ELF AQUITAINE NORGE A/S
311E-W 79/305/PS/bs

Stavanger, 14th September 1979

WELL 18/10 - 1

DRILLING PROGRAMME

J.L. IDELOVICI

p.o

R. SALES

SUMMARY

APPENDIX

I. GENERAL DATA

A. Location

Norwegian continental shelf.
Block 18/10
Licence P 008

B. Position

Required coordinates

04° 07' 02" 13	EAST	565 900 E	UTM	Coordinate
58° 04" 37" 29	NORTH	6 438 000 N	"	"

(see attached drawing)

C. Levels

RKB - Sea level = 25 m
RKB - Sea bottom = 122 m
Water depth = 97 m

D. Well

Identification : 18/10-1
Class : Exploration
Profil : Vertical

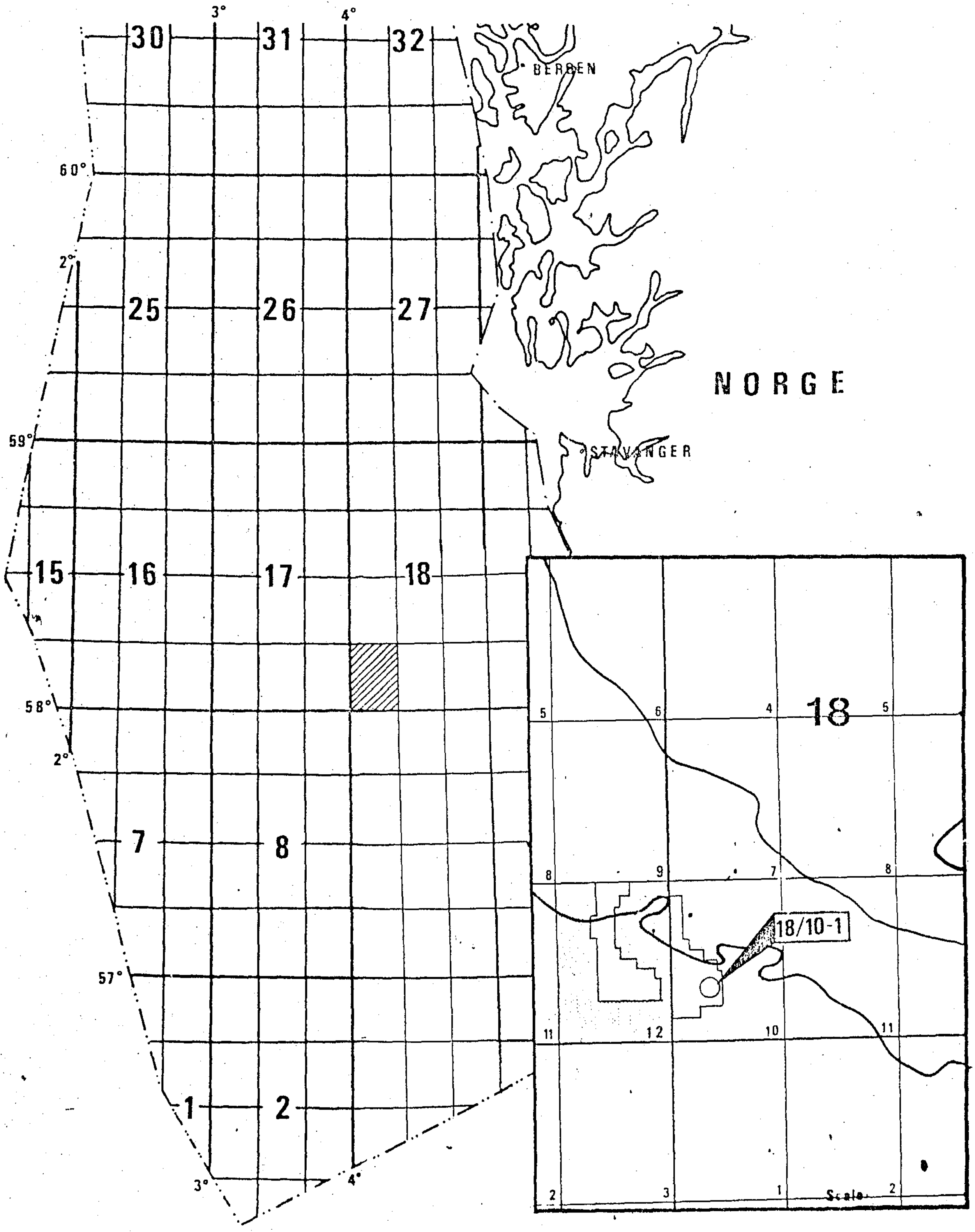
POSITION MAP

BLOCK	:	18/10
WELL	:	18/10-1
OWNER	:	PETRONORD

x: 04° 07' 02.13" E
y: 58°04' 37.29" N

Scale: 1/2500000

Date:



GEOLOGICAL WELL PROGNOSIS **Fig.1**

EXPLORATION DIVISION

II DRILLING PLATFORMS

A. Platform

Name : DYVI ALPHA
Contractor : DYVI OFFSHORE A/S

B. Rig

Capacity : 20.000 ft drilling depth.

Drawork : NATIONAL 1625 DE

Rotary table : NATIONAL C 495

Pumps : NATIONAL 12-P-160 TRIPLEX

C. BOP stack.

Lower package. 18 3/4. 10.000 PSI WP.

Including from bottom to top :

- VETCO H4 hydraulic connector.
- RUCKER SHAFFER studded triple. LWS piperams w/ 3 1/8 (BX 154) outlets. H2S Service.
- RUCKER SHAFFER flanger single. LWS. Blind shear ram w/ 3 1/8 outlets. H2S Service.
- RUCKER SHAFFER mandrel for lower riser package.

Lower Riser package

- RUCKER SHAFFER dual spherical 18 3/4 5000 PSI H2S Service.
- REGAN 24" type CR-1 Ball joint.

III. GEOLOGICAL DATA

A. Prognosis

DEPTH (RKB)	GEOLOGICAL SERIES	FORMATION
122 - 745 m	Tertiary	Sands - Clay
745 - 1340 m	Upper Cretaceous	Chalk
1340 - 1900 m	Lower cretaceous	Clays
1900 - 2365 m	Upper Jurassic	Clays - Shales
2365 - 2625 m	Callovo Oxfordian - Middle Jurassique.	Sandstone
2625 - 2750 m	Lower to Middle Jurassique Top Triassic.	Shale and sandstone

Reference wells are

17/12-1 (BREAM field - PHILLIPS operator)

B. Objectives

- Callovo - oxfordian reservoir sandstones

C. Pressures

Hydrostatic pressure expected in Jurassic sandstones.

GEOLOGICAL WELL PROGNOSIS

Well: 18/10-1

Country: NORWAY off-shore

Coord X: 04°07'02".13 E ground: -97m
Y: 58°04'37".29 N Z R.K.B: +25m.

Depth datum: RKB

Seismic location:
Line: 685402 S.P. 160

Expected date: End of October 1979
Duration: 45 days
P.T.D. 2750 RKB Fm. Early Jurassic/ Top Triassic
Rig: Dyvi. Alpha

Operator: ELF AQUITAINE NORGE

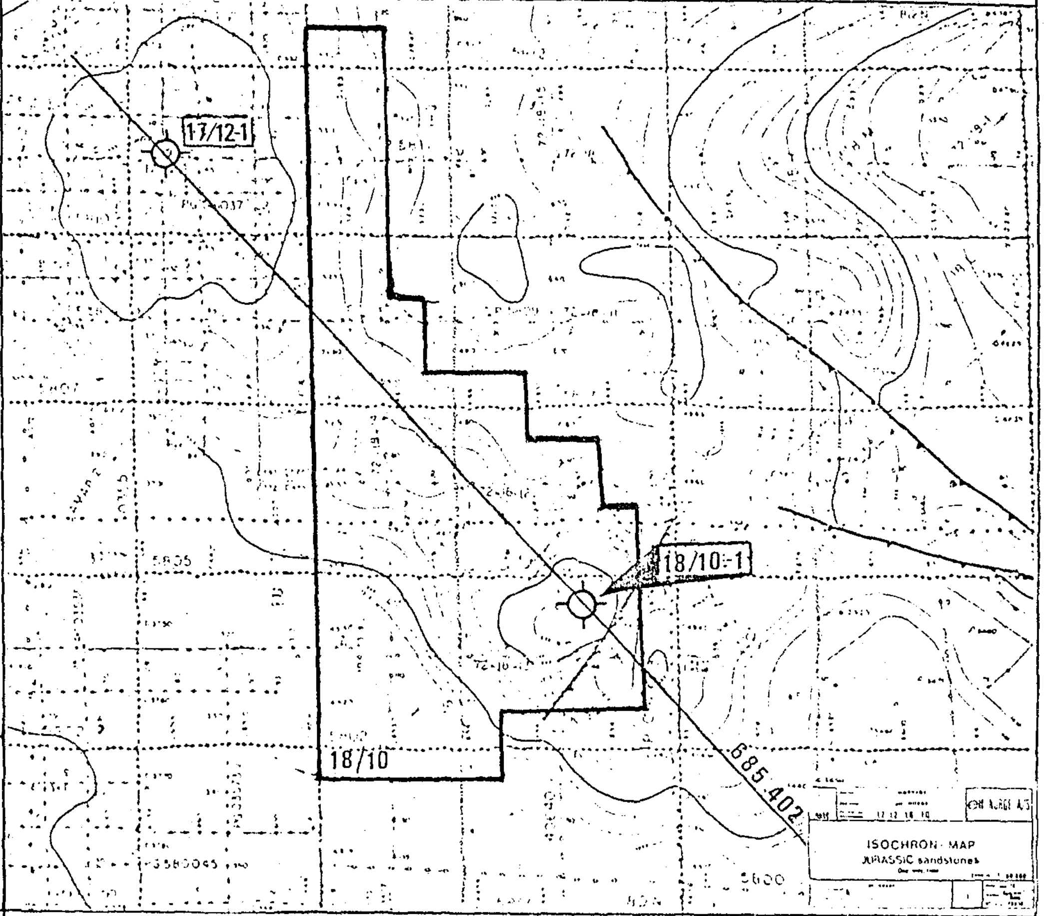
Licence: 008 Owned by: PETRONORD

TARGETS:

MIDDLE JURASSIC SANDSTONES

CASINGS: (RKB)

30"	175m
20"	350m
13"3/8	850m
9"5/8	2300m
7"	if needed



LOGGING:

ISF.SL.GR.PS.and FDC CAL.from top to TD.

HDT.CST:1000 to TD.

DLL/MSFL and CNL-FDC in reservoir zones

CORING:

Any hydrocarbon reservoir zones.

TESTING

Any hydrocarbon bearing reservoir.

MUD

Phase 12 1/4:
MW:1.15/1.25

Phase 8 1/2
MW:1.25

OBSERVATIONS

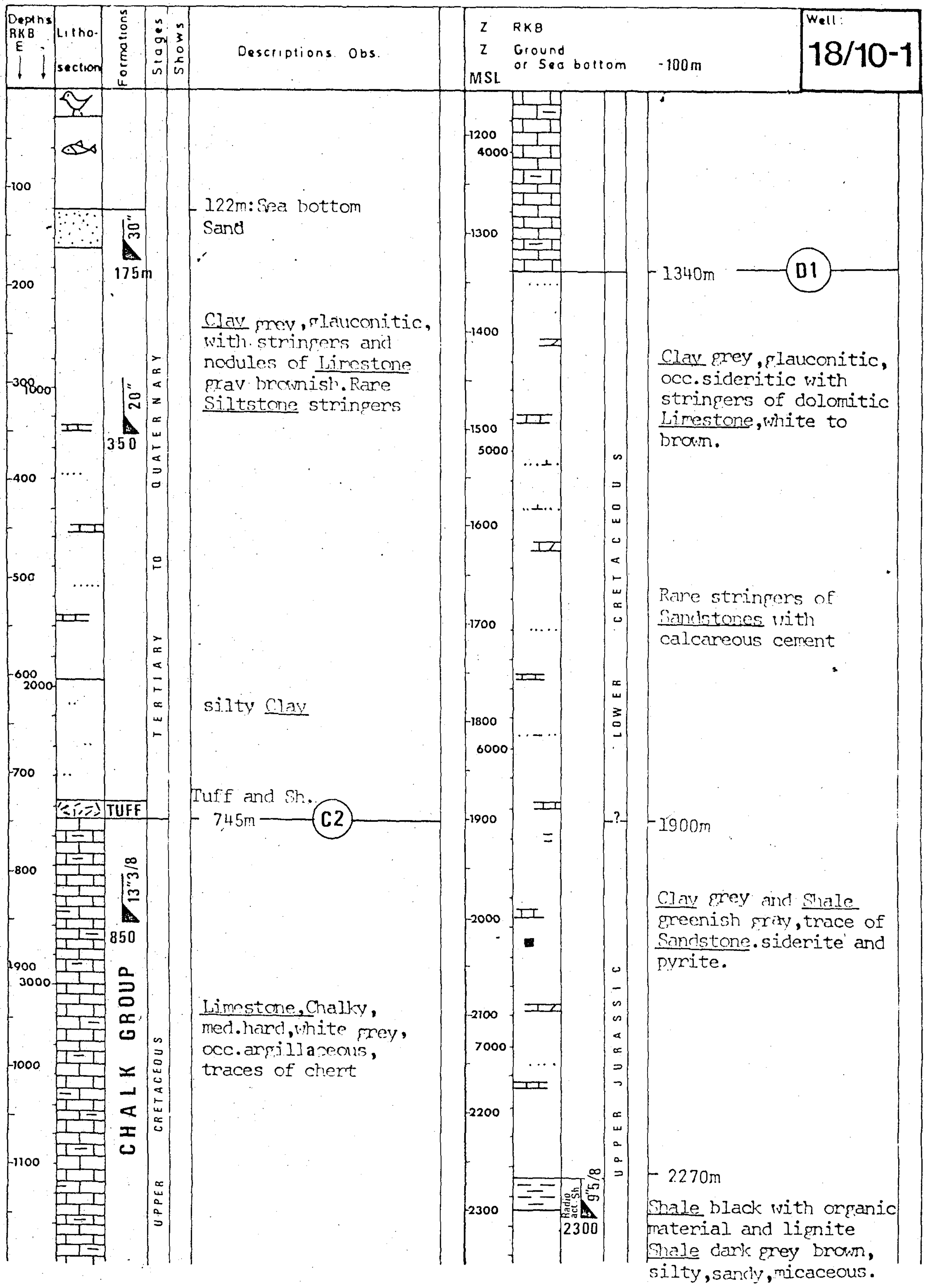
Normal hydrostatic formation pressure is expected.

Checked: S.Guyonnet
F.Verrolles.

Date: 10.09.79

GEOLOGICAL WELL PROGNOSIS.

Well: 18/10-1



122m: Sea bottom
Sand

Clay grey, glauconitic, with stringers and nodules of Limestone gray brownish. Rare Siltstone stringers

silty Clay

Tuff and Sh.

745m (C2)

Limestone, Chalky, med.hard, white grey, occ. argillaceous, traces of chert

1340m (D1)

Clay grey, glauconitic, occ. sideritic with stringers of dolomitic Limestone, white to brown.

Rare stringers of Sandstones with calcareous cement

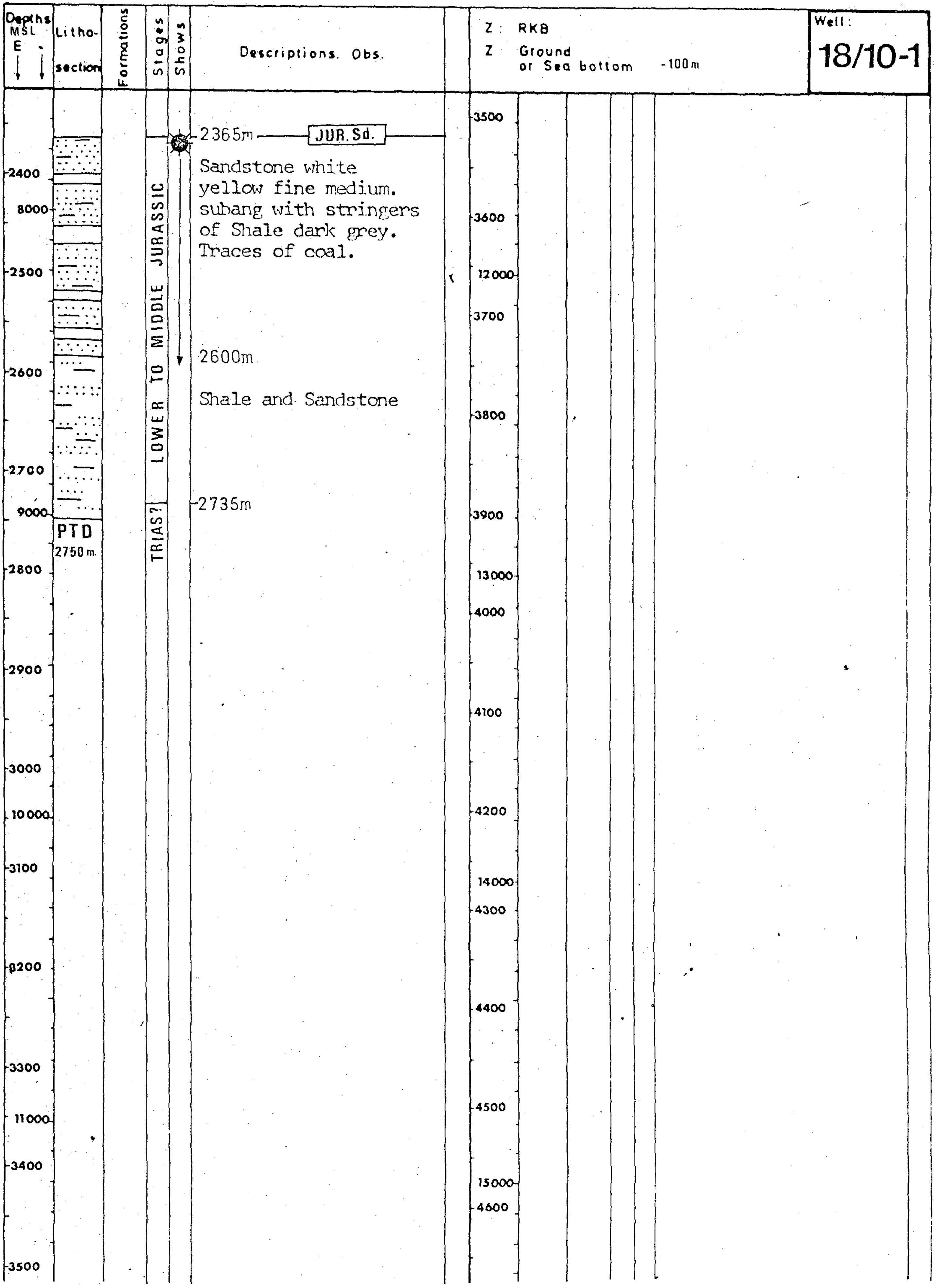
1900m

Clay grey and Shale greenish gray, trace of Sandstone. siderite and pyrite.

2270m

Shale black with organic material and lignite
Shale dark grey brown, silty, sandy, micaceous.

GEOLOGICAL WELL PROGNOSIS:



2365m — JUR. Sd.

Sandstone white yellow fine medium. subang with stringers of Shale dark grey. Traces of coal.

2600m

Shale and Sandstone

2735m

IV. POSITIONING AND SURVEY SERVICES

These operations should be conducted by GEOTEAM with a SNEA(P) representative on board the survey boat.

The coordinates of the well as indicated in General Data are:

X = 04° 07' 02" 13 E

Y = 58° 04' 37" 29 N

Seismic location Shoot Point 160 line 685 402

1. Finding the Well Site

Directed by GEOTEAM and as per results of soil surveys (Side Scan Sonar and Echo Sounder), performed by them from 20th to 25th March 79.

2. Positioning of the Drilling Platform

Within a 100 m radius of intended location.

3. Permanent Indication of the Site

A transpinger 48 KHz, 2 years life, will be run with the permanent base plate. It has to be set 2 m minimum from the base plate.

V. ANCHORING

Anchoring will be made under the contractors responsibilities. Characteristics are:

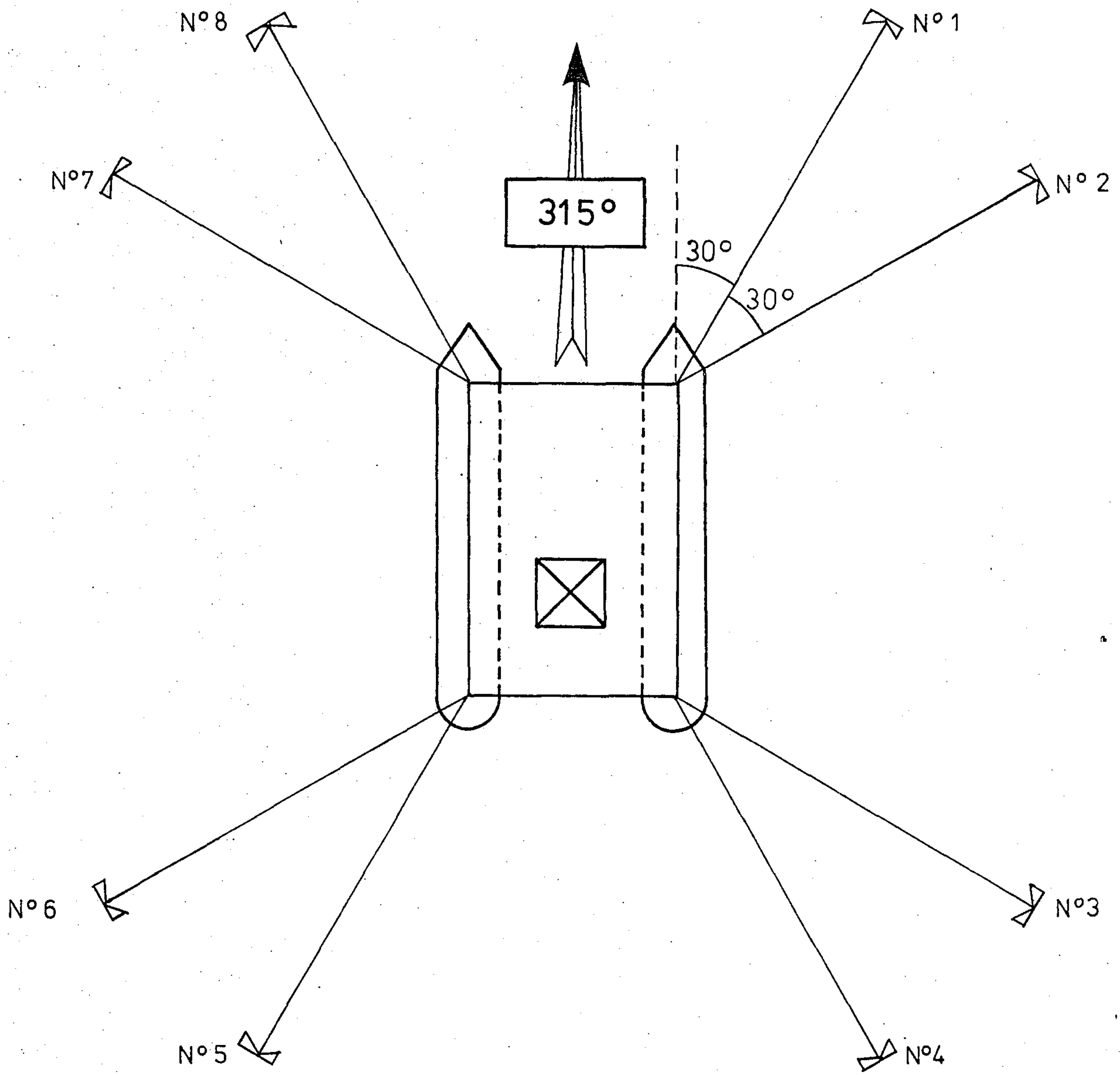
- Heading : 315°
- Anchor lines : 8 x 3500 ft of 3" chain
- Anchors : 8 x 6500 KG BRUCE
- Test of anchors : 350.000 Lbs

Mooring line pattern is given as an indication on next drawing.

MOORING LINE PATTERN

DYVI ALPHA

WELL: 18/10-1



VI DRILLING AND CASING PROGRAMME

HOLE	CASING				
SIZE	SIZE	WEIGHT	GRADE	THREAD	DEPTH
INCH	INCH	LBS/FT			M (RKB)
26" 36" HO	30	310	X52	squnch joint ATD	175 m
17½" 26" HO	20"	133	K55	BUTT	350 m
17½	13 3/8	68	K55	BUTT	850 m
12 1/4	9 5/8	47	N80	BUTT	2300 m
8½	7"	IF NEEDED			2750 m

Estimated total vertical depth : 2750m.

PROPOSED DRILLING PROGRAM

Well

18/10-1

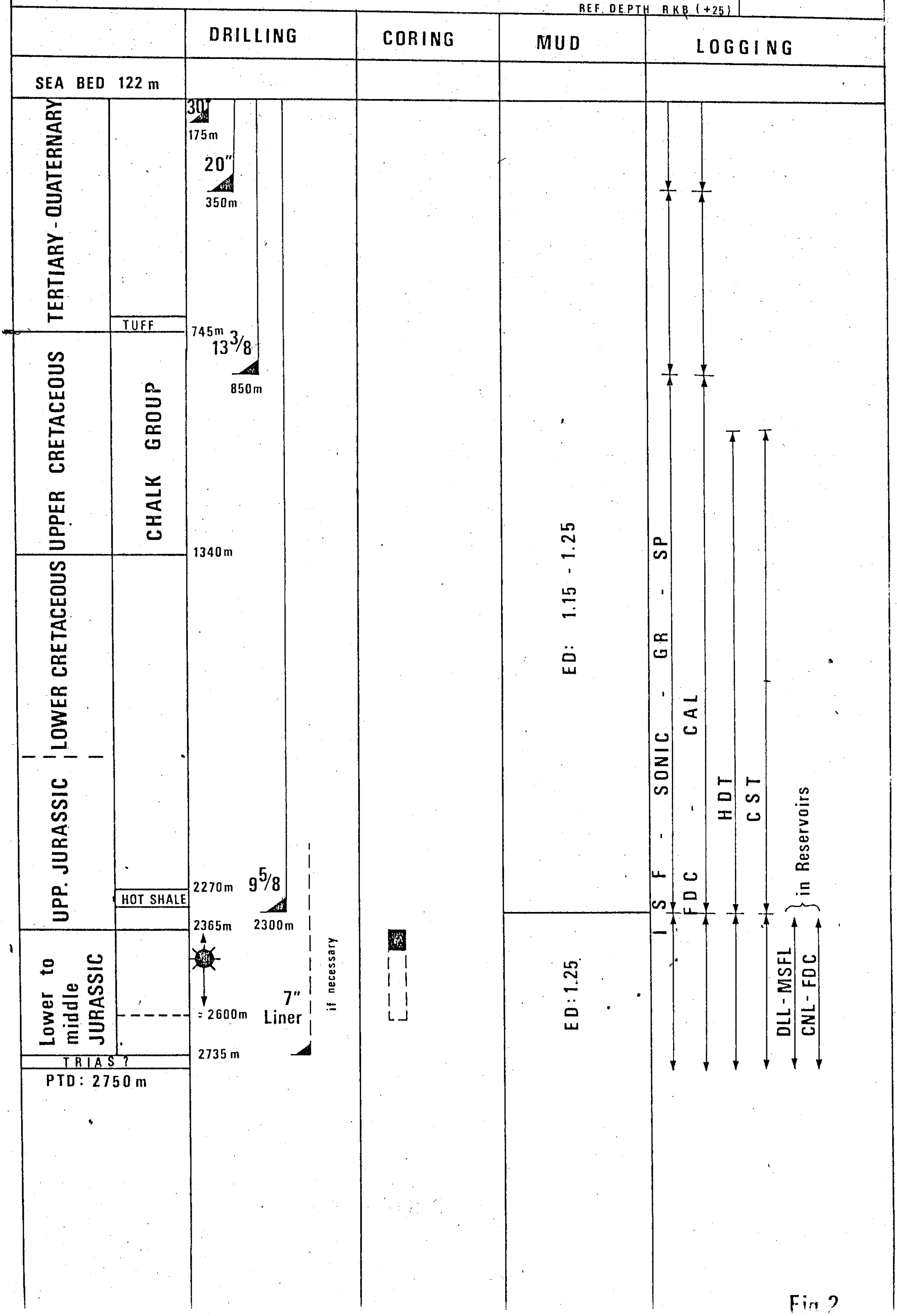


Fig 2

VII CEMENTING PROGRAMME

CASING SIZE	STAGES	CEMENT	SG	INTERVAL
30"	1	LETT	1.53	SHOE - SEABED
20"	1	G LETT	1.90 1.53	775m - 850 m sea bed to 775 m
13"3/8	1	G	1.90	100m above shoe
		LETT	1.53	750m - 175m
9"5/8	1	G LETT	1.90 1.53	2300m - 1800m UP TO 700m
7"	IF NEEDED			

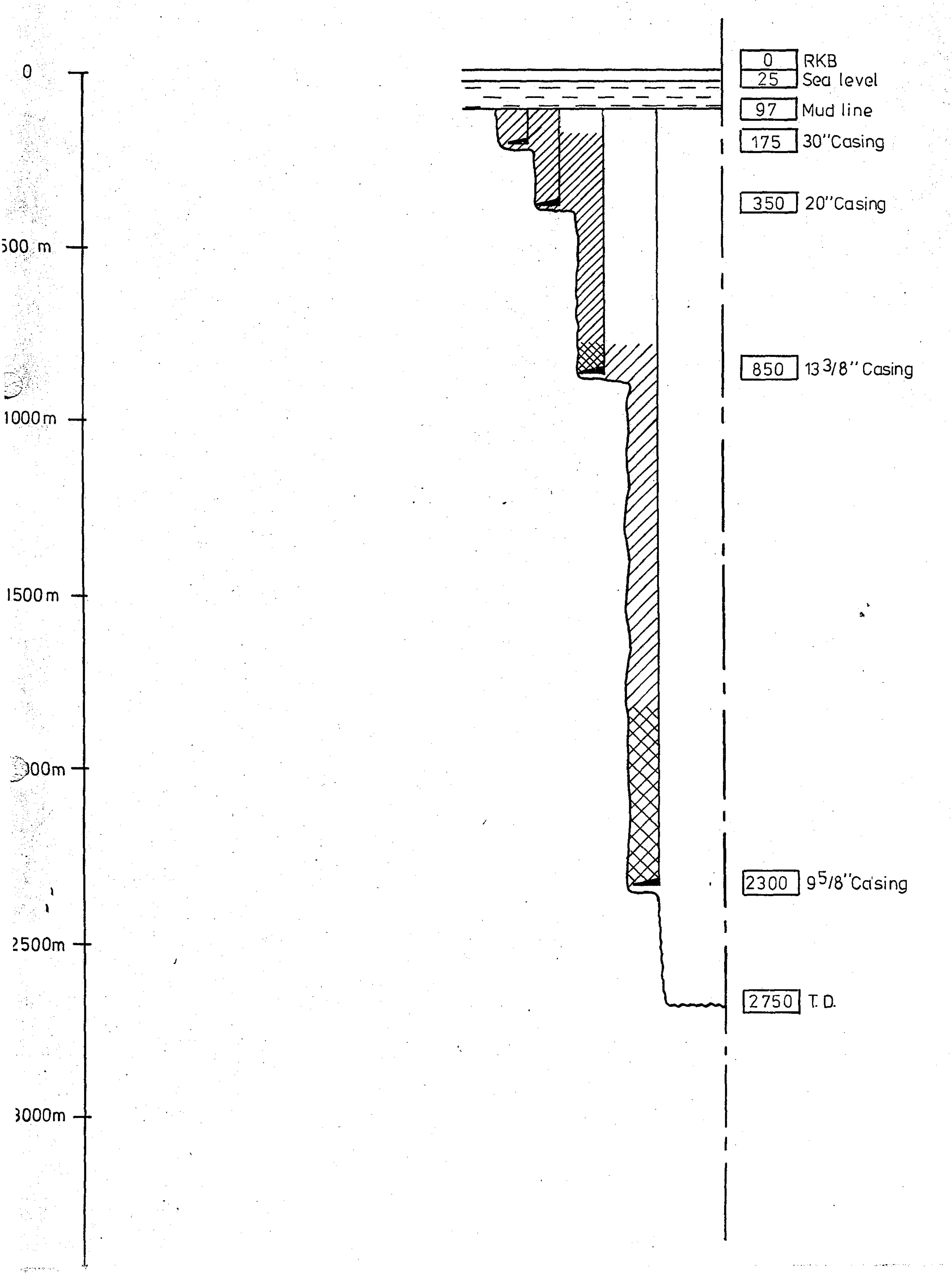
CASING AND CEMENTING PROFILE

WELL: 18/10-1

▨ LETTCEMENT

▦ G CEMENT

┘ CASING SHOE



VIII MUD PROGRAMME

PHASE	TYPE	WEIGHT	VISCOSITY	WATER LOSSES	SOLIDS
36"	BENTONITE	1.04 1.06	120 150	15 20	
26"	BENTONITE + FERROCHROME LIGNOSULFONATE	1.10 1.15	60 70	6 10	5 10
17½	BENTONITE + FERROCHROME LIGNOSULFONATE	1.10 1.15	60 70	6 8	6 10
12 1/4	FERROCHROME LIGNOSULFONATE+ CHROME LIGNITE	1.15 1.25	50 60	3 4	9 13
8½	FERROCHROME LIGNOSULFONATE+ CHROME LIGNITE	1.25 1.26	50 55	2 4	12 14

IX. LOGGING PROGRAMME

A. Basic Runs

In 26", 17"1/2, 12"1/4, and 8 1/2 (and eventually 6") open holes, before setting each casing, an ISF - SL GR and FDC caliper will be performed (GR to be recorded up to the mudline). FDC log is run in order to introduce density parameter in synthetic seismograph computation. ISF - SL - GR - CAL - FDC will have to be available at any time and will have to be permanent on board. Intermediate log could be run if needed on request of Geological/Geophysical Departments.

HDT will be run in open hole below about 850 m and only deviation above, up to 20" casing shoe. On request of Drilling Department, a deviation survey (with HDT) could be run with a spacing of about 500 m.

B. Reservoir Zones

On request from Reservoir and/or Geological Departments on specific intervals:

. DLL- MSFL
. ML MLL
. FDC CNL GR
. DUAL LATERLOG (shallow/deep)

- Spectral Gamma ray could be run if requested by Exploration (in cooperation with laboratories and central services).

- Velocity survey at T.D. (or intermediate on request of Geophysical Department.

- Temperature and cement bond logs will be recorded behind casing if requested by Drilling Department.

- As logs will be recorded at scales 1/500 and 1/200 while for ML MLL they will be in scale 1/200 - 1/40.

- CST (see sampling) technical advice of the well site geologist will have to be considered concerning choise of charges, kind of bullets to be used and so on. In any case, all necessary material will have to be available on-board before surveys in order to obtain the best results considering recovery of S.W.C.

NOTE: Reservoir engineer will be in charge of the logging program, but will need the well-site geologist's technical approval.

X. SAMPLING AND CORING

A. Cuttings/Sampling

Cuttings will be taken every 10 - 5 - 3 m regarding the drilling rate and continuously observed under the microscope and fluoroscope. Sampling intervals can be reduced if the well site geologist decides so. A set of dried and wet samples (according to dispatching list in annexes) will be made at location.

Samples for source rock analysis will be collected every 50 or 100 m in addition to special protecting conditions.

Calcimetry and shale density will be performed on sample with a spacing defined by well site geologist. A carbide test will be used to check log time computation (and degasser) at least once a day in normal drilling conditions. Especially during drilling of the Jurassic objective, we have to get a very good quality of samples. Therefore drilling parameters and choice of bit will have to be discussed between well site geologist and drilling supervisor. In particular, use of diamonds bits will have to get the approval of the well site geologist.

B. Coring Programme

In case of hydrocarbon shows, reservoir zones or if additional lithological information are needed, cores should be cut on demand of Geological or Reservoir Departments. In any case, the top of each Jurassic reservoir will be cored. If the Oxfordian and Callovian sandstones are reached in accordance with the prognosis, their flank position will involve to core them, even in the water zone, with the object to interprete the up-dip reserves.

Pictures of cores will be taken on the rig.

Sidewall cores will be shot before each casing setting(or on request at any time if needed) for checking an accurate information:

micropaleontology, palynology, sedimentology, log character etc...

The program is made by the on-site geologist together with the Exploration Division and laboratory or Reservoir Department if necessary.

XI. TESTING PROGRAMME

A. FIT/RFT

FIT and/or RFT will be run in front of reservoirs as soon as possible in order to get a representative value of the formation pressures whatever the nature of formation fluids. In any case, at the top of the first Jurassic reservoir, an FIT will be performed in order to adjust mud weight.

B. DST

Conventional DST through casing might be performed if warranted by log analysis.

Special test procedure will be made in case of testing operations. (See appendix).

XII DEVIATION SURVEY PROGRAM

A. 36" PHASE

Totco survey dropped prior to pull the bit giving a drift angle indication.

B. 17½ PHASE

Totco survey at least every 250m and prior to pull the 17½ bits. In case of rapid changes of deviation the interval will be reduced to 100m with a maximum dogleg of 1°/100m and a maximum deviation of 3°.

Survey will be run with sandline if bit is not pulled out.

C. 13 3/8 CASING

Gyroscopic multishot survey in casing before 12 1/4 phase.

D. 12 1/4 PHASE

Survey every 100m at least (angle and orientation).

E. 9 5/8 CASING

Gyroscopic multishot survey on casing from shoe to 13 3/8 casing shoe before 8 1/2 phase.

F. 8½ PHASE

Survey every 100m at least (angle and orientation).

G. 7" LINER (Eventual)

Gyroscopic Multishot survey in liner

XIII LEAK OFF TEST PROGRAMME

1. 13 3/8 shoe

One leak off test will be performed at the 13 3/8 shoe after having drilled 3 meters under the 17½ final depth. That leak-off test will be stopped at the leak off value (class B test from procedure given in appendix E).

2. 9 5/8 shoe

The casing shoe must hold an equivalent density of 1.45 (gas coming from 2700m with mud specific gravity of 1.25). One leak-off test will be performed at the 9 5/8 shoe after drilling of 3 meters under the 12 1/4 final depth.
That leak-off test will be stopped at the leak-off value (class B test from procedure).

XIV. DRILLING OPERATIONS

A. 36" Phase (to 175 m approx.)

1. Drilling procedure

The open hole depth will be calculated in order to have the 30" housing 2 m above mudline when 30" shoe is set on bottom.

2. Drilling string

26" bit
36" hole opener
9 - 9" OD.DC
6 - 5" HWDP
5" DP

3. Parameters

RPM: 60 - 80.
Weight: 10.000 - 20.000 lbs.
Flow rate: 1.000 - 1.200 l/min. during the first 15 m. Beyond that depth, maximum pump output.

Note: Spot 5 m^3 gelly mud before each connection.

4. Drilling fluid

See mud programme.

5. Deviation

One survey at end of phase.

6. Logging

No logging.

B. 30" Casing (shoe 175 m approx.)

1. Casing set up

1 - Shoe joint 30" x 1" - 40 FT w/ATD Pin Up x Baker Float Shoe.
3 - 30" x 1" - 40 FT long - Intermediate joints w/ATD connectors.
1 - 30" VETCO Housing w/40 FT long extension - 30" x 1" w/ATD Box connector down.
1 - 1 VETCO permanent guide base w/4 guide posts 10 FT long.

Note: Attach 2 m long extension arm w/basked to permanent guide base and set transpinger before running in hole.

2. Landing string

- Tail pipe 5" DP at about 10 m from the shoe.
- 30" running tool.
- 5" DP to surface.
- Cementing head.

3. Cementing job

30" casing will be cemented in its full length.
Returns will be checked with TV.

Use:

- 49 T "G" cement
- mixed with 22 M3 fresh water
- slurry weight 1.90

This will give an excess of 250% in open hole. Displace to within 4 m above shoe.
Bleed off and check if any return before unlatching 30" running tool.

C. 26" PHASE (to 350m approximately)

1. Drilling procedure

- Install 22" marine riser with diverter system on 30" casing.
- Drill out 30" shoe with 17½" bit and 26" underreamer. Drill 2m of formation. Pull and lay down 26" underreamer.
- Drill 17½" rat hole to approximately 350m.
- Deviation survey.
- Run logs.
- Run 17½" pilot bit with underreamer 26" and underream hole to bottom.
- Fill up hole with mud SG : 1.14. Pull to mud line. Displace riser with sea water. Observe well. If well steady, pull out and disconnect riser.
- Run 26" bit for wiper trip.

2. Drilling string

a)
- . 17½" bit
- . Drill pipe float valve
- . 12 x DC 9"
- . 17½" stabilizers at 9m and 27m from bit
- . 12 x HWDP 5"
- . 5" DP

b)
- . 17½" pilot bit
- . 26" underreamer
- . 12 x DC 9"
- . 17½" stabilizers at 9m and 27m from bit
- . 12 x HWDP 5"
- . 5" DP

3. Parameters

- RPM : 60 - 100

WOB : 10.000 - 15.000 lbs

Flow : Max pump output

4. Drilling fluid

See mud program

5. Deviation

One survey at end of phase

6. Logging

See logging program.

D. 20" CASING (shoe at 350m approx.)

1. Casing set up

From bottom to top

- 1 float shoe 133 lbs/ft. Buttress thread
- 1 joint casing 20" 133 lbs/ft. K55. Buttress thread
- 1 float collar " " "
- X joints casing 20" " " "
- 1 cross over joint 20" OD. 625 wall with ST pin connector up x Buttress pin down
- 1 VETCO 18 3/4" housing w/20" OD x 0.625 wall extension and ST VETCO box connector down

2. Landing string

- VETCO 18 3/4" - 10 000 running tool with subsea cementing system
- 5" HWDP (or 6½ DC)
- Subsea cementing head

3. Cementing job

- 20" casing will be cemented in its full lenght
- Returns will be checked by TV

Use :

- 36.5 T of "G" cement mixed with 35.4 m^3 of fresh water which gives a slurry S.G. = 1.54 followed by
- 34 T of "G" cement mixed with $15m^3$ of fresh water which gives a slurry S.G. = 1.90
- This will give an excess of 150% in open hole.
- Bleed off and check return.

E. 17½ PHASE (to 850m approximately)

1. Drilling procedure

- Test stack on test stump

  Rams to 10.000 psi
  Bag to 3.000 psi

- Install BOP stack, marine riser and diverter on housing
- Pick up test 10 to 15 tons
- Test stack on bottom

  Rams to 5.000 psi
  Bag to 2 500 psi

- Run 17½ bit and test 20" casing to 1000 psi
- Drill 17½ hole down to 850 m approximately
- Wiper trip before logs
- Control trip after logs

2. Drilling string

- 17½ Bit with 20/32 nozzles
- Baker float valve type GA
- Near bit stabilizer 17½
- Non magnetic DC 9" OD
- Middle body stabilizer 17½
- 2 DC 9" OD
- Middle body stabilizer 17½
- 6 to 9 DC
- 1 - 7 3/4 drilling jar
- 12 Hevywate drill pipes 5"
- Drill pipes 5"

3. Parameters

RPM : 80 - 150
Weight: 10000 - 20000 LBS
Flow rate : Maximum pump output.

4. Drilling fluid

See mud programme

5. Deviation

See deviation survey programme

6. Logging

See logging programme

F. 13 3/8 CASING (shoe at 850 m approximately)

1. Casing set up

From bottom to top

- 1 float shoe 68 LBS/FT
- 2 joints K55 - 68 LBS/FT - Buttress
- 1 float collar 68 LBS/FT
- X joints K55 - 68 LBS/FT - Buttress
- 18 3/4" x 13 3/8" casing hanger

(13 3/8 casing 68 LBS/FT drift = 315.3mm)

2. Landing string

From casing hanger to top

- Running tool, 18 3/4" universal casing hanger with subsea cementing system
- 5" HWDP (or 6½" DC)
- Subsea cementing head

G. 12 1/4 PHASE (to 2300m approximately)

1. Drilling procedure.

- Test casing and blind rams to 2000 PSI - 15 MN
- Test BOP stack - Rams to 5000 psi
  - Bag to 2500 psi
- Run 12 1/4 bit and drill cement and shoe then 3 meters in formation
- Perform the leak-off test to the leak off value
- Run gyroscopic multishot survey in 13 3/8 casing at first trip to change 12 1/4 bit
- Drill in 12 1/4 to 2300m approximatively
- Short trip at least every 250m

- Wiper trip before logs
- Run logs
- Control trip after logs
- Retrieve seat protector before running the 9 5/8 casing

2. Drilling string

- 12 1/4 Bit
- Float valve baker model GA
- Near bit stabilizer 12 1/4
- Non magnetic drill collar OD 9"
- Middle body stabilizer 12 1/4
- 2 drill collars 9" OD
- Middle body stabilizer 12 1/4
- 6 drill collars 9" OD
- 9 to 12 drill collars OD 8"
- 2 Hevywate drill pipes 5"
- 1 drilling jar
- 15 Hevywate drill pipes 5"
- Drop in pressure valve sub
- Drill pipes 5" OD

1 rubber protector each stand in casing.

3. Parameters

RPM = 100-140

Weight= 2000 - 50000 LBS

Flowrate: Depending on theological parameters. The flowrate will be fixed every day in connection with use of computerized programmes by EAN mud section.

4. Drilling fluid

See mud programme

5. Deviation

See deviation survey programme.
At least every 100m or before pulling bits.

6. Logging

See logging programme.

CBL - VDL in 13 3/8 casing.

H. 9 5/8 CASING (Shoe at 2300m approximatively)

1. Casing set up

From bottom to top

- 1 float shoe 47 LBS/FT	BUT
- 3 joints N80 47 LBS/FT	BUT threads
- 1 float collar 47 LBS/FT	BUT
- X joints N80 47 LBS/FT	BUT threads
- 18 3/4" x 9 5/8" casing hanger	

Centralizers : Programme will be decided from hole angle and Caliper.

9 5/8 47 LBS/FT drift = 220.5m

Fill up every joint while running in hole. Check float equipment after making-up one joint over float collar.

2. Landing string

From casing hanger to top

- Running tool, 18 3/3", universal casing hanger with subsea cementing system
- 5" HWDP (or 6½ DC)
- Subsea cementing head

3. Cementing job

9 5/8" casing will be cemented from shoe to 1800m with class G cement and from 1800m to 700m (150m above 13 3/8" shoe) with lett cement

Use :

- 23.5 T of G cement mixed with 10m^3 of fresh water slurry SG = 1.90
- 32.2 T of G cement mixed with 30.6m^3 of fresh water slurry SG = 1.54

- (quantities must be calculated according to caliper log)
- Displace with mud at 700 l/MN maximum flowrate.
- Bump plug at 1400 PSI - 5MN
- The total desplacement volume must not exceed the total volume inside casing from top to shoe calculated with a 99% efficiency of the displacement pumps.
- Bleed off and check return.
- Retrieve the landing string by disconnecting the running tool.

- Run and set pack off assembly.
- In case of problems during cement job one temperature log would be run to check top cement.

I. 8½ PHASE (to 2750m approximatively)

1. Drilling Procedure

- Test casing and blind rams to 4000 PSI. 15 MN
- Test BOP stack
  - Rams to 6000 PSI
  - Bag to 2500 PSI
- Run gyroscopic multishot survey in 9 5/8 casing
- Run 8½" bit and drill cement and shoe then 3 meters in formation
- Perform a leak off test until the leak-off value is reached (class B test)
- In case of leak before 1.50 one squeeze of cement will be performed at shoe and a new leak-off test would be performed after waiting for cement to dry
- Drill to 2650m approximately with eventual coring
- Short trip at leat every 250m
- Wiper trip before any logging
- Run logs

2. Drilling string

- 8½ bit
- Float valve BAKER model GA
- Near bit stabilizer 8½
- Non magnetic Drill collar 6 1/2 OD
- Middle body stabilizer 8½
- Drill collar 6½" OD
- Middle body stabilizer 8½
- 22 Drill collar 6½ OD
- Drop in pressure valve sub
- 2 Heavy water Drill pipe 5"
- Drilling jar
- 15 Heavy water drill pipes 5"
- Drill pipes 5"

3. Parameters

RPM : 100 - 140 (80 with insert bits)

Weight: 20 000 - 50 000 LBS

Flowrate: Same remarks as for 12 1/4 phase

4. Drilling fluid

See mud programme

5. Deviation

See deviation survey programme
Survey every 100m or before pulling bits
Gyroscopic multishot survey in 9 5/8.

6. Logging

See logging programme. CBL - VDL in 9 5/8 casing.

J. Liner 7"

In case of favourable formation and formation test decided one 7" liner would be run.
A special programme would be made in time giving all characteristics and detailed instruction to run that liner.

K. Abandonment of well

In case of abandonment of well one special programme approved by authorities would be issued and sent to the rig.

L. Cleaning the well site

It is the responsibility of ELF AQUITAINE NORGE to clean the well site before leaving it.
So it must be reminded that any drop of equipment, material to the sea must be avoided and in case of such a drop the fact must be pointed out to the company's representative on board in order to take proper actions to retrieve the lost equipment.

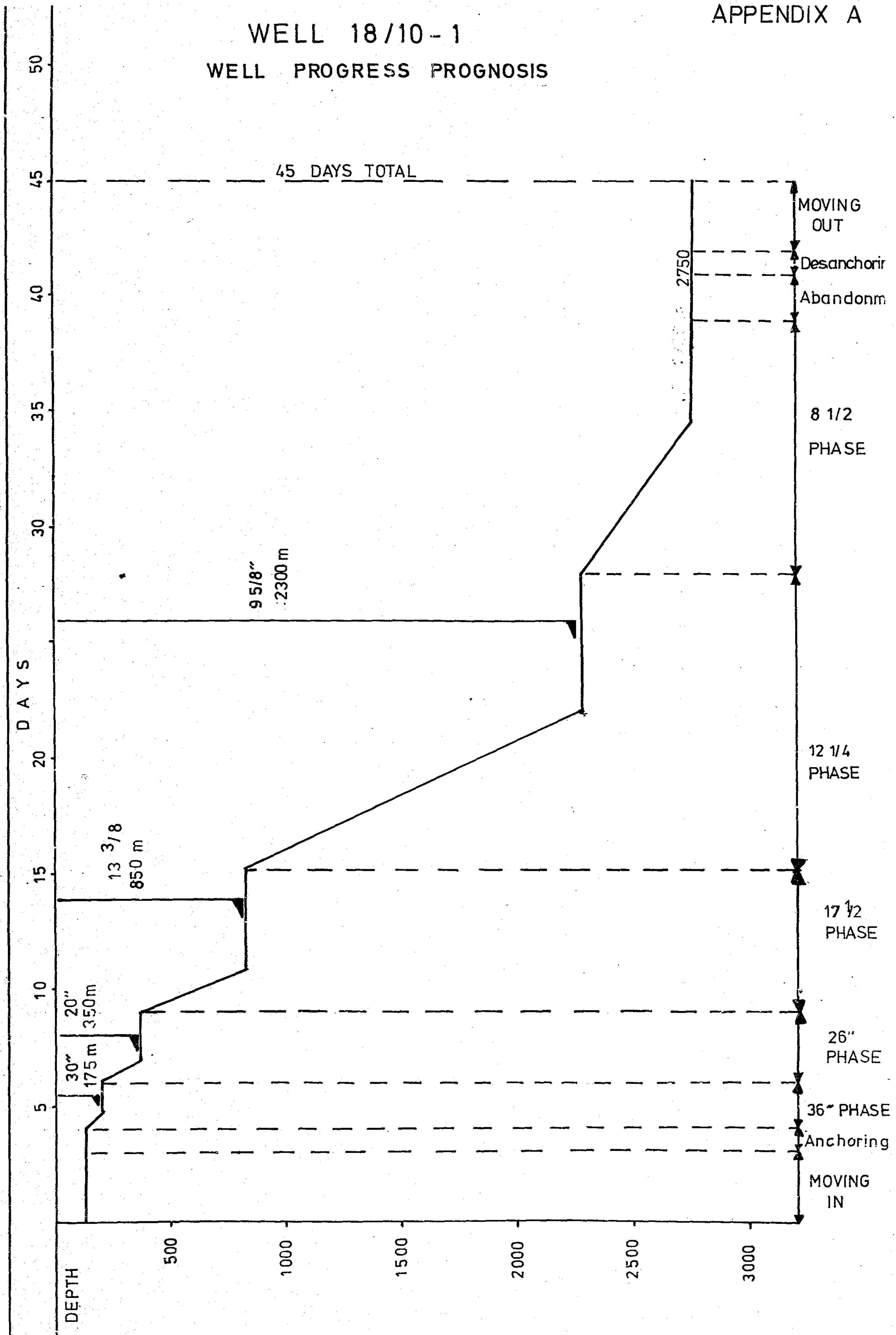
- APPENDIX -

APPENDIX

APPENDIX A

WELL 18/10-1

WELL PROGRESS PROGNOSIS



Appendix B

FLUIDS AND CEMENTING PROGRAM - 18 / 10 - 1

Fluids & Cement

G. COLENO

P.O.

I. 36" PHASE - interval sea bed to 175m. 30" casing at 175m.

1.1. Drill with sea water, allowing returns to go to the sea floor. Displace sea water with 5 - 7 m^3 gelly slugs of mud before each connection. When the 36" hole is drilled, pump to fill up well with gelly mud before making a wiper trip. Circulation with thick mud into the hole for cleaning before pulling out to run 30" casing.

1.2. Composition of high viscosity mud for starting up

sea water : 1000 1

solvitex : from 8 Kg

or

foragum : to 12 Kg

products very sensitive to alcalinity so clean properl the tanks to remove all alcalinity traces

1.3. Characteristics of mud

weight	: 1.04 - 1.06
f. viscosity	: 120 - 150
filtrate 30 min:	15 - 20

1.4. Provide mud : 250 m3

II. 26" PHASE - interval 175 to 350m. 20" casing at ± 350m

2.1. Drill out cement and shoe with sea water and returns to the sea. After drilling the shoe displace sea water b mud and then continue drilling 26" hole to 350m.

2.2. Composition of bentonitic and ferrochromelignosulfonate mud

sea water :1000 l

wypoming bentonite: 50 - 70 Kg (if possible prehydrate in 200 l fresh water.)

FCL : 5 - 10 Kg

caustic soda : 4 - 6 Kg

Staflo HV or LV : 1 - 2 Kg (to adjust viscosity and reduce filtrate)

d. detergent : 1 - 2 l (if "bit balling" or torque)

2.3. Characteristics of mud

weight : 1.10 - 1.15

solids : 5 - 10

funnel viscosity : 60 - 70

apparent viscosity: 25 - 35

plastic viscosity or "N" : 20 - 25

Yield point or "K": 15 - 20

initial gel : 4 - 8

10 min gel : 10 - 20

filtrate 30 min : 6 - 10

pH : 8.5 - 9.5

alcalinity Pf : 0.1 - 0.2

2.4. Provide mud : 300 m3

III. 17"½ PHASE - interval 350 to 850m - 13"3/8 casing at ± 850m

3.1. Before drilling out the cement inside 20" casing, pretreat the system with sodium bicarbonate to avoid cement contamination and the products to adjust the following composition.

3.2. Composition of bentonitic and ferro chrome lignosulfonate mud

sea water : 1000 l

wyoming bentonite : 50 - 70 Kg (if possible prehydrate in 200 l fresh water)

FCL : 10 - 20 Kg

caustic soda : 4 - 6 Kg

staflo HV or LV : 1 - 3 Kg (if adjust viscosity ar reduce filtrate)

d. detergent : 1 - 2 l (if "bit balling" or torque)

3.3. Characteristics of mud

weight : 1.10 - 1.15

solids : 6 - 10

funnel viscosity : 60 - 70

apparent viscosity: 25 - 35

plastic viscosity : 20 - 25

yield point : 15 - 20

initial gel : 4 - 8

10min gel : 10 - 20

filtrate 30 min : 6 - 8

pH : 9 - 9.5

alcalinity Pf : 0.1- 0.2

3.4. Provide mud : 400 m3

IV. 12"1/4 PHASE - interval 850 to 2300 m - 9"5/8 casing at ± 2300m

4.1. Before drilling out the cement inside 13"3/8 casing, pretreat the system with sodium bicarbonate to avoid cement contamination and the products to adjust the following composition.

4.2. Composition of ferro chrome lignosulfonate and chrome lignite mud

sea water	1000 l	
wyiming bentonite	25 - 50 Kg	(it is necessary to ha a good cake)
FCL	30 - 40 Kg	maintain concentratio
CL	10 - 20 Kg	
caustic soda	8 - 12 Kg	
Staflo HV or LV	1 - 4 Kg	(to adjust viscosity o reduce filtrate)
d. detergent	1 - 2 l	(more if "bit balling" or torque)
barite	for weight adjustment	

4.3. Characteristics of mud

weight	1.15 - 1.25
solids	9 - 13
funnel viscosity	50 - 60
apparent viscosity	30 - 40
plastic viscosity	25 - 30
yield point	15 - 20
initial gel	2 - 4
10 min gel	10 - 15
filtrate 30 min	3 - 4
pH	9.5- 10
alcalinity Pf	0.1- 0.3
Ca^{++} and $M g^{++}$	0.3

4.4. Provide mud : 600 m3

V. GENERAL DISCUSSION

It is during this stage that the "Gumbos Shales" are to be drilled. These shales are reputed as being difficult due to problems arising during penetration. They hydrate easily and eventually come apart and, if the mud is not perfectly suited to this type of formation, this may give rise to redrilling and caving.

The mud weight will be progressively increased:

13"3/8 shoe : 1.12
1000 m : 1.14
1200 : 1.16
1400 : 1.18
1600 : 1.20
1800 : 1.22
2300 : 1.24 - 1.25

The mud used in this stage must therefore respond to the following essential criteria:

- have a specific gravity at such a level as to contain the slight tendency to creep in the shales. The specific gravity will be obtained in successive from a level of 1.10 at the start of this phase to 1.24 - 1.25 towards 2280m.

- possess normal rheological properties to have a good dispersed system, to ensure proper cleaning and to avoid a too high equivalent circulating density.

- have a very low filtrate

- The solids will be eliminated on the shales shakers, desilters, desanders, mud cleaners and dilution. Run the smallest screens possible on all shakers and mud cleaners. The shakers will be constantly watched. If there is a decrease of cuttings volume, one short trip to shoe will be made immediately and circulation established.

- be in good electro chemical equilibrium with the shales to avoid hydratation phenomena. pH 9 and $Ca^{++} \leqslant$ 300 ppm.

- In order to maintain this mud in a dispersed state and in good electro chemical equilibrium with the tena constant supervision is required, together with continuous treatment with lignosulfonates and sea water, as well as applying all mechanical means for eliminating solids.

VI. 8"½ PHASE - interval 2300 to 2750m - 7" casing at 2750m ± if needed.

6.1. Before drilling out the cement inside 9"5/8 casing, pretreat the mud with sodium bicarbonate to avoid cement contamination and the products to adjust the following composition. Verification and treatment same as above.

6.2. Composition of ferro chrome lignosulfonate and chrome lignite mud

sea water	:	1000 l		
wyoming bentonite	:	25	- 50 Kg	(it is necessary to have a good cake)
F C L	:	30	- 40 Kg	maintain concentrati
C L	:	10	- 20 Kg	
caustic soda	:	8	- 12 Kg	
staflo HV or LV	:	1	- 4 Kg	(to adjust rheology c reduce filtrate)
d. detergent	:	1	- 2 l	(more if "balling" o torque)
barite	:	for weight adjustment		

6.3. Characteristics of mud

weight	:	1.25	- 1.26
solids	:	12	- 14
funnel viscosity	:	50	- 55
apparent viscosity	:	30	- 40
plastic viscosity	:	25	- 30
yield point	:	15	- 20
initial gel	:	2	- 4
10 min gel	:	10	- 15
filtrate 30 min	:	2	- 4
alcalinity Pf	:	0.1	- 0.3
pH	:	9.5	- 10
Ca^{++} and Mg^{++}	:	0.3	

6.4. Provide mud : 200 m3

VII. PERMANENT INSTRUCTIONS

7.1.

- To avoid any incident, it is imperative to get permanently a volume of mud, that is to say:

  ONE TANK OF MUD WITH A SG OF 1.50 FOR THE 8"½ PHASE

  and necessary products need to make this volume quickly, ready to be used immediately to control any income or blow out.

- Permanent survey of the pit level, volume and of the characteristics of the fluid in circulation, and mainly, if a velocity break, occurs the mud ditch fluid, gas content, temperature, chloride variation, in order to detect any show in case of abnormal pressure.

- Let an homogenous and a steady fluid in well before every pulling out of hole.

- Control the permanent filling of the well, particularly during the trips (possum belly tank).

- Calibrate the densimeter often mainly for the abnormal pressured formation.

- A pressurized mud balance will be used throughout the 8"½ phase to ensure accurate mud weight determination.

- In the purpose of making easier the electrical logging, the running in casings and to assume their best cementing jobs, it is necessary to be very careful to the best rheological fluid characteristics during the circulation which goes before these operations.

- Mud tanks for mixing water with additives will be very well cleaned to have no pollution by mud.

7.2. Permanent safety materials in stock

. barite on the rig	300 T
. barite on each supply	100 T
. W. bentonite	10 T
. attapulgite clay	5 T
. sodium acid pyrophosphate(barite plug)	0.5T
. H2S scavenger (mil gard R or ironite sponge)	1 T
. L. C. M. fiber	1 T
granular (coarse and fine)	1 T
flake	1 T
. pipe free	2000 1
. sodium bicarbonate	1.5T
. soda ash	1 T
. calcium cholride	1.5T

BARITE IN STOCK THE 01.09.1979

COMPANIES	BULK DUSAVIK	BULK TANANGER	SACKS STORAGE	TOTAL
ANCHOR DRIL. FLUID	400	650	90	1140
MILCHEM		120	800	920
CECA	546	1470	142	2158
DRESSER	101	562		663
IMCO	580	1050	8000	9630
BAROID	366	324	11	701
TOTAL m/tons	6893	4176	9043	15212

MATERIALS QUANTITIES ESTIMATION

PHASE/CASING	MATERIALS	QUANTITIES (Kg or l)
36" / 30"	foragum or solvitex	4000
	defoamer	100
	barite	50000
	lost circulation materials	3000
	sodium bicarbonate	1500
	soda ash	1000
	pipe free	2000
	class G cement	60000
	calcium chloride	4000

PHASE/CASING	MATERIALS	QUANTITIES (Kg or l)
26" / 20"	wyoming bentonite	15000
	FCL	3000
	caustic soda	1800
	staflo HV	600
	staflo LV	400
	d. detergent	300
	attapulgite clay	5000
	class G cement	75000
	W. bentonite	1000
	CaCl2	2000

PHASE/CASING	MATERIALS	QUANTITIES (Kg or l)
17"½/13"3/8	Wyoming bentonite	4000
	FCL	8000
	caustic soda	2500
	staflo HV	1000
	staflo LV	500
	drilling mud detergent	800
	defoamer	1000
	sodium acid pyrophosphate	500
	H2S scavenger	1000
	class G cement	70000
	W. bentonite	1000
	CaCl2	1500

PHASE/CASING	MATERIALS	QUANTITIES (Kg or l)
12"1/4/ 9"5/8	wyoming bentonite	30000
	FCL	25000
	CL	12000
	caustic soda	8000
	staflo HV	2000
	CMC LV	500
	drilling mud detergent	1000
	defoamer	700
	barite	300000
	class G cement	60000
	W. bentonite	1000
	reduce f. loss	500
	dispersant	900
	retarder	100

PHASE/CASING	MATERIALS	QUANTITIES (Kg or l)
8"½ / 7"	wyoming bentonite	10000
	FCL	8000
	CL	4000
	caustic soda	2500
	staflo HV	1000
	staflo LV	500
	drilling mud detergent	400
	defoamer	300
	barite	100000

Appendix C

CEMENTING PROGRAM - 18/ 10 - 1

Fluids & Cement

G. COLENO

P.O.

30" CASING (shoe at about)		175
hole gage 36"	656.80	
casing 30" (31o lb)	455.80/407.80	
top cement up to sea bed (water depth 97 and RKB± 25)		122
open hole interval		53
excess in open hole 250%		

SLURRY VOLUME

annulus	36" x 30"	201.00 x 53 (3.5)	=	37286
inside	30" casing	407.80 x 4	=	1632
total volume				38918

equivalent density at bottom 1.27

TIMING OF OPERATION

mix and pump G cement	38918: 700	=	60
drop plug			15
displacement 5"	9.27 x 171 = 1584		
flow rate	700 l/min		3
TOTAL			78
Safety factor	50%		39
Grand TOTAL			117

Thickening time requested (175 m BHST ± 6°C)

class G ≥ 2 hours

SLURRY

Composition	Weight Kg	Volume l.	by m^3FW
fresh water	45	45	
anti foam	0.10	0.10	1
CaCl2 (1.95)	4	2	88.9
G. Cement(3.15)	100	31.75	2222.2

SG ± 1.90

Thickening time recorded

$3^{H}00$

TOTAL MATERIALS NEEDS

fresh water $\quad \dfrac{45 \quad x \quad 49388}{100} = 22225$

anti foam $\quad \dfrac{0.1 \quad x \quad 22225}{100} = 23$

calcium chloride $\quad \dfrac{4 \quad x \quad 49388}{100} = 1975$

class G cement $\quad \dfrac{100 \quad x \quad 38918}{78.8} = 49388$

20" CASING (shoe at about)			350
casing gage	30" (310 lb)	455.80/407.80	175
hole gage	26"	342.50	
casing gage	20" (106.5 lb)	202.96/182.92	
top cement up to sea bed			122
open hole interval			175
casing interval			53
excess in open hole		150 %	

SLURRIES VOLUMES

annulus	26" x 20"	139.54 x 175(2.5)	=	61048
annulus	30" x 20"	204.84 x 53	=	10856
inside	20" casing	182.92 x 12	=	2195
total valume				74099
class G cement volume		139.54 x 75 (2.5)	=	26163
light weight cement volume				47936
equivalent density at bottom 1.46				

TIMING OF OPERATION

mix and pump light weight cement		47936 : 900	54	
mix and pump G cement		26163 : 700	38	38
drop plug			15	15
displacement	20"	182.92 x 214 = 39145		
	5	9.27 x 124 = 1150		
TOTAL		40295		
Flow rate	2500 l/min		17	17
TOTAL			124	70
safety factor		50%	62	35
Grand TOTAL			186	105

Thickening time requested (350 m BHST ± 15°C)

light $\geq$ 3^H

G $\geq$ 2^H

SLURRY LIGHT WEIGHT

Composition	Weight Kg	Volume l	by m^3FW
fresh water	97	97	
anti foam	0.1	0.1	1
W. bentonite prehydrated	2.5	1	25.7
CaCl2	3	1.5	30.9
G. cement	100	31.75	1030.9

SG ± 1.54

Thickening time recorded

4^H30

TOTAL MATERIALS NEEDS

fresh water

$$\frac{97 \times 36509}{100} = 35414$$

anti foam

$$\frac{0.1 \times 35414}{100} = 36$$

W. bentonite

$$\frac{2.5 \times 36509}{100} = 913$$

CaCl2

$$\frac{3 \times 36509}{100} = 1095$$

G. cement

$$\frac{100 \times 47936}{131.3} = 36.509$$

SLURRY G

Composition	Weight Kg	Volume l	by m^3 FW
fresh water	44	44	
anti foam	0.1	0.1	1
CaCl2	2	1	45.4
G. cement	100	31.75	2272.7

SG ± 1.90

Thickening time recorded

$4^{H}00$

TOTAL MATERIALS NEEDS

fresh water $\frac{44 \quad x \quad 34066}{100} = 14989$

anti foam $\frac{0.1 \quad x \quad 14989}{100} = 15$

CaCl2 $\frac{2 \quad x \quad 34066}{100} = 681$

G. cement $\frac{100 \quad x \quad 26163}{76.8} = 34066$

13" 3/8 CASING (shoe at about)		850
casing gage 20" (106.5 lb)	202.96/182.92	350
hole gage 17"½	155.20	
casing gage 13"3/8(68 lb)	90.80/ 78.08	
top cement (78 m under the sea bed)		200
open hole interval		500
casing interval		150

excess in open hole: has to be calculated according to caliper log following calculations made with 50% excess factor.

SLURRIES VOLUMES

annulus 17"½ x 13"3/8	64.40 x 5000 (1.5)	=	48300
annulus 20" x 13"3/8	112.16 x 150	=	16824
inside 13"3/8 casing	78.08 x 24	=	1874
total volume			66998
class G cement volume	64.40 x 250 (1.5)	=	24150
light weight cement volume			42848

equivalent density at bottom 1.55

TIME OF OPERATION

mix and pump light weight cement	42848 : 900	48	
mix and pump G cement	24150 : 700	35	35
drop plug		15	15
displacement 13"3/8	78.08 x 826 = 64.494		
flowrate	1300 l/min	50	50
TOTAL		148	100
safety factor	50%	74	50
GRAND TOTAL		222	150

Thickening time requested (850 m BHST ± 30°C)

light ≫ $4^{H}00$

G ≫ $3^{H}00$

SLURRY LIGHT WEIGHT

Composition	Weight Kg	Volume l	by m^3 FW
fresh water	97	97	
anti foam	0.1	0.1	1
W. bentonite prehydrated	2.5	1	25.7
CaCl2	2	1	20.6
G cement	100	31.75	1030.9

SG ± 1.54

Thickening time recorded

$4^{H}15$

TOTAL MATERIALS NEEDS

fresh water $$\frac{97 \quad x \quad 32758}{100} = 31775$$

anti foam $$\frac{0.1 \quad x \quad 31775}{100} = 32$$

W. bentonite $$\frac{2.5 \quad x \quad 32758}{100} = 819$$

CaCl2 $$\frac{2 \quad x \quad 32775}{100} = 655$$

G. cement $$\frac{100 \quad x \quad 42848}{130.8} = 32758$$

SLURRY G

Composition	Weight Kg	Volume l	by m^3 FW
fresh water	44	44	
anti foam	0.1	0.1	1
CaCl2	1	0.5	22.7
G cement	100	31.75	2272.7
SG ± 1.90	145.1	76.35	

Thickening time recorded

$3^{H}30$

TOTAL MATERIALS NEEDS

fresh water	$\frac{44 \times 31651}{100} =$	13926
anti foam	$\frac{0.1 \times 13926}{100} =$	14
CaCl2	$\frac{1 \times 31651}{100} =$	317
G cement	$\frac{100 \times 24150}{76.3} =$	31651

9"5/8 CASING (shoe at about)			2300
casing gage	13"3/8 (68 lb)	90.80 /78.08	850
hole gage	12"1/4	76.04	
casing gage	9"5/8 (47 lb)	47.10/38.19	
top cement	200m above the 13"3/8 shoe		650
open hole interval			1450
casing interval			200

excess in open hole has to be calculated according to caliper log following calculations made with 25% excess factor.

SLURRIES VOLUMES

annulus	12"1/4 x 9"5/8	28.94 x 1450 (1.25)	=	52453
annulus	13"3/8 x 9"5/8	30.98 x 200	=	6196
inside 9"5/8 casing		38.19 x 36	=	1375
total volume				60024
class G cement volume		28.94 x 500 (1.25)	=	18087
light weight cement volume				41937
equivalent density at bottom		1.54		

TIMING OF OPERATION

mix and pump light weight cement	41937 : 900		47	
mix and pump G cement	18087 : 700		27	27
drop plug			15	15
displacement	38.19 x 2264	= 86462		
Flow rate 1400 l/min	31010		23	23
700 l/min	55452		80	80
TOTAL			192	145
Safety factor	50%		96	73
GRAND TOTAL			288	218

Thickening time requested (2300 m BHST ± 80°C)

light $\geq$ 5^H

G $\geq$ 3^H30

SLURRY LIGHT WEIGHT

Composition	Weight Kg	Volume l	by m^3 FW
fresh water	95	95	
defoamer	0.1	0.1	1
W. bentonite prehydrated	2.5	1	26.3
reduce f. loss	0.93	0.89	9.4
dispersant	1.63	1.33	14
G cement	100	31.75	1052

SG ± 1.54

Thickening time recorded

5^H30

TOTAL MATERIALS NEEDS

fresh water $$\frac{95 \times 32259}{100} = 30646$$

defoamer $$\frac{0.1 \times 30646}{100} = 31$$

W. bentonite $$\frac{2.5 \times 32259}{100} = 807$$

reduce f. loss $$\frac{0.89 \times 32259}{100} = 287$$

dispersant $$\frac{1.33 \times 32259}{100} = 429$$

G. cement $$\frac{100 \times 41937}{130} = 32259$$

SLURRY G

Composition	Weight Kg	Volume l	by m^3 FW
fresh water	42	42	
defoamer	0.1	0.1	1
reduce f. loss	0.93	0.89	21.2
dispersant	2.18	1.78	42.3
retarder	0.34	0.27	6.4
G. cement	100	31.75	2381

SG ± 1.90

Thickening time recorded

4^H

MATERIALS REQUIREMENTS

fresh water $\frac{42 \times 23550}{100} = 9891$

defoamer $\frac{0.1 \times 9891}{100} = 10$

reduce f. loss $\frac{0.89 \times 23550}{100} = 209.6$

dispersant $\frac{1.78 \times 23550}{100} = 419.2$

retarder $\frac{0.27 \times 23550}{100} = 63.6$

G cement $\frac{100 \times 18087}{76.8} = 23550$

CASING CALCULATIONS

1 - 20" CASING CALCULATIONS

1.1. Burst

17½" depth = 850m - 20" shoe = 350m

Mud specific gravity : 1.10 at 350m
1.15 at 850m

- Critical point :

Gas coming from 850m

- Pressure on bottom = 98 bars (1421 psi)
- Well full of gas. The experience gives :

Pressure on bottom = Pressure on top $\left(1+\frac{2.5\ \text{psi}}{100\ \text{psi}} \times \frac{\text{depth ft}}{1000\ \text{ft}}\right)$

which gives : Pressure at BOP = 90 bars.

Casing pressure test

- surface pressure = 70 bars (1000 psi)
- Pressure at shoe with 1.10 SG mud insiole :
  108 bars (1570 psi)

1.2. Collapse

20" casing shoe at 350m

- critical point : cement job.
  - 75m of class G cement SG = 1.90
  - 175m of lett cement SG = 1.54
  - 100m of mud SG = 1.15

which gives maximum collapse pressure with empty casing :

$$\frac{75\text{m} \times 1.90 + 175\text{m} \times 1.54 + 100\text{m} \times 1.15}{100} = 53 \text{ bars}$$

1.3. Choice of casing

20" casing 133 lls/ft grade K55

- burst pressure limit = 211 bars in the air
- collapse pressure limit = 103 bars at no traction.
- at mud line level, the casing choosen can hold

$$211 + \frac{1.03 \times 100}{10} = 221 \text{ bars of burst}$$

- at shoe (no traction) the casing choosen can hold 103 bars of collapse

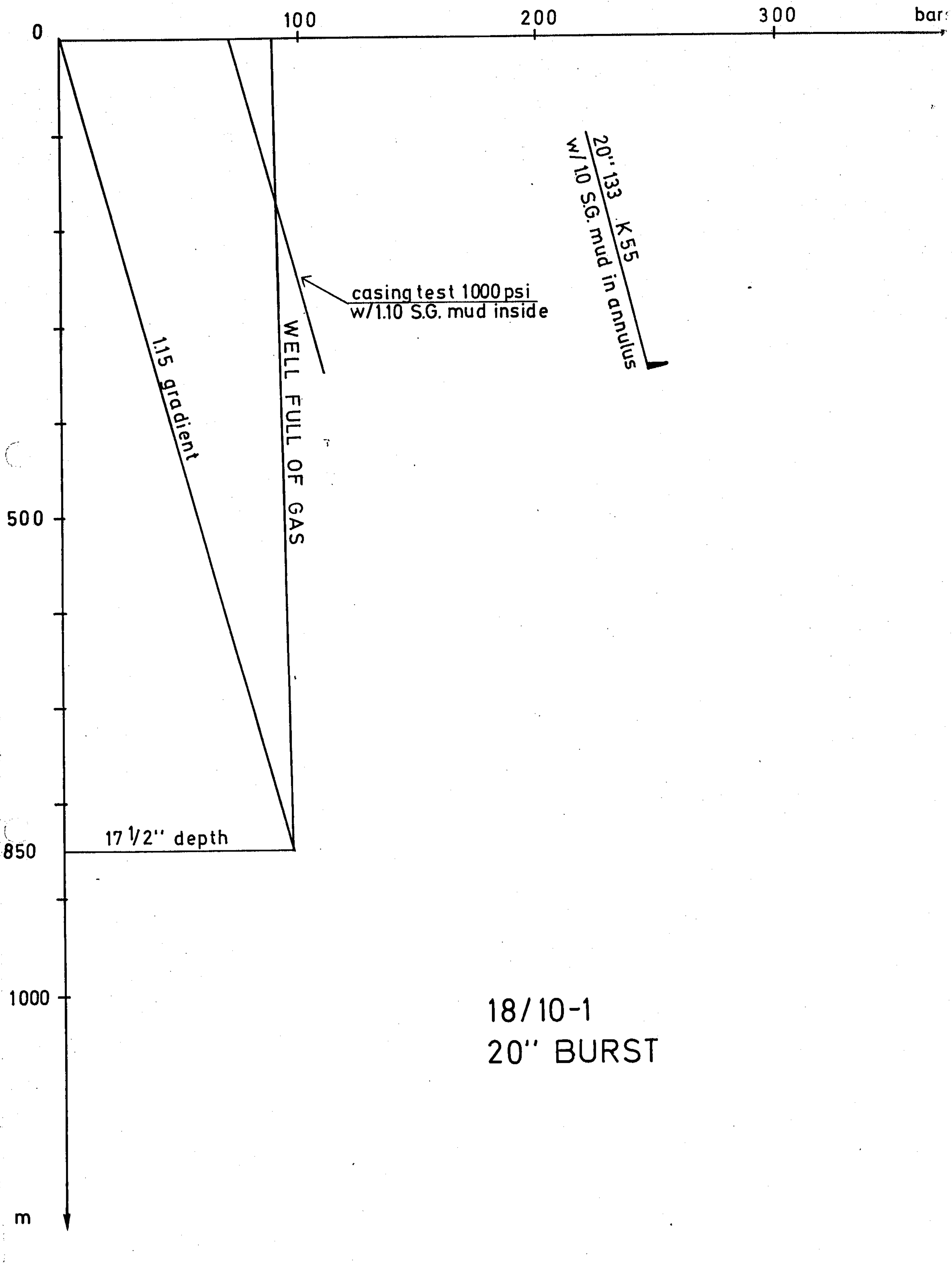
- Safety factors :

  . burst : $$\frac{\text{burst limit at mud line level}}{\text{pressure at BOP well full of gas}} = \frac{221}{90} = 2.45$$

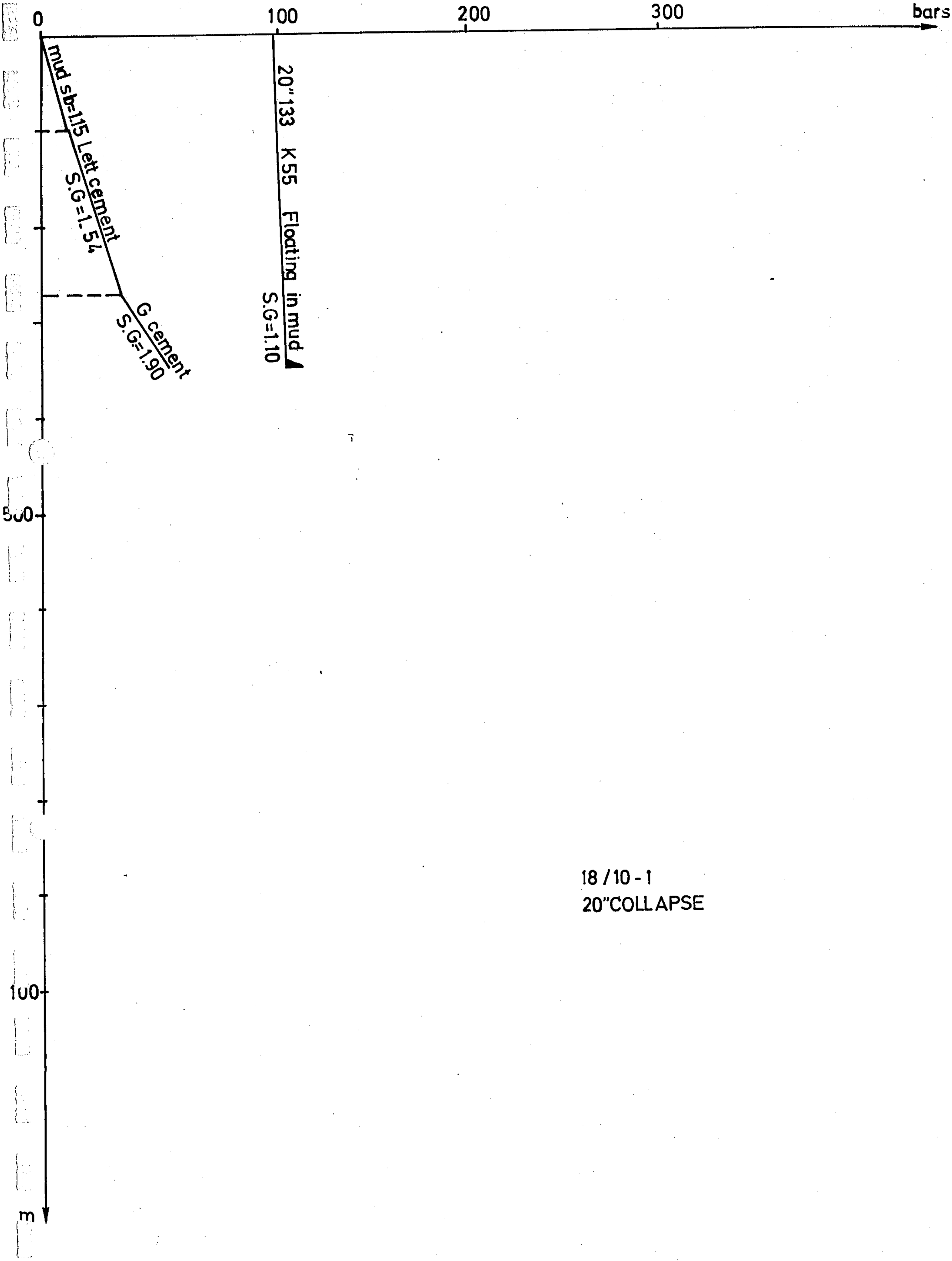
  . collapse: $$\frac{\text{collapse limit at shoe}}{\begin{array}{c}\text{Pressure in annulus at shoe}\\ \text{(end of cement job,casing empty)}\end{array}} = \frac{103}{53} = 1.94$$

1.4. Weight of casing in mud S.G. = 1.10

195.62 kg/m x 350m x 0.859 = 59 Tons.



18/10-1
20" BURST



18 / 10 - 1
20"COLLAPSE

2. 13 3/8 CASING CALCULATIONS

2.1. Burst

12 1/4 depth 2300m. 13 3/8 shoe 850m.

Mud specific gravity 1.15 at 850m
1.25 at 2300m

- Critical point.
  Gas coming from 2300m
  - Pressure on bottom : 287 bars (4170 PSI)
  - Well full of gas. The experience gives

$$\text{Pressure on bottom} = \text{Pressure at top} \cdot \left(1 + \frac{2.5\ \text{PSI}}{100\ \text{PSI}} \times \frac{\text{H FT}}{1000\ \text{FT}}\right)$$

  - Pressure at top : 233 bars (3378 PSI)
  - Pressure at BOP : 234 bars

Casing pressure test

- Surface pressure 140 bars (2000 PSI)
- Pressure at shoe with 1.15 SG mud inside

$$140 + \frac{1.15 \times 850}{10} = \quad 238 \text{ bars} \quad (3450 \text{ psi})$$

2.2. Collapse

13 3/8 shoe 850m

- Critical point.
  Cement job
  - 100m of class G SG = 1.90
  - 575m of lettcement SG = 1.53
  - 100m of water SG = 1.06

Maximum of outside pressure :

$$\frac{100m \times 1.90 + 575m \times 1.53 + 100 \times 1.06}{10} = 118 \text{ bars}$$

Inside pressure 1 BAR (casing empty)

2.3. Choice of casing

13 3/8 casing 68 LBS/FT GRADE K55

- Burst pressure limit 238 BARS in the air
- Collapse pressure limit 134 BARS at no traction

- On bottom of sea the casing choosen can hold

$$238 \text{ bars} + \frac{1.06 \times 100}{10} = 249 \text{ BARS of burst}$$

- At shoe (no traction) the casing choosen can hold 134 bars of collapse

- Safety factors

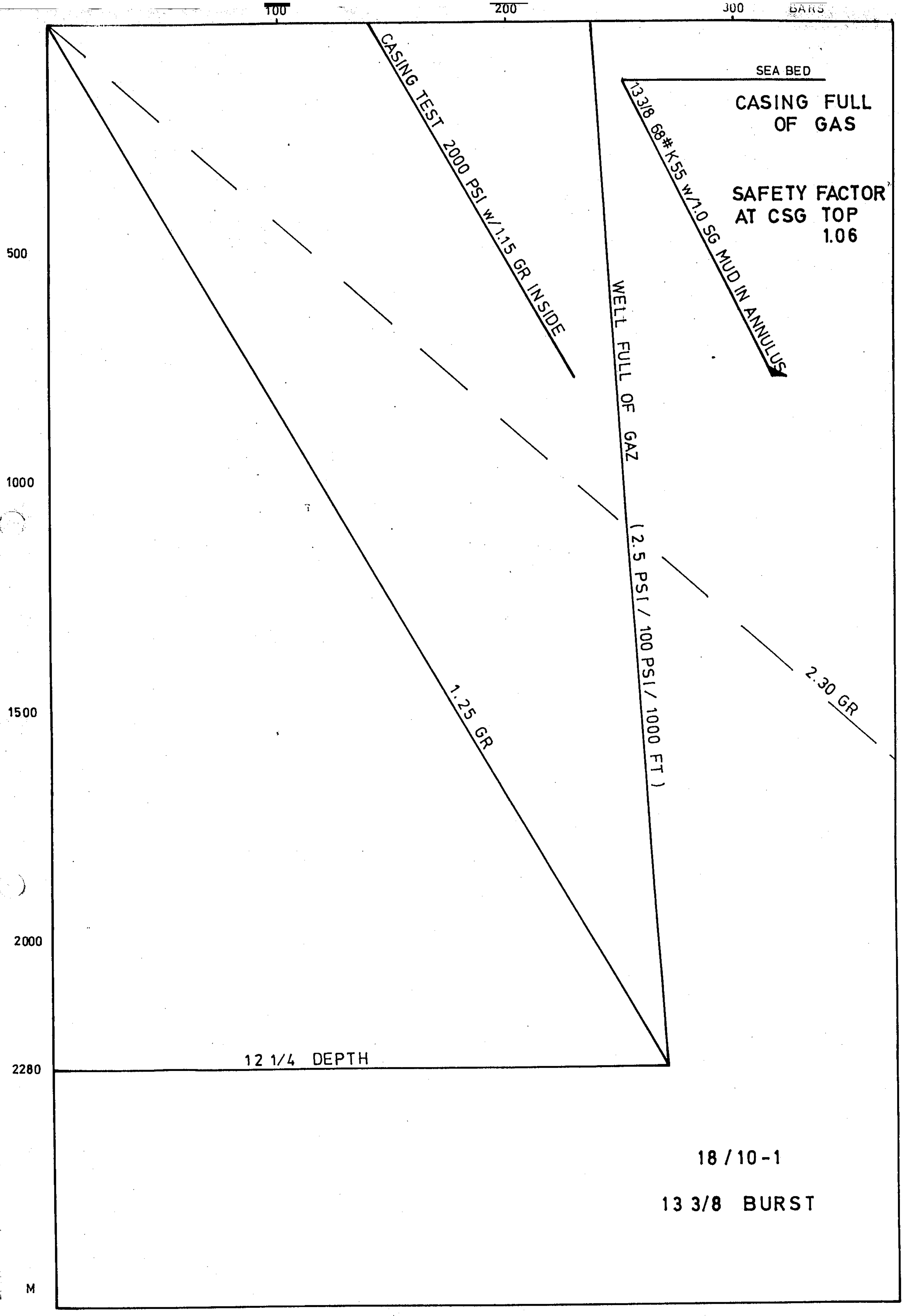
- Burst $\dfrac{\text{Burst limit on bottom of sea}}{\text{Pressure at BOP when well full of gas}} = \dfrac{249}{234} = 1.06.$

- Collapse $\dfrac{\text{Collapse limit at shoe}}{\text{Pressure in annulus at shoe (end of cement job, casing empty)}} = \dfrac{134}{117} = 1.15$

- The two values are acceptable for the 13 3/8.

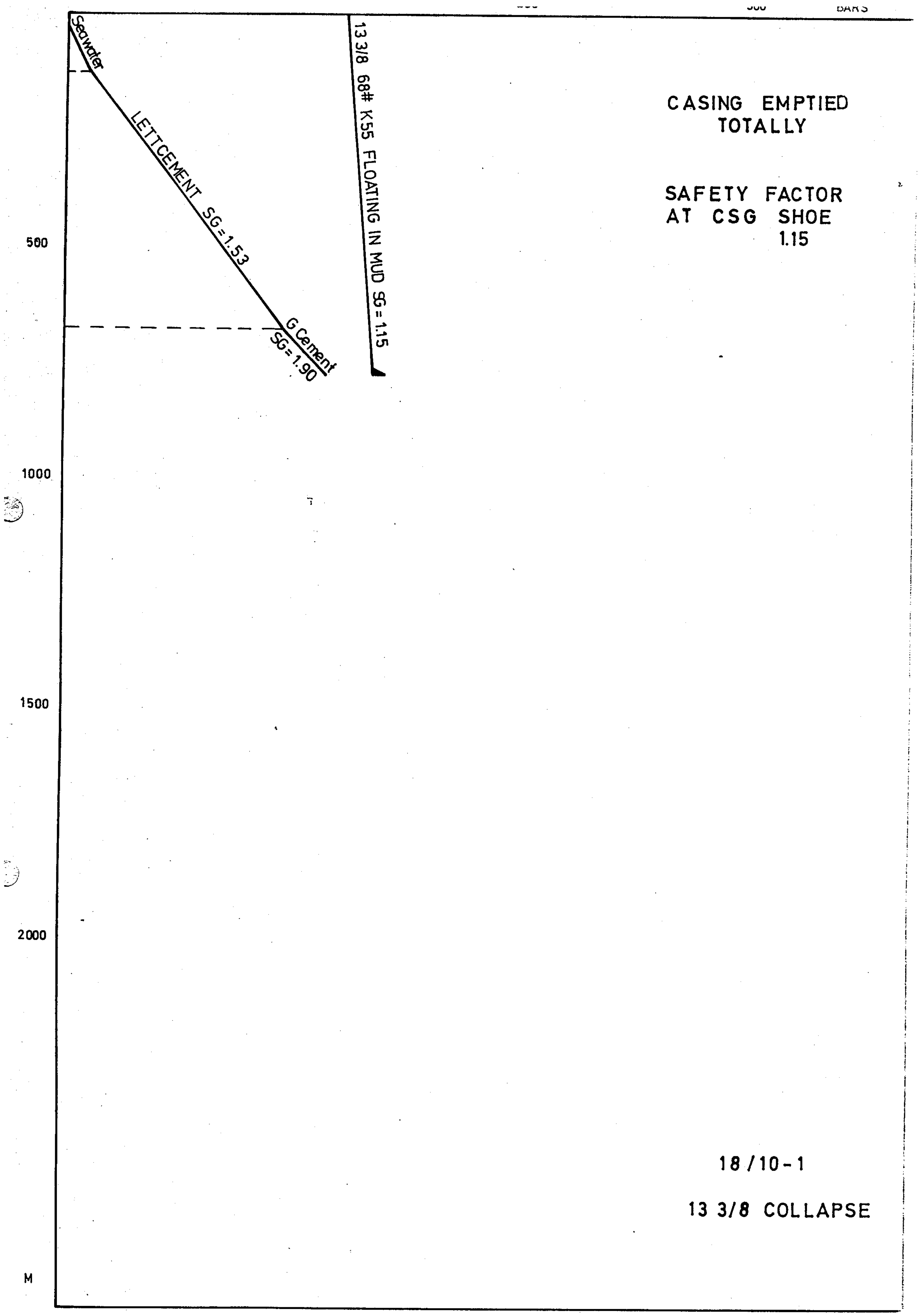
2.4. Weight of casing in mud SG = 1.15

100.08 KG/M x 780m x 0.853 = 67 TONS



18 / 10 - 1

13 3/8 BURST



CASING EMPTIED
TOTALLY

SAFETY FACTOR
AT CSG SHOE
1.15

18/10-1

13 3/8 COLLAPSE

3. 9 5/8 CASING CALCULATIONS

3.1. Burst

8½ depth 2650m - 9 5/8 shoe 2300m

Mud specific gravity 1.25

Critical point

Gas coming from 2650m

- Pressure on bottom : 331 BARS (4803 PSI)
- Well full of gas : The experience gives

$$\text{Pressure on bottom} = \text{Pressure at top} \cdot \left(1 + \frac{2.5 \text{ PSI}}{100 \text{ PSI}} \times \frac{\text{H FT}}{1000 \text{ FT}} \right)$$

- Pressure at top : 259 BARS (3760 PSI)
- Pressure at BOP : 262 BARS

Casing pressure test

- Surface pressure : 280 BARS (4000 PSI)
- Pressure at shoe with 1.25 SG mud inside

$$280 + \frac{1.25 \times 2300}{10} = 568 \text{ BARS} \quad (8228 \text{ PSI})$$

3.2. Collapse

9 5/8 shoe 2300m.

- Critical point.

  Cement job

  500m of class G SG = 1.90

  1100m of lett cement SG = 1.53

  100m of water SG = 1.06

  700m of mud SG = 1.25

Maximum of outside pressure

$$\frac{700m \times 1.25 + 1100m \times 1.53 \quad + 500m \times 1.90}{10} = 350 \text{ BA}$$

Inside pressure 1 BAR (casing empty)

3.3. Choice of casing

9 5/8 casing 47 LBS/FT GRADE N80

- Burst pressure limit 474 BARS in the air
- Collapse pressure limit 328 BARS at no traction

- On bottom of sea the casing choosen can hold

$$474 \text{ BARS} + \frac{1.06 \times 100}{10} = 485 \text{ BARS of burst}$$

- At shoe (no traction) the casing choosen can hold

328 Bars of collapse

- Safety factors

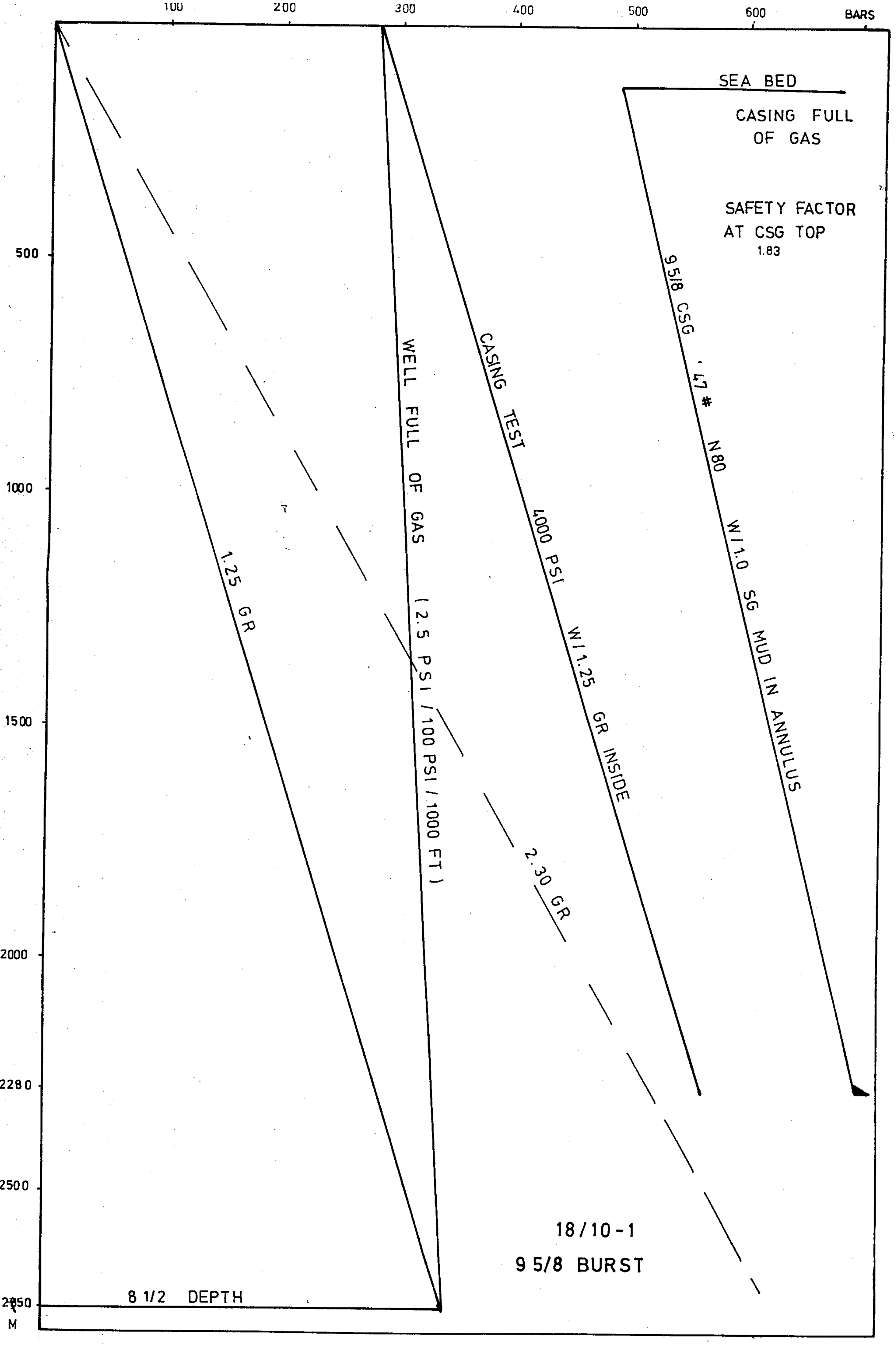
$$\text{Burst} = \frac{\text{Burst limit on bottom of sea}}{\text{Pressure at BOP when well full of gas}} = \frac{485}{262} = 1.85$$

$$\text{Collapse} = \frac{\text{Collapse limit at shoe}}{\text{Pressure in annulus at shoe (end of cement job, casing empty)}} = \frac{328}{350} = 0.94$$

The two values are acceptable for 9 5/8 casing

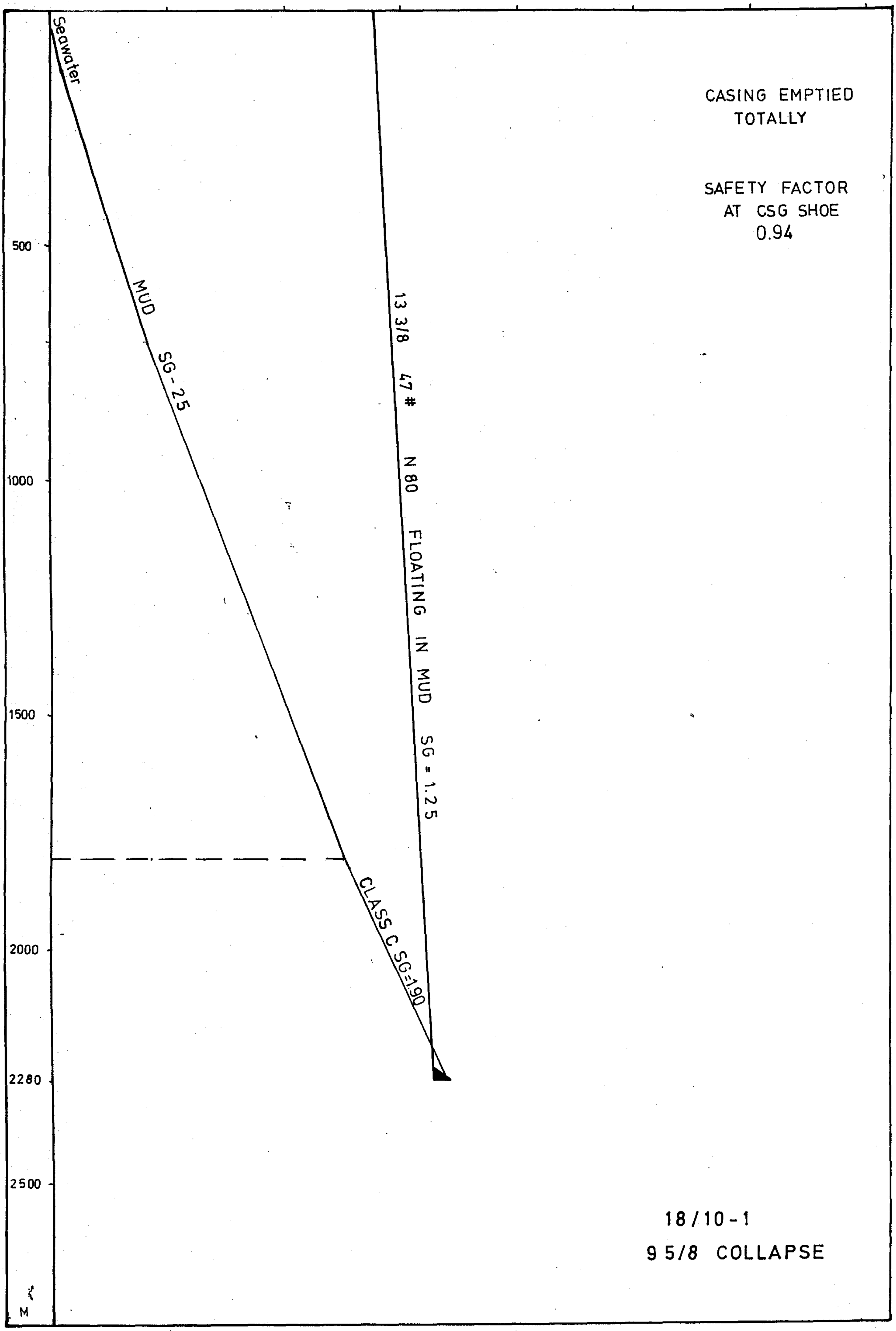
3.4. Weight of casing in mud SG = 1.25

69.89 KG/M x 2280 x 0.8405 = 134 T



18/10-1

9 5/8 BURST


Seawater
MUD SG-25
13 3/8 47 # N 80 FLOATING IN MUD SG = 1.25
CLASS C SG=1.90
CASING EMPTIED TOTALLY
SAFETY FACTOR AT CSG SHOE 0.94
500
1000
1500
2000
2280
2500
M
18/10-1
9 5/8 COLLAPSE

4. CASING CHARACTERISTICS

CASING SIZE IN	WEIGHT LBS/FT	GRADE	THREAD	MAKE-UP TORQUE M. KG.	WEIGHT w/ COLLAR KG/M	TENSION LIMIT T	COLLAPSE BARS	BURST BARS	THICK-NESS MM	INSIDE VOLUME L/M	SPECIAL EQUIP.
30	310	X52	SQUNCH JOINT ATD		461	2110	109	207	25.4	397.2	30" HOUSING
[illegible] 3/8	68	K55	BUTT	∇	100.1	475	134	238	12.19	78.1	DV stag colla
9 5/8	47	N80	BUTT	∇	69.9	482	238	474	11.99	38.2	
20"	133	K55	BUTT	∇			103	211	16.13	177.76	18 3/4" HOOSIN

CASING TESTS / LEAK OFF TESTS PROCEDURES

PRESSURE TESTING AFTER SETTING INTERMEDIATE CASING

I - Casing test

11 - Casing testing requires a high pressure pumping unit with measuring tanks. Casing is tested prior to drilling out cement, first with drill string out of hole (to test total shut-in) and then with bit on cementing collar (to test shut-in around the pipe if the casing has not been already tested at end of cementing operation).

12 - Pressure should be increased gradually (50 to 200 l/min). The pressure-volume relationship should be plotted. (Record one point every 50 to 200 l depending upon the total volume to be pumped, and at least 5 points.) If there is no leakoff, the relationship is linear. See Example on Fig. 1 attached.

13 - Under no circumstances should the maximum pressure exceed:

- The working pressure of the wellhead.
- Ninety percent of the internal yield pressure of the most exposed casing pipe, which is not necessarily the top pipe, (mud weight in string and annulus are to be considered).

The test pressure less than the two preceeding measures may be set if justified by the maximum operating pressure anticipated at the wellhead during the subsequent drilling phase.

14 - Pressure should be maintained for 15 minutes. The pressure test is considered positive, when the pressure drops less than 10 percent during this time. The pressure test should be recorded.

15 - Release pressure and measure the mud returns in the measuring tank. Compare with the theoretical volume required, taking into account size and length of casing (see Chart 1).

2 - Casing seat testing.

The purpose of this testing procedure is to test the resistance of the formations immediately beneath the casing shoe and the quality of the cement sheath around the shoe, if the latter is set in a relatively imperious zone (clay, shale etc.).

21 - Drill out cement and drill:

- 3 to 10 - m new hole, if the formation is impervious, when testing the quality of the cement sheath;
- not more than 50 - m new hole, if a permeable zone is expected in this interval.

22 - If necessary, circulate until mud weight is constant.

23 - Pull the bit up to the shoe, close the B.O.P. and pump mud into the drill pipe at a speed between 50 and 100 l/min. Plot the pressure-volume relationship on a graph (one point every 50 or 100 l).

24 - Stop the pump when <u>one of the three following preset requirements</u> is fulfilled:

Class A test: When the pressure attains a preset level, considered sufficient to cope with the problems anticipated during the subsequent drilling phase.

Class B test: When two consecutive points are distinctly out of the normal trend set by the linear relationship of the previous points (see reference line recorded during casing test). The point of deviations from the linear relationship marks the beginning of fluid leakoff into the formation. The corresponding bottom-hole pressure is the initial squeeze pressure by the depth at which fluid leakoff takes place. Se Fig. 2.

Class C test: When after passing through a maximum, the pressure drops rapidly, the bottom-hole pressure corresponding to the maximum is the fracturing pressure "FP". The equivalent fracturing density "FD" is calculated by dividing the fracturing pressure by the depth at which fracturing takes place. See Fig. 3 and 4. In the case of Fig. 4, it has not been possible to detect the leakoff point due to excessive pump speed. This is to be avoided.

25 - After shut down of the pump, maintain pressure of 10 minutes and record the pressure drop every minute.

26 - Release pressure and measure the mud returns. Compare to the returns after casing test.

3 - Open hole pressure test.

An open hole pressure test while drilling may be justified in the following cases:

- After drilling through a permeable zone.
- Before entering into transition zone.
- Before entering into a doubtful zone.
- Before increasing mud weight significantly.

The higher the open hole, the greater the number of anomalies while increasing pressure and therefore the difficulties encountered for determining the actual leakoff point.

31 - While pulling out, stop the bit at the shoe and proceed as set forth in para 23.

32 - If due to leakoff, it appears that the pressure rise will last more than half-an-hour, stop the pump, release pressure, and resume operation with a higher pump speed (200 to 300 l/min.).

33 - Stop the pump:

- either when the preset pressure has been attained (this pressure being for instance calculated so that the bottom-hole pressure at the shoes does not exceed the squeeze pressure determined during the first test);
- or when 3 or 4 successive points deviate from the average linear relationship in the neighbourhood of the normally expected pressure drop (see Fig. 5).

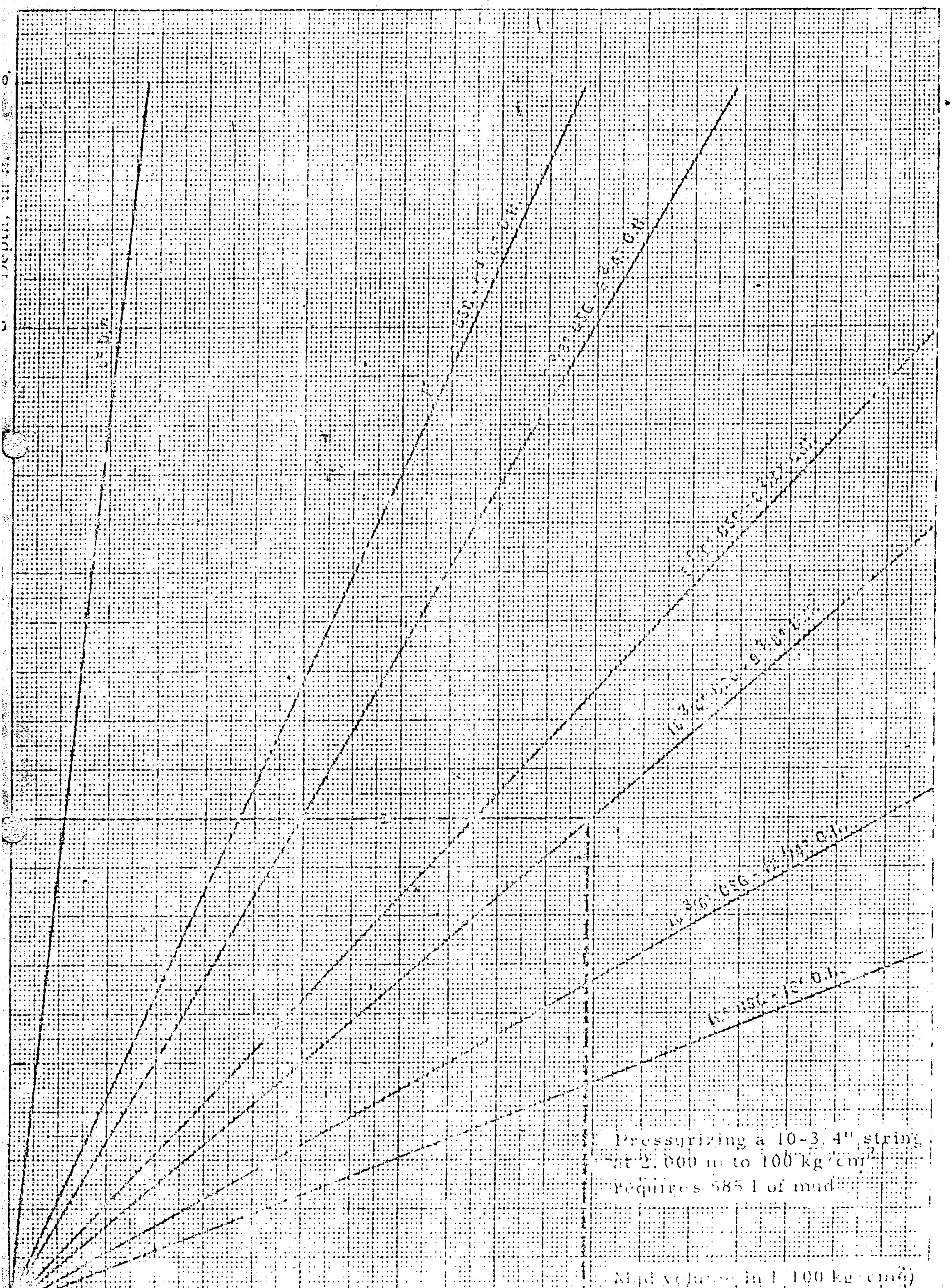
34 - Complete the test as set forth in para. 25 and 26.

4 - Important note.

Watch annulus between strings while carrying out pressure tests and bleed pressure off if required.

When the access to this annulus is impossible carefully observe the volumes pumped during the casing test (prior to drilling out cement) and ascertain that they are in accordance within 10 percent with the theoretical volumes shown in Chart No 1, since monitoring the mud volumes consitutes the only means available to check if a string is leak-proof and if the pressure is not taken by preceding string. I should be noted that pressuring the annulus between two strings may burst the outer string if the annulus between the two strings is shut-of (cement top above shoe).

When pressure testing below the shoe, mud volume monitoring becomes inefficient due to fluid leakoff into the formation, such leakoff increasing with the height of the open hole (see Fig. 5). However, if the casing has been shown to be leak-proof during the casing test, it will be sufficient, during the subsequent tests in the open hole, to stay below the casing test pressure to avoid any risk of "wild" leak through the annulus.



Pressurizing a 10-3/4" string at 2,000 m to 100 kg/cm² requires 585 l of mud

Fig 1

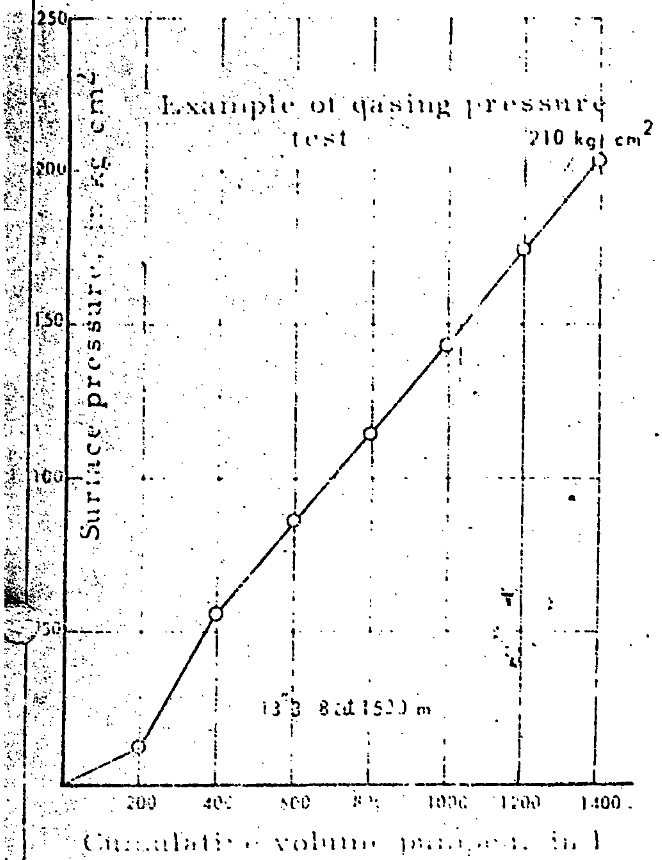
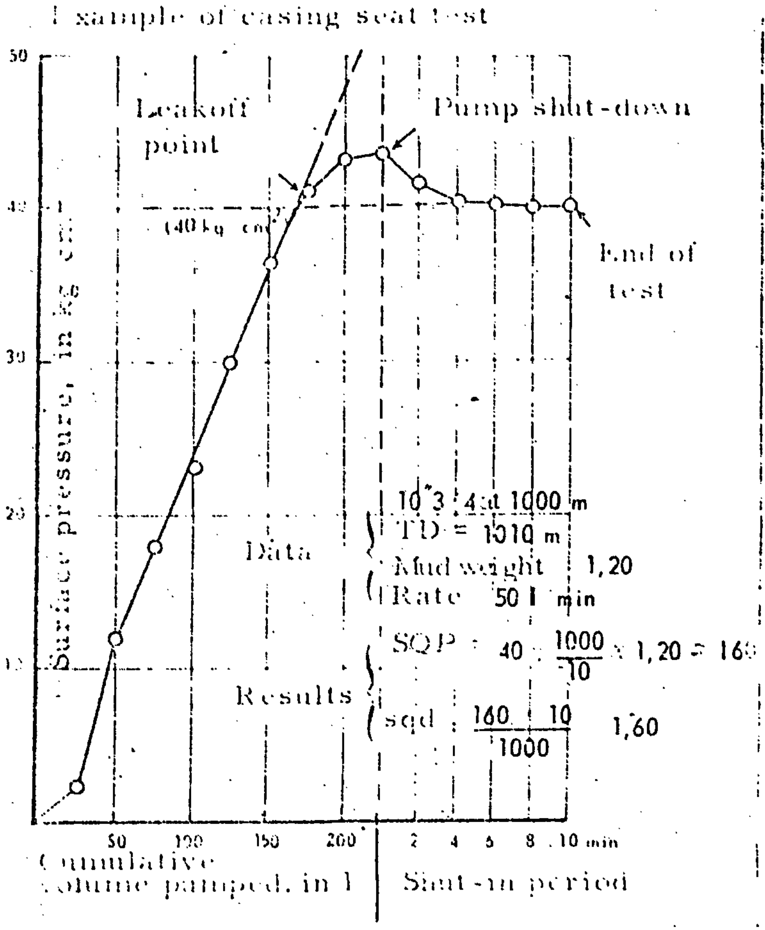


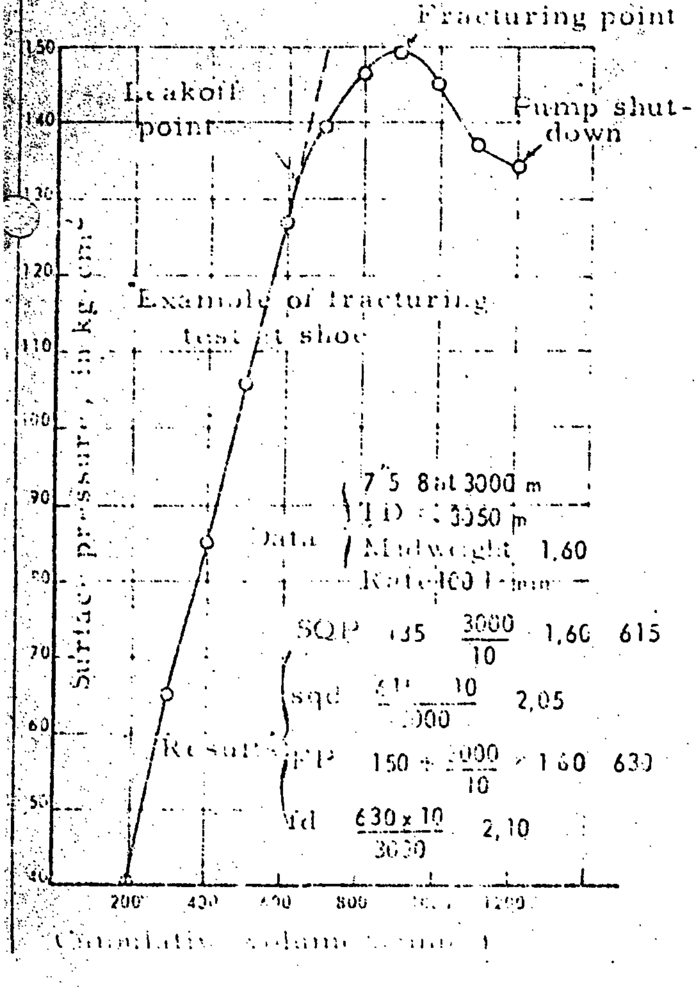
Fig. 2



Data
10"3/4 at 1000 m
TD = 1010 m
Mud weight 1,20
Rate 50 l/min

Results
SQP = 40 + $\frac{1000}{10}$ × 1,20 = 160
sqd = $\frac{160 \times 10}{1000}$ = 1,60

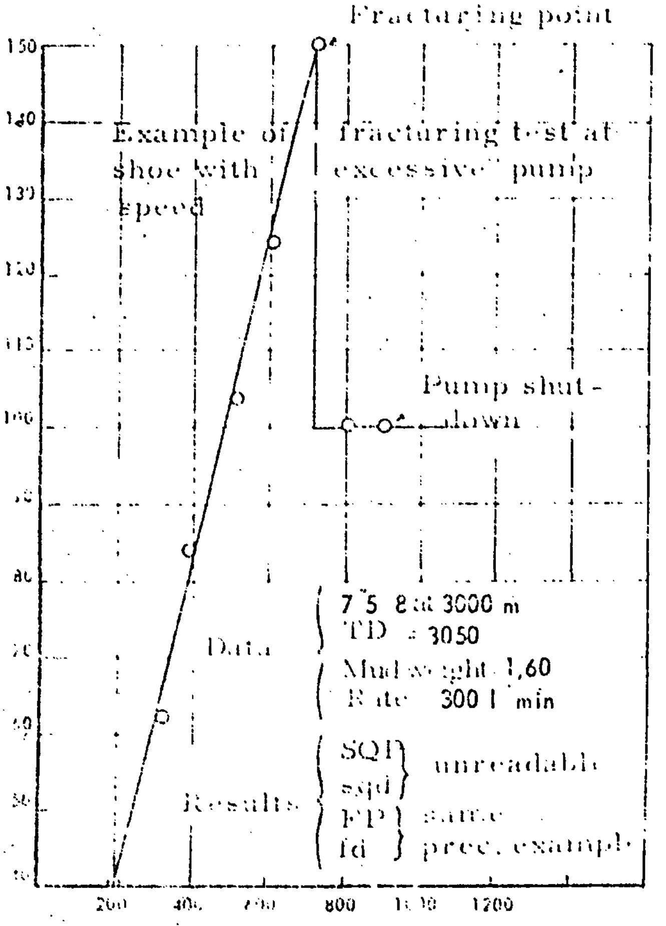
Fig. 3



Data
7"5/8 at 3000 m
TD = 3050 m
Mudweight 1,60
Rate 400 l/min

Results
SQP = 135 + $\frac{3000}{10}$ × 1,60 = 615
sqd = $\frac{615 \times 10}{3000}$ = 2,05
FP = 150 + $\frac{3000}{10}$ × 1,60 = 630
fd = $\frac{630 \times 10}{3000}$ = 2,10

Fig. 4

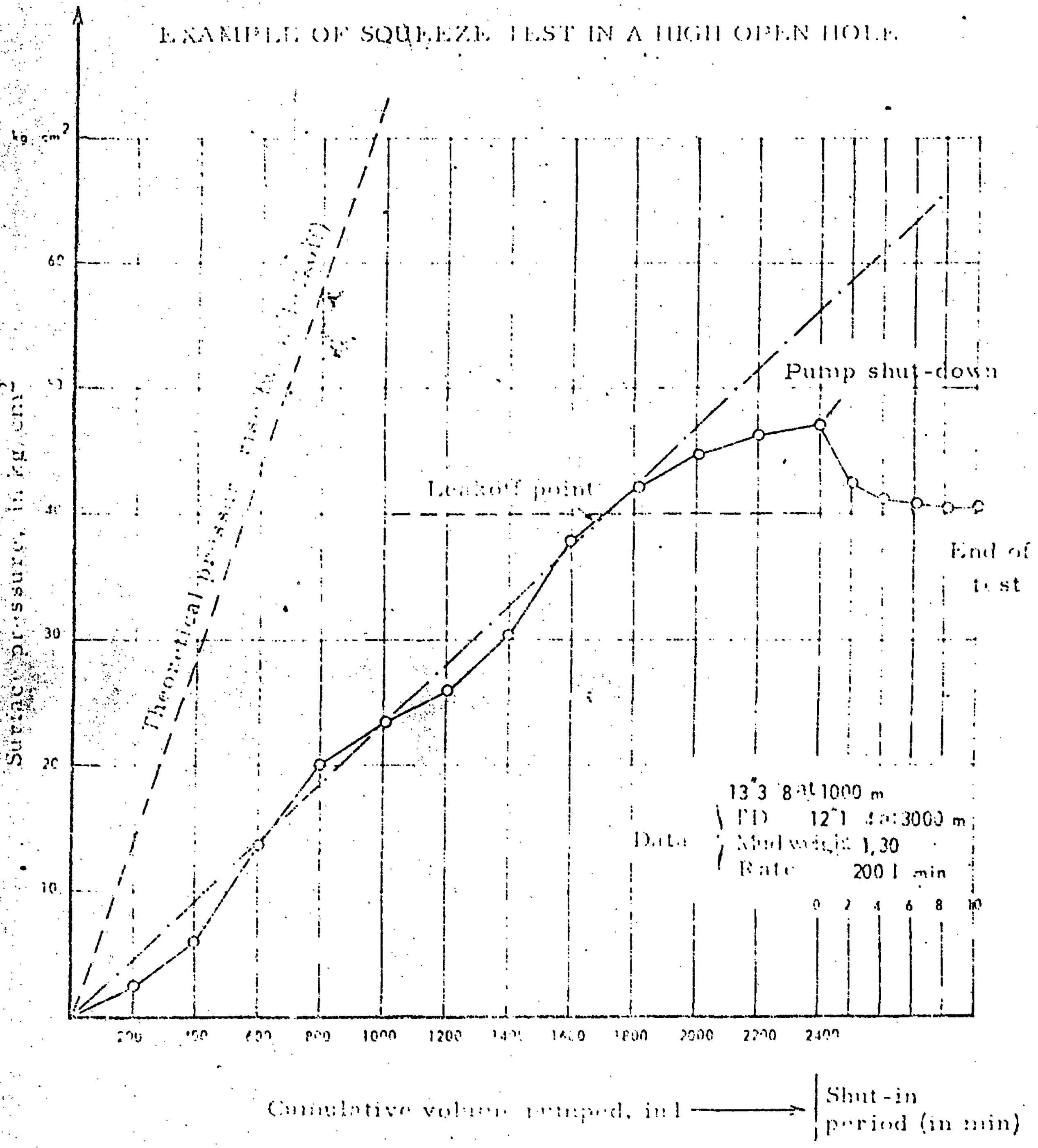


Data
7"5/8 at 3000 m
TD = 3050
Mud weight 1,60
Rate 300 l/min

Results
SQP, sqd: unreadable
FP, fd: same prec. example

Fig. 5

EXAMPLE OF SQUEEZE TEST IN A HIGH OPEN HOLE



Resistance --- at shoe

$$SQP \geqslant 40 + \frac{1000}{10} \cdot 1{,}30 = 170 \text{ kg/cm}^2$$

$$sqi \geqslant \frac{170 \cdot 10}{1000} = 1{,}70$$

at bottom

$$SQP \geqslant 40 + \frac{3000}{10} \cdot 1{,}30 = 430 \text{ kg/cm}^2$$

$$sqi \geqslant \frac{430 \cdot 10}{3000} = 1{,}43$$

ELF NORGE A/S
STAVANGER

From : DRILLING SUPERINTENDANT

To : ELF NORGE A/S - SUPERVISORS

RESPONSIBILITIES

1. Elf Norge A/S toolpusher on a Contractor rig is the Company representative on that rig.
2. No visitors are allowed when not announced by Drilling head office.
3. It is always the Elf Norge A/S responsibility when supervising contractor-operated rigs, regardless of the type of contract, to see that drilling operations are conducted in such manner that adequate well control is maintained at all times.

   Well control starts with the planning of the well prognosis and includes an alert drilling crew having knowledge of possible hazards, mud control techniques and the mechanical facilities to detect at the earliest possible moment indications of trouble. It requires proper training of contractor personnel and continuous surveillance of the drilling operations by all concerned.
4. Elf Norge A/S is responsible for rig safety at all times ; apart from being in charge during normal drilling operations, he will have the responsibility for well completion and well abandonment in connection with Drilling Department.

Drilling Superintendant
(R.Sales)

Appendix G.

Elf Norge A/S

Stavanger,

WELL KILLING CONTINGENCY PLAN WHEN DRILLING EXPLORATION WELL 18/10-1

1. INTRODUCTION

The only method to kill a flowing well is to drill relief wells 18/10-1. This contingency plan is established for exploration well in case of blow-out occurence after the 13"3/8 casing has been set at 750m (RKB).

II. GENERAL PROGRAM

II.I. Number of Relief Wells

The general method consists in drilling two relief wells.

- The first one to intercept the flowing well around the shoe of the last casing string set.
- The second one to intercept the well in the flowing formation (generally the bottom of the hole).

This figure permits to pump heavy mud at two different levels in the flowing well and have best results for killing wells particularly in case of blow-out.

II.2. Positionning Drilling Platform

II.2.I. Distance between flowing well and relief well.

The spud location depends on depth reached and design of the rig drilling the relief well.

II.2.2. Position of the rig

The rigs must be located following the winds and currents.

II.3. Objectives

Around the shoe of the last casing string set and the flowin formation. The objective will be chosen according to available geological data and electrical logs in order to have the best facilities to establish communication between the wells.

II.4. Well Profiles

II.4.1. Direction and inclination will be determined exactly according to the objectives. Drawing in annexe. shows the well profiles in case of uncontrolled blow-out during 12 1/4 and 8½ drilling phases.

II.4.2. The target should be within 30/50m from well 18/10-1. Such accuracies should be obtained by using good survey equipment, and is sufficient to obtain communication between the wells.

II.5. Casing Program

Setting depth of casing will be determined according to the objectives and geological results of 18/10-1.
General design is shown in the drawing given in annexe.

III. KILLING PROCEDURE

- 7" liner will be set approx. 100m above the target
- Drill to approx. 50m below liner shoe
- For fracturing and heavy mud injection a 3"½ DP will be run to the top of the liner (owing to high pressure loss it is not recommended to run the drill string inside the 7" liner)
- Pump heavy mud until blow out stop
- When the blow-out is controlled, squeeze cement to plug the well and the bore hole.

IV. PARAMETERS DURING KILLING OPERATION

IV.1. Mud Weight

Mud weight will be adjusted according to knowledges obtained on the 18/10-1.
Expected mud weight : SG = 1.25 - 1.40.

IV.2. Volume of mud

The experience shows that it is necessary to have an important volume of heavy mud to succeed in a blow-out control. About three ot four times the volume of the flowing well may be required after pumping sea water in high quantities.
In this case we need :

- For blow-out when drilling 12 1/4 hole : 750m^3.
- For blow-out when drilling 8 ½ hole : 500m^3.

This volume must be ready before drilling out 9"5/8 shoe in the relief well(s).

IV.3. Pumping rate

Heavy mud must be pumped at a high rate in the flowing well as soon as the communication is estabished. For the well 18/10-1 pumping rate should be 6 m^3/min.

V. CALCULATIONS

As an example, assume the blow-out occuring at 2700m when drilling the Jurassic Sands

The relief well in operation will be equipped with 9"5/8 casing, set at 2250m vertical and a 7" liner set at 2600m vertical . Top liner hanger will be at 2100m vertical. Drilling will be performed with a 6" bit to approx. 50m below the liner shoe.

For fracturing and heavy mud injection a 3"½ drill string will be run to top of liner. Due to high pressure loss it is not recommended to run the drill string inside the 7" casing.

Pumping will mainly take place in the annular space 9"5/8 - 3"½ in order to avoid high pumping pressures.

V.1. Fracture Pressure

Using the ARTEP formule - Le Tirant (1972)

$$P_{fr} = \frac{1}{1+\mu}(2 \sqrt{3} + R_{+}) + P_{f}$$

μ = Poison^{1} coefficient (0,15 - 0,25 for silt)

σ_3= Lateral stress due to the overburden = Σ_1

R_t= Resistance to rock traction 30 kg/cm^3

P_f= Formation pressure

Pressure due to overburden : $\Sigma_1 = 2,35 \times \frac{2700}{10} = 634$ kg/cm^2

Vertical stress : $\sigma_1 = \Sigma_1 - \alpha P_f = 631 - 1x\ 337 = 294$ kg/cm

($\alpha_{PF} = 1$)

Taking the extremely high pressure into account :

$$\frac{\sigma_1}{\sigma_3} = 2 \text{ or } 3$$

Most unfavorable : $\frac{\sigma_1}{\sigma_3} = 2 \quad \sigma_3 = \frac{\sigma_1}{2} = \frac{294}{2} = 147$ kg/cm^2

This gives the fracture Pressure :

$$P_{fr} = \frac{1}{1+\mu} (2\sigma_3 + R_f) + P_f$$

$$P_{fr} = \frac{1}{1+0,2} (2 \times 147 + 30) + 337$$

$\underline{P_{fr} = 607 \text{ kg/cm}^2}$

V.2. Injection Pressure

The injection pressure will vary with the specific gravity of the liquid injected and the pressure loss.

$$P_{inj} = P_{fr} - R_t - P_h + \Delta P$$

where P_h = hydrostatic bottom hole pressure

ΔP = pressure loss

Mud injection

Using mud of specific gravity = 1,40

Pressure loss in the annulus 9"5/8 - 3"½ and inside the 7" liner are : about 150 kg/cm2 for flowrate 6 m3/min.

Flow Rate 6 m^3/min.

$$P_{inj.} = 607 - 30 - 1{,}4 \times \frac{2700}{10} + 200 = 349 \text{ Kg/cm}^2$$

i.e.:

Hydraulic power required : $349 \times \frac{6000}{450} = \underline{4650 \text{ HP}}$

Mechanical Power : $\frac{4650}{0{,}7} = \underline{6650 \text{ HP}}$

V.3. Potential Flow Rate and Blow Out

In the specific case choosen above, the following characteristics of the flowing formation can be assumed :

Formation Pressure = 337 Kg/cm^2

Temperature = 55°C

VI. EQUIPMENT AND MATERIALS

Drilling Platforms

No problem is foreseen in making drilling platforms available to drill relief wells.

Well Heads and Casing

Sufficient well head equipment and casing is available from own stock and partners' stocks.

Mud Chemicals and Baryte

Baryte needed is available at Tananger and Dusavik bases on a permanent basis.

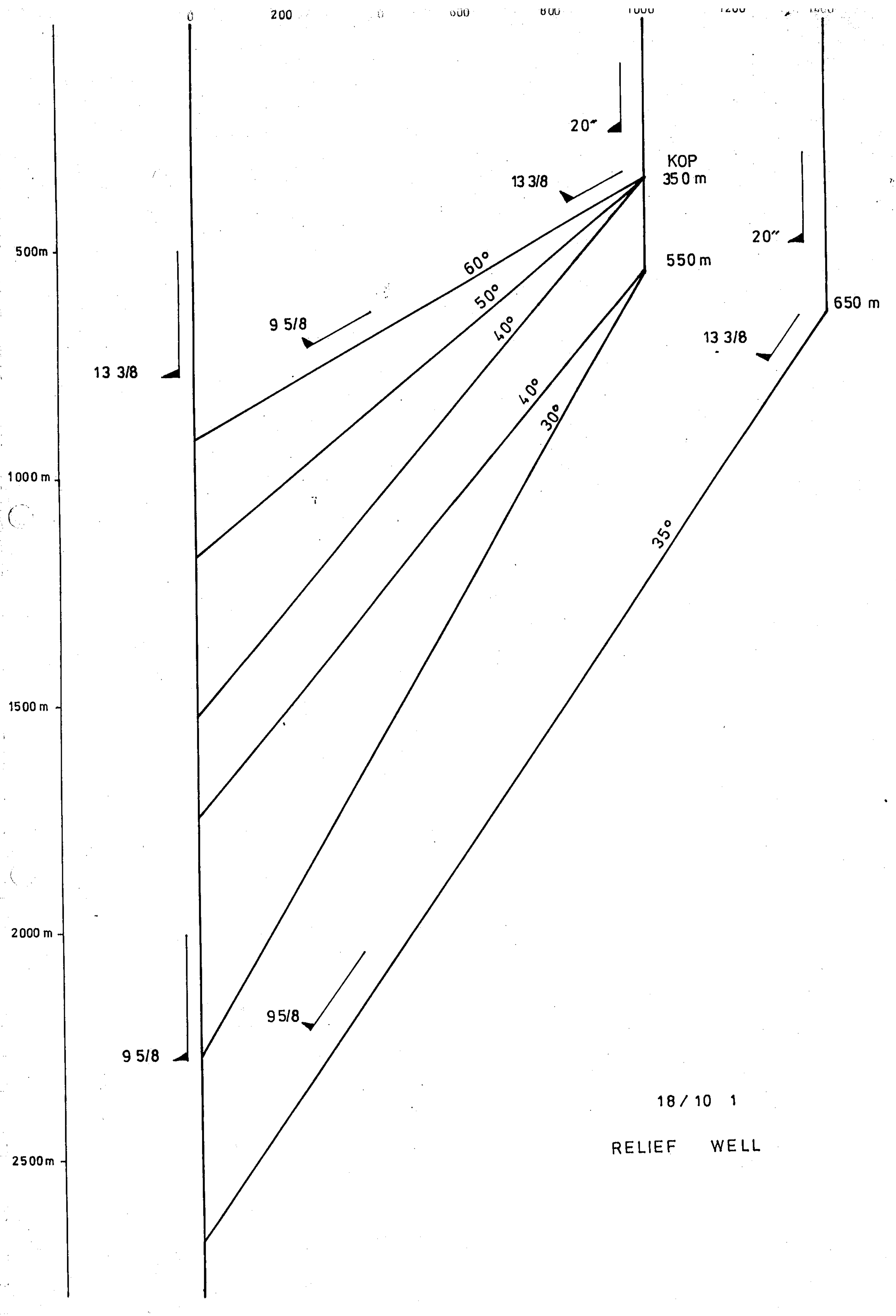
Pumps

Generally the North Sea drilling platforms are equipped with a pumping power of 4000 - 4800 mech.HP. The addition of three or four more pumping skids will bring the total mechanical HP up to approx. 7300 HP.

Calculations shows that the mechanical HP required on each rig when pumping at 6000 l/min. is the range of 6800 HP. So, by installing some additional pumping unit we will have sufficient power to perform the operation.

VII. ORGANISATION

Emergency task force is shown in table No.2.
Technical and personnel assistance will be given by ELF head office and ELF subsidiaries if necessary.

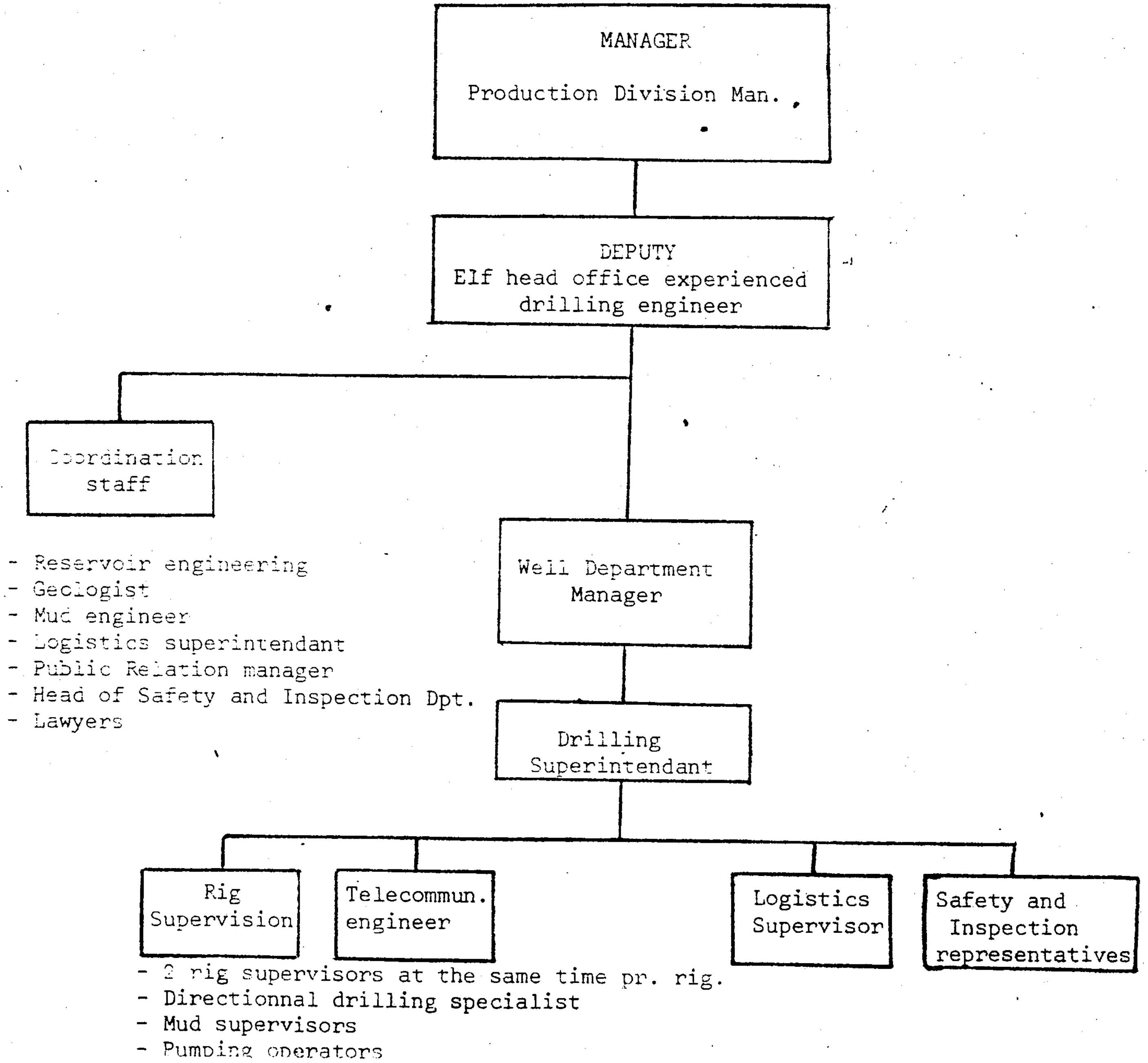


18 / 10 1

RELIEF WELL

TABLE 2

EMERGENCY TASK FORCE



- Reservoir engineering
- Geologist
- Mud engineer
- Logistics superintendant
- Public Relation manager
- Head of Safety and Inspection Dpt.
- Lawyers

- 2 rig supervisors at the same time pr. rig.
- Directionnal drilling specialist
- Mud supervisors
- Pumping operators

GEOLOGICAL WELL PROGNOSIS

Well: **18/10-1**

Country: **NORWAY off-shore**

Coord X: 04°07'02"13 E
Y: 58°04'37"29 N
Z ground: -97m
Z R.K.B: +25m.

Depth datum: RKB

Seismic location:
Line: 685402
S.P. 160

Expected date: End of October 1979
Duration: 45 days
P.T.D. 2750 RKB
Fm. Early Jurassic/ Top Triassic
Rig: Dyvi. Alpha

Operator: ELF AQUITAINE NORGE

Licence: 008

Owned by: PETRONORD

TARGETS:

MIDDLE JURASSIC SANDSTONES

CASINGS: (RKB)

30"	175m
20"	350m
13"3/8	850m
9"5/8	2300m
7"	if needed

LOGGING:

ISF.SL.GR.PS.and FDC CAL.from top to TD.

HDT.CST:1000 to TD.

DLL/MSFL and CNL-FDC in reservoir zones

CORING:

Any hydrocarbon reservoir zones.

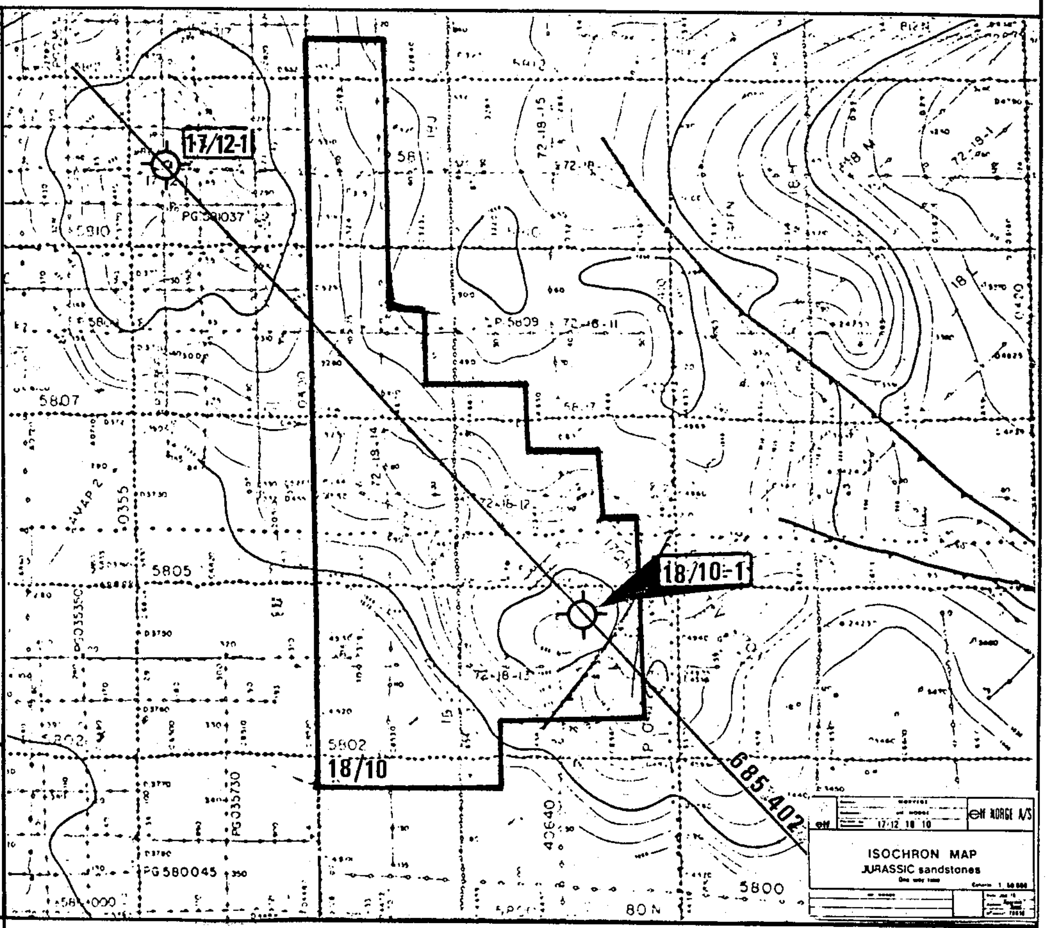
TESTING

Any hydrocarbon bearing reservoir.

MUD

Phase 12 1/4:
MW:1.15/1.25

Phase 8 1/2
MW:1.25



OBSERVATIONS

Normal hydrostatic formation pressure is expected.

Checked: S.Guyonnet
F.Verrolles.

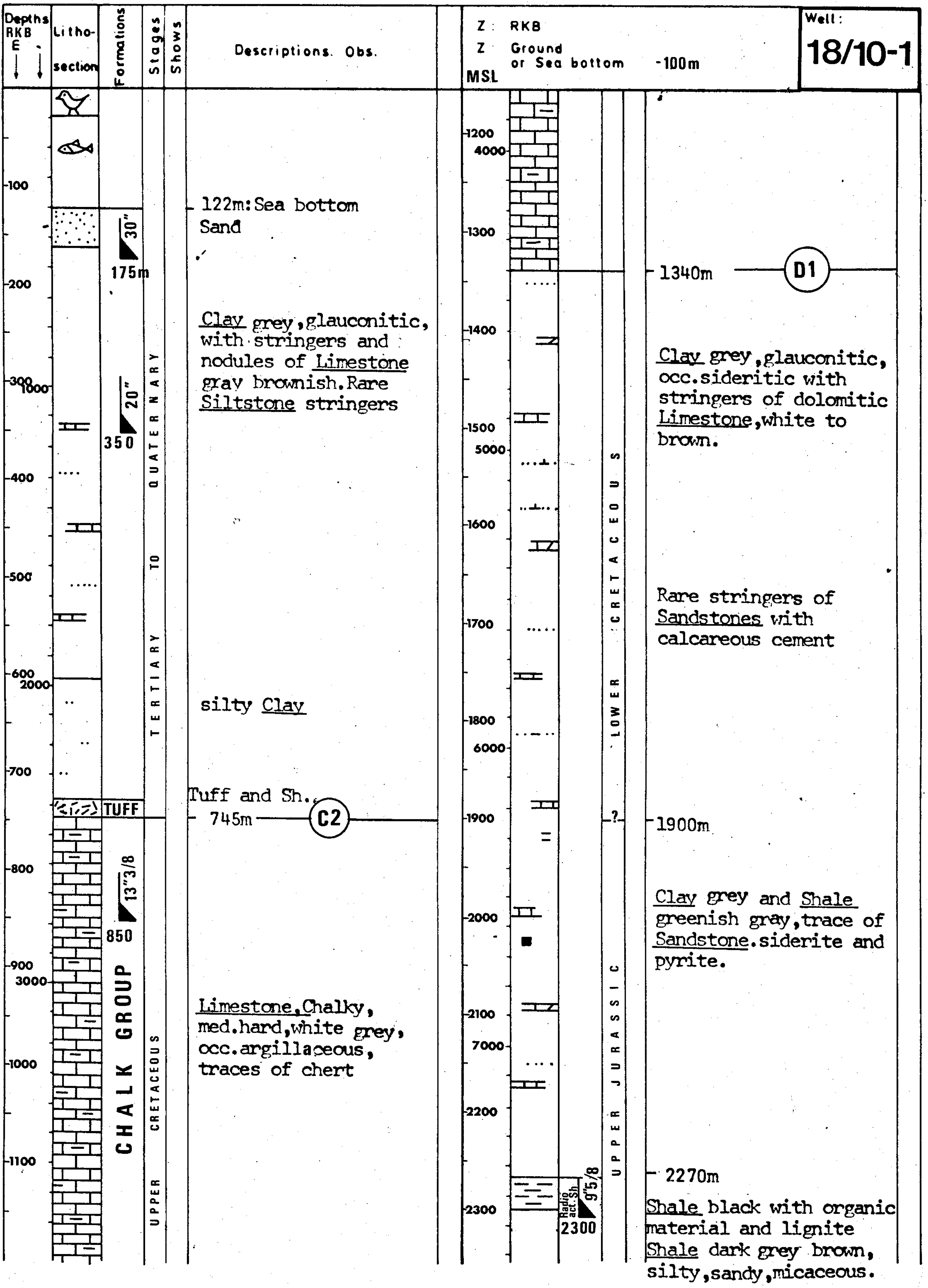
Date: 10.09.79

Pl.1

GEOLOGICAL WELL PROGNOSIS.

Well: 18/10-1

Z: RKB
Z Ground or Sea bottom -100m



122m: Sea bottom
Sand

Clay grey, glauconitic, with stringers and nodules of Limestone gray brownish. Rare Siltstone stringers

silty Clay

Tuff and Sh.

745m C2

Limestone, Chalky, med.hard, white grey, occ.argillaceous, traces of chert

1340m D1

Clay grey, glauconitic, occ.sideritic with stringers of dolomitic Limestone, white to brown.

Rare stringers of Sandstones with calcareous cement

1900m

Clay grey and Shale greenish gray, trace of Sandstone. siderite and pyrite.

2270m

Shale black with organic material and lignite
Shale dark grey brown, silty, sandy, micaceous.

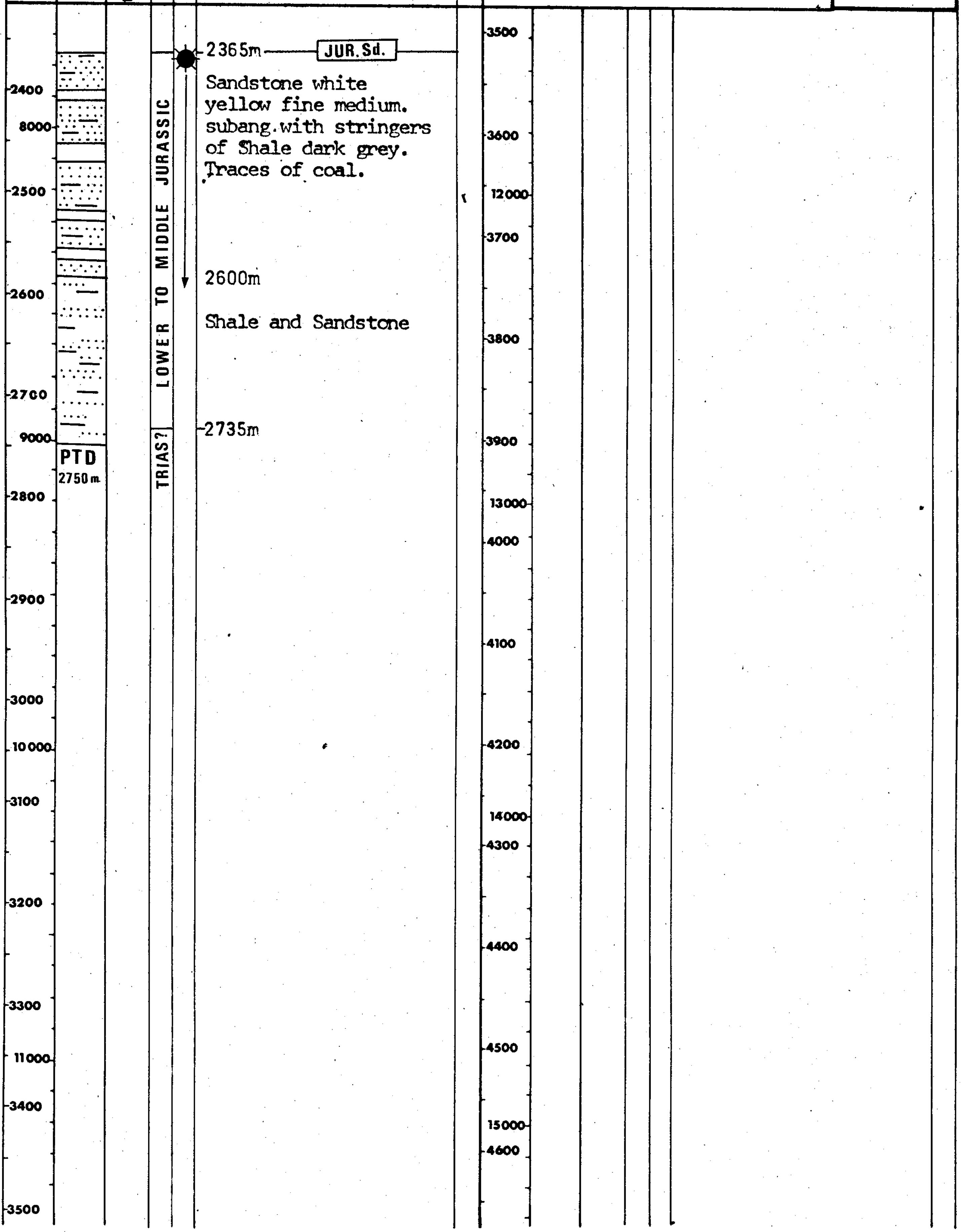
GEOLOGICAL WELL PROGNOSIS:

Well: **18/10-1**

Z : RKB

Z : Ground or Sea bottom -100 m

Depths MSL m ft	Litho-section	Formations	Stages	Shows	Descriptions. Obs.



2365m — JUR. Sd.

Sandstone white yellow fine medium. subang. with stringers of Shale dark grey. Traces of coal.

2600m

Shale and Sandstone

2735m

Coord x: 03° 56' 28"Ez ground: -377' y: 58° 11' 17"Nz RKB: +90' Line : SP: Depths datum: RK3 Rig: OCEAN VIKING (ODECO) Stopped in : ZECHSTEIN	Spudded : 26-10-71 14-03-72 Started drilling: 26-10-71 18-03-72 At T.D: 02-11-71 27-05-72 Completed : - - - - - - 21-06-72 T D Driller: 14100' (4297m) T.D. Logger:	Well **17/12-1** Country **NORWAY off shore**
OPERATOR PPCO	LICENCE 016 OWNED BY PPCO	

TARGETS

Jurassic sands.

RESULTS

Middle jurassic sand oil bearing

Plugged and abandonned.

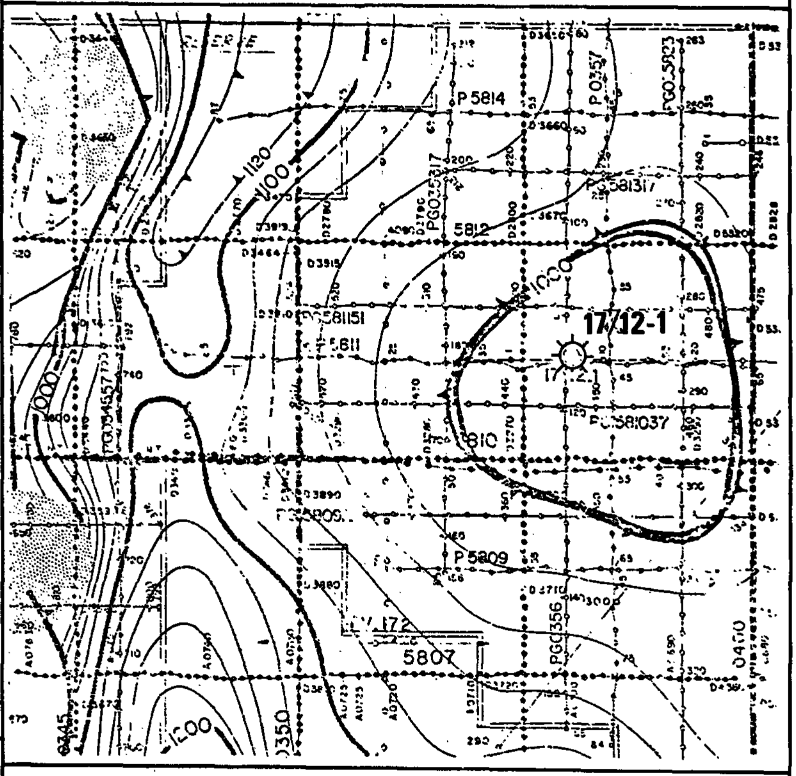
CASINGS

30" at 583' (177 m)
20" at 1460' (435m)
13 3/8" at 3557' (1084m)
9 5/8" at 7901' (2408m)

CORES

SHOWS

* 7600' to 7700'



LOGS

GR. SL	3592 - 476	1
"	7919-3557	2
"	13180-7888	3
"	13865-13180	4
IES	3598-1461	1
"	7908-3556	2
"	13187-7890	3
"	13875-13187	4
GR	7888-7000	1
FDC	7900-6900	1
"	13876-7888	2
CBL	7888-3500	1

TESTS

1. $\frac{7668}{7682}$ ø $^{12}/_{64}$" ● 141m³/j
2. $\frac{7600}{7628}$ ø $^{8}/_{64}$" ● 80m³/j
3. $\frac{7574}{7594}$ ø
4. $\frac{7530}{7560}$ ε ⊕ 66000ppm

5-6. $\frac{7596}{7682}$ ø $^{8}/_{64}$" ● 162m³/j

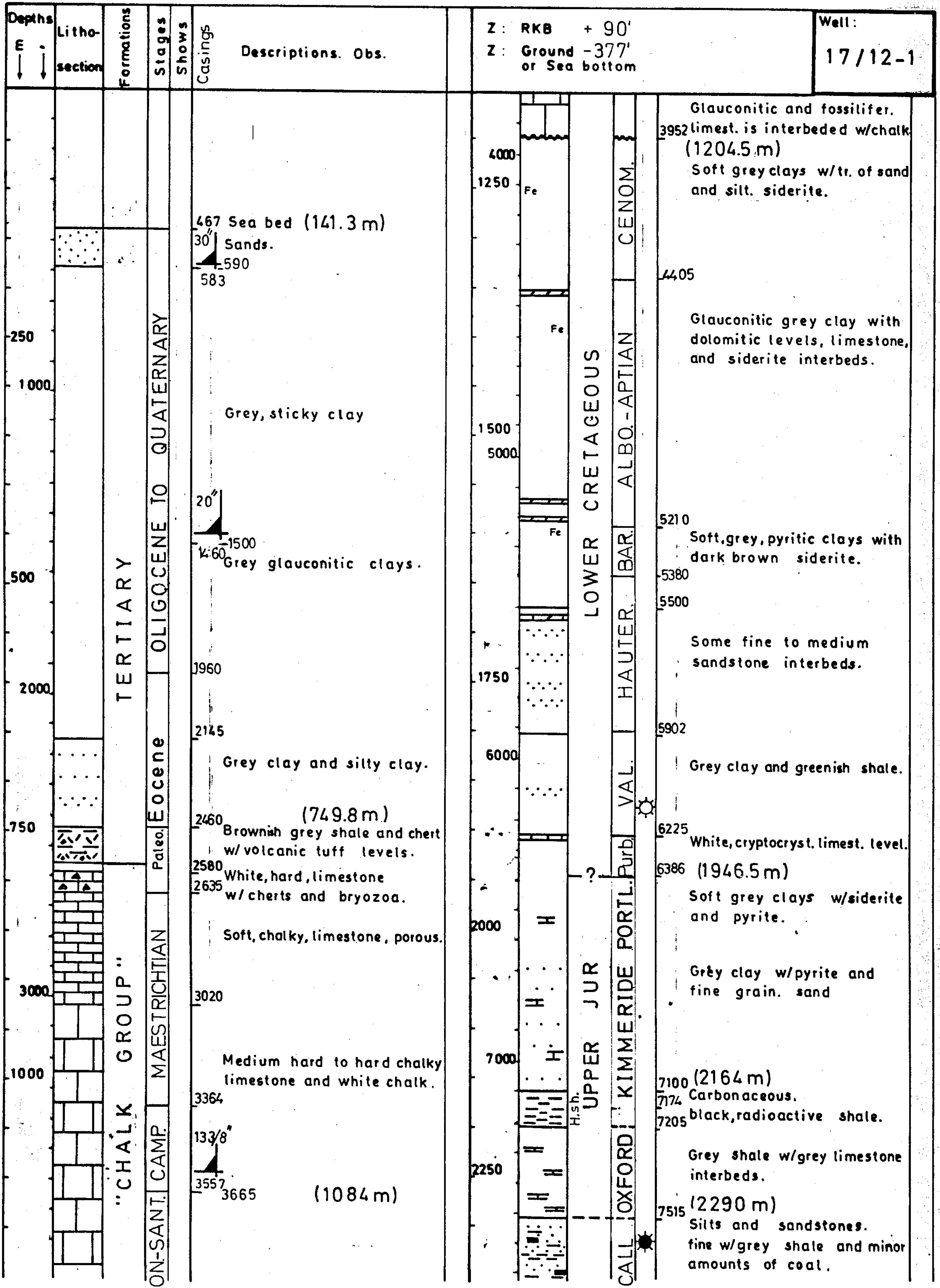
7. $\frac{7703}{7691}$ ⊕ 70000ppm

Plate 2

Checked	AP/S.G.
Date	18.09.79.

Well: 17/12-1

Z: RKB + 90'
Z: Ground -377'
or Sea bottom



467 Sea bed (141.3 m)

Sands.

590

583

Grey, sticky clay

1500

1460

Grey glauconitic clays.

1960

2145

Grey clay and silty clay.

2460 (749.8 m)

Brownish grey shale and chert w/volcanic tuff levels.

2580

2635

White, hard, limestone w/cherts and bryozoa.

Soft, chalky, limestone, porous.

3020

Medium hard to hard chalky limestone and white chalk.

3364

3557

3665 (1084 m)

3952 Glauconitic and fossilifer. limest. is interbeded w/chalk.

(1204.5 m)

Soft grey clays w/tr. of sand and silt. siderite.

4405

Glauconitic grey clay with dolomitic levels, limestone, and siderite interbeds.

5210

Soft, grey, pyritic clays with dark brown siderite.

5380

5500

Some fine to medium sandstone interbeds.

5902

Grey clay and greenish shale.

6225

White, cryptocryst. limest. level.

6386 (1946.5 m)

Soft grey clays w/siderite and pyrite.

Grey clay w/pyrite and fine grain. sand

7100 (2164 m)

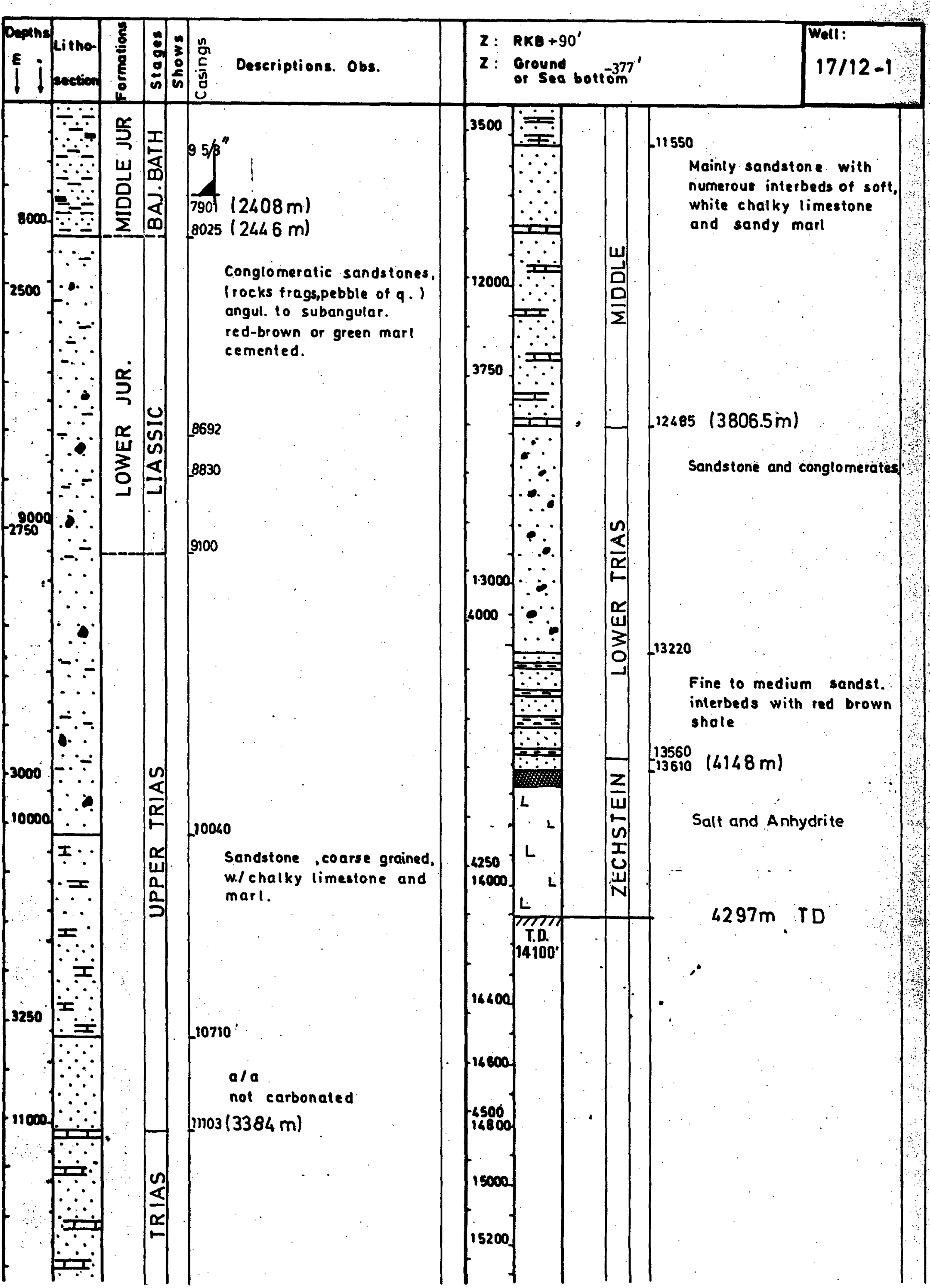
7174 Carbonaceous, black, radioactive shale.

7205

Grey shale w/grey limestone interbeds.

7515 (2290 m)

Silts and sandstones. fine w/grey shale and minor amounts of coal.



Z : RKB +90'

Z : Ground or Sea bottom -377'

Well: 17/12-1

Conglomeratic sandstones, (rocks frags,pebble of q.) angul. to subangular. red-brown or green marl cemented.

Sandstone ,coarse grained, w./chalky limestone and marl.

a/a
not carbonated

Mainly sandstone with numerous interbeds of soft, white chalky limestone and sandy marl

Sandstone and conglomerates

Fine to medium sandst. interbeds with red brown shale

Salt and Anhydrite

4297m TD