	=	140 kg/m	G_{c2}	=	0.187 bar/m
G_p	=	0.1 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:

$$P_{B1} = X \times G_f - (X - Z)G_{gas} - Z_1 \times G_p$$
$$= 500 \times 0.141 - (500 - 110) \times 0.01 - 87 \times 0.1 = \underline{57.9 \text{ bar}}$$

Burst load at casing shoe, when pressure testing casing to 60 bar.

$$P_{B2} = 60 + X \times G_i - (X-Z+Z_1) \times G_p$$

$$= 60 + 500 \times 0.108 - (500 - 23) \times 0.1 = \underline{66.3 \text{ bar}}$$

COLLAPSE:

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.

$$P_C = (55-L)G_{c2} + (X - 55 - Z)G_{c1} + Z_1 \times G_p - (X - L)G_p$$
$$= (55-12) \times 0.187 + (500-55-110) \times 0.153 + 87 \times 0.1-(500-12) \times 0.1$$
$$= \underline{19.2 \text{ bar}}$$

Collapse load is zero at wellhead.

Select: 110 - 500 m : 20", 140 kg/m (94 lb/ft), X - 56, Vetco LS

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

Safety factor: Collapse:

$$S.F._C = \frac{RES_C}{P_C} = \frac{36}{19.2} = \underline{1.88}$$

Safety factor: Burst:

$$S.F._B = \frac{RES_B}{P_{B1}} = \frac{152}{66.3} = \underline{2.29}$$

TENSION:

Weight of casing string in air:

$$T_c = (X - Z) \times M_c = (500 - 110) \times 140 \times 10^{-3} = \underline{54.6 \text{tons}}$$

Casing inside diameter: ID = 48.6cm

Extra tensile load when bumping plug with 55 bar:

$$T_{cem} = (55 - P_c) \times 0.98 \left(\frac{ID}{2}\right)^2 \times 3.14 \times 10^{-3}$$

$$= (55 - 19.2)\ 0.98 \times \left(\frac{48.6}{2}\right)^2 \times 3.14 \times 10^{-3}$$

$$= \underline{65.1 \text{ tons}}$$

Total weight load at wellhead :

$$T = T_c + T_{cem}$$
$$= (54.6 + 65.1) \text{ tons} = \underline{119.7 \text{ tons}}$$

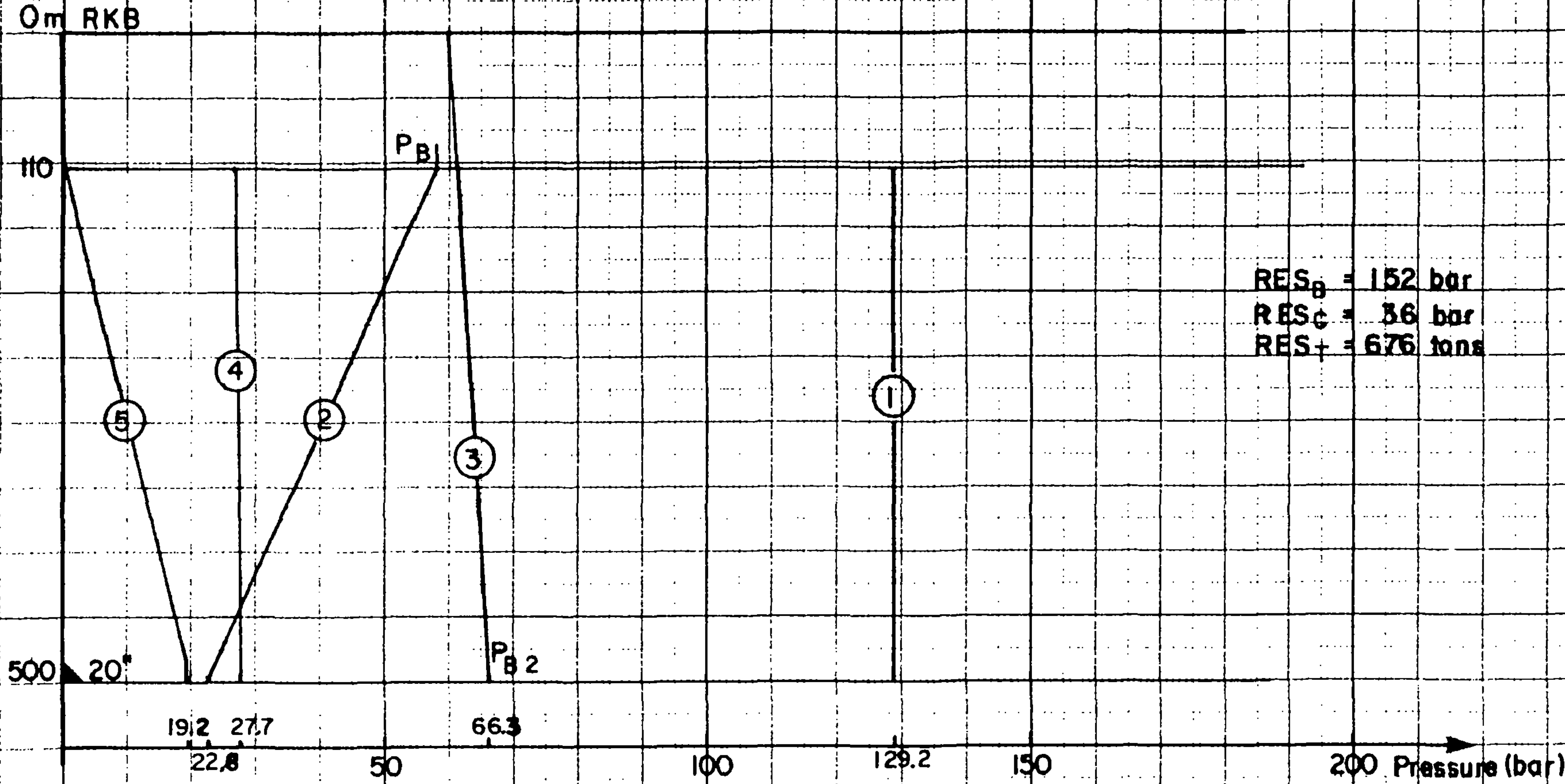
<u>Safety factor: Tension</u>

$$S.F._T = \frac{RES_T}{load} = \frac{676}{119.7} = \underline{5.65}$$

20" CASING DESIGN

WELL 15/12-4 βw

20" CASING : X-56, 94 lb/ft, VETCO LS



① BURST RESISTANCE, CORR. FOR S.F. = 1.18
② BURST LOAD, CASING FILLED W/GAS
③ BURST LOAD, PRESSURE TEST CASING TO 60 BAR
④ COLLAPSE RESISTANCE, CORR. FOR S.F = 1.3 AND BIAXIAL STRESS
⑤ COLLAPSE LOAD DURING CEMENTING

statoil
Den norske stats oljeselskap a.s

ORIGINAL: TS
TEGNET: AM
DATO: 30-11-83

4-3-8-61

13 3/8" Casing Design 15/12-4

$X = 1600$ m	$G_p = 0.1$ bar/m
$W_D = 2740$ m	$G_f = 0.162$ bar/m
$L = 24$ m	$G_{gas} = 0.02$ bar/m
$Z = 110$ m	$G_{c1} = 0.153$ bar/m
$Z_1 = 87$ m	$G_{c2} = 0.187$ bar/m
$G_i = 0.108$ bar/m	$M_c = 106.6$ kg/m
$G'_i = 0.135$ bar/m	

Design Criteria:

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

BURST:

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

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

$$= 1600 \times 0.162 - (1600 - 110) \times 0.02 - 110 \times 0.1 = \underline{218.4 \text{ bar}}$$

Max burst load while testing casing to 241 bar

$$P_{B2} = 241 + X \times (G_i - G_p)$$

$$= 241 + 1600 \times (0.108 - 0.1) = \underline{253.8 \text{ bar}}$$

SELECT: 110 - 1600 m: 13 3/8", 72 lb/ft, N-80, buttress.

$RES_C = 184$ bar
$RES_B = 371$ bar
$RES_T = 723$ tons

Safety factor burst:

$$S.F._B = \frac{RES_B}{P_{B2}} = \frac{371}{253.8} = \underline{1.46}$$

COLLAPSE

Max allowable load while cementing:

$$P_C = (X - L) \times (G_f - G_i)$$

$$= (1600 - 24) \times (0.162 - 0.108) = \underline{85.1 \text{ bar}}$$

Max. collapse load at float collar during cementing. (cement 100m into 20" casing). $10m^3$ tail in slurry leaves 126 m in annulus and 24 m inside casing:

$$P_{C1} = G_{c1} \times (X - 126 - 500 + 100) + G_{c2} \times (126 - L) -$$

$$G_i \times (X - L - 500 + 100)$$

$$= 0.153 \times 1074 + 0.187 \times 102 - 0.108 \times 1176 = \underline{56.4 \text{ bar}}$$

Reduced RES_C on top casing due to biaxial stress:

Weight load in air: $T_C = (X-Z) \times M_C = (1600-110) \times 106.6$
$= \underline{158.8 \text{ tons}}$

$$\frac{T_C}{RES_T} = \frac{158.8 \text{ tons}}{723 \text{ tons}} = \underline{0.22}$$

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

Safety factor collapse:

$$S.F._C = \frac{RES_C}{P_C} \times 0.88 = \frac{161.9}{56.4} = \underline{2.87}$$

TENSION:

Extra tensile load when bumping plug (neglecting steel buoyancy for extra safety) with 172 bar. Casing inside diameter:
ID = 31.36 cm

$$T_{cem} = (172 - P_{c1}) \times 0.98 \times \left(\frac{ID}{2}\right)^2 \times 3.14 \times 10^{-3}$$

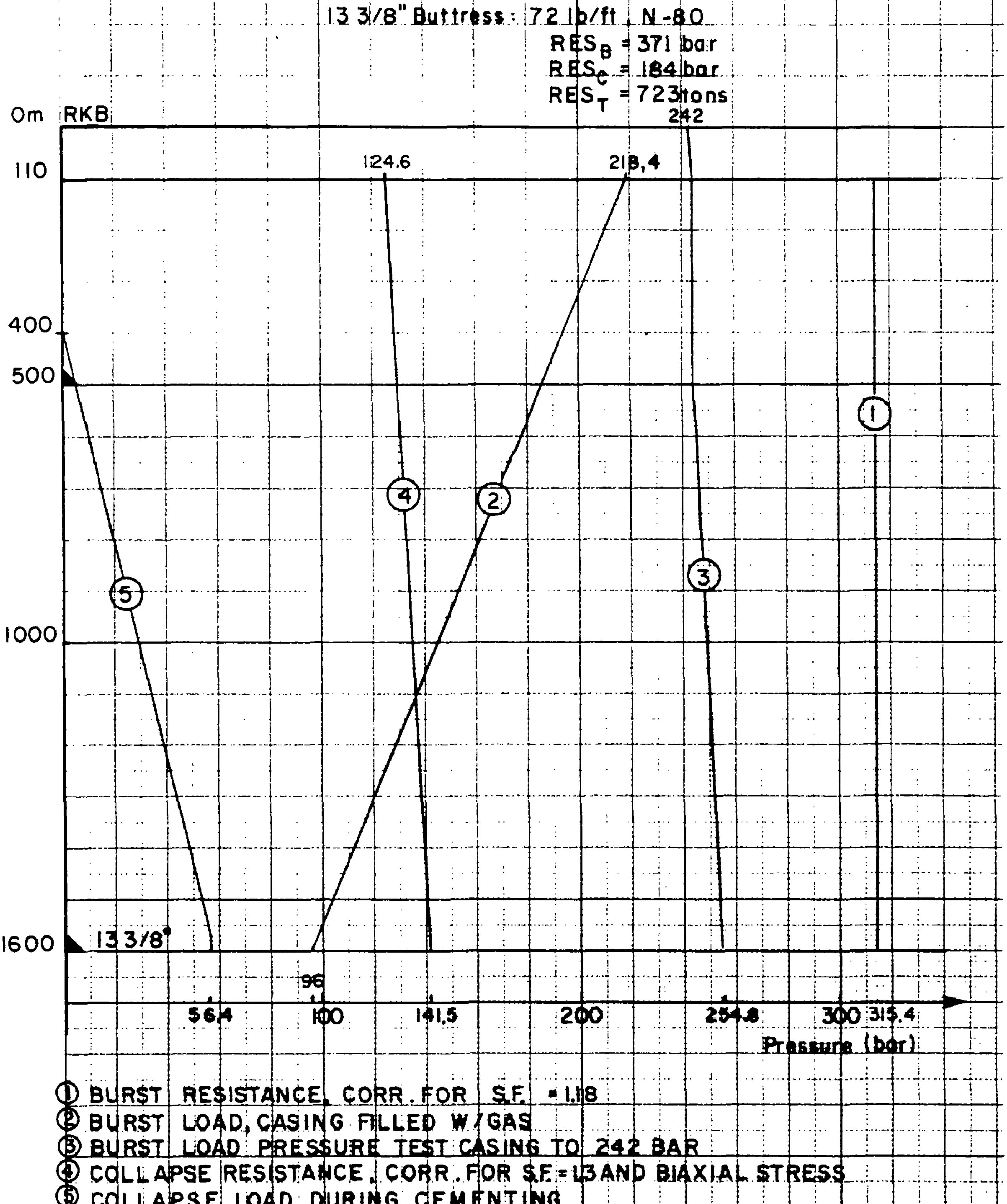
$$= (172-56.4) \times 0.98 \times \left(\frac{31.36}{2}\right)^2 \times 3.14 \times 10^{-3} = \underline{87.5 \text{ tons}}$$

Total weight load: $T = T_c + T_{cem}$

$= (158.8 + 87.5)$ tons $=$ 246.3 tons

$$S.F._T = \frac{RES_T}{load} = \frac{723}{246.3} = \underline{2.93}$$

13 3/8" CASING DESIGN, WELL 15/12-4 β w



statoil

ORIGINAL: TS
TEGNET: AM
DATO: 29-11-83

4-3-8-60

<u>9 5/8" Casing Design 15/12-4</u>

X	=	2720 m	G_f	=	0.169 bar/m
W_D	=	3600 m	G_i	=	0.135 bar/m
Z	=	110 m	G'_i	=	0.145 bar/m
Z_1	=	87 m	G''_i	=	0.145 bar/m
L	=	24 m	G_{gas}	=	0.023 bar/m
G_p	=	0.1 bar/m	G_{c1}	=	0.153 bar/m
G'_p	=	0.140 bar/m at 2880m	G_{c2}	=	0.186 bar/m
G''_p	=	0.131 bar/m	M_c	=	70 kg/m (9 5/8")
			M_c	=	43.15 kg/m (7")

<u>Design Criteria:</u>

BURST : Tubing leak while testing.

COLLAPSE : Collapse load during cementing.

TENSION : Tension load when bumping plug.

<u>Burst:</u>

Burst load at wellhead if there is tubing leak just below the wellhead while testing at 2880m.

$$P_{B1} = G'_p \times 2880 - G_{gas} \times (2880 - Z) - Z \times G_p$$

$$= 0.140 \times 2880 - 0.023 \times (2880-110) - 110 \times 0.1 = \underline{328.5 \text{ bar}}$$

Burst load at 2570m (7" liner top) if tubing leak at wellhead.

$$P_{B2} = P_{B1} + (2570 - Z) \times G''_i - (2570 - 1600) \times G_p$$

$$-(1600 - Z) \times G_i$$

$$= 328.5 + (2570 - 110) \times 0.145 - 970 \times 0.1$$

$$-(1600 - 110) \times 0.135 = \underline{387.1 \text{ bar}}$$

Burst load at wellhead with casing filled with gas.

$$P_{B3} = G''_p \times W_D - (W_D - Z) \times G_{gas} - Z \times G_p$$

$$= 0.131 \times 3600 - (3600 - 110) \times 0.023 - 110 \times 0.1 = \underline{380.3 \text{ bar}}$$

Max burst load when testing casing to 385 bar

$$P_{B4} = 385 + (G_i - G_p) \times (X - 1600 + Z)$$

$$= 385 + (0.135 - 0.1) \times (2720 - 1600 + 110)$$

$$= \underline{428.1 \text{ bar}}$$

Select: 110 - 2000m: 47 lb/ft, N-80 buttress

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

Select: 2000 - 2720m: 47 lb/ft, P-110 buttress

RES_C = 366 bar
RES_B = 651 bar
RES_T = 646 tons

Test pressure at 2000m:

$$P_{B5} = 385 + (G_i - G_p) \times (2000 - 1600 + Z)$$

$$= 385 + (0.135 - 0.1) \times 510$$

$$= \underline{402.9 \text{ bar}}$$

Safety factor burst

$$S.F._B = \frac{RES_B}{P_{B3}} = \frac{651}{428,1} = \underline{1.52} \quad \text{for P-110 at 2720 m}$$

$$S.F._B = \frac{RES_B}{P_{B4}} = \frac{474}{402.9} = \underline{1.18} \quad \text{for N-80 at 2000 m}$$

Collapse:

During cementing (cement 100 m into 13 3/8" casing).
$10m^3$ tail in slurry leaves 315m outside and 24m inside 9 5/8" casing.

$$P_C = (315 - L) \times G_{c2} + (X - 315 - 1600 + 100) \times G_{c1}$$

$$- (X - L - 1600 + 100) \times G_i$$

$$= (315 - 24) \times 0.186 + (2720 - 1815) \times 0.153 - (2720-1524) \times 0.135$$

$$= \underline{31.1 \text{ bar}}$$

Tensile load at wellhead

$$T = T_1 + T_2 = (X - Z) \times M_c = (2720 - 110)\text{m} \times 70 \text{ kg/m} = \underline{182.7 \text{ tons}}$$

$$\frac{T}{RES_T} = \frac{182.7}{472} = \underline{0.39}$$

From the Ellipse of Biaxial Yield Stress, this gives 26% reduction in collapse strength.

Safety Factor Collapse

$$S.F._C = \frac{RES_C}{P_C} \times 0.74 = \frac{328}{31.1} \times 0.74 = \underline{7.81}$$

Tension:

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

$T_c = X \times M_c = 2720m \times 70\ kg/m$ = 190.4 tons

Extra tensile load when bumping plug at 172 bar
(neglecting buoyancy of steel):
Note: Liner inside diameter : ID = 15.71 cm

P_C = 43.3 bar for 7" liner (see 7" liner design).

$$T_{cem} = (172 - P_C) \times 0.98 \times \left(\frac{ID}{2}\right)^2 \times 3.14 \times 10^{-3}$$

$$= (172-43.3) \times 0.98 \times \left(\frac{15.71}{2}\right)^2 \times 3.14 \times 10^{-3} \quad = \underline{24.4\ tons}$$

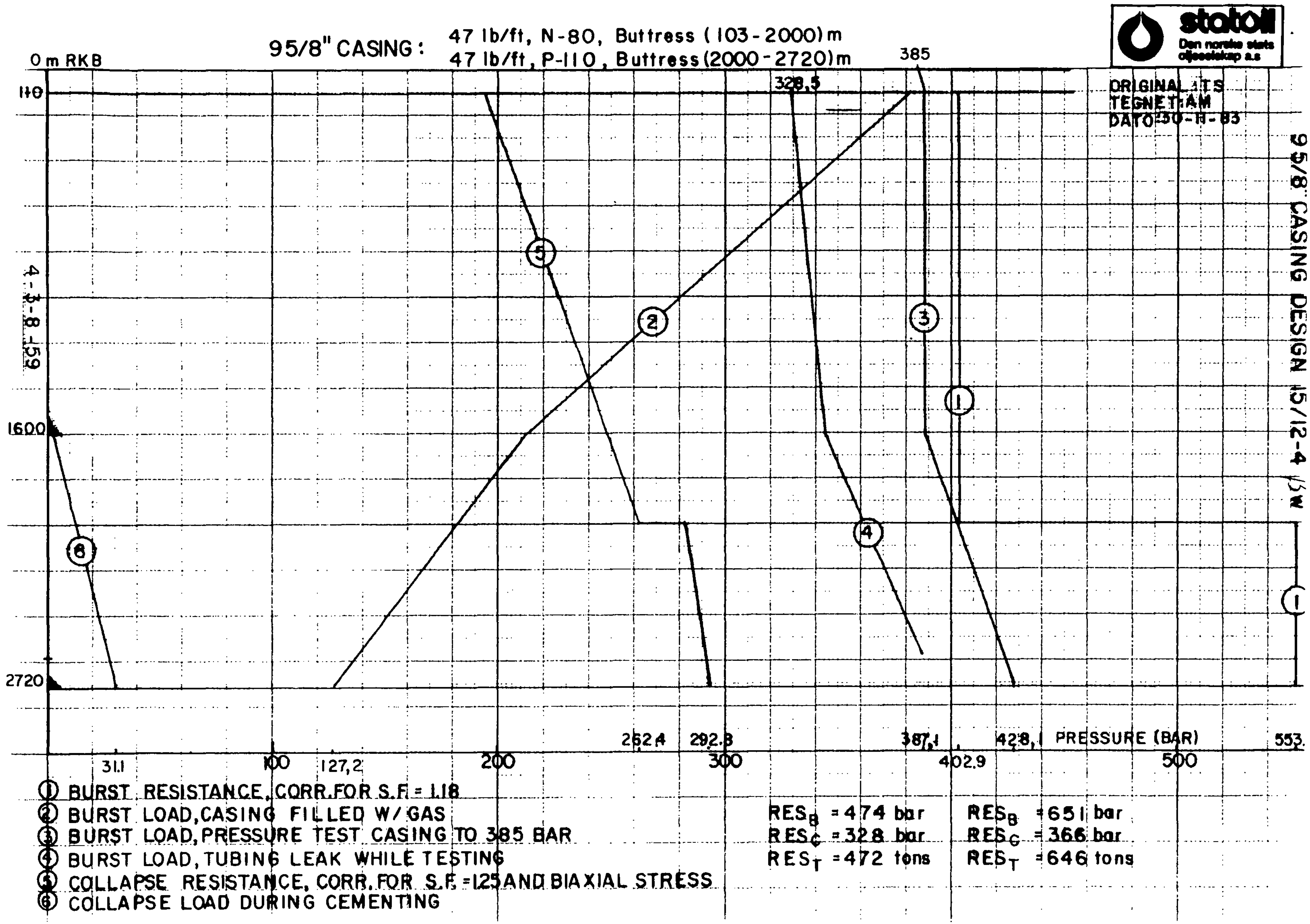
Weight load of 7" liner: $T_l = (W_D - X + 150) \times M_c$

$= (3600-2720 + 150)m \times 43.15\ kg/m$ = 44.4 tons

Total weight load: $T = T_c + T_{cem} + T_l$

$= (190.4 + 24.4 + 44.4)$tons = 259.2 tons

$$S.F._T = \frac{RES_T}{T} = \frac{472}{259.2} = \underline{1.82}$$


95/8" CASING DESIGN 15/12-4 /3w
statoil Den norske stats oljeselskap a.s
ORIGINAL: TS
TEGNET: AM
DATO: 30-11-83
95/8" CASING : 47 lb/ft, N-80, Buttress (103-2000) m
47 lb/ft, P-110, Buttress (2000-2720) m
0 m RKB
110
1600
2720
4-3-8-159
385
328,5
262,4
292,8
387,1
402,9
428,1
PRESSURE (BAR)
553
31,1
100
127,2
200
300
500
① BURST RESISTANCE, CORR. FOR S.F = 1.18
② BURST LOAD, CASING FILLED W/GAS
③ BURST LOAD, PRESSURE TEST CASING TO 385 BAR
④ BURST LOAD, TUBING LEAK WHILE TESTING
⑤ COLLAPSE RESISTANCE, CORR. FOR S.F = 1.25 AND BIAXIAL STRESS
⑥ COLLAPSE LOAD DURING CEMENTING
RES_B = 474 bar
RES_C = 328 bar
RES_T = 472 tons
RES_B = 651 bar
RES_C = 366 bar
RES_T = 646 tons

7" Liner Design 15/12-4

X	= 3600m		
W_D	= 3600m	G_p	= 0.1 bar/m
Z	= 110 m	G'_p	= 0.140 bar/m at 2880m
Z_1	= 87 m	G_{gas}	= 0.023 bar/m
M_c	= 43.15 kg/m	G_c	= 0.187 bar/m
G_i	= 0.145 bar/m	G'_i	= 0.145 bar/m
G''_i	= 0.145 bar/m		

Design criteria:

BURST : Tubing leak while testing
Pressure testing casing/liner
COLLAPSE: Collapse load while 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 2880 m.

$$P_{B1} = G'_p \times 2880 - G_{gas} \times (2880 - Z) - G_p \times Z$$

$$= 0.140 \times 2880 - 0.023\ (2880 - 110) - 0.1 \times 110$$

$$= \underline{328.5 \text{ bar}}$$

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 2880 m
(Packer at 2850 m).

$$P_{B2} = P_{B1} + (2850 - Z) \times G''_i - (1600 - Z) \times 0.135$$

$$- (2850 - 1600) \times G_p$$

$$= 328.5 + (2850-110) \times 0.145 - (1600 - 110) \times 0.135 - 1250 \times 0.1$$

$$= \underline{399.7 \text{ bar}}$$

Burst load when testing 7" liner /9 5/8" casing to 345 bar with 1.48 S.G. mud.

$$P_{B3} = 345 + G_i x X - (1600-Z) \times 0.135 - (X-1600+Z) \times G_p$$

$$= 345 + 0.145 \times 3600 - (1600-110) \times 0.135 - (3600-1600+110) \times 0.1$$

$$= \underline{454.9 \text{ bar}}$$

From 2570 - 3600 m select : 7", 29 lb/ft, N-80, Buttress

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

$$S.F._B = \frac{RES_B}{P_{B3}} = \frac{563}{454.9} = \underline{1.24}$$

<u>Collapse:</u>

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

Collapse load during cementing:

$$P_C = (G_c - G_i) x (X-2570) = (0.187-0.145) \times (3600-2570)$$

$$= \underline{43.3 \text{ bar}}$$

Minimum flowing bottom hole pressure when testing at 2880 m

$$P_{WF}\ \text{min} = 2880 \times G'_p - \frac{RES_C}{1.25}$$

$$P_{WF}\ \text{min} = 2880 \times 0.140 - \frac{484}{1.25} = \underline{16\ \text{bar}}$$

Tension:

Weight load in air:

$$T_c = (X-2570) \times M_c = (3600-2570)\text{m} \times 43.15\text{kg/m} = \underline{44.4\ \text{tons}}$$

Liner I.D. = 15.71 cm

Extra tensile load when bumping plug with 172 bar:

$$T_{cem} = (172 - 43.3) \times 0.98 \times \left(\frac{15.71}{2}\right)^2 \times 3.14 \times 10^{-3}$$

$$= \underline{24.4\ \text{tons}}$$

Total tensile load $T = T_c + T_{cem}$
$= (44.4 + 24.4)$ tons $= \underline{68.8 \text{ tons}}$

$$S.F._T = \frac{RES_T}{T} = \frac{294}{68.8} = \underline{4.27}$$

30" CASING CEMENT DATA AND CALCULATIONS, 15/12-4

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.........................:	110 m
Depth kb-last shoe.......................:	
Depth kb-casing set point................:	175 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 + 4.00 1/100 kg Liquid Econolite	CLASS "G"-cement
Mix water	1/100 kg	92.00 sea	45.09 sea
Total liquid	1/100 kg	96.00	45.09
Slurry weight	g/cm^3	1.56	1.90
Slurry yield	1/100 kg	127.75	76.04
TEST DATA AT BHCT			
Thickening time at BHHP, hr:min		5:00	4:30
Crit. Turb.Flow rate:m/s (1/min)			
Fluid loss,			
TEST DATA AT BHST, BHHP			
Compr. strength, bar 16 hr		31	62

REMARKS:

Fann VG Readings 600/300/200/100		
Free Water	0.5 %	1.8 %

Volume calculations (30" casing):

Annular volume	: 0.200 m^3/m x (175-110)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 + 4.00 1/100 kg Liquid Econolite mixed with seawater at 1.56 g/cm^3
18600 kg cement equivalent to 23.7 m^3 slurry

Tail-in slurry : Class G-cement mixed with seawater to 1.90 g/cm^3.
13000 kg cement equivalent to 10.0 m^3 slurry

Chemicals needed: Total volume of Liquid Econolite needed : 750 L

20" CASING CEMENT DATA AND CALCULATIONS, 15/12-4

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..........................:	110 m
Depth kb-last shoe........................:	175 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 lbs/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)......:	35 °C
Est. bottom hole circulating temp. (BHCT).:	30 °C
Est. formation integrity..................:	0.142 bar/m

		FILLER/LEAD SLURRY	TAIL IN SLURRY
CEMENT SLURRY COMPOSITION		CLASS "G"cement + 4.0 1/100 kg Liquid Econolite	CLASS "G"cement
Mix water	1/100 kg	92.0 sea	45.1 sea
Total liquid	1/100 kg	96.0	45.1
Slurry weight	g/cm^3	1.56	1.90
Slurry yield	1/100 kg	127.8	76.8
TEST DATA AT BHCT			
Thickening time at BHHP, hr:min		4:30	3:00
Crit. Turb.Flow rate:m/s (l/min)			
Fluid loss, ml/			
TEST DATA AT BHST, BHHP			
Compr. strength, bar 24 hr		30	70

REMARKS:

Fann VG Readings
600/300/200/100

Volume calculations (20" casing):

Annular volume	: 0.1394 m^3/m x (500-175)m	= 45.3 m^3
Volume between csg's:	0.194 m^3/m x(175-110) m	= 12.6 m^3
12 m plug at shoe	: 0.1853 m^3/m x 12m	= 2.2 m^3
100% excess in open hole:		= 45.3 m^3
Total volume		=105.4 m^3

Lead slurry : Class "G"-cement + 4.0 l/100 kg Liquid Econolite mixed with seawater to 1.56 g/cm^3.
76300 kg cement equivalent to 95.4 m^3 slurry

Tail-in slurry : Class "G"-cement mixed with seawater to 1.90 g/cm^3.
13200 kg cement equivalent to 10.0 m^3 slurry

Chemicals needed: Total volume of Econolite needed : 3052 l

Hydrostatic pressure at 20" csg. shoe

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

Hydrostatic head of lead slurry :

0.153 bar/m x (500-110-56)m = 51.1 bar

Hydrostatic head of tail-in slurry :

0.186 bar/m x 56 m = 10.4 bar

Hydrostatic head of sea-water :

0.1 bar/m x (110 - 23)m = 8.7 bar

Total hydrostatic pressure = 70.2 bar

Equivalent pressure gradient at 20" shoe:

$$\frac{70.2\ \text{bar}}{500\ \text{m}} = 0.140\ \frac{\text{bar}}{\text{m}}$$

Estimated formation integrity : 0.141 bar/m.

13 3/8" CASING CEMENT DATA AND CALCULATIONS, 15/12-4

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.......................... :	110 m
Depth kb-last shoe........................ :	500 m
Depth kb-casing set point................. :	1600 m
Open hole dia............................. :	17 1/2"
Annulus capacity, cased hole.. .... :	94.5 l/m
Annulus capacity, open hole...... .... :	64.4 l/m
Internal capacity, 13 3/8"casing 72 lb/ft :	77.2 l/m
Mud weight................................ :	1.10 g/cm^3
Bottom hole hydrostatic pres. (BHHP)...... :	173 bar
Est. bottom hole static temp. (BHST)...... :	65 °C
Est. bottom hole circulating temp. (BHCT). :	44 °C
Est. formation integrity.................. :	0.156 bar/m

		LEAD SLURRY	TAIL IN SLURRY
CEMENT SLURRY COMPOSITION		CLASS "G" cement + 1.95 l/100 kg CFR-2L + 0.18 l/100 kg HR-6L + 2.25 kg/100 kg Prehydrated Bentonite	CLASS "G" cement + 1.33 l/100 KG CFR-2L + 0.27 l/100 kg HR-6L
Mix water	l/100 kg	90.20 fresh	42.81 fresh
Total liquid	l/100 kg	93.18	44.41
Slurry weight	g/cm^3	1.56	1.90
Slurry yield	l/100 kg	125.00	76.16
TEST DATA AT BHCT			
Thickening time at BHHP, hr:min		5:00 +	3:55
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		110	159

REMARKS:

Fann VG Readings 600/300/200/100	18/9/7/5	39/16/10/5
Free Water	0 %	0.4 %

Volume calculations (13 3/8" casing):

Annular volume	: 0.0644 m^3/m x (1600-500)m	= 70.8 m^3
Volume between csg's:	0.0945 m^3/m x 100 m	= 9.5 m^3
24 m plug inside casing	: 0.0772 m^3/m x 24m	= 1.9 m^3
Total cement slurry volume		= 82.2 m^3

Lead Slurry : Class G-cement + 1.95 l/100 kg CFR-2L + 0.18 l/100 kg HR-6L + 2.25 kg/100 kg Prehydrated Bentonite mixed with fresh water to 1.56 g/cm^3. 57800 kg cement equivalent to 72.2m^3 slurry.

Tail-in slurry: Class G-cement + 1.33 l/100 kg CFR-2L + 0.27 l/100 kg HR-6L fresh water to 1.90 g/cm^3 13200 kg cement 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 CFR-2L needed	:	1305 l
Total volume of HR-6L needed	:	140 l
Total amount of Bentonite needed	:	1300 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.

Height of tail-in slurry: $(10.0 - 1.9)m^3/0.0644m^3/m$ = 126 m

Hydrostatic pressure calculations:

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

Height of slurry : (1600-500-126 + 100)m = 1074 m

Hydrostatic head from mud: 0.108 bar/m x 400m = 43.2 bar

Hydrostatic head from lead slurry : 0.153 bar/m x 1074 m = 164.3 bar

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

Total hydrostatic head at 13 3/8" shoe = 231.1bar

Equivalent pressure gradient at 13 3/8" shoe :

$$\frac{231.1 \text{ bar}}{1600 \text{ m}} = 0.144 \text{ bar/m}$$

Estimated formation integrity at 13 3/8" shoe : = 0.162bar/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 : $\frac{58.5 \text{ bar}}{500 \text{ m}}$ = 0.117bar/m

Estimated formation integrity at 20" shoe = 0.141bar/m

9 5/8" CASING CEMENT DATA AND CALCULATIONS, 15/12-4

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.........................:	110 m
Depth kb-last shoe.......................:	1600 m
Depth kb-casing set point................:	2720 m
Open hole dia............................:	12 1/4"
Annulus capacity, cased hole.. ....:	30.1 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...............................:	1.38 g/cm^3
Bottom hole hydrostatic pres. (BHHP)......:	368 bar
Est. bottom hole static temp. (BHST)......:	91 °C
Est. bottom hole circulating temp. (BHCT).:	63 °C
Est. formation integrity.................:	0.169 bar/m

		LEAD SLURRY	TAIL-IN SLURRY
CEMENT SLURRY COMPOSITION: (all additives are per 100 kg cement)		1.95 CFR-2L 0.27 HR-6L 2.25 kg Prehydrated Bentonite	1.95 CFR-2L 5.33 Halad-10L
Mix water	1/100 kg	90.27 F.W.	37.41 F.W.
Total liquid	1/100 kg	93.34 (incl. GEL)	44.69
Slurry weight	g/cm^3	1.56	1.90
Slurry yield	1/100 kg	125.09	76.44
TEST DATA AT BHCT			
Thickening time at BHHP, hr:min		5:30+	5:30
Crit. Turb.Flow rate:m/s (l/min)			
Fluid loss, ml/30 min, 70 bar		332	192
TEST DATA AT BHST, BHHP			
Compr. strength, bar 16 hr		73	164
REMARKS: K/N			
N_{RE} turb plug			
Fann VG-readings		17/9/7/5	61/29/19/10
Free water		0.8%	1.6 vol%

Volume calculations (9 5/8" casing):

Annular volume	: 0.0289 m^3/m x (2720-1600)m	= 32.4 m^3
Volume between csg's:	0.0301 m^3/m x 100 m	= 3.0 m^3
24 m plug inside casing	: 0.0382 m^3/m x 24m	= 0.9 m^3
Total cement slurry volume		= 36.3 m^3

A) Lead slurry: Class "G" Cement + 1.95 1/100 kg CFR-2L + 0.27 1/100 kg HR-6L + 2.25 kg/100 kg Prehydrated Bentonite mixed with fresh water to 1.56 S.G. 21100 kg cement equivalent to 26.3m^3 slurry.

Tail slurry: Class "G" Cement + 1.95 1/100 kg CFR-2L + 5.33 1/100 kg Halad-10L mixed with freshwater to 1.9 S.G. 13100 kg cement equivalent to 10m^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 m into 13 3/8" csg. The amount of excess should be discussed with the operation office before any decision are made.

B) Chemicals needed:

Lead slurry:	475 kg Bentonite
	415 l CFR-2L
	60 l HR-6L
Tail-in slurry:	260 l CFR-2L
	700 l Halad-10L

Remarks: Consider pumping preflush ahead of slurry.

The Statoil supervisor is responsible for sending in cement (min 5 kg), drillwater and additives from the rig. The operation office is responsible for making arrangements to have the slurry composition tested before the cement job. Please inform under remarks on daily drilling report how and when the chemicals are sent in.

Hydrostatic pressure calculations:

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

Height of Lead : (2720 -1600 - 315 + 100)m = 905 m

Height of mud : (1600-100) = 1500 m

Hydrostatic pressure calculations :

Hydrostatic head from mud : 0.135 bar/m x 1500m = 202.5 bar
Hydrostatic head from lead slurry : 0.153 bar/m x 905 m = 138.5 bar
Hydrostatic head from tail-in slurry: 0.186 bar/m x 315m = 58.6 bar

Total hydrostatic head at 9 5/8" shoe = 399.6 bar

Equivalent pressure gradient at 9 5/8" shoe :

$$\frac{399.6 \text{ bar}}{2720 \text{ m}} = \underline{0.147 \text{ bar/m}}$$

Estimated formation integrity at 9 5/8" shoe = 0.169 bar/m

Estimate formation integrity in Cretaceous Chalk: = 0.157 bar/m

Hydrostatic head at 13 3/8" shoe:
202.5 bar + 0.153 bar/m x 100 m = 217.8 bar

Equivalent pressure gradient at 13 3/8" shoe :

$$\frac{217.8 \text{ bar}}{1600 \text{ m}} = \underline{0.136 \text{ bar/m}}$$

Estimated formation integrity at 13 3/8" shoe : 0.162 bar/m

7" LINER CEMENT DATA AND CALCULATIONS, 15/12-4 *

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.........................:	110 m
Depth kb-last shoe.......................:	2720 m
Depth kb-casing set point................:	3600 m
Open hole dia............................:	8 1/2"
Annulus capacity, cased hole.............:	13.3 l/m
Annulus capacity, open hole..............:	11.7 l/m
Internal capacity, 7"liner 29 lb/ft......:	19.4 l/m
Mud weight...............................:	1.48 g/cm^3
Bottom hole hydrostatic pres. (BHHP).....:	523 bar
Est. bottom hole static temp. (BHST).....:	112 °C
Est. bottom hole circulating temp. (BHCT).:	84 °C
Est. formation integrity.................:	0.162 bar/m

CEMENT SLURRY COMPOSITION

CLASS "G" CEMENT
+ 1.95 l/100 kg CFR-2L
+ 7.10 l/100 kg Halad-10L

Mix water	l/100 kg	35.72	fresh
Total liquid	l/100 kg	44.77	
Slurry weight	g/cm^3	1.90	
Slurry yield	l/100 kg	76.52	

TEST DATA AT BHCT

Thickening time at BHHP, hr:min	4:00
Crit. Turb.Flow rate:m/s (l/min)	
Fluid loss, ml/30 min, 70 bar	188

TEST DATA AT BHST, BHHP

Compr. strength, bar 16 hr 220

REMARKS:

N_{RE} Critical vel.turb.flow, m^3/min

Fann VG Readings	
600/300/200/100	44/21/14/7
Free water	0.8%

Volume calculations (7" liner):

Annular volume	: $0.0117\ m^3/m \times (3600-2720)m$	=	$10.3\ m^3$
Volume between csg's:	$0.0133\ m^3/m \times 150\ m$	=	$2.0\ m^3$
24 m plug inside casing	: $0.0194\ m^3/m \times 24m$	=	$0.5\ m^3$
Total cement slurry volume		=	$12.8\ m^3$

Slurry: Class G-cement + 1.95 l/100kg CFR-2L + 7.10 l/100kg Halad 10-L mixed with fresh water to 1.90 g/cm^3. 16800 kg cementequivalent to 12.8 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 any decision are made.

Chemicals needed:

Total volume of CFR-2L needed : 330 l
Total volume of Halad 10-L needed : 1200 l

Remarks: Pump 1.6 m^3 of spacer ahead of slurry. Spacer weight 1.7 g/cm^3.

Adequate samples of cement (min 5 kg), additives and drillwater should be forwarded to Statoil's Mud and Cement Lab, Forus, for testing prior to the cement job.

*Note:

Pilot test prior to cement job: BHST : 112°C
BHCT : 84°C
T.D. : 3600 m

Hydrostatic pressure calculations:

Height of spacer/preflush: 1.6 m^3/0.0249 m^3/m = <u>64 m</u>

Height of mud : (2720-150-64)m = <u>2506 m</u>

Height of slurry : (3600-2720+150) = <u>1030 m</u>

Hydrostatic head from spacer/preflush: 0.167 bar/m x64m = 10.7 bar

Hydrostatic head from mud: 0.145 bar/m x 2506 m = 363.4 bar

Hydrostatic head from slurry : 0.187 bar/m x 1030 m = <u>192.6 bar</u>

Total hydrostatic head at 7" shoe = <u>566.7 bar</u>

Equivalent pressure gradient at 7" shoe :

$$\frac{566.7\ \text{bar}}{3600\ \text{m}} = \underline{0.157\ \text{bar/m}}$$

Estimated formation integrity at 7" shoe : = <u>0.162 bar/m</u>

Hydrostatic head at 9 5/8" shoe:
(10.7 + 363.4) bar + 0.187 bar/m x 150 m = <u>402.2 bar</u>

Equivalent pressure gradient at 9 5/8" shoe :

$$\frac{402.2\ \text{bar}}{2720\text{m}} = \underline{0.148\ \text{bar/m}}$$

Estimated formation integrity at 9 5/8" shoe = <u>0.169 bar/m</u>

WELL 15/12-4

(Not to scale)

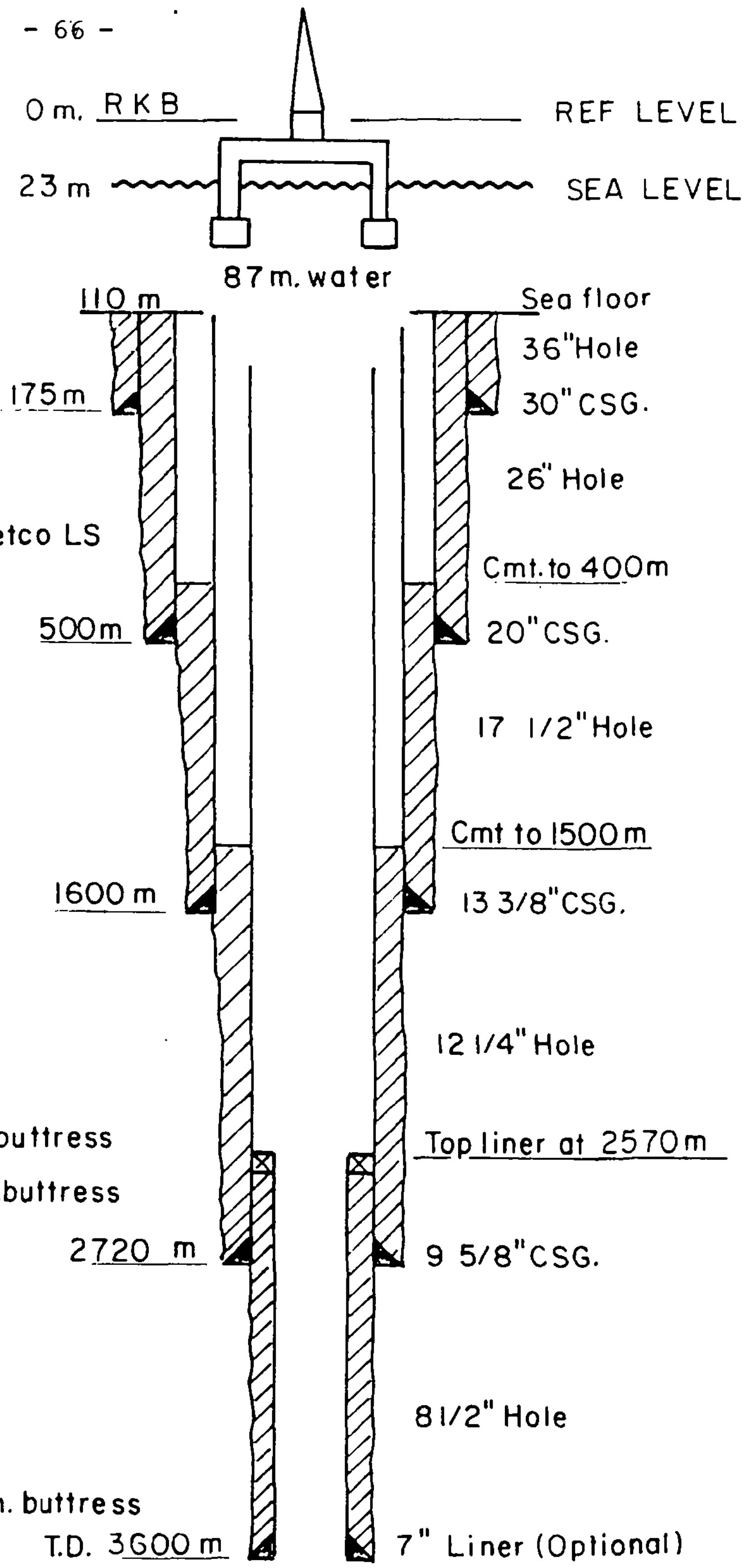
30", grade B, Vetco ST-2
1 jnt. 1 1/2" wall th.
4 jnt. 1" wall.
Cement to seabed + 150 % excess

20", X-56, 94 lb/ft (110 - 500) m, Vetco LS
Cement to seabed + 100 % excess

13 3/8", N-80, 72 lb/ft
(110 - 1600) m. buttress
Cement to 400 m

9 5/8", N-80, 47 lb/ft (110 - 2000) m. buttress
9 5/8", P-110, 47 lb/ft (2000 - 2720) m. buttress
Cement to 1500 m

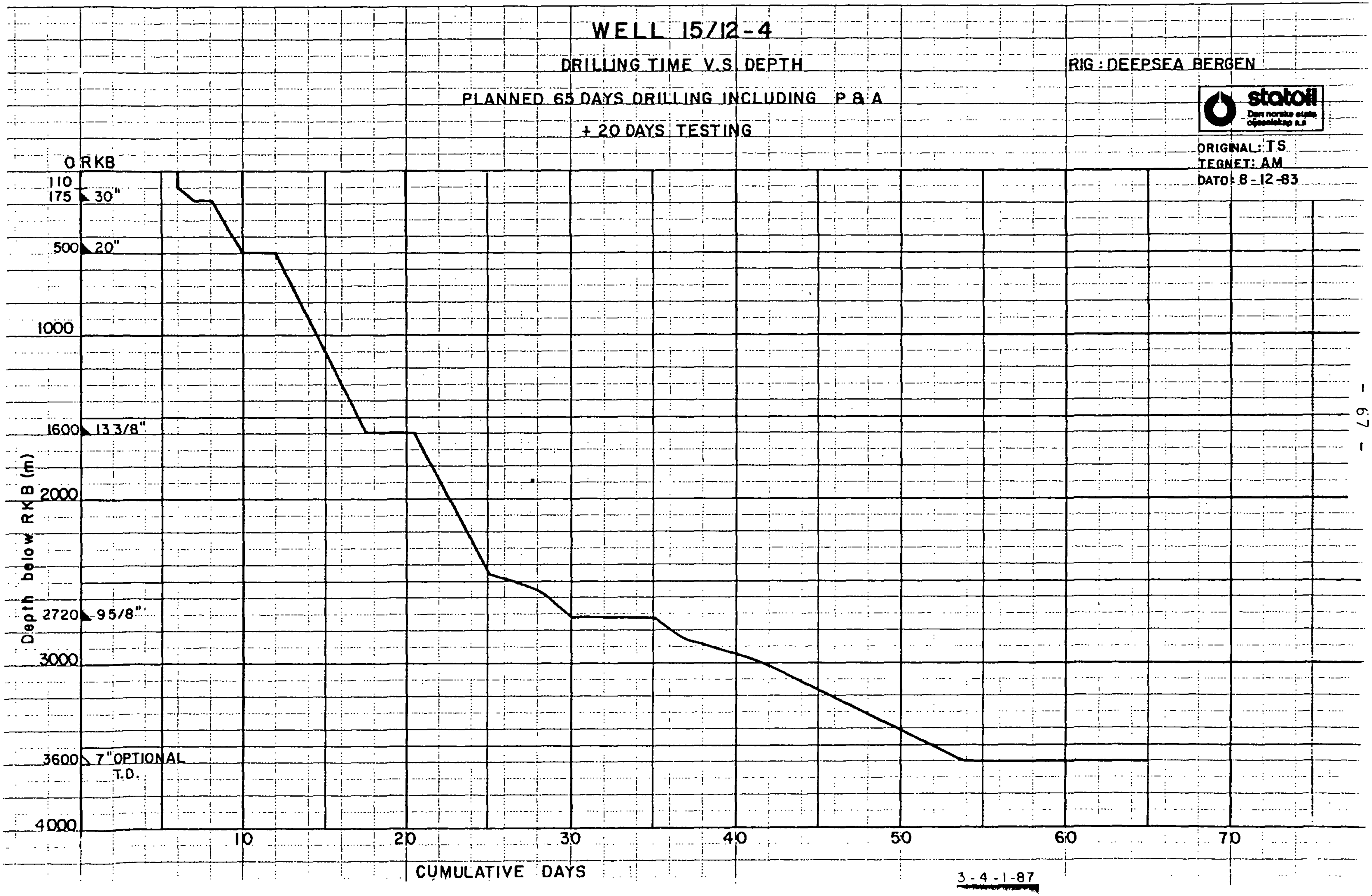
7", N-80, 29 lb/ft (2570 - 3600) m. buttress
Cement to full length.



statoil
Den norske stats oljeselskap a.s

Original av: TS
Tegnet av: AM
Dato: 10-11-83
29-11-83
RETTET 17/7-84

4-3-8-49


WELL 15/12-4
DRILLING TIME V.S DEPTH
PLANNED 65 DAYS DRILLING INCLUDING P & A
+ 20 DAYS TESTING
RIG : DEEPSEA BERGEN
statoil
Den norske stats oljeselskap a.s
ORIGINAL: TS
TEGNET: AM
DATO: 8-12-83
0 RKB
110
175
30"
500
20"
1000
1600
13 3/8"
2000
2720
9 5/8"
3000
3600
7" OPTIONAL T.D.
4000
Depth below RKB (m)
10
20
30
40
50
60
70
CUMULATIVE DAYS
3-4-1-87