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lagret hos:

 **STATOIL**

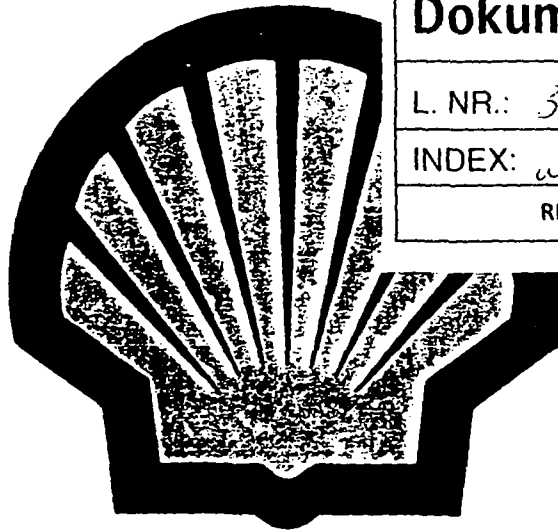
(74.0026 312-2)

Dokumentcenter ST-FH

L. NR.: 302 84 43 0024

INDEX: well 31/2-5 Nr. 51

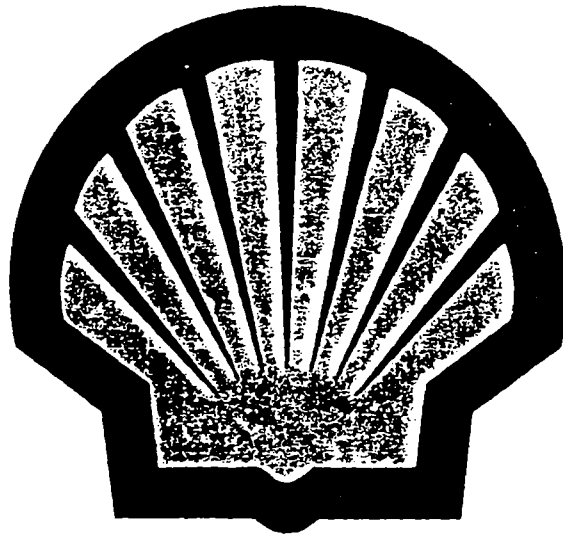
RETURNERES ETTER BRUK



A/S Norske Shell

NSEP 220 WELL RESUME 31/2 - 5 RE-ENTRY

OCTOBER 1984



A/S Norske Shell

**NSEP 220
WELL RESUME
31/2 - 5 RE-ENTRY**

OCTOBER 1984

PL 054 ENGINEERING SUB-COMMITTEE

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A/S NORSKE SHELL
TROLL FIELD
WELL RESUME 31/2-5 RE-ENTRY

A/S Norske Shell
Exploration and Production

NSEP 220

CONFIDENTIAL

A/S NORSKE SHELL
TROLL FIELD
WELL RESUME 31/2-5 RE-ENTRY

Forus
October 1984

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1. INTRODUCTION

Well 31/2-5 is located in the southern part of the oil province in the Troll West field. The coordinates of the well are:

60⁰ 64' 16.20" N
03⁰ 25' 53.46" E

The well was drilled in 1980 and re-entered in 1981 for production testing. After testing max 7800 bbl/D the well was suspended for later testing.

The well was re-entered on March 16th 1984 with following objective:

- To effect a temporary recompletion for the purpose of testing the water-oil coning behaviour. Quantification of the coning performance will provide crucial input for the specification of the Field Development Plan for the Troll field

After a successful oil test (6300 bbl/D) the well was plugged and abandoned on April 22, 1984.

Well 31/2-5

Summary of Well Data

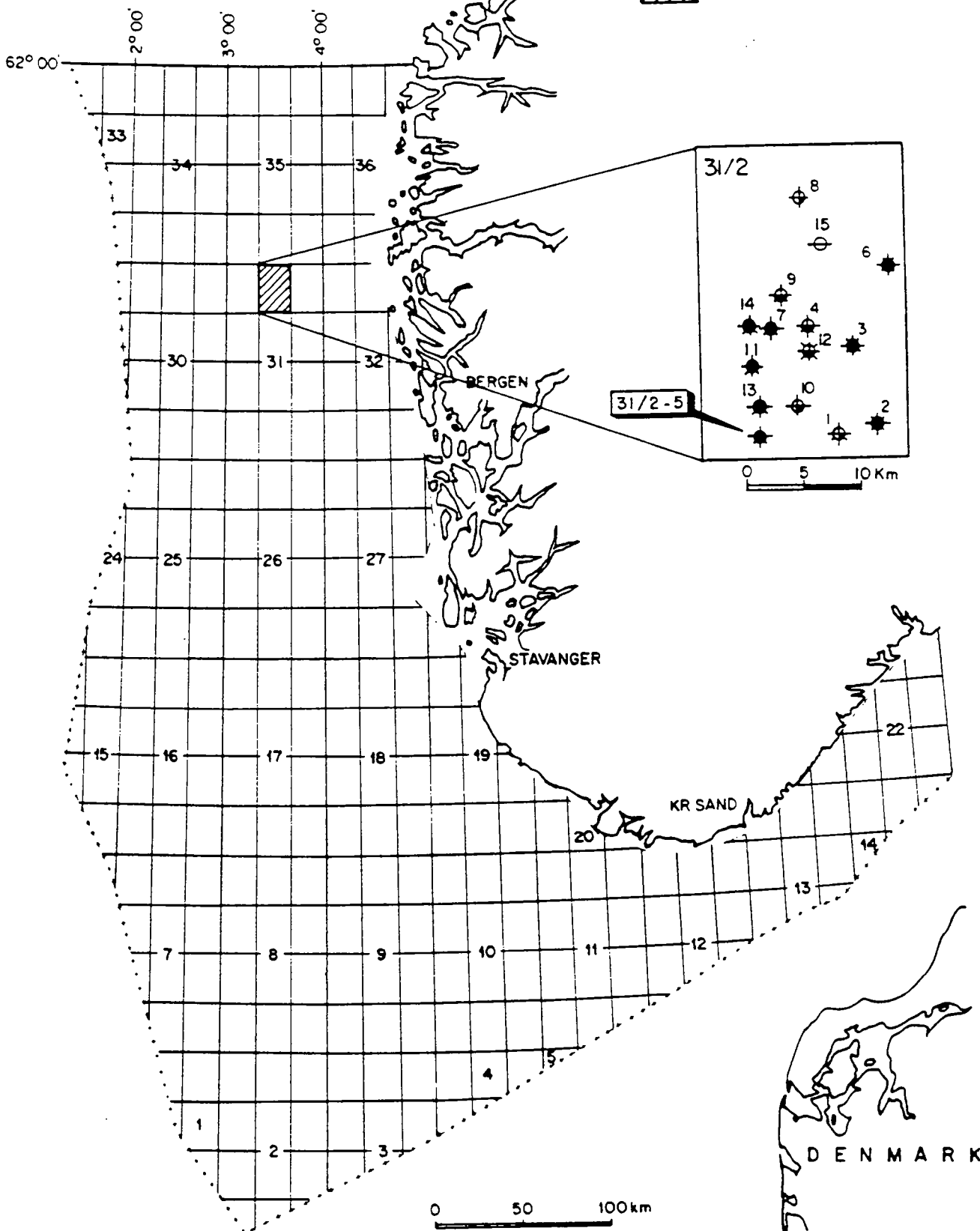
Well classification	Wildcat, re-entered 1982 and 1984
Location coordinates	60° 46' 16.20" N 03° 25' 53.46" E
Contractor/Rig	Smedvig Drilling, West Venture. Re-entry: Dolphin Services, Borgny Dolphin
Derrick Floor Elevation	West Venture 32 m Borgny Dolphin 25 m
Water Depth	333 m
Spudded	26.10.80
Suspended at TD	21.12.80
1981 Re-Entry	16.06.81
Suspended after Oil Test	16.07.81
1984 Re-Entry	16.03.84
Plugged and Abandoned	22.04.84
Objective	Evaluation of Humber Group reservoir sequence
Results	1981 oil test : 7800 bbl/D 2 x 1" choke, GOR : 1400 scf/bbl 29° API 1984 oil test : 6300 bbl/D 2 x 1" choke, GOR : 200 scf/bbl
Costs (31.08.84)	1984 re-entry : 38 x 10 ⁶ NOK Total (drilling and two re-entry): 115 x 10 ⁶ NOK
Present Status	Plugged and abandoned
Casing Records	30" at 443 m BDF West Venture 20" at 810 m " " " 13-3/8" at 1470 m " " " 9-5/8" at 1802 m " " "

Production Licence 054 Group

Statoil	50%	
Norske Shell	35%	Operator
Norske Conoco	5%	
Norsk Hydro	5%	
Superior Oil Norge	5%	



LIC. 054
STATOIL/SHELL GROUP

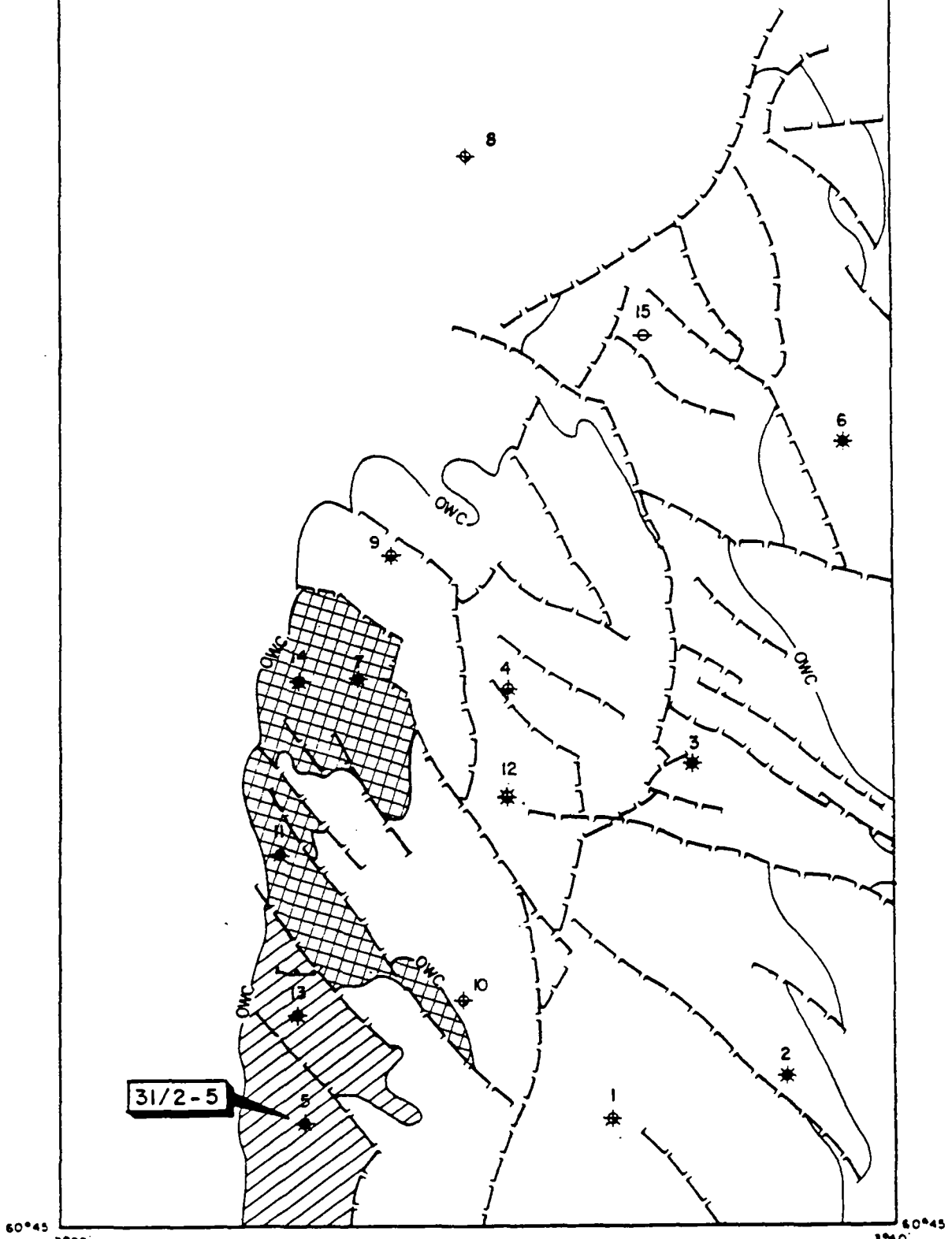



0 50 100 km

a-s Norske Shell		
EXPLORATION & PRODUCTION FORUS		
BLOCK 31/2		
LOCATION MAP		
AUTHOR EPP/31	FIG. DATE OCT. '84	
REPORT NO NSEP220	1.1	DRAW NO G1677/1

3°20' 3°40' 61°00' 61°00'

31/2 SHELL/STATOIL



 22m OIL COLUMN

 28m OIL COLUMN.

a-s Norske Shell EXPLORATION & PRODUCTION NORWAY		
BLOCK 31/2 WELL LOCATION MAP		
AUTHOR: EPPP/31	FIG. 1.2	DATE: OCT '84
REPORT NO. NSEP220		DRAW. NO. G1677/2

R.H.

2. RIG MOVE AND ANCHORING REPORT

Summary

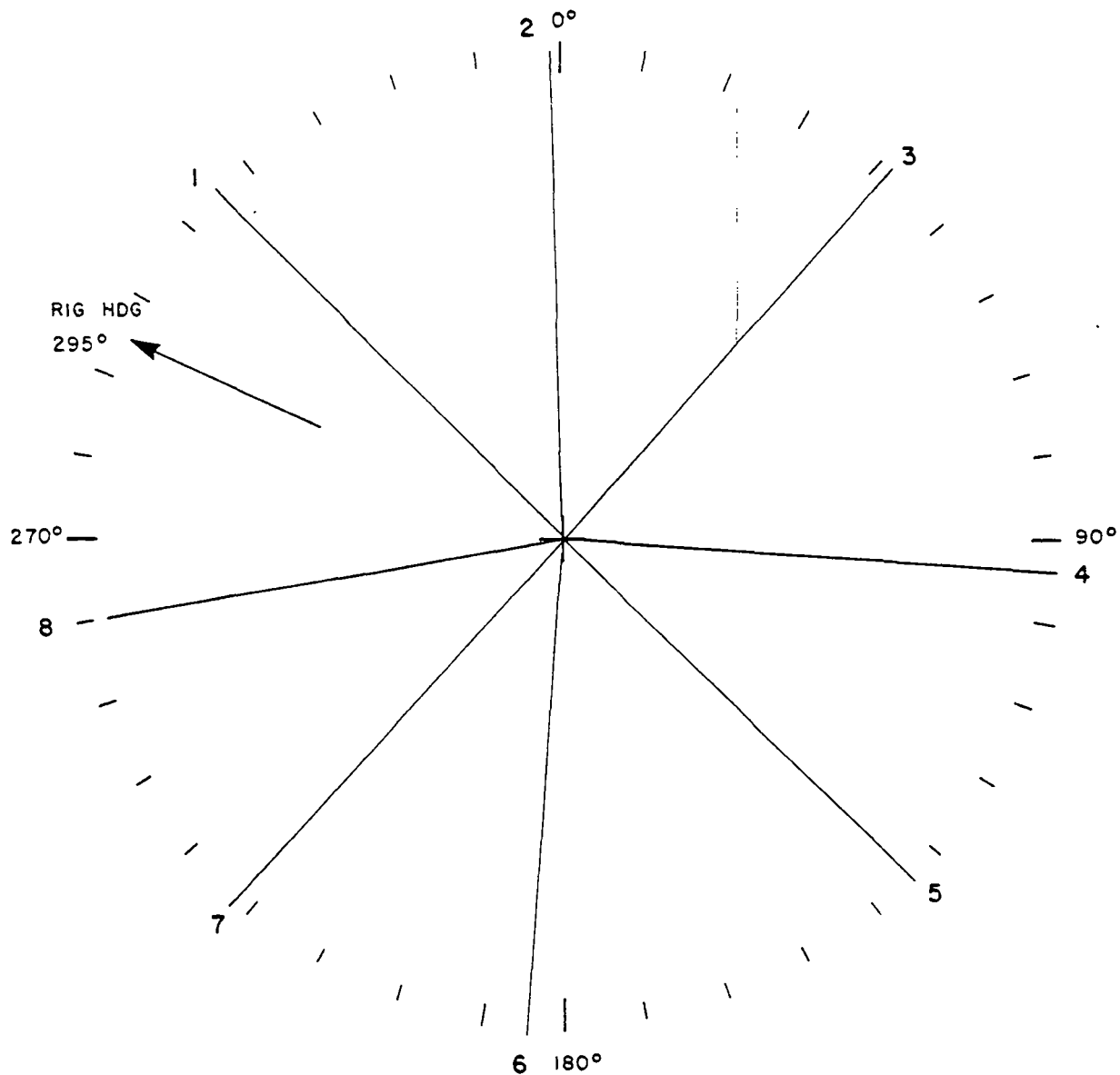
Rig	Borgny Dolphin
Old location	31/2-13
New location	31/2-5 Re-Entry
Rig released	14.03.84
Rig arrival	17.03.84
Co-ordinates actual	46' 16.20" N, 03 ^o 25' 53.46" E
Water depth	333 m
Rig heading	319 ^o
Rig mover	Shell Expro.
Survey operator	Norske Shell, Geoteam


SKETCH OF ANCHOR PATTERN

RIG BORGNY DOLPHIN

PREVIOUS LOCATION: WELL 31/2 - 13

DATE 29 / 12 / 83



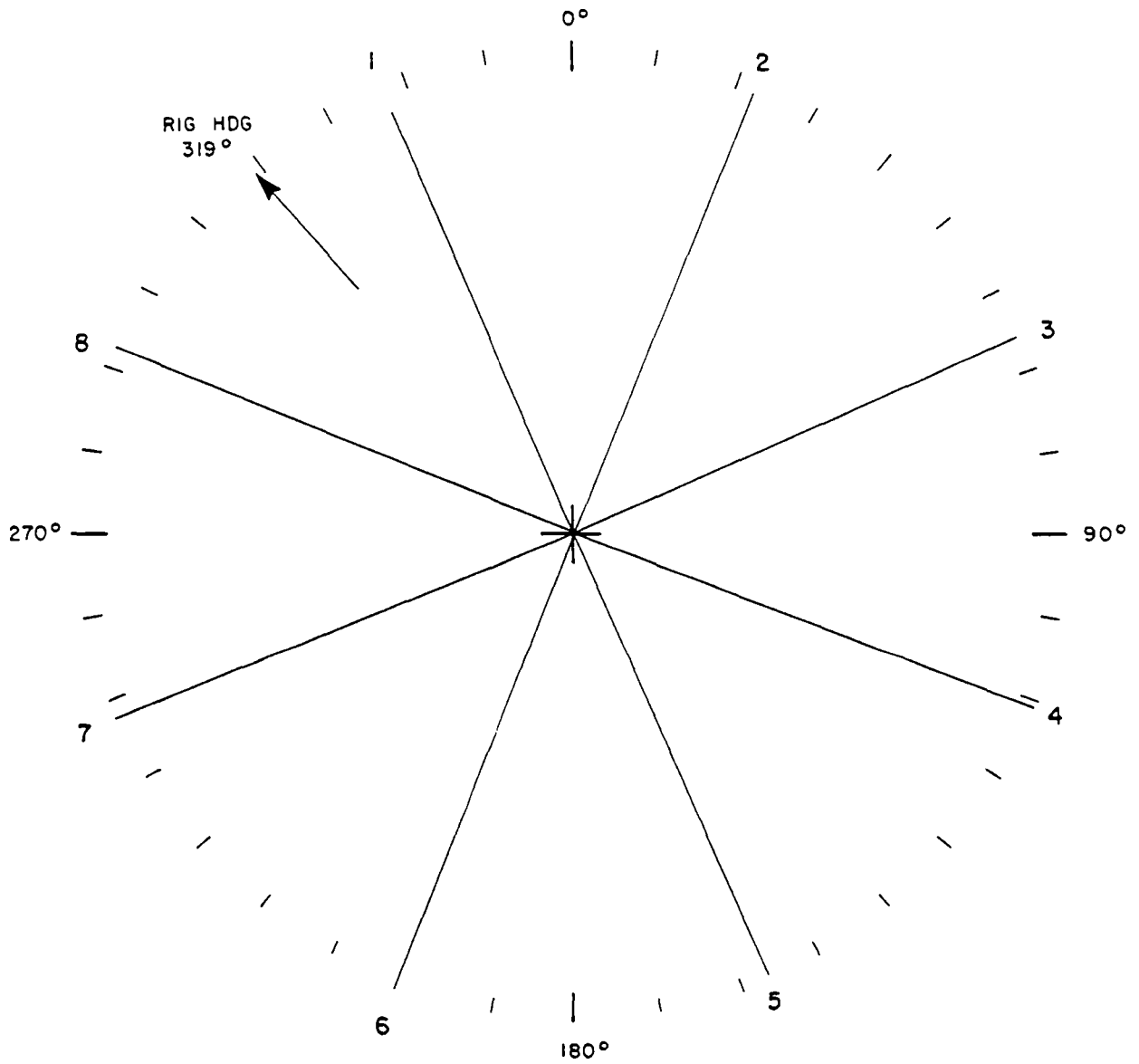
A/S Norske Shell		
EXPLORATION & PRODUCTION FORUS 		
WELL 31/2 - 5 RE-ENTRY		
ANCHOR PATTERN		
PREVIOUS LOCATION		
AUTHOR EPPP/31	FIG 2.2	DATE OCT. 84
REPORT NO NSEP220		DRAW NO G1677/4

SKETCH OF ANCHOR PATTERN

RIG : BORGNY DOLPHIN

NEW LOCATION : WELL 31/2-5

DATE 17/3/84



A/S Norske Shell		
EXPLORATION & PRODUCTION FORUS		
WELL 31/2-5 RE-ENTRY		
ANCHOR PATTERN		
NEW LOCATION		
AUTHOR EPPP/31	FIG. 2.1	DATE OCT '84
REPORT NO NSEP220		DRAW NO G1677/3

R I G M O V E R E P O R T

RIG NAME: Borgny Dolphin DATE: 17th March, 1984

OWNER: Dolphin Services A/S CHARTERER: Norske Shell

	RIG RELEASED	RIG ARRIVAL	TOTAL
EXPECTED TIME	14th /2030	16th /0530	33 hours
ACTUAL TIME	14th /2030	17th /0130	53 hours

Note:- All times are Norwegian local time, i.e. GMT + 1 hour

A. LOCATIONS

BLOCK NAME/NO.

CO-ORDINATES

WATER DEPTH

RIG HEADING

OLD LOCATION

NEW LOCATION

31/2-H	31/2-5
60 47 13.8N 03 26 03.31E	60 46 16.2N 03 25 53.5E
340m	1150 ft
295°T	319°T

B. PRE-MOVE CORRESPONDENCE

REFER

PRE MOVE MEETING: 14.3.84 ON: Board ATTENDED BY: Personnel listed below.

C. PERSONNEL ON BOARD INVOLVED IN RIG MOVE:

COMPANY:

1. PERSON IN CHARGE OF RIG:	A. Pedersen	Dolphin Services
2. BARGE ENGINEER :	P. Michaelsen	Dolphin Services
3. CHARTERERS DRILL REPR. :	F. Van Kampen	Norske Shell
4. INSURANCE SURVEYOR :		
5. RIG MONITOR :	J. Pepp	Shell Expro
6. RIG EM OPERATOR :	J. Christensen	Norske Shell
	G. Nacker	Geo Team
	J. Nerland	Geo Team
	T. Campbell	U.D.I. / Geo Team

D. CRAFT INVOLVED:

	VESSEL	TYPE	SHP	S.P.	MASTER	ON LOCATION		DISMISSED	
						DATE	TIME	DATE	TIME
1.	Active Boy	AHSV	9100	100	H. Fjellly	13/3	0715	16/3	1815
2.	Sirra Grant	AHSV	10,800	126	H. C. Ness	14/3	1030	16/3	2115
3.	Normand Ranger	AHSV	8000	90	C. Ness	14/3	1320	17/3	0130
4.									
5.									
6.									
7.									

E. WEATHER SUMMARY: (SPECIFY RETRIEVING/TCW/RUNNING)

DATE	TIME	WIND		ACTUAL SEA STATE			WEATHER	VIS.	RETR/ T/ RUN
		DIR.	SPEED	DIR.	HT. M	PERIOD			
14/3	2000	N	22	N	2-3	8	Cloudy, Clear	G	-
	2400	N	20	N	2-3	8	" "	G	Retr.
15/3	0400	NNE	25	N	2-3	8	" "	G	"
	0800	NNE	38	N	3-4	8	" , Rain shrs.	G	"
	1200	N	38	N	4-5	8	" " "	G	WCW
	1600	ENE	25	N	4-5	8	Cloudy, Clear	G	"
	2000	ENE	22	N	3-5	8	" "	G	"
16/3	2400	Ely	18	N	3-4	8	" "	G	"
	0400	Var	8	N	1-1	8	" "	G	Retr.
	0800	Var	5	N	2	8	" "	G	Run.
	1200	SE	5	N	2	8	" "	G	Run
	1600	Var	-	N	2	8	" "	G	-
	2000	Var	-	N	2	8	" "	G	-
	2400	Ely	2	N	1	8	" "	G	-

REPORT SIGNIFICANT CHANGE IN WEATHER ATTACH WEATHER REPORTS AND FORECASTS

F. TIME SUMMARY:

	FROM	TO	TOTAL	%
RIG RELEASED/IN POSITION	14 /2030	17 /0130	53h 00m	
RETRIEVING BACK UPS		N/A		
RETRIEVING MAIN ANCHORS	14 /2200 16 /0100	15 /1012 16 /0534	12h 12m 4h 34m	
UNDER TOW	16 /0534	16 /0718	1h 44m	
RUNNING ANCHORS	16 /0718	16 /1310	5h 52m	
RE-LAYING ANCHORS				
RUNNING BACK UPS	16 /2100	17 /0130	4h 30m	
RE-LAYING BACK UPS				
TEST LOADING ANCHORS	16 /1840 17 /0105	16 /2100 17 /0120	2h 20m - 15m	
TENSION ANCHORS TO 350/400 KIPS				

G. LOST TIME SUMMARY:

	DAYS	HOURS	%
W.O.W.		14h	48m
RIG EQUIPMENT FAILURE			
CRAFT EQUIPMENT FAILURE			
MOORING EQUIPMENT FAILURE			
SURVEY EQUIPMENT FAILURE			
CRAFT PROBLEMS			
W.O. SURVEY VESSEL			
W.O. LOCATION MARKERS			
RE-LAYING ANCHORS			
RE-LAYING BACK UPS			
OTHERS - Chasing, recovering & refurbishing nos. 1, 7 and 8 anchors		18h	15m

REMARKS

G. BREAKDOWN LOST TIME SUMMARY

<u>RETRIEVING:</u>	<u>DAYS/HOURS</u>	<u>REMARKS</u>
W.O.W.	14h 48m	WOW: 15 / 1013 - 16 / 017
RIG EQUIPMENT FAILURE		
CRAFT EQUIPMENT FAILURE		
MOORING EQUIPMENT FAILURE		
CRAFT PROBLEMS (NON TECHN.)		
CHASING NOS. 2, 7 & 8 ANCHOR PLUS } PENNANT RECOVERY & REFURBISHMENT. }	13h 08m	
SUB TOTAL:	27h 56m	
 <u>UNDER TOW:</u>		
W.O.W.		
RIG EQUIPMENT FAILURE		
CRAFT EQUIPMENT FAILURE		
SURVEY EQUIPMENT FAILURE		
W.O. SURVEY VESSEL		
W.O. LOCATION MARKERS		
OTHERS		
SUB TOTAL:		
 <u>RUNNING ANCHORS:</u>		
W.O.W.		
RIG EQUIPMENT FAILURE		
CRAFT EQUIPMENT FAILURE		
MOORING EQUIPMENT FAILURE		
CRAFT PROBLEMS (NON TECHN.)		
OTHERS		
SUB TOTAL:		
TOTAL:		

H. TOWING/TOW ARRANGEMENTS

	TOWING VESSELS	BHP	B.P.	CONNECTED	DISCONNECTED
1.	Normand Ranger	8000	90	16 /0330	16 /0910
2.	Active Boy	8100	100	16 /0444	16 /0745
3.					

BUILD UP OF TOWING GEAR AND METHOD OF TOWING:

No. 8 anchor:- 100 ft Anchor chain + 1000 ft x 2½" Pennant Wire - "Active Boy"

No. 1 anchor:- 100 ft Anchor chain + 1000 ft x 2½" Pennant Wire - "Normand Ranger"

TOWING DRAFT:²² FT/ M RIG DECKLOAD: 1277 TONS

CHANGES IN INITIAL TOWING DRAFT (REASON):

RIG ASSISTED PROPULSION: Yes

AVERAGE THROTTLE: 50 %

TYPE AND NUMBER OF THRUSTERS: 2 Kort nozzles

BHP: 2 x 3,500

TOW COMMENCED: 16 /0534

TOW FINISHED: 16 /0718

TOWING DISTANCE: 1 mile

AVERAGE SPEED: N/A

I. SOIL INFORMATION:

	OLD LOCATION	NEW LOCATION
TYPE :	Soft Mud	Sand Clay
GOOD HOLDING :	X	X
FAIR HOLDING :		
POOR HOLDING :		

OLD LOCATION

J. MOORING ASSEMBLY AND TESTS

ANCHOR NO.	WIRE CHAIN LENGTH + SIZE	DISTANCE (FEET)	BEARING (TRUE)	TYPE/WEIGHT ANCHOR	LENGTH/SIZE GROUND WIRE/CHAIN	TYPE/WEIGHT BACK-UPS	PENNANT COMPOS.	TYPE OF BUOY + NO./LETTER	SPRING BUOY	TEST TENSION (K.LBS)
1	3430	4530	315	10 ton Delta Flipper	30' x 3"	N/A	1 x 200 2 x 500 1 x 300	320m x 1" wire to 2 cu m Soft Buoy		375/400
2	3654	4400	358	"	"	"	"	"		"
3	3316	4420	042	"	"	"	"	"		"
4	3910	4230	094	"	"	"	"	"		"
5	5100	4050	133	"	"	"	"	"		"
6	5100	4260	186	"	"	"	"	"		"
7	5101	4480	223	"	"	"	"	"		"
8	5104	3935	260	"	"	"	"	Missing		"

FINAL OR CORRECT POSITION OF ANCHOR BUOYS RELATIVE TO CORNER OF RIG.

NEW LOCATION.

J. MOORING / ASSEMBLY AND TESTS

Total Useable

ANCHOR NO.	CHAIN LENGTH + 12%	DISTANCE (FEET)	BEARING (TRUE)	TYPE/WEIGHT ANCHOR	LENGTH/SIZE GROUND WIRE/CHAIN	TYPE/WEIGHT BACK-UPS	PENNANT COMPOS. 2 1/2"	TYPE OF BUOY + NO./LEFTER	SPRING BUOY	TEST TENSION (K. PS)
1	4000	4240	337	10 ton Delta Flipper	30' x 3"		2 x 500' 1 x 300' 1 x 200'	320m x 28mm wire retrieval system to 2 cum soft buoy	350/400	
2	3975	3975	022	"	"	10 ton Delta Flipper *	"	"	"	"
3	4075	4075	066	"	"	"	"	"	"	"
4	4400	4400	111	"	"	"	"	Missing	"	"
5	4110	4110	157	"	"	"	"	320m x 28mm wire retrieval system to 2 cum soft buoy	"	"
6	4200	4200	202	"	"	"	"	"	"	"
7	4250	4250	248	"	"	"	"	"	"	"
8	4270	4270	293	"	"	"	"	"	"	"

* Lay down pennants - 3 x 500' x 2 1/2"

FINAL OBSERVED POSITION OF ANCHOR BUOYS RELATIVE TO CORNER OF RIG.

M. RETRIEVED. MAIN ANCHORS

ANCHOR NO.	VESSEL.	VESSEL CALLED	BUOYS/ CHASER ON BOARD	ANCHOR OFF BOTTOM	RIG START HEAVING	ANCHOR RACKED	PENNANTS HANDED TO RIG	TOTAL TIME	LOST TIME	REMARKS EVENT + TIME
1	Normand Ranger	16/0100	16/0120	16/0210	16/0210	16/0336	Normand Ranger	Towing on 100 ft chain with 100 ft		
X							of chain deployed.			
2	Normand Ranger	14/2317	15/0022	15/0552	15/0700	15/1012	15/1012	10 55	7 45	See Page 4 re. lost time.
X										
3	Active Boy	14/2317	14/2345	15/0048	15/0048	15/0215	15/0215	2 58	-	
X										
4	RIP			16/0534	16/0414			1 20		
X										
5	Sirra Giant	16/0100	16/0107	16/0214	16/0214	16/0335	16/0335	2 35		
X										
6	Active Boy	15/0215	15/0250	15/0325	15/0345	15/0507	15/0507	2 52		
X										
7	Sirra Giant	14/2200	Chaser on chain 14/2107	14/2338	15/0130	15/0250	15/0254	4 54	2 08	See Page 4 re. lost time.
X						ANCHOR on bottom	Buoy in water			
8	Sirra Giant	15/0254	Chaser on chain 15/0320	15/0445		15/0815	15/0930	6 36	3 15	See Page 4 re. lost time.
X										
9	Active Boy	16/0220	16/0240	16/0335	16/0335	16/0444	'Active Boy	towing on No. 4 chain with 100 ft		
X							of chain	deployed.		

N. LOG OF TOW

DATE	TIME	CO-ORDINATES	SPEED	DRAFT	DISTANCE COVERED	DISTANCE TO GO
		N / A				

REMARKS:

P. RUNNING BACK-UP ANCHORS (PIGGY BACKS)

A:- 2 x 500' x 1/2"
 1 x 300' x 1/2"
 1 x 200' x 1/2"

B:- 3 x 500' x 1/2" + 320m x 28mm -
 pennant wire retrieval system.

ANCHOR NO.	VESSEL	PIGGY BACK ON BOARD	BUOY ON BOARD/ START	P.B. ON BOTTOM	BUOY IN WATER	COMPOSITION OF PENNANTS	TOTAL TIME	LOST TIME	REMARKS
2	Normand Ranger	16 /2200	16 /2400	17 /0105	17 /0130	A: Anchor/Anchor B: Anchor/Buoy/3h	3h 30m		
TOTAL							3h 30m		

Q. RELAYING MAIN AND/OR BACK-UP ANCHORS

ANCHOR NO.	VESSEL	MAIN ANCHOR		BACK-UP ANCHOR		DELAYS	REMARKS
		FROM	TO	FROM	TO		
				N / A			
			TOTAL.		TOTAL.		

R. LOG OF CRAFT UTILISATION

RETRIEVING ANCHORS

VESSEL	NO. OF ANCHORS
1. Active Boy	3
2. Sirra Giant	3 (No. 8 anchor chased out refurbished & reset.)
3. Normand Ranger	2
4. Rig	1

RUNNING ANCHORS

VESSEL	NO. OF ANCHORS
1. Active Boy	3
2. Sirra Giant	2
3. Normand Ranger	2 + 1 back-up
4. Rig	1

VESSEL PERFORMANCE

The handling of the vessel's and efficiency of their crews was of a high standard throughout the rig move.

S. COMMENTS ON RIG MOVE

A high standard of co-operation and understanding between all involved personnel existed throughout the duration of the rig move.

Although a strong NE'ly set was experienced when running into location, no great difficulty was experienced with setting the bow and stern anchors. Once the rigs position relative to the wellhead had been ascertained, the four bear anchors were quickly deployed.

SUGGESTED IMPROVEMENTS/SOLUTIONS

In order to recover anchors where the pennant recovery wire has parted or the surface buoy is missing, it is necessary to utilise a number of pennant wires to provide the anchor handling vessels with a chasing wire of adequate length. This requirement should be kept in mind when ordering the equipment for a forthcoming move.

Additionally, it is recommended that a complete set of made-up pennant retrieval moorings be supplied for the next move of the "Borgny Dolphin", with the existing retrieval systems returned to Tananger for inspection and refurbishment as necessary. A growing number of welding repairs are being found necessary on the existing systems, causing delay due to the difficulty of carrying out this work on the open deck of an anchor handling vessel at sea on a short move.

A separate Note has been addressed to Norske Shell on the above subject.

3. OPERATIONS REPORT

(Note that all depths are BDF BORGNY DOLPHIN)

The last anchor was pulled on location 31/2-13 at 05:30 hrs 16.03.84, and Borgny Dolphin was towed to location 31/2-5 for re-entry of the well suspended July 1981. The last anchor was layed out on the location at 12:50 hours on 16.03.84. The final position of the rig was:

N 60⁰ 46' 16.20"
E 03⁰ 25' 53.46"

Divers were jumped and the protective caps were removed from the top of the high pressure corrosion cap (H-4 connector) and the primary hydraulic control connectors. Guide wires were installed in the guide posts. An unsuccessful attempt was made to connect the hydraulic control hoses, due to the connectors being too big. The retrieving tool was run and an attempt was made to engage the corrosion cap tool. The tool showed signs of wear on the upset and was therefore reduced in size, then run again without success due to it hanging up in the funnel on top of the corrosion cap. An attempt was made with divers to attach the control hoses using an alternative fitting. This was again unsuccessful as the coupling was too small.

A 6 1/2" OD bitsub was run on the drillstring in an attempt to operate the pressure equalising valve in the corrosion cap, and 40.000 lbs weight were set down on the valve, but no signs of pressure escape were observed. An attempt to attach a 9 5/8" casing elevator below the funnel was then made without success due to excessive rig heave.

The divers were then again jumped with different hydraulic connectors which this time were successfully connected to the male connector on the corrosion cap. 2000 psi was applied to the primary release function to release the corrosion cap. However, the H-4 connector did not release and it was assumed that the needle valves installed on the male hydraulic connectors on the corrosion cap were closed. An attempt was then made to open these needle valves without success.

The primary lock port connector was then backed out from the H-4 connector and a further attempt made to open the valve on the primary release port connector. Only 3/4 of a turn was possible in either direction so an extension arm was made and extra torque applied to open the valve. The stem then sheared off the valve. The complete primary release connector was then backed out and retrieved. The valve was found to be in the open position. A replacement primary release connector was then screwed in the corrosion cap and 2500 psi applied to open the H-4 connector. This time the release mechanism operated and the corrosion cap was retrieved with a 9 5/8" single joint casing elevator around the base of the funnel.

The BOP stack was run and successfully pressure tested before Schlumberger was rigged up and ran HRT/CCL to a hold up depth of 1261 m.

A 8 1/2" bit was run and the marine riser displaced to a 1.15 SC CaCl₂ unfiltered brine with bit at seabed, and the string was lowered further and top of cement located at 1261 m. The casing was successfully pressure tested to 3500 psi and the cement plug from 1261-1450 m drilled out with a maximum total gas reading of 30% at the bottom of the plug. The string was lowered further and gravel sand

located at 1520 m and the hole was circulated and conditioned with 1.15 SG CaCl₂ brine before the string was pulled.

A bit and scraper run was made down to 1450 m before the Model "C-1" retrievable bridge plug at 1526 m was pulled free and recovered with a Model "H" retrieving tool. A Model "S" retrieving tool was run and the SC-1 packer plug in the SC-1 gravel pack packer was recovered without problems. The SC-1 packer retrieving tool was then run, and the packer with the gravel pack assembly down to the shear joint was pulled free with 40,000 lbs overpull.

Circulation was established and a max gas reading of 20% was recorded. As a slug was pumped, the pressure built up and it was impossible to circulate, however; the reverse circulation was still possible. To avoid swabbing, the string was pulled in singles in the beginning and then in stands, observing the volumes very closely. Recovering the fish, showed that the rubber on the packer had swollen to 8 3/4" OD.

A washover string was run and the gravel pack assembly was washed over from 1565-1593 m, and the hole cleaned out with a viscous pill. The rest of the gravel pack assembly was subsequently recovered with a spiral grapple. The bridge plug at 1593 m was milled and pushed down to 1664 m before a bit and scraper run was made to the same depth and the hole cleaned out with a viscous pill.

An injectivity test was made through the perforations at 1582-1588 m with the RTTS packer set at 1347 m and the bottom tail pipe at 1600 m, resulting in an injection rate of +/- 2 BPM. A cement plug was set from 1600 - 1400 m, and 2 bbls slurry was squeezed away to the formation with 1000 psi surface pressure. When the surface samples were hard the pressure was bled off and the string pulled. The cement plug was drilled out down to 1567 m and the casing successfully tested to 3500 psi, before the rest of the cement plug was drilled out. At this stage the perforations were tested to 1500 psi with the total hole volume pressurized. A scraper assembly was subsequently run in hole to 1664 m and the hole circulated clean.

The RTTS packer was re-run and set at 1560 m, and a second pressure test to 1500 psi on the perforations was successful. An inflow test was carried out on the squeezed off perforations with diesel in the string giving 400 psi drawdown. No pressure build-up was observed.

After retrieving the wearbushing with difficulty, because the annular preventer had not retracted fully, the BOP test tool was run and a successful BOP test carried out.

The drillcollars and the 3 1/2" plastic coated drillpipe to be used for the later gravel pack job were run and the hole circulated to sea water. After several hours of sea water circulation, a viscous pill was spotted across the perforations, the string pulled above the perforations and 48 bbls of 7 1/2% HCL acid circulated around. The string was lowered back to bottom and the measured solids level decreased to 13 NTU after a total of 30 hours circulating with sea water.

The hole was then displaced to 1.15 SG brine which was filtered to an irreducible solids level of +/- 5 NTU after 10 hours. Schlumberger ran a gauge ring and set a Model 'D' sump packer at 1600 m. The 4 1/2" tubing riser was then run and spaced out with the fluted hanger landed off in the wearbushing, pulled and set back in the derrick.

The tubing conveyed perforating assembly and 3 1/2" tubing were run and spaced out with the aid of a multi-acting indicating collet stabbed into the sump packer. The string was landed off on the 4 1/2" tubing riser with gun positioned from 1591-1594 m. Schlumberger ran a slimhole GR/CCL for final depth correlation and confirmed the gun to be on depth. The flowhead was installed and brine circulated to clean possible fill on top of the glass disc, the "FH" packer set and the tubing and sump successfully pressure tested. The string was displaced to diesel through the SSD to give 250 psi drawdown on the formation.

The detonating bar was run on wireline and the well perforated from 1591-1594 m at 19:04 hrs on 3rd April 1984. 20 bbls were backsurged through open choke before the flow was beaned down. After a total production of 24 bbls, the well died and a plug was set in the XN-nipple and the SSD opened with difficulty. The string volume was reversed out then displaced to diesel before the SSD was shut. In an attempt to pull the wireline plug from the XN-nipple, 6 m of formation sand fill was found on top of the plug. A total of 67 sand bailing runs were necessary to gain access to the wireline plug, after which the plug was retrieved. The well was re-opened and a flowrate of +/- 270 bbls/day at 315 psi on a 16/64" choke was established decreasing to approximately 60 bbls/day at 70 psi on a 20/64" choke after 8 hours flow. The well was killed by bullheading a viscous chalk/brine pill followed with 1.15 SC CaCl₂ brine, and conditioned through the SSARV valve.

Having pulled the perforating string, Schlumberger logged CCL/GR (run no. 2), recording a hold-up depth at 1658 m, (3 m sand fill in the sump below the model 'D' packer).

A gravel pack assembly was run on 3 1/2" drill pipe and the Baker SC-1 packer set at 1545.5 m with gravel pack screens from 1588 to 1599 m. The gravel pack job was carried out successfully, and the drill pipe with gravel pack work string pulled.

The production string was then run. Initial space out of the string was performed with 3 1/2" drill pipe after which the complete production string was landed off (string consisting of 350 m 4 1/2" TBG to seabed and 1160 m of 3 1/2" TBG to 1510 m with a 75 m long subassembly, bringing the mule shoe to 1590 m, i.e. just above the perforations).

The well was opened with an initial THP of 340 psi with 230 bbls/day production. The well died three time and had to be brought alive again with diesel. To stabilise the gravel pack, the well was flowed for 6 hours at each rate as follows:

CHOKE 1/64"	GROSS RATE (BBL/D)	THP (psig)	GOR (SCF/BBL)	BSW (%)	DURATION HOURS
24	1000	400	390	48	6
32	2000	420	300	35	6

The well was shut in and pressure gauges run and landed in the 'F'-nipple. To investigate the water coning effect and the dehydration behaviour of the reservoir fluid the well was flowed as follows:

CHOKE 1/64"	GROSS RATE (BBL/D)	THP (psig)	GOR (SCF/BBL)	BSW (%)	DURATION HOURS
24	1000	472	300	30	9
32	2000	466	350	28	6
56	4000	323	335	25	6
112	5200	181	350	20	36
32	2000	482	340	18	12
112	5200	178	365	19	3

The well was shut in downhole at the PCT valve for a 2 hour build-up period.

While flowing at the maximum rate with a BSW of 20%, severe difficulty was encountered in obtaining separation through the test separator. Consequently, the separator water outlet was closed and discharge taken only from the oil outlet. In order to observe whether separation was possible at this rate the separator temperature was then raised to 100°F and 700 ppm demulsifier added. Even under these conditions there was still 20% oil in the water outlet and 15% water in the oil outlet.

The pressure gauges were retrieved and three bottom hole samples taken while flowing the well at 2000 bbls/day. The samples were then pulled while still flowing the well and gradient stops made at 1000 m, 410 m and in the lubricator in order to determine the pressure and temperature profile in the well while flowing.

A 25 bbls 15% HCl acid job was carried out allowing the acid to soak for 2 hours. The well was opened gradually to 32/64" choke size and cleaned up for 5 hours at 2000 bbls/day before it was shut in and pressure gauges run and landed in the F nipple. The well was re-opened and beamed up in stages to the maximum rate:

CHOKE 1/64"	GROSS RATE (BBL/D)	THP (psig)	GOR (SCF/BBL)	BSW (%)	DURATION HOURS
32	2100	500	330	20	2
56	4450	375	350	25	2
128	6050	205	205	22	6

After flowing for 6 hours at maximum rate the well was shut in at the PCT for 2 hours build up. The pressure gauges were pulled and a wireline sand bailer run to locate hold up depth in the sump below the model 'D' packer. The sand bailer hung up in the 'O' ring seal sub in the gravel pack liner probably due to obstructions from the shattered flapper valve.

The well was killed by bullheading a 25 bbls viscous chalk/brine pill displaced with brine. The SSARV was opened and the tubing contents reversed out. The hole was then circulated normally with brine and the seal assembly pulled out of the packer and bottoms up circulated before the production string was pulled.

To evaluate the gravel pack, Schlumberger logged:

GR/CNL (Run No. 1)

From the Schlumberger log it was possible to see the top of the gravel pack at 1573.5 m (18.5 m above top perforation).

Abandonment started with cement plug no. 5 being set from 1596-1400 m and an unsuccessful attempt was made to squeeze away cement into the perforations with 2000 psi. Top of cement was located at 1393 m and pressure tested to 2000 psi. Baker model N-1 bridge plugs were set on Schlumberger wireline in 9 5/8" casing at 1345 m and 850 m.

The 9 5/8" casing was perforated under pressure control at 800 m and 380 m with 4 spf and the integrity of the 9 5/8" x 13 3/8" annulus pressure tested to 1200 psi. The casing was cut at 799 m and 34 joints of 9 5/8" casing retrieved. Abandonment cement plug no. 6 was set from 850-700 m. The cement was located at 706 m and pressure tested to 1500 psi. The 13 3/8" casing was perforated at 380 m under pressure control and the integrity of the 13 3/8" x 20" annulus pressure tested to 1200 psi. The 13 3/8" casing was cut at 471 m and 9 joints of casing retrieved.

Abandonment cement plug no. 7 was then set from 600-400 m, the plug was located at 400 m, and pressure tested to 1200 psi.

The BOP stack and marine riser were pulled and the explosive casing cutter run on the sand line to cut the 20" and 30" casings at 361 m. The permanent and temporary guide bases were recovered using an H-4 connector.

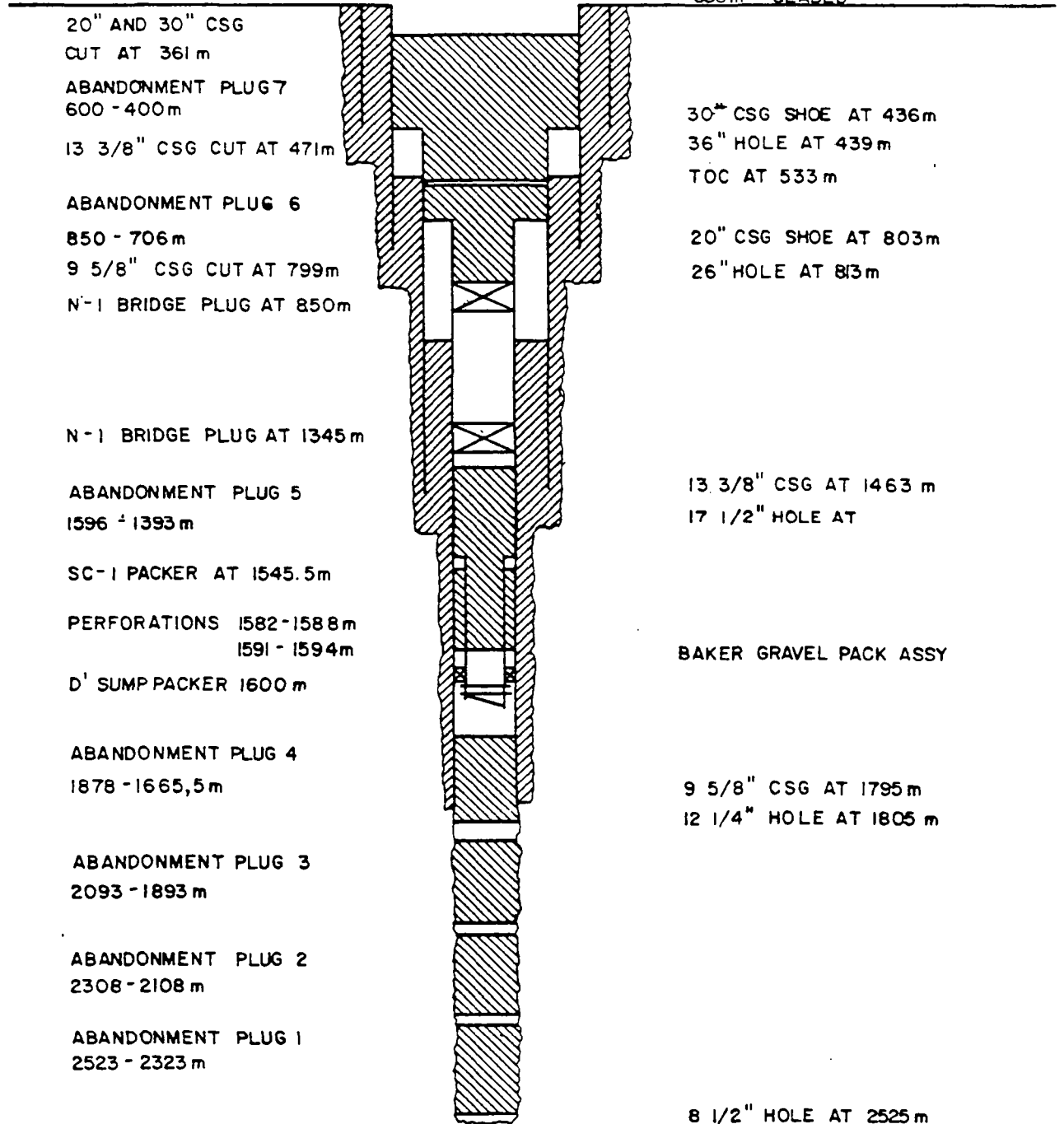
The divers made a seabed survey around the well head area, the rig was deballasted and the anchors pulled. The last anchor was pulled at 20:00 hours on 22 April 1984 and the rig was towed from location 31/2-5 to location 31/2-0.

ABANDONMENT STATUS DIAGRAM 31/2-5

0m DERRICK FLOOR BORGNY DOLPHIN

25m MEAN SEA LEVEL

358m SEABED



30" CSG SHOE AT 436m
36" HOLE AT 439m
TOC AT 533m

20" CSG SHOE AT 803m
26" HOLE AT 813m

13 3/8" CSG AT 1463 m
17 1/2" HOLE AT

BAKER GRAVEL PACK ASSY

9 5/8" CSG AT 1795m
12 1/4" HOLE AT 1805 m

8 1/2" HOLE AT 2525 m


A/S Norske Shell	
EXPLORATION & PRODUCTION FORUS	
WELL 31/2-5 RE-ENTRY	
ABANDONMENT STATUS	
DIAGRAM	
AUTHOR EPPP/11	FIG. DATE OCT. 84
REPORT NO NSEP220	3.1 DRAW NO G1677/5

TIME ALLOCATION 31/2-5

On tow to well 31/2-5 at 05.30 hrs, 16.03.84 for testing. The well was permanently abandoned at 20:00 hrs 22.04.84.

PHASE	ITEM	MARCH	APRIL	TOTAL HRS	%
PREPARATION	- Towing	2		2	0.22
	- Laying/ pulling anchors	14.5		14.5	1.61
	- General preparation/re-entering wellhead	118.5		118.5	13.13
	- Running riser/ BOP stack, testing	32.5		32.5	3.60
	<u>Sub total</u>			<u>167.5</u>	<u>18.56</u>
WORKOVER	- Remove plugs/ gravel pack/ bridge plugs	136.5		136.5	15.12
	<u>Sub total</u>			<u>136.5</u>	<u>15.12</u>
EVALUATION	- Logging	2.5	7	9.5	1.05
	<u>Sub total</u>			<u>9.5</u>	<u>1.05</u>
TESTING	- Condition hole for tubing	32.5	10.5	43	4.76
	- Running/ pulling tubing/DP/GP	16.5	80	96.5	10.69
	- Rigging up surface eqp etc.	1.5	10.5	12	1.33
	- Circulation/ observing well	4	22	26	2.88
	- Bullhead/ gravel packing		8	8	0.89
	- Testing BOP's etc.	17.5	20.5	38	4.2
	- Schlumberger wireline		4.5	4.5	0.50
	- Flopetrol wireline		94	94	10.42
	- Flowing well		118.5	118.5	13.13
	- Pressure build ups		4.5	4.5	0.50
	- Back surge operation		2	2	0.22
	- Abandonment test zones		5	5	0.55
	- WOW/ repair		5	5	0.55
<u>Sub total</u>			<u>457</u>	<u>50.64</u>	
ABANDONMENT	- Plugging back & WOC		50.5	50.5	5.60
	- Cutting/ retrieving casing		57.5	57.5	6.37
	- Pulling riser/ BOP stack		8.5	8.5	0.94
	- Preparing for move		6.5	6.5	0.72
	- Anchor handling		9	9	1.00
<u>Sub total</u>			<u>132</u>	<u>14.63</u>	
TOTAL HOURS				902.5	100 %

Total time on location 37 days and 14.5 hrs.

A/S Norske Shell		
EXPLORATION & PRODUCTION FORUS		
WELL 31/2-5 RE-ENTRY		
TIME ALLOCATION		
AUTHOR EPPP/II	FIG. 3.2	DATE OCT. '84
REPORT NO NSEP220	DRAW NO 81677/8	

4. WELL TESTING REPORT

Summary

A 3 m interval directly above the oil-water contact (1566-1569 mss) was tested. The well produced up to 6300 b/d liquid, including 21% water. The test confirms the validity of the mobility parameters used for development studies (viz. relative water permeability = 0.15 at residual oil saturation).

Introduction

The suspended well 31/2-5 was re-entered during April 1984 to effect a short production test prior to final abandonment. The test was conducted to evaluate water mobility in the aquifer zone underlying the oil column.

The gravel-pack completion of the 1981 test was recovered, the original perforations squeezed off and a new gravel pack installed over a 3 m section immediately above the oil-water contact (1566-1569 mss). The oil column in well 31/2-5 is encountered in uniform high quality sand (10 D). These highly permeable sands extend across the oil-water contact.

The sands directly below the oil-water contact contain residual oil ($S_o = 20\%$) down to at least 1594 m ss.

Test History

After clean-up and running gauges (2 SDP's, 1 Amerada), the well was opened up. During three days, the well was tested at six stable liquid rates. This period was concluded with two hours shut-in to obtain pressure build-up (PBU) data.

The gauges were pulled and inspected. The gauges had functioned well, but the SDP gauge programmed to register the PBU had run out before shut-in. Reason was the extension of the originally planned flow period to have a stable water cut and to check rate independence of the water cut.

After one day spent on bottom hole sampling, acidising and cleaning up, the well was opened again, with three gauges in the hole (2 SDP's and 1 Amerada). The well was tested at three stable liquid rates, and shut in for a 2 hour PBU. The gauges had functioned well again, and the PBU had been registered with 10 second interval time.

Liquid rates and pressure statistics of the test can be found in Figs. 4.1 and 4.5.

Test Analysis

i) Water/Oil Mobility

Over a period of six days, the well was produced at gross liquid rates varying between 1000 and 6000 b/d. The watercut decreased in two days from high initial values ($> 40\%$) to a stable value of 20%, independent of the liquid rate.

Quantitatively, the high initial water cut can be explained by production of fluids lost into the formation (some 80 bbls) and of water in the oil-water transition zone. Later, the water cut stabilises to a value determined by the relative mobilities of oil and water, independent of the production rate. The gravitational forces are negligible in this case, due to the proximity of the completion to the oil-water contact.

The watercut behaviour was quantitatively analysed with a numerical simulation model. Salient features of the model that gave a good match of the test data (see fig. 4.2) are:

- water relative permeability = 0.15 at residual oil saturation = 0.25
- no tight (calcareous) layers
- 25 m residual oil below free water level
- a 3 m oil-water transition zone defined by petrophysical evaluation

ii) Pressure Build-up Analysis

The pressure build-up after the pre-acid flow period was sampled at 30 second intervals, after the post-acid flow period at 10 second intervals. No (Gringarten) log-log type curve match could be obtained in either case. A Horner plot of the data shows a horizontal straight line with a slope of 1 psi/cycle or less.

Lower bounds on skin ($S > 20$) and permeability - thickness ($kh > 200 D$ ft) can be deduced from these observations. More precise values for these parameters will be deduced in the next section.

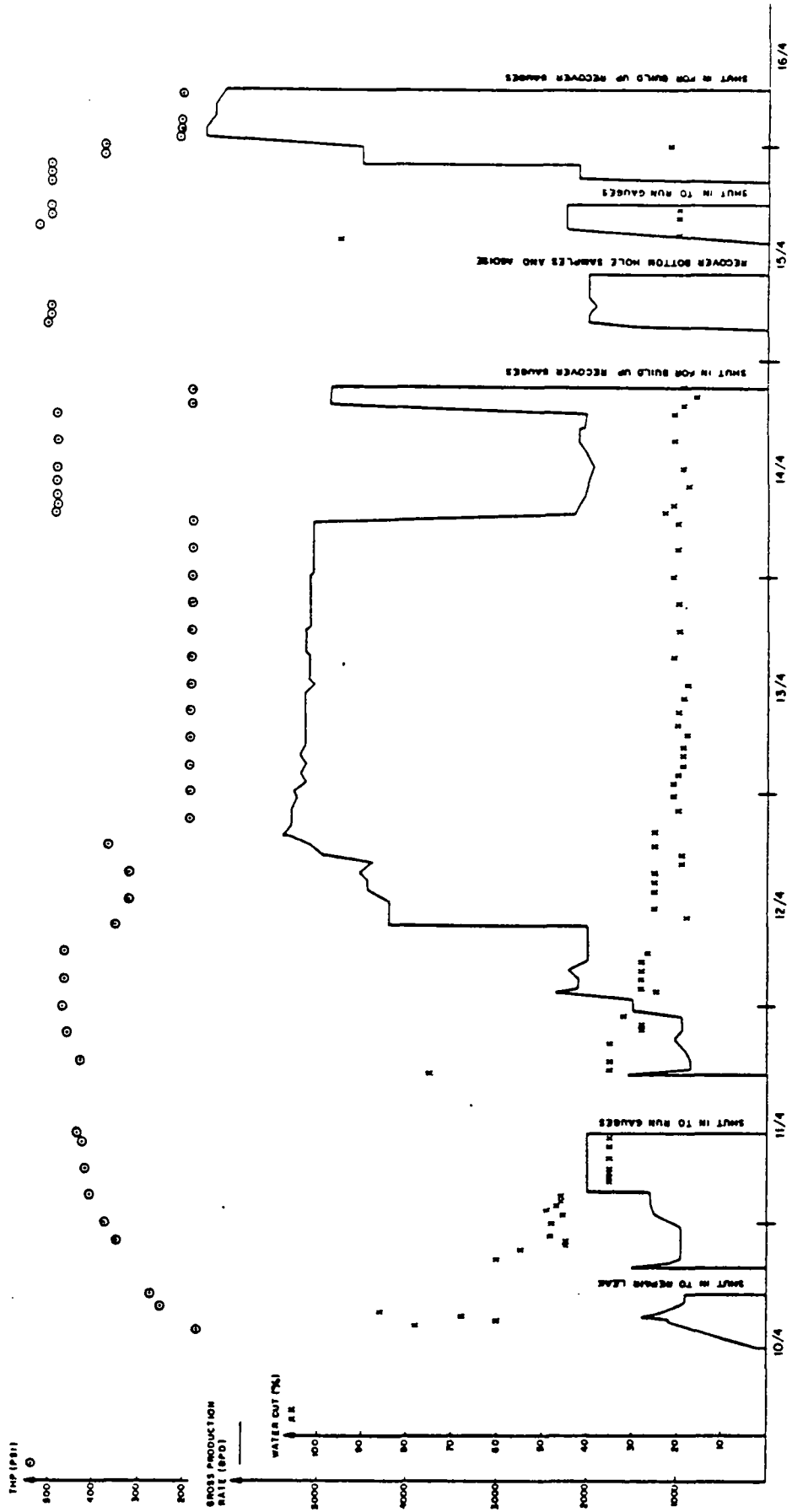
iii) Drawdown Analysis, Productivity Indices

Before the acid job the gross productivity index (PI) varied between 8 and 13 b/d/psi, after the acid job between 14 and 18 b/d/psi. In Fig. 4.4 PI^{-1} (liq.) is plotted versus liquid rate. The rate dependence of the PI, significant before the acid job, has almost disappeared after acidising. Turbulent (non-inertial) flow probably caused the rate dependence (cf. 1981 test) due to the short (3 m) completed interval. The Darcy skin calculated from the rate independent part of the PI decreased from 180 before to 140 after the acid job. (Fig. 4.3). The gross productivity index after (before) the acid job was 16 (8) b/d/psi at 5000 b/d liquid; Darcy skin caused 77% (39%) of the drawdown, turbulence 9% (56%), at 5000 b/d. The analysis assumes an average permeability in the 22 m oil column of 10 Darcy, as indicated by core analysis, petrophysical logs and the simulator match of the gas break through during the production test of 31/2-5 in 1981.

Conclusion

The test indicates that the relative permeability at residual oil saturation is about 0.15.

SUMMARY OF TEST DATA WELL 31/2-5 (RE-ENTRY 1984)

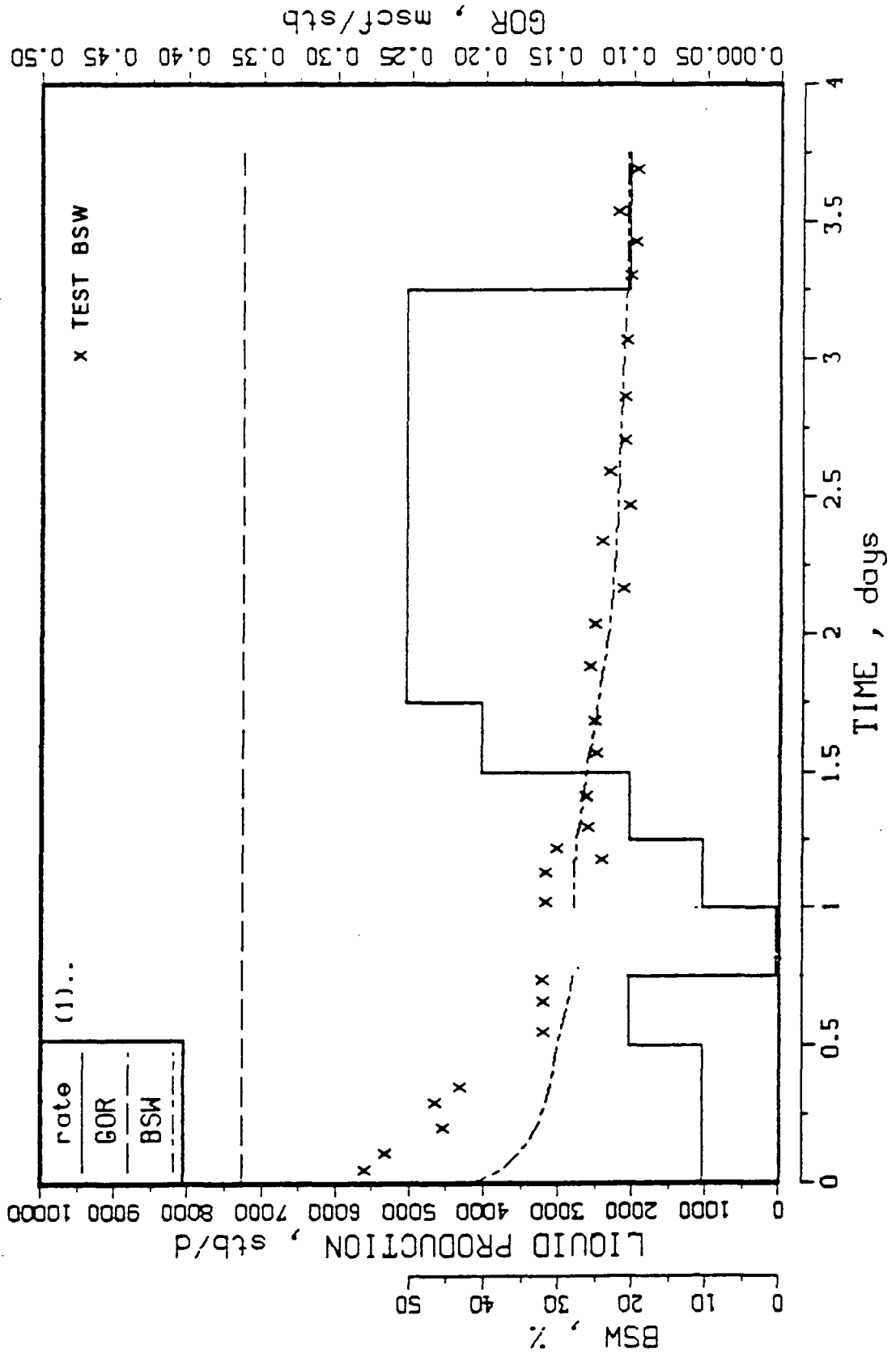


A/S Norske Shell EXPLORATION & PRODUCTION FORUS		
WELL 31/2-5 RE-ENTRY SUMMARY OF TEST DATA		
AUTHOR EPPP/21	FIG. 4.1	DATE OCT. 84
REPORT NO NSEP 220		DRAW NO 81677/7

R.H.

TROLL FIELD 31/2-5 WATERCUT TEST 4-84

BSW MATCH



A/S Norske Shell	
EXPLORATION & PRODUCTION FORUS	
WELL 31/2-5 RE-ENTRY	
WATERCUT TEST	
AUTHOR EPPP/21	FIG. DATE OCT. '84
REPORT NO NSEP220	4.2 DATA NO 91877/B

Calculation of Skin from Productivity Index

Before acid job:

$$PI^{-1} \text{ liq (psi/b/d)} \times 100 = 7.13 + 0.00111 \times q_L \text{ (b/d)}$$

After acid job:

$$PI^{-1} \text{ liq (psi/b/d)} \times 100 = 5.80 + 0.00010 \times q_L \text{ (b/d)}$$

Gross PI at zero rate:

17 (14) b/d/psi after (before) acid job.

Oil PI at zero rate (20% watercut, segregated flow)


20 (16) b/d/psi after (before) acid job.

$$PI_{\text{ideal}} \text{ (oil)} = \frac{7.08 \times 10^{-3} \times k \times h}{u \times Bo \times (\ln re/rw - 3/4 + Spp)} = 133 \text{ b/d/psi,}$$

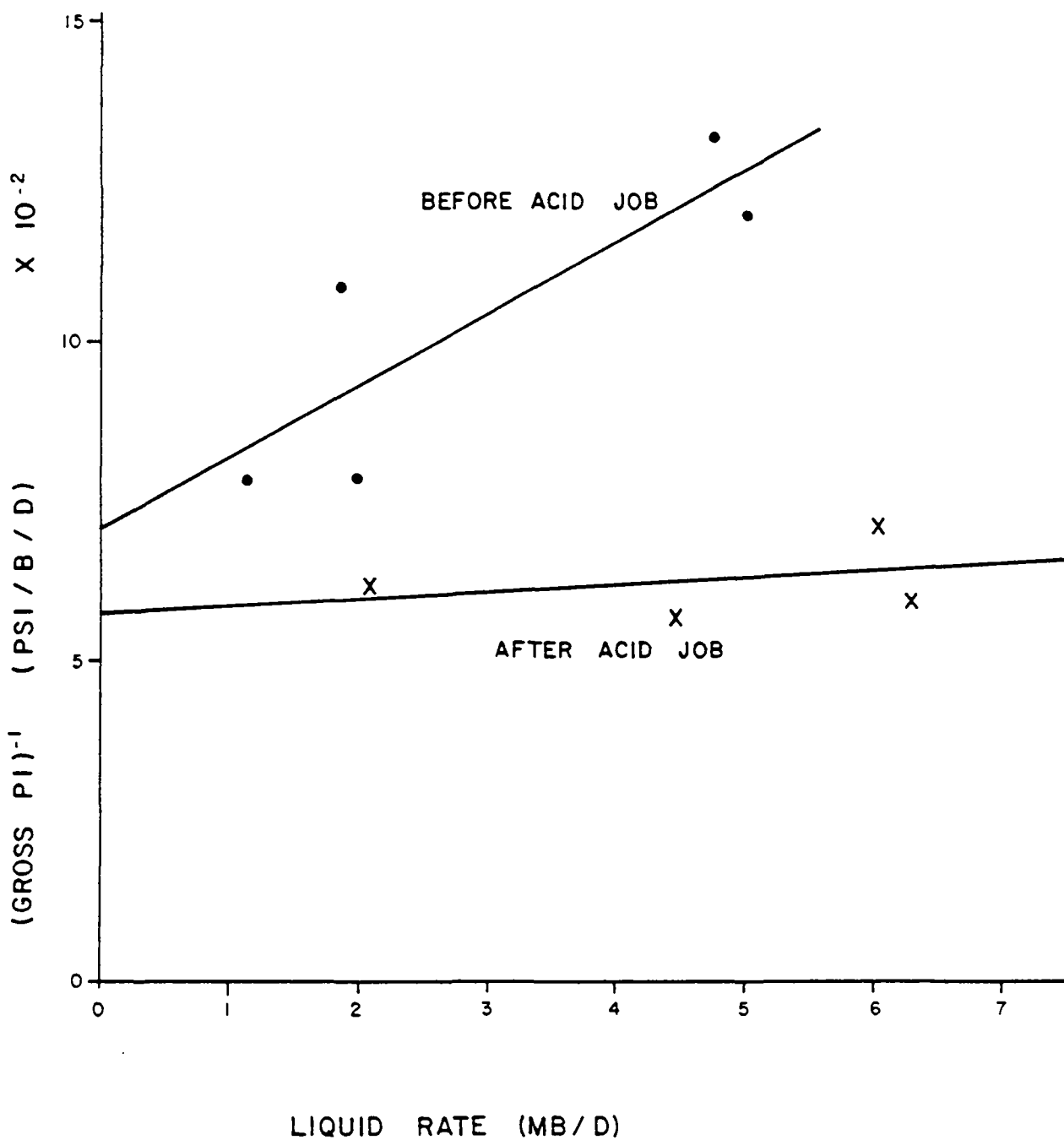
using $k = 10 \text{ D}$, $h = 72 \text{ ft}$, $u = 1.3 \text{ cp}$, $Bo = 1.18 \text{ rb/stb}$,
 $\ln re/rw - 3/4 = 8$, $Spp = 17$.

Darcy skin:

$S_D = 141$ (183) after (before) acid job.

A/S Norske Shell			
EXPLORATION & PRODUCTION FORUS			
WELL 31/2-5 RE-ENTRY			
CALCULATION OF SKIN			
AUTHOR EPPP/21	FIG 4.3	DATE OCT. 84	
REPORT NO NSEP 220		DRAW NO G1677/9	

(PRODUCTIVITY)⁻¹ VS. RATE



A/S Norske Shell		
EXPLORATION & PRODUCTION FORUS		
WELL 31/2-5 RE-ENTRY		
PRODUCTION TEST		
AUTHOR EPPP/21	FIG. 44	DATE OCT '84
REPORT NO NSEP220	44	DRAW NO G1677/10