APPENDIX B

FLUIDS PROGRAM - 3/7-2

FLUIDS AND CEMENT

G. COLENO

1. <u>36" PHASE</u> interval sea bed 85 to 145 m. 30" casing at ± 140 m.

1.1. Drill with sea water, allowing returns to go to the sea Displace sea water with 6-8 m^3 gelly slugs of mud before each connection. When the 36" hole is drilled, pump to fill up well with thick mud before making a wiper trip.

Criculation with viscous mud into the hole for cleaning before pulling out to run 30" casing.

To avoid any incident, fill the hole and circulate. It is necessary to get permanently in reserve a volume of thick mud corresponding to the hole volume.

1.2. <u>Composition of high viscosity mud for starting up</u>

Sea water	: 1000	
CMC extra HV	: 2 - 5	Kg to adjust rheology and reduce filtrate
Caustic soda	: 3 - 6	Kg
Wyoming bentonite	: 80 - 120	Kg if possible prehydrated in 300 l FW

1.3. <u>Characteristics of mud</u>

Weight	: 1.04 - 1.06
f.viscosity	: 140 - 160
filtrate	: 10 - 15
pH	: 8.5 - 9

1.4. <u>Provide mud</u> 250 m^3

2. <u>26" PHASE</u> interval 145 to 760 m. 20" casing at ± 750 m.

2.1. Drill out cement and shoe with sea water and returns to the sea. After drilling the shoe, displace sea water by mud and continue drilling 17 1/2 hole to 760 m. After logging opening 26" hole.

Before running in the 20"casing, the hole control with 26" bit with no mud return, requires an important volume of mud. To avoid any incident, fill the hole and circulate. It is imperative to get permanently in reserve, a volume of mud corresponding.

2.2. Composition of bentonite and lignosulfonate mud

Sea water	:	1000 l
CMC HV or LV	:	4 - 6 Kg to adjust rheology reduce filtrate
FCL	:	6 - 8 Kg
Caustic soda	:	5 - 7 Kg
w.bentonite	:	50 - 70Kg
d.detergent	:	1 - 2 l if "bit balling" or torque

2.3. Characteristics of mud

Weight	:	1.10 - 1.15
Solids	:	7 - 11
Funnel viscosity	:	65 - 70
Plastic viscosity or "N"	:	15 - 20 / 0.55 - 0.60
yield point or "K"	:	10 - 15 / 1.30 - 1.60
gel 10 sec	:	2 - 5
gel 10 min	:	10 - 15
filtrate 30 min	:	5 - 8
pH	:	9 - 9.5
alkalinity Pf	:	0.1 - 0.3

2.4. Provide mud 1100 m^3

3. <u>17 1/2 PHASE</u> interval 760 to 2560 m. 13 3/8 casing at ± 2550m.

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

3.2. Composition of gypsum surfactant system

Sea water	: 1000	1	
CMC extra. HVouLV	: 5 - 10	Kg	to adjust rheology reduce filtrate
FCL	: 15 - 20	Kg	
Surfactant	: 10 - 15	Kg	control the normal tendency of shales to ball up
Caustic soda	: 8 - 12	Kg	
Gypsum	: 10 - 15	Kg	to adjust ca ++
W.bentonite	: 40 - 60	Kg	cake and filtrate
barite	: for weight adjustment		

3.3. Characteristics of mud

Weight	: 1.15 grading to 1.30	
Solids	: 9 - 11	13·16
funnel viscosity	: 55 - 60	
plastic viscosity or "N"	: 30 - 35 / 0.60 - 0.65	
yield point or "K"	: 25 - 22 / 0.80 - 0.85	
gel 10 see	: 2 - 4	
gel 10 min	: 10 - 15	
filtrate 30 min	: 4 - 6	
pH	: 9.5 - 10	
alkalinity Pf	: 1 - 1.5	
Ga^{++} (filtrate)	: 1 - 1.5	

3.4. Provide mud 1500 m^3

4. GENERAL DISCUSSION

It is during this stage that the "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:

20" shoe	:	1.10 - 1.15
1000 m	:	1.16
1200	:	1.18
1400	:	1.20
1600	:	1.22
1800	:	1.24
2000	:	1.26
to		
2560	:	1.28 - 1.30

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 1.15 at the start of this phase to 1.26 towards 2000m.
- 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 electrochemical equilibrium with the shales to avoid hydratation phenomena. pH 9.5 - 10.
- In order to maintain this mud in a dispersed state and in good electrochemical equilibrium with the formation, constant supervision is required, together with continuous treatment with lignosulfonate, surfactant and gypsum, as well as applying all mechanical means for eliminating solids.

5. 12 1/4 PHASE interval 2560 to 3200m. 9 5/8 casing at ± 3250m.

5.1. Before drilling out the cement inside 13 3/8 casing, mud weight will be increased to 1.50 and pretreat the system with sodium bicarbonate to avoid cement contamination and the products to adjust the following composition.

5.2. Composition of ferro chrome lignosulfonate and chrome lignite mud

Sea water	:	1000 l	
CMC pure HV or LV	:	4 - 8	to adjust rheology and reduce filtrate
FCL	:	25 - 35 Kg	maintain concentration
CL	:	25 - 35 Kg	
caustic soda	:	8 - 12 Kg	
w.bentonite	:	30 - 50 Kg	necessary to have a good cake
d.detergent	:	1 - 2 l	more if "bit balling" or torque
barite	:	for weight adjustment	

5.3. Characteristics to mud

Weight	:	1.50 grading to 1.60	
Solids	:	18 - 21	21 - 24
funnel viscosity	:	50 - 60	
plastic viscosity or "N"	:	27 - 34 / 0.65 - 0.70	
yield point or "K"	:	10 - 13 / 0.70 - 0.80	
gel 10 sec.	:	1 - 2	
gel 10 min	:	10 - 15	
filtrate 30 min	:	3 - 5	
filtrate HT/HP	:	10 - 12	
pH	:	9.5 - 10	
alkalinity Pf	:	0.3 - 0.5	

5.4. Provide mud : 500 m^3

5.5. The mud weight will be progressively increased:

13 3/8 shoe	1.50
2700 m	1.52
2900	1.54
3100	1.56
3200	1.58
3250	1.60

6. <u>8 1/2 PHASE</u> interval 3260 to 4500 m. 7"liner if needed.

6.1. Before drilling out the cement inside 9 5/8 casing dump and clean the mud pits, and made satured salt mud. Pretreat if necessary, this mud with sodium bicarbonate to avoid cement contramination and displace lignosulfonate mud by saturated sålt mud.

6.2. Composition of saturated salt mud

Sea water	:	1000 l
Salt	:	350 Kg
attapulgite clay	:	20 - 30 Kg
starch	:	20 - 30 Kg
caustic soda	:	2 - 4 Kg (after drilling out cement)
barite	:	for weight adjustment
CMC R110	:	will be added after 4000 m if starch is deficiency w/T°

6.3. Characteristics of mud

Weight	:	1.60	grading to 1.80
Solids	:	21 - 24	27 - 30
funnel viscosity	:	50 - 55	
plastic viscosity or "N"	:	45 - 50 / 0.70 - 0.80	
yield point or "K"	:	18 - 22 / 0.80 - 0.90	
gel 10 sec.	:	2 - 4	
gel 10 min.	:	10 - 15	
filtrate 30 min	:	3 - 4	
filtrate HT/HP	:	10 - 12	
pH	:	8.5 - 9	
alkalinity Pf	:	$0 - 0^{+}$	
Na Cl	:	maintain maximum saturation	

6.4. Provide mud : 500 m^3

6.5. The mud weight will be progressively increased:

9 5/8 shoe	1.60
3300 m	1.63
3400	1.66
3500	1.70
3600	1.72
3800	1.76
4000	1.80
to	to
TD	1.80

7. PERMANENT INSTRUCTIONS

7.1. To face any problem it is necessary to keep one mud pit full with heavy mud as safety, that is to say:

ONE TANK OF MUD W/A S.G. OF 2.10 FOR THE 12 1/4 AND 8 1/2 PHASES

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

- For an immediate action, take care to test as soon as possible all the installations and facilities enabling a quick controle of any income.
- Further in the sequence of the precautions to take care, be sure to be able to make and circulate quickly a barite plug and a cement plug.
- Permanent survey of the pit level, volumes 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, pH, should be under survey, in order to detect any show in cases of abnormal pressure, H^2S etc...
- 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 throughtout the 12 1/4 and 8 1/2 phases to ensure accurate mud weight determination.
- For the purpcse of making easier the electrical logging, the running in casings and to assume their best cementing jobs easier, it is necessary to be very careful to have the best rheological fluid characteristics during the circulation preceding these operations.
- Mud tanks for mixing water with additives will be throughly cleaned to prevent pollution by mud.

HYDRAULIC RECOMMENDATIONS

DEPTH	CUTTING THICK X Ø	VELOCITY m/min	SG MUD	B or P	PV or "K"	YP or "N"	HOLE DIAMETER MINUS D.C DIAMETER	CRITICAL FLOW RATE	LARGEST ANNULUS CASING MINUS D.PIPE	MINIMAL FLOW RATE PULLING CUTTING	FLOW RATE FOR N Re 1300	OPTIMUM FLOW RATE
150			1.04				36 9.50					maxi
400	5	10	1.10	P	1.90	0.55	17.50 9.50	12313	28 5	5430	7406	maxi
700	3 x 5	5	1.19	P	1.56	0.57	26 9.50	21559	28 5	3446	12966	maxi
900	3 x 5	15	1.15	P	0.54	0.66	17.50	6380	18.7	3463	3839	3600
1580	3 x 5	18	1.22	P	0.65	0.65	9.50	6809	5	3838	4097	3900
2044	3 x 5	20	1.33	P	1.79	0.58		11262		3841	6773	3900
2300	3 x 5	20	1.40	P	1.08	0.64		8845		3871	5322	3900
2486	3 x 5	20	1.40	P	0.61	0.70		6639		3991	3999	4000
2510	3 x 5	25	1.40	P	0.46	0.70	12.25	2676	12.34	1919	1612	2000
2610	3 x 5	25	1.42	P	0.89	0.66	9.50	3726	5	1821	2242	2200
2792	3 x 5	25	1.45	B	37	17		3014		1778	2178	2100
2892	3 x 5	25	1.47	P	1.02	0.64		3754		1789	2259	2200
3000	3 x 4	25	1.19	P	1.18	0,66	8.50	3010	8.53	738	1811	1200
3300	2 x 3	25	1.20	P	0.76	0.67	6.50	2242	5	720	1350	1200
3500	2 x 4	25	1.20	P	0.48	0.73		2057		742	1240	1100

7.2. Permanent safety materials in stock

- barite on the rig	200 T
- barite on each supply boat (2)	100 T
- w. bentonite	20 T
- cement	40 T
- attapulgite clay (sack)	5 T
- calcium chloride liquid	1.5 m^3
- L.C.M. fiber	0.5 T
granular (coarse and fine)	1 T
flake	0.5 T
- pipe free	2 m^3
- sodium bicarbonate	1 T
- soda ash	1 T
- sodium tetraphosphate pH 10	0.5 T
- H2S scavenger	1 T

BARITE IN STOCK THE 01.10.80

COMPANIES	BULK DUSAVIK	BULK TANANGER	SACKS STORAGE	TOTAL
ANCHOR DRIL. FLUID	370	376	55	801
MILCHEM	550	270	1100	1920
CECA	507	922		1429
DRESSER	301	171	230	702
IMCO	227	994	647	1868
NORSK PETR.	538	232		770
TOTAL m/tons	2493	2965	2032	7490

MATERIALS QUANTITIES ESTIMATION

PHASE	MATERIALS	QUANTITIES (Kg or l)
36" $\pm$ 250 m^3	CMC extra HV	1500
	caustic soda	1500
	w. bentonite	30000
	attapulgite clay (sack)	5000
	defoamer	250
	barite	50000
	lost circulation material	2000
	sodium bicarbonate	1000
	soda ash	1000
	pipe free	2000

PHASE	MATERIALS	QANTITIES (Kg or l)
26" $\pm$ 1100 m^3	CMC extra HV	3500
	CMC LV	3500
	FCL	9000
	caustic soda	8000
	w. bentonite	70000
	defoamer	500
	drilling detergent	1000
	barite	100000

PHASE	MATERIALS	QUANTITIES (Kg or l)
17 1/2 ± 1500 m^3	CMC extra HV	7000
	CMC LV	8000
	FCL	30000
	surfactant	23000
	caustic soda	18000
	gypsum	23000
	defoamer	1200
	barite	200000
	sodium tetraphospate	500
	H2s scavenger	1000
	drilling detergent	800

PHASE	MATERIALS	QANTITIES (Kg or l)
12 1/4	CMC pure HV	1000
± 500 m^3	CMC pure LV	3000
	FCL	18000
	CL	18000
	caustic soda	6000
	w. bentonite	25000
	drilling mud detergent	600
	defoamer	400
	barite	450000
	sodium bicarbonate	500

PHASE	MATERIALS	QANTITIES (Kg or l)
8 3/8 $\pm$ 500 m^3	salt attapulgite clay starch caustic soda defoamer barite CMC pure LV	180000 15000 15000 2000 600 700000 4000

APPENDIX C

CEMENTING AND DISPLACEMENT CALCULATIONS

APPENDIX C

CEMENTING PROGRAM 3/7-2

FLUIDS AND CEMENT

G. COLENO

C E M E N T I N G   P R O G R A M

HOLE SIZE CASING LINER	WEIGHT lbs/ft	DV SHOE	CLASS CEMENT	SG	INTERVAL m	MUD SG	MAXIMUM EXPECTED PRESSURE DURING DISPLACEMENT KG/cm2	MAXIMUM ESTIMATED EQUIVALENT DENSITY DURING DISPLACEMENT
36" 30"	310	140	G	1.90	140 to 85	1.05	17	1.46
26" 20"	133	750	LIGHT G G	1.50 1.90	650 - 85 750 - 650	1.15	104	1.54
17 1/2 second 13 3/8 stage	72	700	LIGHT G G	1.50 1.90	600 - 400 700 - 600			
17 1/2 first 13 3/8 stage		2550	LIGHT G G	1.50 1.90	2400 - 2000 2550 - 2400	1.30		
12 1/4 9 5/8	53,5	3200	LIGHT G G	1.50 1.98	3100 - 2450 3200 - 3100	1.60		
8 3/8 7	35	4500	E	2.10	If needed	1.90		

DEPTH RECALL

WATER DEPTH	60 m
RKB SEA LEVEL	25 m
RKB SEA BOTTOM	85 m

ADDITIVES FOR CEMENT SLURRIES

- PREHYDRATED BENTONITE

  Contact time with fresh water must be sifficient to let Wyoming bentonite to be hydrated. It is generally know that this one is complete after an important mixing of about one hour.

- CALCIUM CHLORIDE

  The effect of the calcium chloride on the viscosities of slurries is without influence. The calcium chloride must be added into prehydrated bentonite just before to mixt the cement slurry.

ADDITIVES FOR CEMENT WITH LIQUID ADDITIVES SYSTEM

Extender is incompatible with $CaCl_2$, the extender mixing in water with $CaCl_2$ causes massive precipitation of a white insoluble residue.

FLUID LOSS REDUCER MUST BE COMPULSORY ADDED AND MIXED WITH WATER BEFORE ADDING DISPERSANT AND RETARDER.

CLASS G AND E CEMENT

The rapid knowledge on the rig of the cement quality G and E will be obligatory before each operation.
Founded on two easy measures of specific gravity on rheology, it will lead to check if the cement has not been contaminated during its transport.
After been prepared the current should have their characteristics available in the hereby intervals:

MEASURES	G RATION WATER/CEMENT 44%	E RATIO WATER/CEMENT 38%
SG	1.90 - 1.92	1.96 - 1.98
600	90 - 1.20	95 - 125
300	60 - 90	50 - 80
200	50 - 75	35 - 60
100	40 - 60	20 - 45
INITIAL GEL	10 - 20	5 - 15
10 GEL	< 100	< 100

30" CASING shoe at about 140

Hole gage	36"		656,80	
Casing gage	30"	(310lb)	455,80/28" 407.80	
Top cement up to sea bed				85
Open hole interval				55
Excess in open hole 200% (hole size ± 46")				

SLURRY VOLUME

Annular	36" x 30"	201.00 x 55 (3)	=	33165
Inside	30"	407.80 x 5	=	2039
Total volume G cement			=	35204

TIMING OF OPERATION

Mix and pump G cement 35204:700 =	51
Drop plug	20
Displacement 5" DP ± 9.27 x (140-5) = 1251	
Flow rate 700 l/min	2
Total	73
Safety factor 50%	
GRAND TOTAL min	110

30" SLURRY

Composition	Weight-Kg/100	Volume-1/100	By m^3 FW	For each 10 bbls
Fresh water	42	42		
Defoamer	0.050	0.050	1.19 1	0.50 gal
Accelerator D77	6.081	4.439	105.69 1	44.37 "
G cement	100	31.75		
SG ± 1.89		78.239		

RESULTS (± 140m BHST 5°C - mud weight 1.05)

T.T. requested: $2^{H}00$
T.T. recorded : $6^{H}00$
24 hours compressive strenght: 94 b
rheology and gels: 175 - 138 - 121 - 102/49-114
Maximum expected pressure during displacement: 16.80 b
Maximum estimated equivalent density : 1.46

REQUIREMENTS

Fresh water $\frac{42 \times 44995}{100} =$ 18898 1

Defoamer $\frac{0.050 \times 44995}{100} =$ 22.5 1

Accelerator D77 $\frac{4.439 \times 44995}{100} =$ 1997.3 1

G cement $\frac{100 \times 35204}{78.24} =$ 4499.5 Kg

20" CASING shoe at about 750

Casing gage 30" (310 lb)	455,80/407.80	140
Hoel gage 26"	342,50	
Casing gage 20" (133 lb)	202,96/ 18.72" 177,76	
Top cement up to sea bed		85
Open hole interval		610
Casing interval		55
Excess in open hole 125% (hole size ± 32")		

SLURRIES VOLUMES

Lead-light 30" x 20"	204,84 x	55	=	11.266
Lead-light	139,54 x	510(2.25)	=	160.122
TOTAL VOLUME LIGHT			=	171.388
Tail - G	139,54 x	100(2.25)	=	31.396
Inside 20"	177.76 x	12	=	2.133
TOTAL VOLUME G			=	33.529

TIMING OF OPERATION

Mix and pump light	171388 : 900 =	191	
Mix and pump G	33529 : 700 =	49	49
Drop top plug		20	20
Displacement 20" 177,76	x 653 = 116077		
HW ±4,61	x 85 = 392		
Total displacement	116469		
Flow rate 2000 l/min		59	59
Total		319	128
Safety factor 50%			64
GRAND TOTAL (min.)		478	192

20 " LEAD SLURRY

Composition	Weight-Kg/100	Volume-1/100	By m^3 SW	For each 100 bbls
Sea water	109.60	107		
Defoamer	0.05	0.05	0.47 l	0.20 gal
Extender D75	6.30	4.50	42.05 l	17.65 gal
G cement	100	31.75		
SG $\pm$ 1.50		143.30		

RESULTS ($\pm$ 750 m BHST 25°C - mud weight 1.15)

T.T. requested: $\geq$ 8^h00
T.T. recorded : 8^h30
24 hours compressive strength: 35 b
Rheology and gels: 50-39-35-30/18-39

REQUIREMENTS

Sea water $\frac{107 \quad x \quad 119601}{100}$ =127973 l

Defoamer $\frac{0,05 \; x \; 119601}{100}$ = 60 l

Extender D75 $\frac{4,50 \; x \; 119601}{100}$ = 5382 l

G cement $\frac{100 \quad x \; 171388}{143,30}$ = 119601 Kg

20" TAIL SLURRY

Composition	Weight-Kg/100	Volume-1/100	By m^3 FW	For each 10 bbls
Fresh water	44	40		
Defoamer	0.05	0.05	1.14 1	0.47 gal
G cement	100	31.75		
SG $\pm$ 1.90		75.80		

RESULTS ($\pm$ 750 BHST 25°C - mud weight 1.15)

T.T. requested: ≥ 3^h15
T.T. recorded : 7^h00
24 hrs. compressive strenght: 122 b
Rheology and gels: 133-92-79-60/14-21
Maximum expected pressure during displacement: 104 b
Maximum estimated equivalent density : 1.54

REQUIREMENTS

Fresh water $\frac{44 \quad x \quad 44233}{100} = 19462 \text{ l}$

Defoamer $\frac{0.05 \text{ x } 44233}{100} = 22 \text{ l}$

G cement $\frac{100 \quad x \quad 33529}{75.80} = 44233 \text{ Kg}$

13 3/8 CASING Shoe at about 2550

Casing gage 20" (133 lb) 202,96/18,72"		177,76	750
DV at about			700
Hole gage 17 1/2	155.20		
Casing gage 13 3/8 (72 lb) 90.80/12.34"		77,24	
Top cement first stage			2000
Top cement second stage			400
Open hole interval first stage			550
Casing interval second stage			300

The cement volumes are calculated according to:

- the theoretical volume increased by 58% (hole size ± 19 1/2") for the preliminary calculations.
- and the volume given by the caliper increased by 10% for the final calculations.

SLURRIES VOLUMES

Fisrt stage

Lead light	17 1/2 x 13 3/8	64,40	x	400	(1,58)	=	40700
Tail G	17 1/2 x 13 3/8	64,40	x	150	(1,58)	=	15262
Inside G	13 3/8	77,24	x	24		=	1854
Total G						=	17116

Second stage

Lead light	20" x 13 3/8	86,96 x 200	=	17392
Tail G	20" x 13 3/8	86.96 x 100	=	8696

TIMING OF OPERATION (first stage)

Pump the spacer (at least 100 m of annulus) SG.
Rheological and gels slightly greater than the mud one.

Mix and pump light	40700 : 900	=		46	
Mix and pump G	17116 : 700	=		25	25
Drop top plug				20	20
Displacement 13 3/8 ±	77,24 x 2526	=	195108		
Flow rate	2500 l/min		125000	50	50
	1600 l/min		70108	45	45
TOTAL				186	140
Safety factor 50%				93	70
GRAND TOTAL				279	210

Before cementing the second stage, circulate w/mud through DV necessary time for gelation of the first stage slurry (about tail slurry T.T. requested).

TIMING OF OPERATION (second stage)

Pump the spacer (at least 100 m of annulus) SG.
Rheological and gels slightly greater than the mud one.

Mix and pump light	17392 : 900 =		20	
Mix and pump G	8696 : 700 =		13	13
Drop top plug			20	20
Displacement 13 3/8 ± 77.24 x 700 = 54068				
Flow rate 2500 l/min		21000	9	9
1600 l/min		33068	22	22
TOTAL			84	64
Safety factor 50%			42	32
GRAND TOTAL			126	96

13 3/8 LEAD SLURRY (first stage)

Composition	Weight Kg/100	Volume 1/100	By m^3 FW	for each 10 bbls
Fresh water	102	102		
Defoamer	0.05	0.05	0.49 1	0.20 gal
Extender D75	7	5	49 1	20.58 gal
G cement	100	31.75		
SG ± 1.50		138.80		

RESULTS (± 2550 m BHST 75°C - mud weight 1.30)

T.T. requested: > 5^h00
T.T. recorded : 5^h15
24 hrs. compressive strenght: 31 b
Rheology and gels: 56-36-29-20/10-29

REQUIREMENTS

Spacer ± 5 x 6500 = 33 Kg

Fresh water $\frac{102 \times 29323}{100}$ = 29912 1

Defoamer $\frac{0.05 \times 29323}{100}$ = 15 1

Extender D75 – $\frac{5 \times 29323}{100}$ = 1466 1

G cement $\frac{100 \times 40700}{138.8}$ = 29323 Kg

13 3/8 TAIL SLURRY (first stage)

Composition	Weight-Kg/100	Volume-l/100	By m^3 FW	For each 10 bbls
Fresh water	42	42		
Defoamer	0.05	0.05	1.19 l	0.5 gal
F.loss reduce D73	1.398	1.331	31.69 l	13.3 gal
Dispersant D80	0.546	0.444	10.57 l	4.4 gal
Retarder D81	0.446	0.355	8.45 l	3.5 gal
G cement	100	31.75		
SG± 1.90		75.93		

RESULTS (± 2550 m BHST 75°C - Mud weight 1.30)

T.T. requested: ≥ 3^h45
T.T. recorded : 3^h30
24 hrs. compressive strength: 262 b
Fluid loss: 92
Rheology and gels: 62-31-20-10/2-12
Maximum expected pressure during displacement: 351.50b
Maximum estimated equivalent density : 1.38

REQUIREMENTS

Fresh water $\frac{42 \times 22542}{100} = 9468$ l

Defoamer $\frac{0.05 \times 22542}{100} = 12$ l

F.loss reduce D73 $\frac{1.331 \times 22542}{100} = 300$ l

Dispersant D80 $\frac{0.444 \times 22542}{100} = 100$ l

Retarder D81 $\frac{0.355 \times 22542}{100} = 80$ l

G. cement $\frac{100 \times 17116}{75.93} = 22542$ Kg

13 3/8 LEAD SLURRY (second stage)

Composition	Weight-Kg/100	Volume-1/100	By m^3 SW	For each 10 bbls
Sea water	109.6	107		
Defoamer	0.05	0.05	0.47 1	0.20 gal
Extender D75	6.30	4.50	42 1	17.65 gal
G cement	100	31.75		
SG ± 1.50		143.30		

RESULTS (± 816m - BHST 30°C - Mud weight 1.25)

T.T. requested: ≥ 2^h00
T.T. recorded : 10^h
24 hrs. compressive strenght : 31 b
Rheology and gels: 46-35-31-21/14-20

REQUIREMENTS

Spacer	±5 x 8696	=	44	Kg
Sea water	$\frac{107 \times 12137}{100}$	=	12987	1
Defoamer	$\frac{0.05 \times 12137}{100}$	=	6	1
Extender D75	$\frac{4.5 \times 12137}{100}$	=	546	1
G cement	$\frac{100 \times 17392}{143.30}$	=	12137	Kg

13 3/8 TAIL SLURRY (second stage)

Composition	Weight-Kg/100	Volume-l/100	By m^3 FW	For each 10 bbls
Fresh water	44	44		
Defoamer	0.05	0.05	1.14 l	0.5 gal
G. cement	100	31.75		
SG ± 1.90		75.80		

RESULTS (816 m - BHST 30°C - mud weight 1.25)

T.T. requested: ⟩ 2^h00
T.T. recorded : ⟫ 6^h00
24 hrs. compressive strenght: 101 b
Rheology and gels : 127-87-70-53/18-22
Maximum expected pressure during displacement: 123 b
Maximum estimated equivalent density : 1.41

REQUIREMENTS

Fresh water $\frac{44 \quad x\ 11472}{100} = 5048$ l

Defoamer $\frac{0.05\ x\ 11472}{100} = 6$ l

G cement $\frac{100 \quad x \quad 8696}{75,8} = 11472$ Kg

9 5/8 CASING Shoe at about 3250

Casing gage	13 3/8	72 lbs	90.80/12.34"	77.24	2550
Hole gage	12 1/4		76.04		
Casing gage	9 5/8	53.5 "	47.10/ 8.53"	37.92	
Top cement	100 m above the 13 3/8 shoe				2450
Open hole interval					700
Casing interval					100

The cement volumes are calculated according to:

- The theoretical volume increased by 56% (hole size ± 13 1/2) for the preliminary calculations.
- And the volume given by the caliper increased by 10% for the final calculations.

SLURRIES VOLUMES

Lead-light 13 3/8 x 9 5/8	30.14	x	100		=	3014
Lead-light 12 1/4 x 9 5/8	27.94	x	550	(1.56)	=	24831
TOTAL VOLUME LIGHT					=	27855
Tail G	28.94	x	150	(1.56)	=	6772
Inside 9 5/8	37.92	x	36		=	1365
TOTAL VOLUME G					=	8137

TIMING OF OPERATION

Pump the spacer (at least 200 m of annulus) SG, rheology and gels slightly greater than the mud one.

Mix and pump light cement	27855	:	900	32	
Mix and pump G "	8137	:	700	13	13
Drop top plug				20	20
Displacement ± 37.92 x 3250 =	121875				
Flow rate 1800 l/min	87000			49	49
700 l/min maxi	34875			51	51
Total				165	133
Safety factor 50%				83	67
GRAND TOTAL (min.)				248	200

9 5/8 LEAD SLURRY

Composition	Weight-Kg/100	Volume-1/100	By m^3 FW	For each 10 bbls
Fresh water	101	101		
Defoamer	0.05	0.05	0.50 l	0.20 gal
Extender D75	7	5	49.50 l	20.78 gal
F.loss reduce D73	1.398	1.331	13.18 l	5.53 gal
Dispersant D80	0.546	0.444	4.40 l	1.85 gal
Retarder D81	0.223	0.177	1.75 l	0.74 gal
G cement	100	31.75		
SG ± 1.50		139.75		

RESULTS (± 32~~5~~0 0 m BHST 100°C - Mud weight 1.60)

T.T. requested: ≫ 4^h00
T.T. recorded : 5^h30
24 hrs. compressive strength: 50 b
Fluid loss: 520
Rheology and gels: 37-26-22-18/17-24

REQUIREMENTS

Spacer $\frac{\pm 5 \times 5800}{1000} = 29$ Kg

Fresh water $\frac{101 \times 19932}{100} = 20131$ l

Defoamer $\frac{0.05 \times 19932}{100} = 10$ l

Extender D75 $\frac{5 \times 19932}{100} = 997$ l

F.loss reduce D73 $\frac{1.331 \times 19932}{100} = 265$ l

Displacement D80 $\frac{0.444 \times 19932}{100} = 88.5$ l

Retarder D81 $\frac{0.177 \times 19932}{100} = 35$ l

G cement $\frac{100 \times 27855}{100} = 19932$ Kg

9 5/8 TAIL SLURRY

Composition	Weight-Kg/100	Volume-l/100	By m^3 FW	For each 10 bbls
Fresh water	41	41		
Defoamer	0.05	0.05	1.220 l	0.51 gal
F.loss reduce D73	1.864	1.775	43.293 l	18.17 gal
Dispersant D80	1.095	0.887	21.634 l	9 gal
Retarder D81	0.671	0.532	12.976 l	5.45 gal
G cement	100	31.75		
SG ± 1.90		75.99		

RESULTS (± 3250 m BHST 100°C - Mud weight 1.60)

T.T. requested: 3^h30
T.T. recorded : 4^h00
24 hrs. compressive strength: 250 b
Fluid loss: 19
Rheology and gels: 70-32-22-11/2-38
Maximum expected pressure during displacement: 530 b
Maximum estimated equivalent density : 1.63

REQUIREMENTS

Fresh water $\frac{41 \times 10707}{100} = 4390$ l

Defoamer $\frac{0.05 \times 10707}{100} = 6$ l

F.loss reduce D73 $\frac{1.775 \times 10707}{100} = 190$ l

Dispersant D80 $\frac{0.887 \times 10707}{100} = 95$ l

Retarder D81 $\frac{0.532 \times 10707}{100} = 57$ l

G cement $\frac{100 \times 8137}{76} = 10707$ Kg

7" LINER (if required) shoe at about 4300

Landing collar					4240
Casing gage	9 5/8	(53.5 lb)	47.10/ 8.53"	37.92	3250
Hole gage	8 3/8		36.61		
Liner gage	7"	(35 lb)	24.88/ 6 "	18.27	
Drill pipe	5"	(19.5 lb)	13.16/ 4.27"	9.16	
Top liner					3150
Open hole interval					1050
Between casing-liner					100

The cement volumes are calculated according to:

- The theoretical volume increased by 78% (hole size ± 9 1/2) plus a 50% wash out factor for the preliminary calculations.
- Practically the final volumes calculations shall be based on the caliper log increased by 10% plus a 50% wash out factor (slurry SG 1.95).

SLURRY VOLUME

Annular 9 5/8 x 7	13.04	x	100	=	1304
Annular 8 3/8 x 7	10.66	x	1050(1.78)	=	19923
Wash out volume 50%					9962
Left in 7"	18.27	x	60	=	1095
Total volume E cement					32285

TIMING OF OPERATION

Circulating the necessary time to obtain a homogeneous system and the best rheological and thixotropic characteristics of the mud. Pump the lead spacer (at least 200 m of annulus) SG, rheological and gels slightly greater than the mud one.

Mix and pump E cement	32285 : 600 =	55
Drop pump down plug		20

In order to avoid contact between the mud inside the drill pipe and the cement above the stinger during the displacement, it will be preferable to pump behind the plug a volume of tail spacer which will fill the liner at least 200 m above the running tool extension.

First bumping pressure	5" 9.16 x 3155 =	28900	
Final bumping pressure	7" 18.27 x 1080 =	18732	
Total displacement ±		48632	
Flow rate	1000 l/min	12000	12
	300 l/min maxi	11000	38
	500 l/min	25632	52

Energizing work		30
Inverse circulating	$\frac{9.16 \times 3155}{1000}$ (+ 10962)	40
Total		247
Safety factor 50%		124
GRAND TOTAL	6h18	371

7" SLURRY

Composition	Weight-kg/100	Volume-1/100	weight by m3SW
salt water	45	38	
defoamer	0.05	0.05	0.5 1
f. loss reduce D 59	0.75	0.75	19.7 kg
dispersant D 45	0.20	0.15	5.3 kg
E cement	100	31.75	
SG ± 2.06		70.7	
SG ± 1.95 (for wash out volume)			

RESULTS : ±(4300 m-BHST 140° C - mud weight 1.90)

T.T. requested: 6:00 hrs.

T.T. recorded:

24 hrs. compressive strength:

Fluid loss:

Rheology and gels:

Maximum expected pressure during displacement: 836 b

Maximum estimated equivalent density : 1.94

REQUIREMENTS

Spacer $\frac{\pm 5 \times 2700}{1000}$ = 14 kg

Fresh water $\frac{32.5 \times 45664}{100}$ = 14841 1

Salt $\frac{279 \times 14841}{1000}$ = 4141 kg

F. loss reduce D59 $\frac{0.75 \times 45664}{100}$ = 344 kg

dispersant D45 $\underline{0.20 \times 45664}$ = 92

E cement $\frac{100 \times 32285}{70.7}$ = 45664 kg

APPENDIX D

CASING CALCULATIONS

Maximal pressure at the weak point (casing shoe) Ps max is reached when gas comes to this point. To have P max lower than p frac, we need :

$$P\ pore + S \leq P\ frac + \frac{\Delta Z - hs}{10}\ d + \frac{hs}{10}\ fm \qquad (1)$$

Considering gas is perfect ($\frac{PV}{ZT}$ = constante)

$$(P\ pore + S)\ h_b\ rk = P\ frac \times hs \qquad (2)$$

(1) + (2) give:

$$hb \leq \frac{10 \times P\ frac}{(d - fm)(P\ pore + S)} \left[P\ frac + \frac{\Delta Z}{10}\ d - P\ pore - S \frac{1}{rk} \right]$$

Symbols:

- S : safety factor over pressure when circulating bubble
- ΔZ : height between bottom and casing shoe
- hs : height of gas bubble at shoe
- hb : height of gas bubble at bottom
- d : mud specific gravity
- fm : average gas density
- r : ratio linear volum at bottom/linear volum at shoe
- k : $\frac{Zs \times Ts}{Zb \times Tb}$ with T = absolute temperature
  Z = compressibility gas factor

	A	B	C
Casing set	20"	13 3/8	9 5/8
Drilling in	17 1/2	12 1/4	8 1/2
P fracturation	at 750m: 125kg	at 2550m:450kg	at 3250m:675kg
d (mud)	at 2560m: 1.35	at 3260m: 1.60	at 4500m: 1.80
f (gas)	at 2560m: 0.25	at 3260m: 0.30	at 4500m: 0.35
P pore	at 2560m: 346 kg	at 3260m:522kg	at 4500m:810kg
S	10 kg	10 kg	10 kg
ΔZ	1810 m	710 m	1250 m
K	0.95	1.0	1.0
r	0.766	0.683	0.625

Nota:- P frac is higher than p max used for leak off test.

- While circulating, we keep an overpressure on bottom around $10 kg/cm^2$. (safety factor S)
- K = 1. We admit that T and Z remain constant between bottom and shoe except for case A where we come near the surface.

Calculation of r:

- case A: At bottom 17 1/2 hole, 9 1/2 DC

  at shoe 17 1/2 hole, 5" drill pipes

  $$r = \frac{109.\ 1/m}{142.5\ 1/m} = 0.766$$

- case B: at bottom 12 1/4 hole, 8" DC

  at shoe 12 1/4 hole, 5" drill pipes

  $$r = \frac{43\ 1/m}{63\ 1/m} = 0.683$$

- case C: at bottom 8 1/2 hole, 6 1/2 DC

  at bottom 8 1/2 hole, 5 " drill pipes

  $$r = \frac{15\ 1/m}{24\ 1/m} = 0.625$$

<u>MAXIMUM BUBBLE ALLOWABLE VOLUM</u> :

CASE A: hb = 59m, we can have a maximum influx of gas around 6.5 m^3.

CASE B: hb = 405m. It exceeds height of 8" DC. By considering an average r including string upper 8" DC., we have hb = 310m with an average linear volum of 51 l/m. The maximum influx of gas is then $16 m^3$.

CASE C: hb = 725m. same considerations give a maximum gas influx of $10 m^3$ without control problems.

20"	K55	133 lbs	BUTT	at	750 m	660 m	string
13 3/8	N80/P110	72 lbs	VAM	at	2550 m	2460 m	string
9 5/8	P110	53.5lbs	VAM	at	3250 m	3160 m	string

	BURST 1.1		COLLAPSE		TENSION 1.5.		WEIGHT IN AIR
	STANDART	SAFETY FACTOR	STANDART	SAFETY FACTOR	STANDART	SAFETY FACTOR	
20"	211	190	103	95	945	630	129
13 3/8 N80	371	337	184	143	738	492	259
13 3/8 P110	510	464	199	164	970	647	259
9 5/8 P110	752	684	547	427	759	506	256
	kg/cm^2	kg/cm^2	kg/cm^2	kg/cm^2	10^3 da N	10^3 da N	10^3 da N

NB: For collapse, safety factor depends on the weight of the string in mud. But we considered weight in air, which is a greater safety factor.

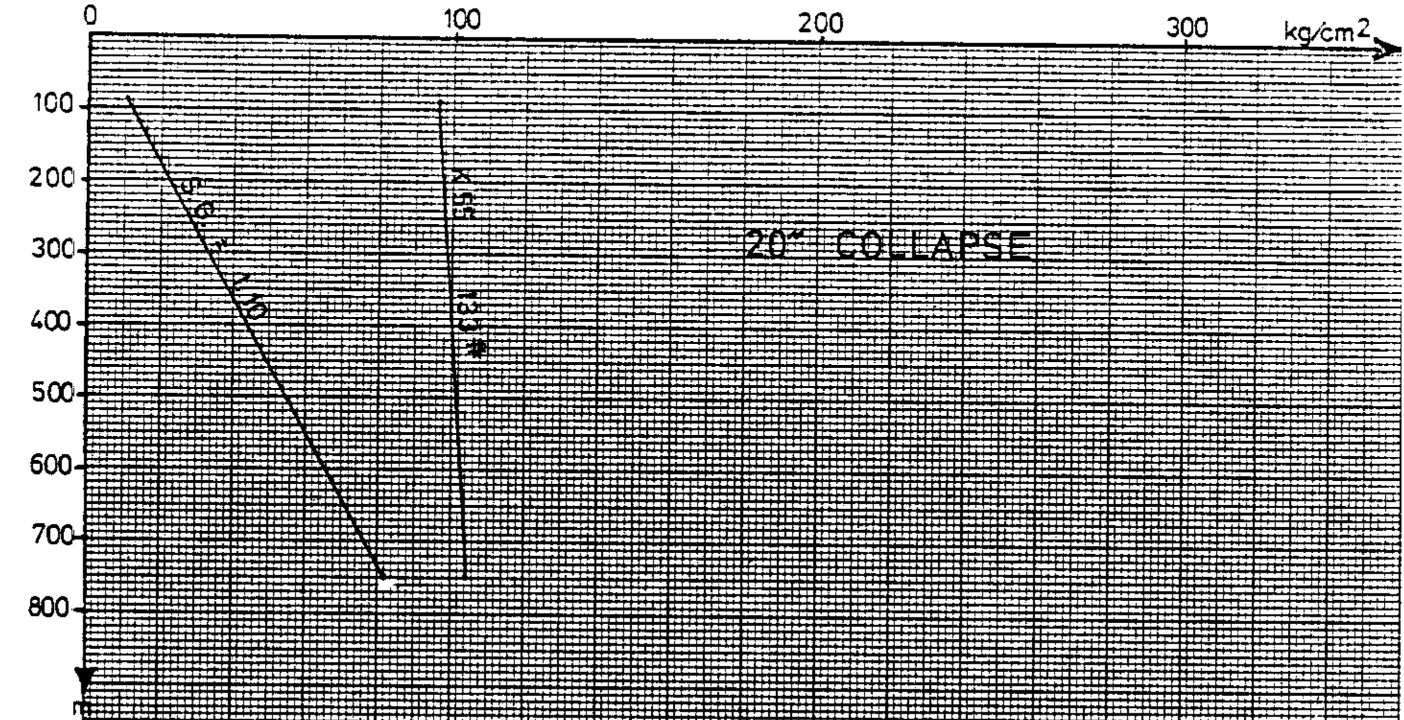
For burst, we admit that fluid behind casing is 1.0 specific gravity.
For collapse, we admit that fluid behind casing has the maximum specific gravity of the mud used during the corresponding phase.

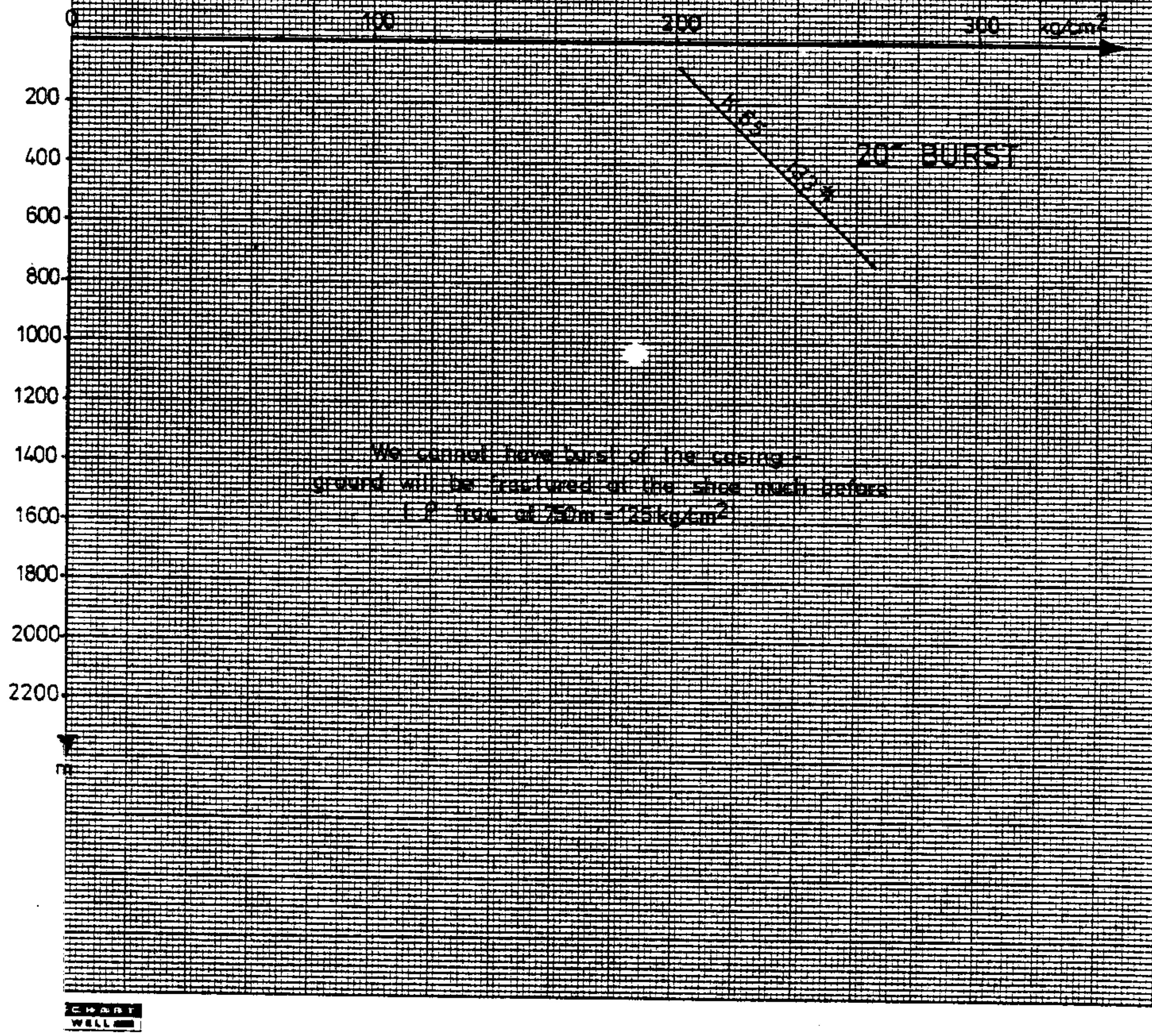
CONCLUSIONS:

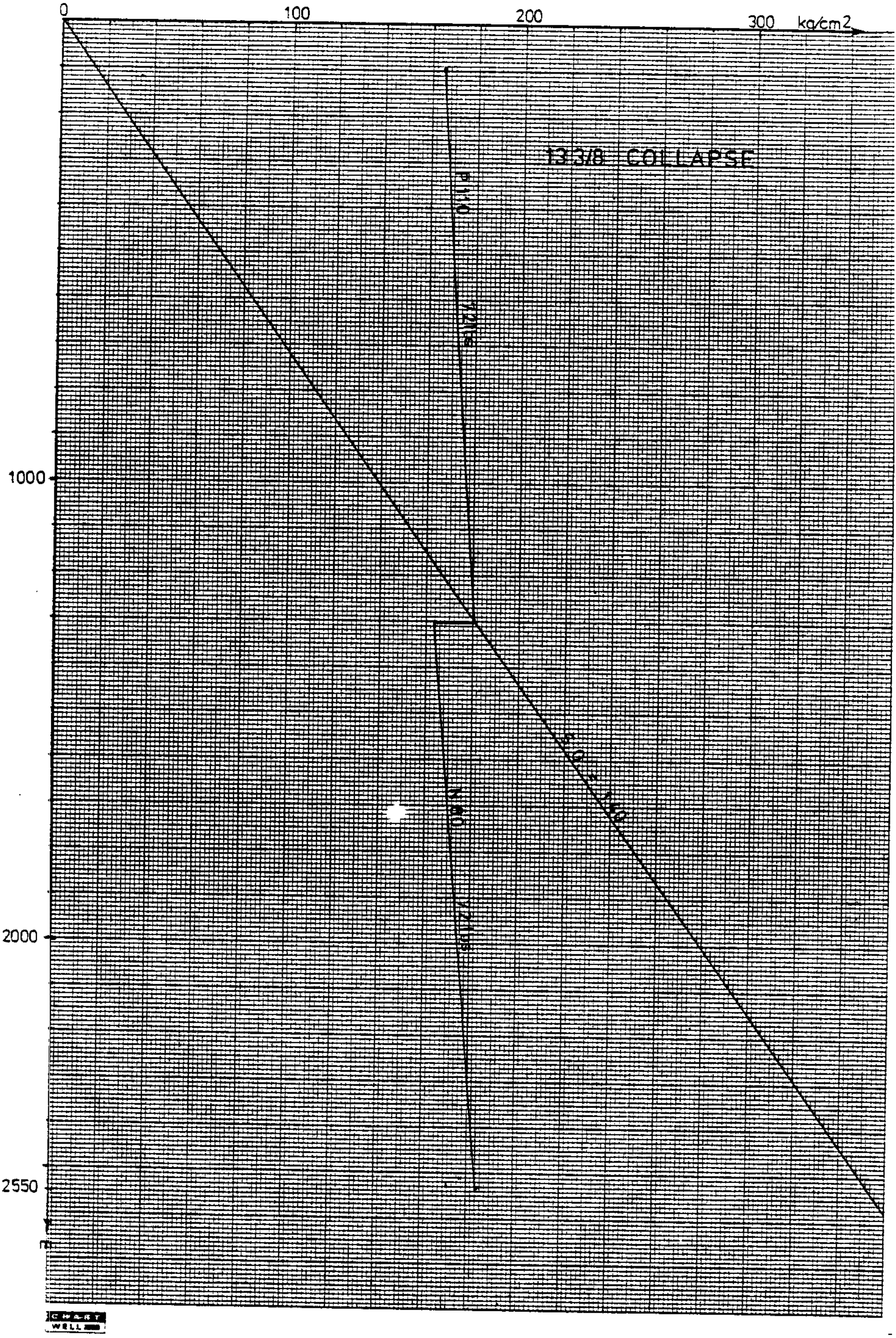
20" casing can be emptied in its full length.
During 17 1/2 drilling, a 6.5m^3 gas bubble can be admitted.
In any case, there will not be a burst from 20" casing but possibl
fracturation at shoe.

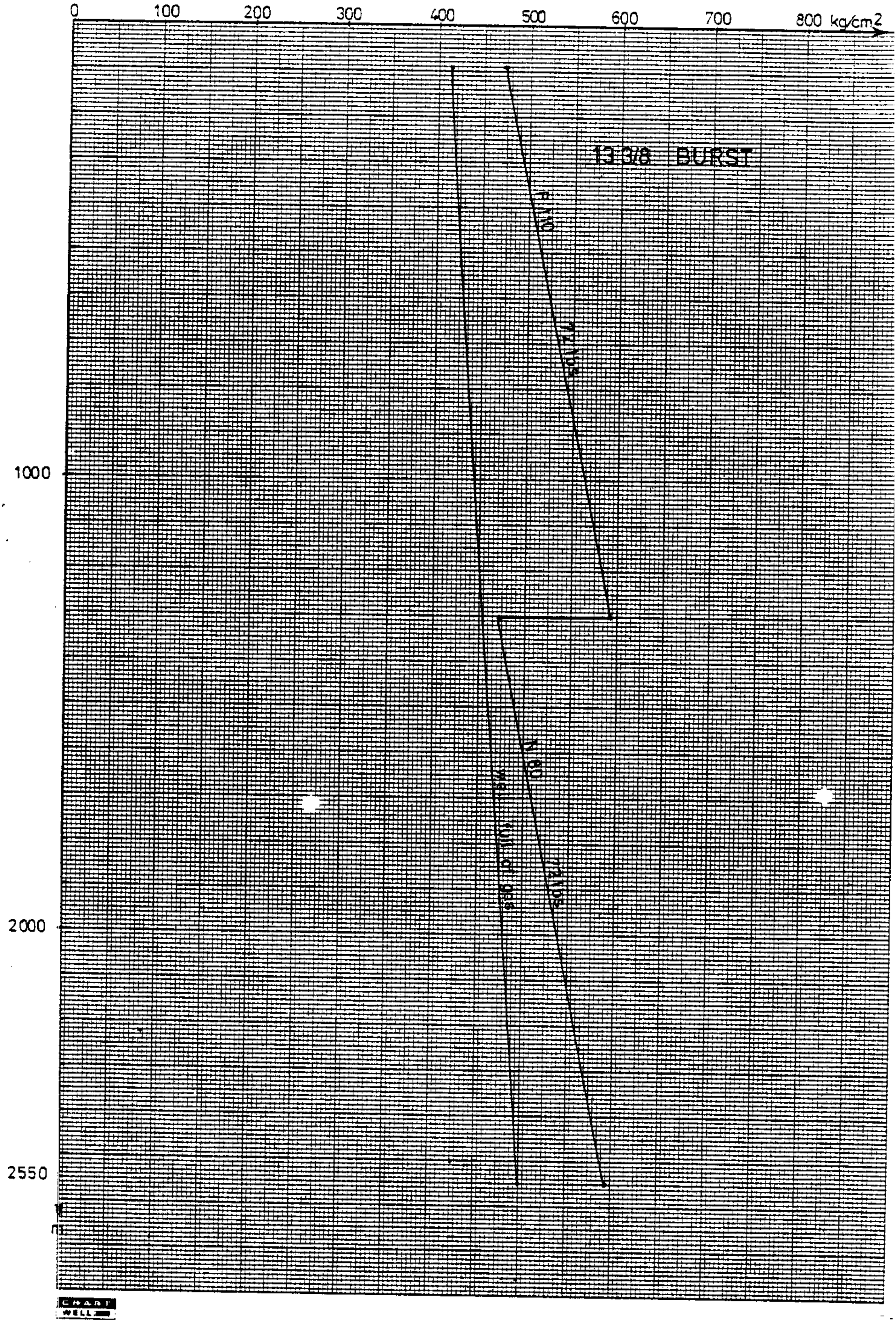
13 3/8 casing can be emptied down to 1300 m.
During 12 1/4 drilling, a 16m^3 gas bubble can be admitted.
The well can be full of gas without burst of casing.
In that case, pressure at shoe will be around 500 hg/cm^2
(compared to an estimated P frac = 460 hg/cm^2.)
There will be fracturation at shoe.

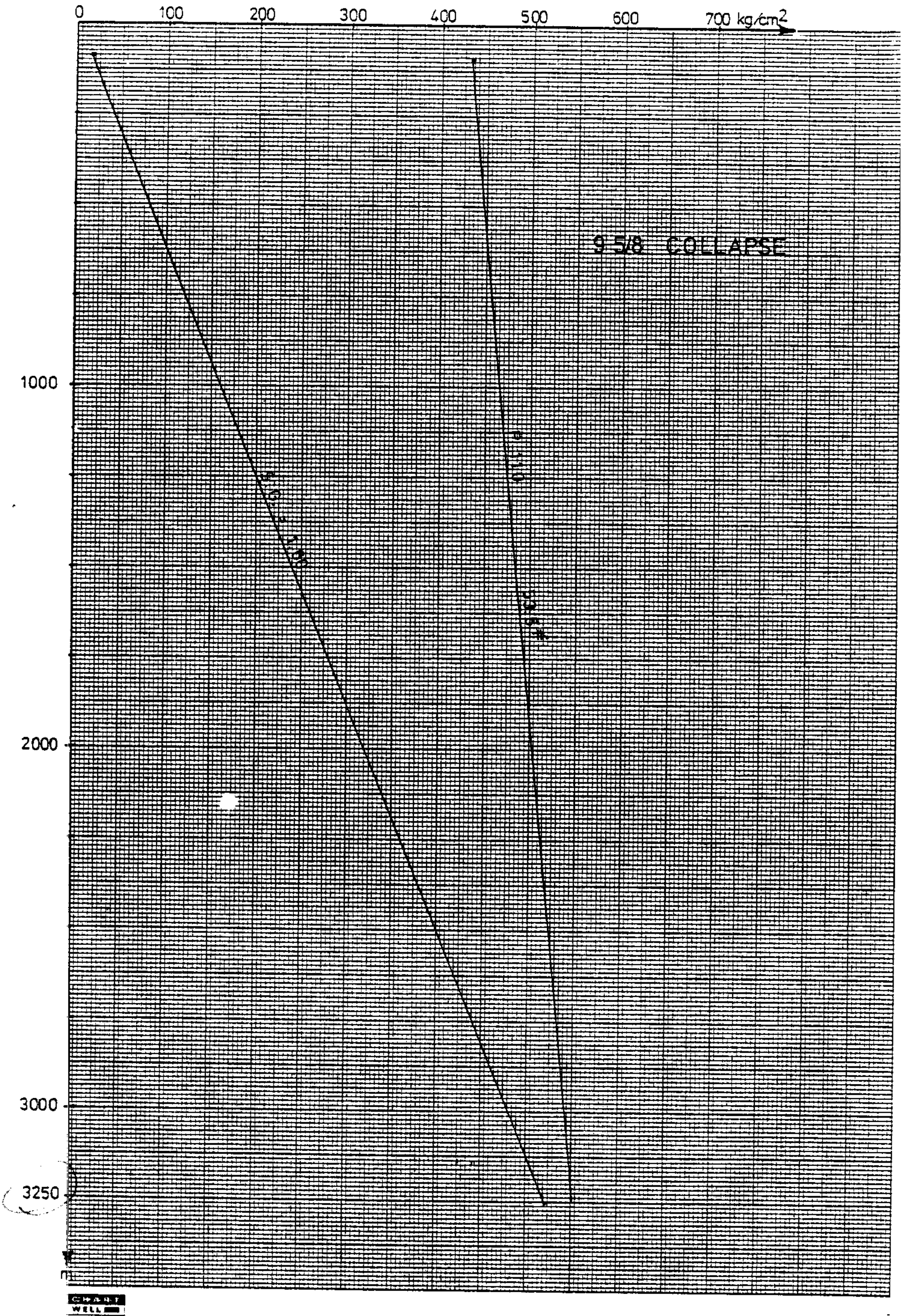
9 5/8 casing can be emptied in its full length.
During 8 1/2 drilling, a 10m^3 gas bubble can be admitted.
The well can be full of gas without burst of casing.
In that case, pressure at shoe will be around 730 hg/cm^2
(compared to an estimated P frac = 675 hg/cm^2). There will
be fracturation at shoe.


0
100
200
300
kg/cm2
100
200
300
400
500
600
700
800
m
20" COLLAPSE
K 55
133 #

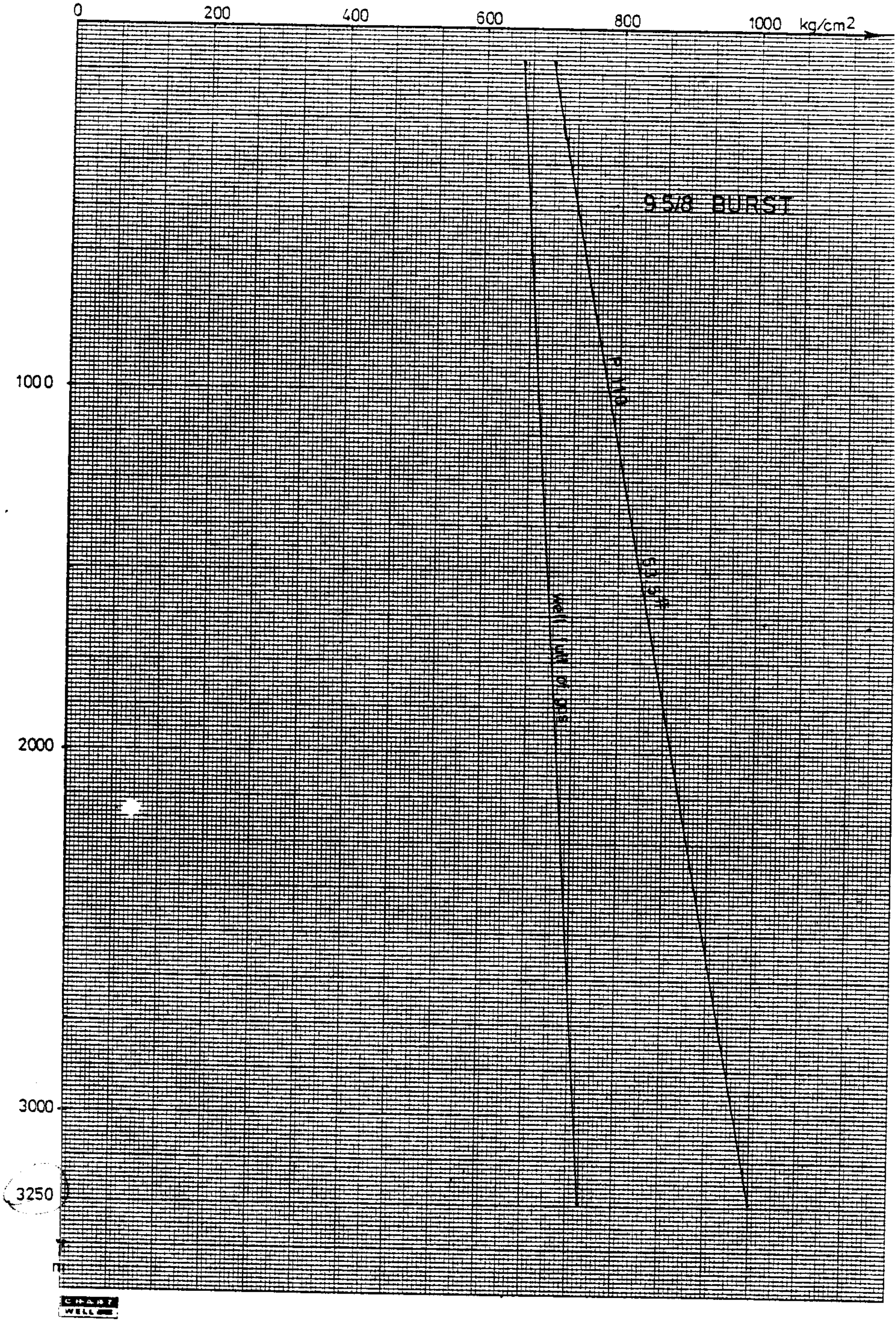

0
100
200
300
kg/cm2
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
m
20" BURST
K 55
133 #
We cannot have burst of the casing -
ground will be fractured at the shoe much before
750m = 125 kg/cm2


0
100
200
300
kg/cm2
13 3/8 COLLAPSE
P110
72lbs
5.0 = 140
N80
72lbs
1000
2000
2550
m


13 3/8 BURST
0
100
200
300
400
500
600
700
800 kg/cm2
1000
2000
2550
m
P 110
72 lbs
N 80
72 lbs
Well full of gas



0
100
200
300
400
500
600
700 kg/cm2
9 5/8 COLLAPSE
1000
2000
3000
3250
m



0
200
400
600
800
1000
kg/cm2
9 5/8 BURST
P 110
53.5 #
well limit of gas
1000
2000
3000
3250
m

ELF AQUITAINE NORGE A/S
EMERGENCY TASK FORCE

EAN MANAGEMENT

CHOUZENOUX: 588 123
HODEE : 528 257
POL : 527 223
JEAN : 542 192

DEPUTY

ELF HEAD OFFICE EXPERIENCED DRILLING ENGINEER

DRILLING CONTRACTOR

B. CAMPBELL: 555 235

DRILLING DEPT.
097-62435

SALES - 542 134
IDELOVICI - 534 984
VIAUD - 542 138

RIG SUPERVISION

RIG SUPERVISORS (2).
DIRECTIONAL DRILLING ENGINEER
SUBCONTRACTORS REPRESENTATIVES

COORDINATION STAFF

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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. See 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 - <u>Open hole pressure test.</u>

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-o (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.

(in l/100 kg/cm²)

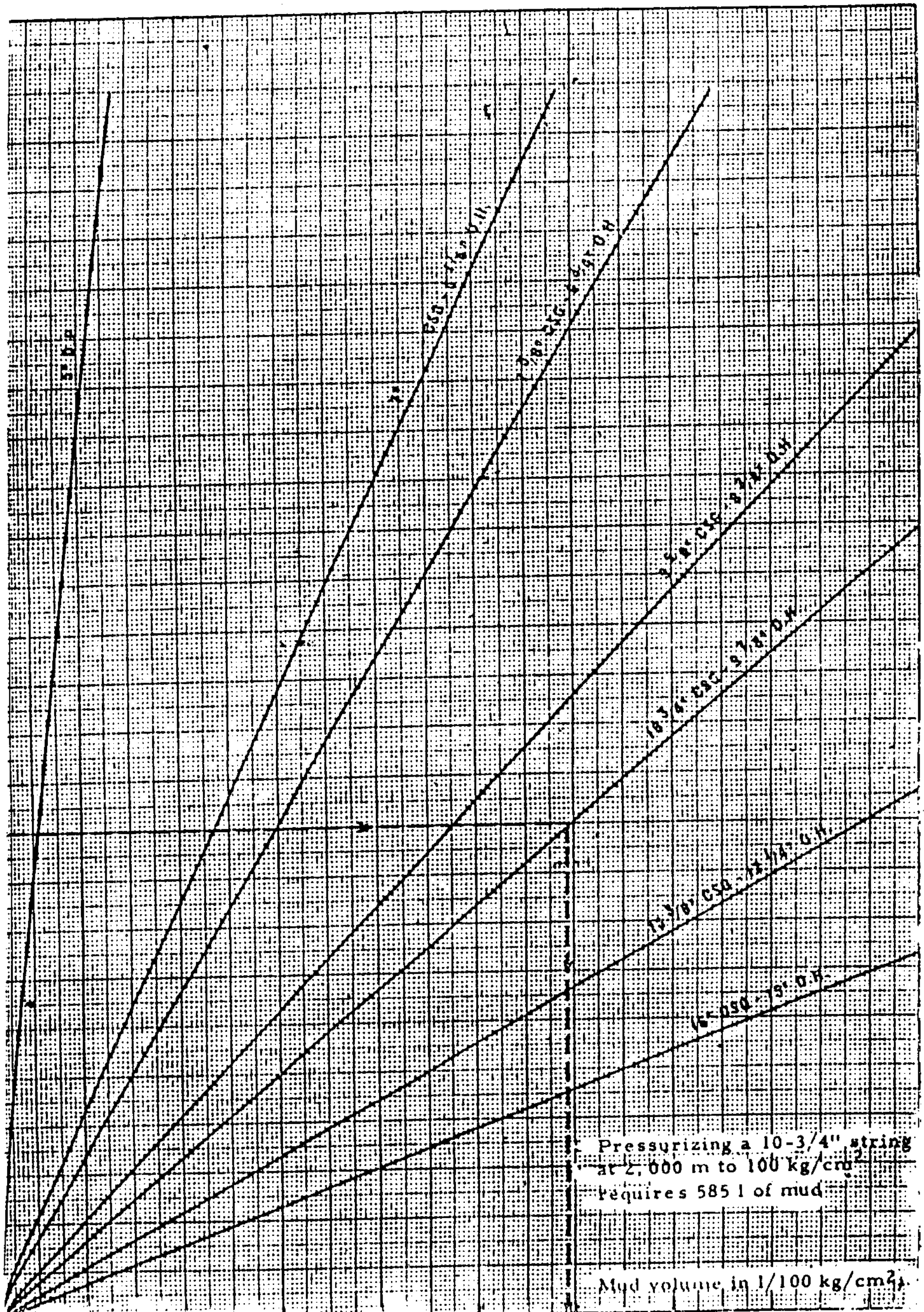
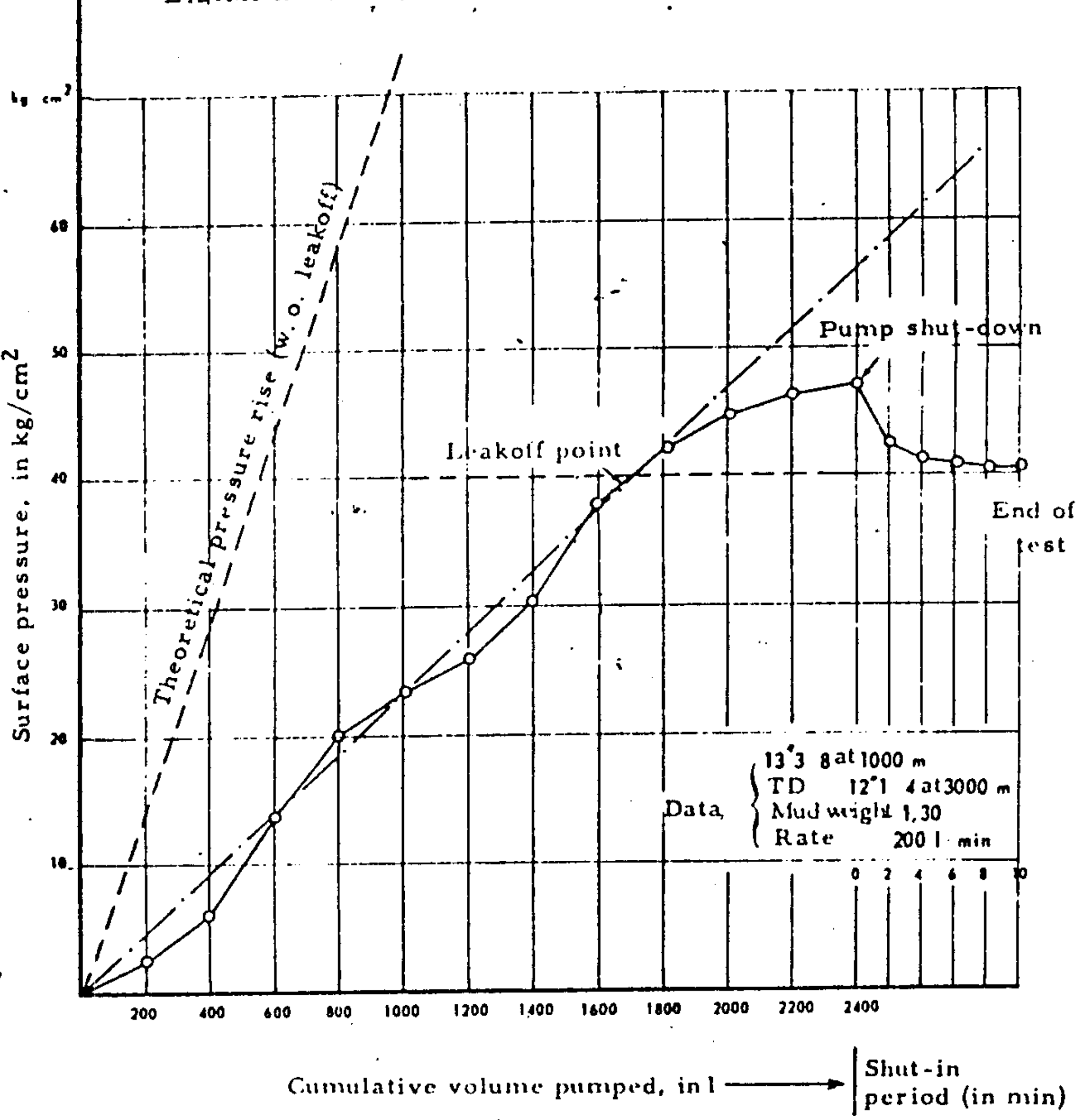


Fig. 5

EXAMPLE OF SQUEEZE TEST IN A HIGH OPEN HOLE



Resistance —

- at shoe
  - $SQP \geqslant 40 + \frac{1000}{10} \times 1{,}30 = 170\ kg/cm^2$
  - $sqd \geqslant \frac{170 \times 10}{1000} = 1{,}70$
- at bottom
  - $SQP \geqslant 40 + \frac{3000}{10} \times 1{,}30 = 430\ kg/cm^2$
  - $sqd \geqslant \frac{430 \times 10}{3000} = 1{,}43$

Fig. 1

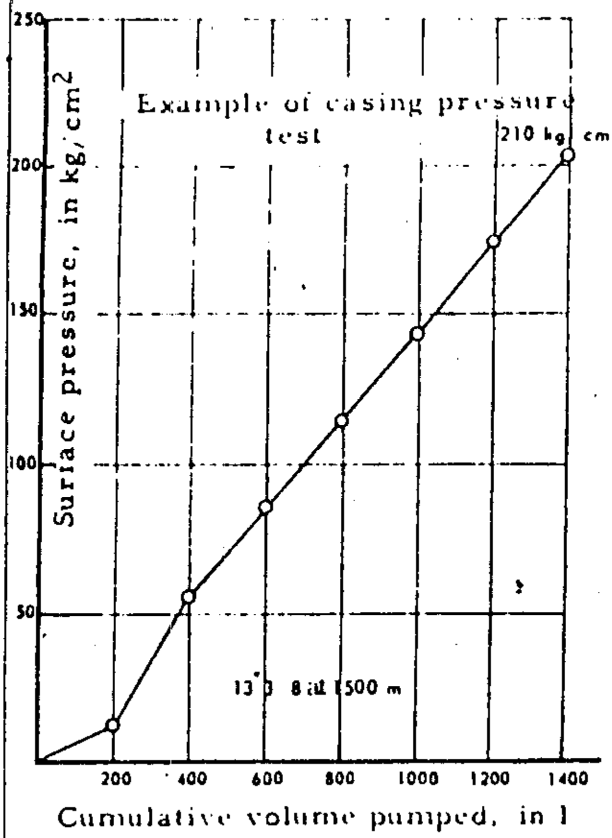


Fig. 2

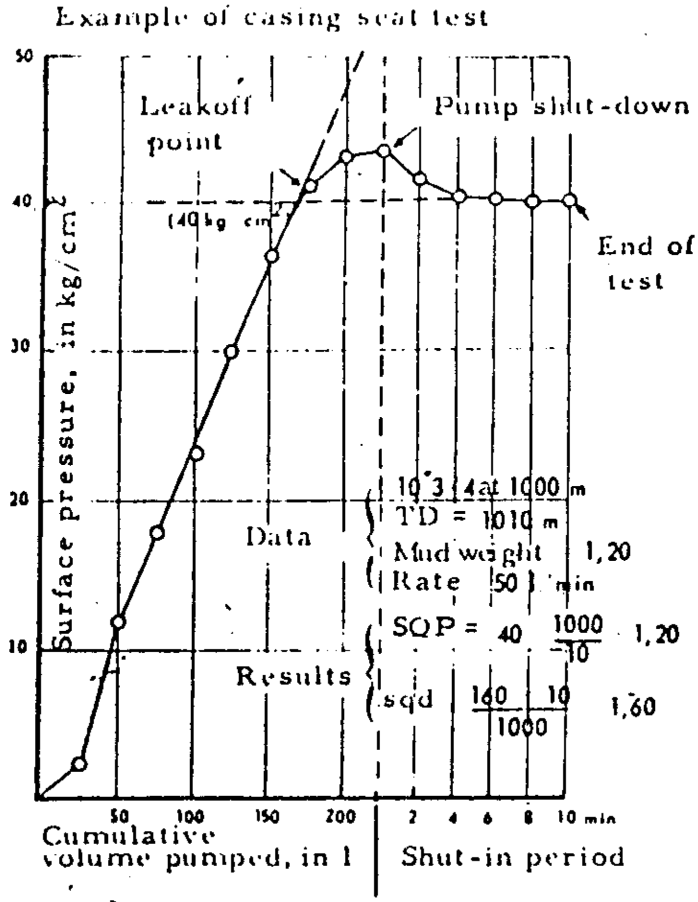


Fig. 3

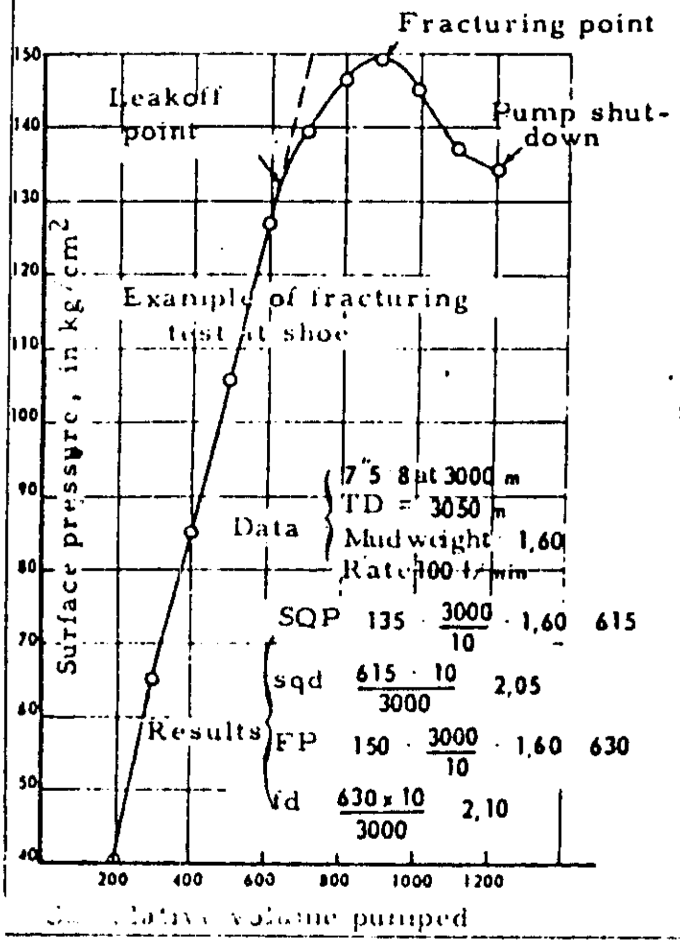
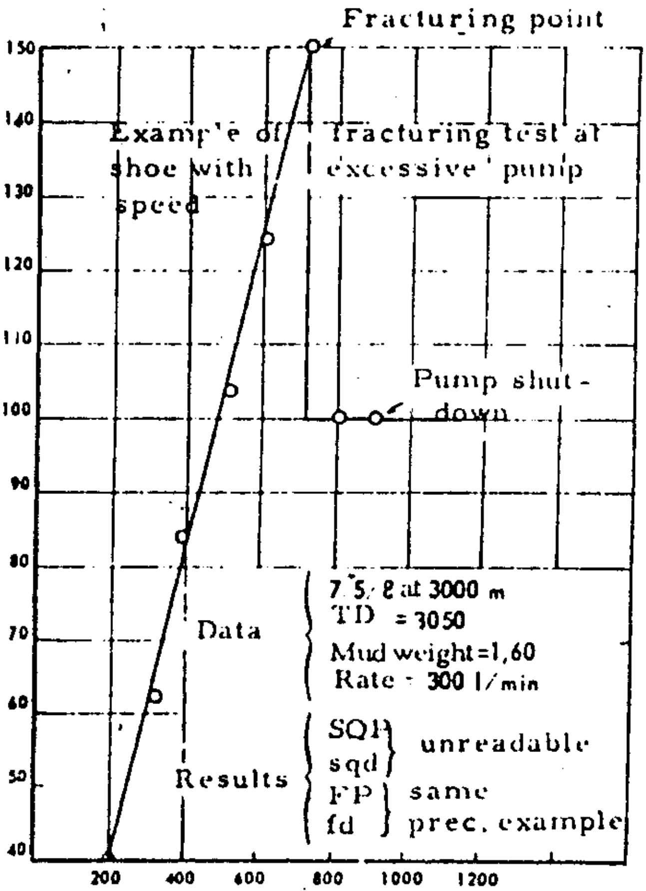


Fig. 4



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)

Elf Norge A/S Stavanger,

WELL KILLING CONTINGENCY PLAN WHEN DRILLING EXPLORATION WELL

1. INTRODUCTION

The only method to kill a flowing well is to drill relief wells. This contingency plan is established for exploration well in case of blow-out occurence after the 13"3/8 casing or 9 5/8 casing have been set.

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, and deviation surveys (single shot surveys during drilling and Multishot Gyro surveys in casing strings) obtained during drilling operations.

II.4. Well Profiles

II.4.1. Direction and inclination will be determined exactly according to the objectives.

II.4.2. The target should be within 30/50m from bloming well. 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 encountered during drilling.

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 during drilling.

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 established. (Pumping rate could be estimated at about $6m^3$/Min.).

V . EQUIPMENT AND MATERIALS

Drilling Platforms

No problem is foreseen in making drilling platforms available to drill relief wells, as NSOC has pledged to maintain a current list of equipment available in an emergency situation.

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.

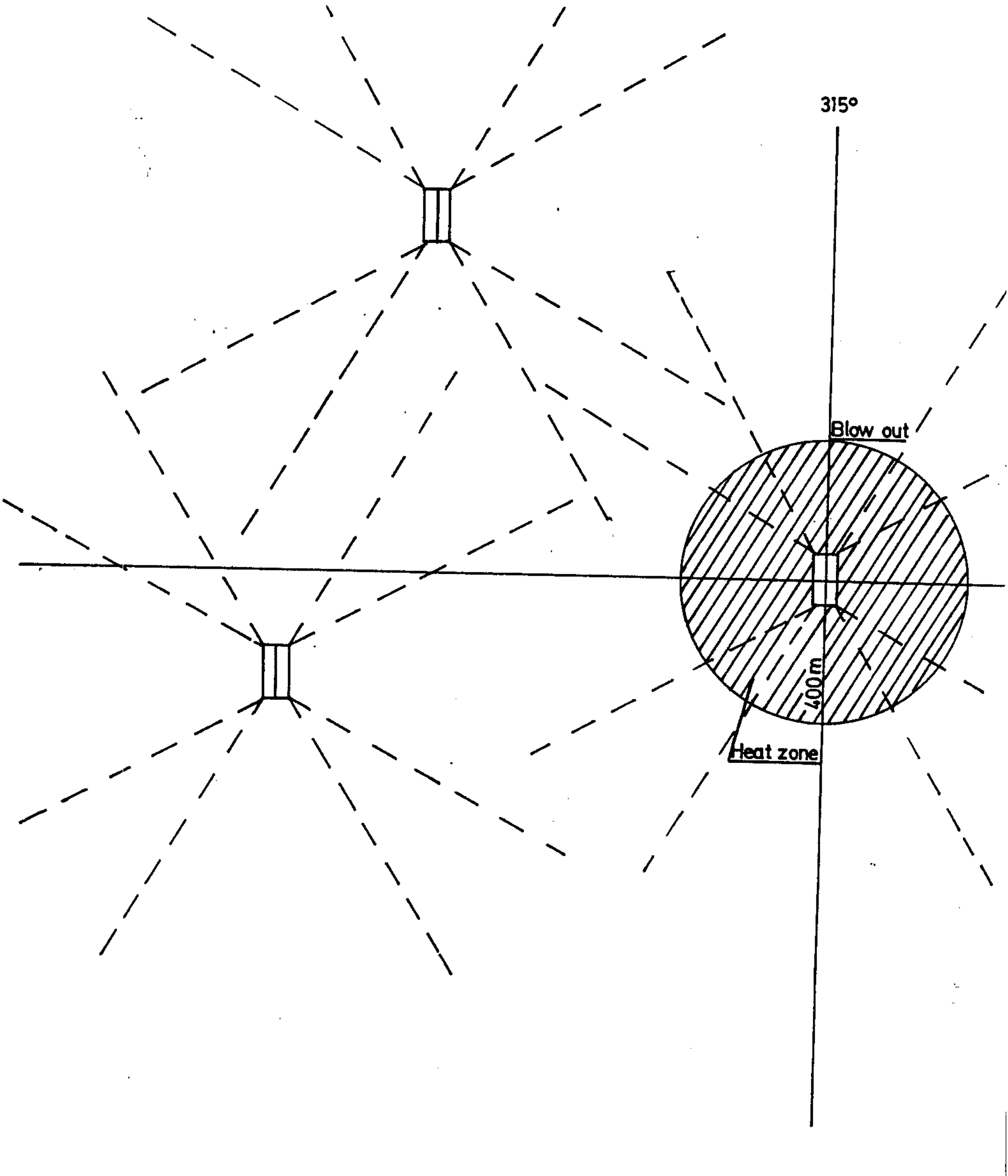
Pumps

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.

VI . ORGANISATION

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



ANCHOR PATTERN (SCHEMATIC)