

# WELLFILE

TESTREPORT 34/10-1

HC/LR/StL  
13.10.78.

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WELL 34/10-1 TESTOPERATIONS,- RESULTS AND ANALYSIS.

1: Introduction.

Well 34/10-1 was spudded June 18, 1978 and abandoned September 8, 1978. The well was drilled to a depth of -2437 m (MSL).

Cores were taken in the Brentformation from 1757 m to 1922.5 m, and one core was taken in the Dunlin-formation (Amundsen member) from 2207.5 m to 2225.5 m (MSL).

RFT's were taken both in the Brent- and the Statfjord-formation. One fluids sample was taken from Brent at a depth of 1871 m and one fluids sample from Statfjord in a depth of 2244.5 m (MSL).

2: Summary of production tests.

DST no. 1:

Perforations : Brentformation -1905 m to -1910 m (MSL) (-1930 m to -1935 m RKB, ref. FDC/CNL) 4" casing gun, 4 shots/foot.

Buffer : Teststring filled with water down to RTTS-circulation valve.

Pressurerecorders in function	Manufac.	No.	Range	Time	On string/wireline
:	Amarada	34947	0-8000psi	72 h.	on string
:	Kuster	8961	0-8000psi	48 h.	on string

Temperature recorders : All temperature recorders malfunctioned.

Production data August 21, 1978 (4.15 - 8.45 a.m.):

Choke : 12.7 mm (32/64")  
Oilrate : 190.8 m<sup>3</sup>/day (1200 STB/D)  
Gasrate : 19708 Nm<sup>3</sup>/day (726·10<sup>3</sup> Scf/D)

GOR : 103.3 Nm<sup>3</sup>/m<sup>3</sup> (605 scf/stb)  
Bottom hole pressure: 135 bar (1995 psia)  
Surface pressure : 29 bar (435 psia)  
Bottom hole temp. : -  
Surface temperature : 21.4°C  
Oildensity : 0.881 g/cc (28.9 °API)  
Gasgravity : 0.632 (air = 1)  
No waterproduction.  
Sandproduction stopped by screen.

Separator samples:

Flopetrol: Oil: 2  
Gas: 2

Statoil : Oil: 1  
Gas: 1

Bottom hole samples:

Failure.

DST no. 2:

Perforations : Brentformation  
-1814 m to -1819 m (MSL)  
(-1839 m to -1844 m RKB ref. FDC/CNL)  
4" casing guns, 4 shots/foot.

Buffer : Teststring filled with water down to RTTS  
circulation valve.

Pressure recorders in function:	<u>Manufac.</u>	<u>No.</u>	<u>Range</u>	<u>Time</u>	<u>On wireline/ On string</u>
	Sperry Sun	349	0-8000psi	42 h.	wireline
	Kuster	9058	0-8000psi	48 h.	on string
	Amarada	34947	0-8000psi	48 h.	wireline

Temperature recorders (in function): Sperry Sun maximum temperature recorder.

Productiondata: August 24. 1978 (5.30 - 9.22 a.m.)

Chokesize : 6.75 mm (17/64")  
Oil rate : 248.5 m<sup>3</sup>/day (1789 STB/D)  
Gas rate : 24906 Nm<sup>3</sup>/day (917·10<sup>3</sup> scf/day)  
GOR : 87.5 Nm<sup>3</sup>/m<sup>3</sup> (512.7 scf/STB)  
Bottomhole pressure: 302 bar (4393 psia)  
Surface pressure : 154 bar (2234 psia)  
Surface temp. : 22.1°C (72°F)  
Bottomhole temp. : 71.7°C (161°F)  
Oil density : 0.879 g/cc (29.4° API)  
Gas gravity : 0.626 (air = 1)  
No water production  
No detectable sand production.

Productiondata: August 24-25. 1978 (9.30 p.m. - 1.35 a.m.)  
(Average of 3 last ratereadings.)

Chokesize : 14.29 mm (36/64")  
Oil rate : 1048 m<sup>3</sup>/day (6600 STB/D)  
Gas rate : 83300 Nm<sup>3</sup>/day (3070·10<sup>3</sup> scf/D)  
GOR : 79.5 Nm<sup>3</sup>/m<sup>3</sup> (465 scf/STB)  
Bottomhole pressure: 290 bar (4208 psia)  
Surface pressure : 116 bar (1680 psia)  
Bottomhole temp. : 71.7°C (161°F)  
Surface temp. : 45.5°C (114°F)  
Oil density : 0.885 g/cc (28.4° API)  
Gas gravity : 0.61 (air = 1)  
No waterproduction  
No detectable sandproduction.

Separator samples:

Flopetrol: Oil: 4  
Gas: 4

Statoil : Oil: 2  
Gas: 2

Bottom hole samples:

Bubblepoint at reservoir conditions.

- 1) 260 bar (3771 psia)
- 2) 246 bar (4571 psia)
- 3) 252 bar (3657 psia)
- 4) 260 bar (3774 psia)

DST no. 3:

Perforations : Brentformation  
-1763 m to -1767 m (MSL)  
(-1788 m to -1792 m RKB, ref. FDC/CNL)  
4" casing gun, 4 shots/foot.

Buffer : Teststring filled with water down to RTTS-  
circulation valve.

Pressurerecorders in function:	<u>Manufac.</u>	<u>No.</u>	<u>Range</u>	<u>Time</u>	<u>On string/ wireline</u>
	Sperry Sun	112	0-8000 psi	42 h	wireline
	Amerada	34947	0-8000 psi	48 h	wireline

Temperaturerecorders: GRC 41679 30-150°C 72 h on string  
Sperry Sun maximum temperature recorder.

Productiondata: August 29. 1978 (3.47 - 7.00 p.m.)

Choke size : 6.75 m (17/64")  
Oil rate : 322 m<sup>3</sup>/day (2032 STB/D)  
Gas rate : 28151 Nm<sup>3</sup>/day (1037·10<sup>3</sup> scf/day)  
GOR : 87.4 Nm<sup>3</sup>/M<sup>3</sup> (510 scf/STB)  
Bottomhole pressure: 299 bar (4339 psia)  
Surface pressure : 154 bar (2332 psia)  
Surface temp. : 23°C (73°F)  
Bottomhole temp. : 69°C (156°F)  
Oil density : 0.882 g/cc (29° API)  
Gas gravity : 0.62 (air = 1)  
No water production  
No sandproduction at this rate.

Separator samples:

Flopetrol: Oil: 2  
Gas: 2

Statoil : Oil: 1  
Gas: 1

Bottom hole samples:

Bubblepoint at reservoir conditions:

- 1) 184 bar (2670 psia)
- 2) 255 bar (3699 psia)

3: SUMMARY OF TESTING ACTIVITIES

Date	Time	Activity
Aug		
19	00.00 - 24.00	Preparations for DST No. 1. Set cementplug at -1926 m (MSL) (1951 m RKB).
	19.30	Perforated from -1905 m to - 1910 m MSL.
20	00.00 - 22.45	RIH with teststring. Two unsuccessful trials to run pressure recorders.
	22.46 - 23.24	Opened the well at 6.35 mm (16/64") choke and changed to 12.7 mm (32/64"). (38 min.) Produced 2.4 m <sup>3</sup> (15 bbl).
	23.24 - 24.00	Closed the well, ran pressurerecorders.
21	00.00 - 01.36	Ran pressurerecorders and set them in xn-nipple.
	01.36 - 03.06	Opened the well at 19.05 mm (48/64") choke. (90 min)
	03.06 - 03.53	Changed to 12.7 mm (32/64") choke. (47 min)
	03.53 - 08.59	Produced to separator at 12.7 mm (32/64") choke. (306 min)
	08.59 - 21.59	Shut the well in at the APR-n valve. (780 min)
	21.59 - 23.27	Ran two BHS to a depth of -1865 m (MSL). (28 min)
	23.27 - 24.00	Opened APR-n valve and produced at 3.18 mm (8/64") choke. FWHP declined from 127 bar (1850 psia). Very low flow rate. Changed choke to 1.58 mm (4/64").
22	00.00 - 00.09	Continued to produce at 1.58 mm (4/64") choke (9 min) with declining WHP down to 74.8 bar (1085 psi).
	00.09 - 00.15	Changed to 6.35 mm (16/64") choke and WHP (6 min) declined to 65.5 bar (950 psi).
	00.15 - 00.36	Changed to 3.175 mm (8/64") choke. WHP declined (21 min) to 59.6 bar (865 psi).
	00.36 - 00.48	Changed to 6.35 mm (16/64") choke and WHP (12 min) declined to 33.4 bar (485 bar).
	00.48 - 01.57	WHP increased suddenly up to 103 bar (169 min) (1495 psi).
	01.57 - 24.00	Well shut-in at surface. Unable to pull BHS. Pulled teststring. 2 Sperry- Sun pressure recorders lost in the hole.

Date	Time	Activity
		RIH with drillpipe and tagged sand at -1901 m (MSL).
23	00.00 - 24.00	Finished DST no. 1. Preparations for DST no. 2. Set cementplug at -1902 m (MSL). Perforated from -1814 m to -1819 m (MSL). RIH with teststring.
24	00.00 - 01.22	Ran pressure recorders on wireline.
	01.22 - 01.34 (12 min)	Opened the well at 1.59 mm (4/64") choke and changed gradually to 7.94 mm (20/64"). Total production 0.8 m <sup>3</sup> (15 bbl).
	01.34 - 02.46 (72 min)	Well shut-in at APR-n valve.
	02.46 - 03.41 (55 min)	Opened the well and produced at 6.45 mm (16/64") choke.
	03.41 - 04.38 (57 min)	Changed chokesize in order to clean up chokes.
	04.38 - 05.30 (52 min)	Produced the well at 6.75 mm (17/64") choke.
	05.30 - 09.27 (237 min)	Produced to separator at 6.75 mm (17/64") choke. WHP 160.6 bar (2330 psi).
	09.27 - 09.45 (18 min)	Produced to tank with chokesize 1.98 mm (5/64").
	09.45 - 13.27	Ran two BHS to -1514 m (MSL) and produced at 2.38 mm (6/64") choke. Pulled the BHS.
	13.27 - 16.58	Ran two BHS to -1574 m(MSL) and produced at 2.38 mm (6/64") choke. Pulled the BHS.
	16.58 - 17.47 (49 min)	Opened the well at 6.75 (17/64") choke. Increased the choke to 14.29 mm (36/64").
	Opened well two times.	Got serious problems with plugging of metal-debris both in the chokes and burners. The pressure on the lines from chokemanifold to the burners was in excess of test pressure.
	17.47 - 20.53 (186 min)	Well shut-in. Cleaned the chokes and burners.
	20.53 - 21.30 (37 min)	Produced the well through 14.29 mm (36/64") choke.
	21.30 - 24.00 (150 min)	Opened to separators. Still problems with plugging especially at the burners.



Date	Time	Activity
25	00.00 - 00.33 (33 min)	Produced to separator.
	00.33 - 01.35 (62 min)	Produced to separator, with both burners active. The pressure at the separator and downstream Choke manifold declined and stabilized.
	01.35	Changed to one burner. The pressure between the chokes and the burner exceeded the test-pressure and the well was shut in.
	01.36 - 24.00	Teststring was pulled. RIH w/drillpipe to tag cementplug. No sand was encountered. Finished DST no. 2.
26	00.00 - 24.00	Set cementplug at -1810 m(MSL). Preparation for DST no. 3. Perforated from -1763 m to -1767 m (MSL). RIH with teststring. Leakage. Pulled test-string.
27	00.00 - 24.00	RIH with teststring.
28	00.00 - 24.00	Ran pressure recorders. APR-n valve did not open. Pulled teststring. Changed APR-n valve. RIH with teststring.
29	00.00 - 11.06	Ran teststring. Set pressure recorders in xn-nipple.
	11.06 - 11.15 (9 min)	Opened well at 1.59 mm (4/64") choke and increased gradually to 7.94 mm (20/64"). Total Production 0.5 m <sup>3</sup> (3 bbl).
	11.15 - 12.15 (60 min)	Shut-in well at APR-n valve.
	12.15 - 14.04 (109 min)	Opened the well at 4.76 mm (12/64") choke. Changed choke gradually to 7.94 mm (20/64") choke. Problem with plugging and changed to 6.75 (17/64") choke. Plugging was caused by metal debris.
	14.04 - 14.52 (48 min)	Shut-in the well at surface. Cleaned the chokes for metal debris.
	14.52 - 15.47 (55 min)	Opened the well at 6.35 mm (16/64") choke. Increased chokesize gradually to 15.88 mm (40/64") and then decreased to 6.75 mm (17/64") choke. No more problems with metaldebris.

Date	Time	Activity
29	15.47 - 19.00 (193 min)	Produced to separator at 6.75 mm (17/64") choke. WHP = 156.5 bar (2270 psi).
	19.00 - 19.44 (44 min)	Changed choke gradually to 2.38 mm (6/64") choke.
	19.44 - 23.48	Ran two BHS. Produced at 2.38 mm (6/64") choke. Pulled BHS.
	23.48 - 24.00 (12 min)	Opened well at 12.7 mm (32/64") choke. Changed gradually to 17.46 mm (44/64"). Valves partially plugged with sand.
30	00.00 - 00.40 (40 min)	Decreased chokesize gradually to 4.76 mm (12/64"), but the pressure decreased at surface as the variable choke was eroded.
	00.40 - 01.48 (68 min)	Changed to fixed choke at 6.75 mm (17/64"). WHP stabilized and the sand gradually disappeared.
	01.48 - 03.48	Well shut-in at surface.
	03.48 - 24.00	Pulled teststring. Finished DST no. 3.

4. Teststrings for the different tests

Description	ID inch	OD inch	DST nr. 1		DST nr. 2		DST nr. 3	
			Length	Depth	Length	Depth	Length	Depth
			m	mRKB	m	mRKB	m	mRKB
Otis surface tree above RKB			4.55	+ 4.55	4.55	+ 4.55	4.55	+ 4.55
Tubing	2.75	3.50	8.04	8.04	12.59	8.04	12.59	8.04
Otis labricator	2.88		2.00	10.04	2.00	10.04	2.00	10.04
Tubing	2.75	3.50	144.98	155.02	144.98	155.02	144.98	155.02
Otis SSTT	2.88		4.98	160.00	4.98	160.00	4.98	160.00
X-over etc	2.60		0.37	160.37	0.20	160.20	0.20	160.20
Drill-pipe	2.60	3.50	1512.35	1672.72	1422.29	1582.49	1370.17	1530.37
Slip joint (open)	2.25	5.00	5.53	1678.25	5.53	1588.02	5.53	1535.90
Slip joint (closed)	2.25	5.00	4.01	1682.26	4.01	1592.03	4.01	1539.91
Drill collars (5 std)	2.25	4.75	142.75	1825.01	142.75	1734.78	142.75	1682.66
X-over	2.25	4.75	0.24	1825.25	0.24	1735.02	0.24	1682.90
RTTS circ. valve	2.44	4.87	0.84	1826.09	0.84	1735.86	0.84	1683.74
X-over	2.25	4.75	0.24	1826.33	0.24	1736.10	0.24	1683.98
Drill collars (1 std)	2.25	4.75	28.57	1854.90	28.57	1764.67	28.57	1712.55
Slip joint (closed)	2.25	5.00	4.01	1858.91	4.01	1768.68	4.01	1716.56
Slip joint (closed)	2.25	5.00	4.01	1862.92	4.01	1772.69	4.01	1720.57
Drill collars (1 std)	2.25	4.75	28.55	1891.47	28.55	1801.24	28.55	1749.12
APR-a circ. valve	2.25	5.00	0.73	1892.20	0.73	1801.97	0.73	1749.85
APR-n tester valve	2.25	5.00	4.05	1896.25	4.05	1806.02	4.05	1753.90
Big John Jars	2.37	4.63	1.52	1897.77	1.52	1807.54	1.52	1755.42
RTTS circ. valve	2.44	4.87	0.84	1898.61	0.84	1808.38	0.84	1756.26
RTTS safety joint	2.44	4.87	1.00	1899.61	1.00	1809.38	1.00	1757.26
RTTS packer above	2.185	5.75	0.43	1900.04	0.43	1809.81	0.43	1757.69
below			0.78	1900.82	0.78	1810.51	0.78	1758.47
Pup joint	2.25	2.875			1.22	1811.81	1.22	1759.69
Sand screen (254 mic.)	2.25	2.875	3.01	1903.83	3.05	1814.86	3.05	1762.74
Otis xN-nipple w/X-overs	1.82		0.94	1904.77	0.94	1815.80	0.94	1763.68
Tubing	2.25	2.875	9.47	1914.24	9.47	1825.27	9.47	1773.15
Tubing (w/recorders)	2.25	2.875	9.47	1923.71	9.45	1834.72	9.45	1782.60
Bull plug			0.23	1923.94	0.23	1834.95	0.23	1782.83
Perforation			1930 - 1935		1839 - 1844		1788 - 1792	

## 5: Analysis of tests

The primary purpose of the testing of 34/10-1 was to get representative fluidsamples. Based on coresamples it was anticipated that the permeability was so large that conventional build-up/drawdown tests would not give accurate results in all zones under consideration. For DST no. 1 the permeability from cores was measured to about 50 md while it was well above 1 Darcy for DST no. 2 and 3.

Because of this the testprogram called for a build-up period (bottomhole shut-in) for test no. 1. For DST no. 2 and 3 it was planned to shut the well in (downhole) in 2-3 hours after the final productionperiod (high rate). Because of operational reasons the well had to be shut in at surface after the last productionperiod in both DST no. 2 and no. 3. This together with the small pressuredrawdown in the reservoir makes the analysis of these tests both difficult and uncertain.

### Method of analysis

DST no. 1 is analysed with conventional build-up analysis <sup>1)</sup>. Darcy's law is used for DST no. 2. For DST no. 3 conventional build-up, multirate build-up and Darcy's law is used.

Odeh's method for "apparent skin" is used where only a part of the formation is perforated. Odeh-Selig's <sup>3)</sup> method for calculation of pseudorate and -time is used.

The petrophysical analysis of the well <sup>4)</sup> is utilized for determination of porosity and liquidsaturations in the zones of interest. CPI log and coreanalysis is used to determine the productive interval.

References:

- 1) Earlougher: Advances in Well Test Analysis SPE Monograph Volume 5.
- 2) ODEH: Steady-State Flow Capacity of Wells With Limited Entry to Flow. Trans AIME vol. 243.
- 3) Odeh-Selig: "Pressure Build-up Analysis, Variable-Rate Case. SPE Reprint Series No 9.
- 4) Average of reservoir parameters from well 34/10-1. Petrophysical group Statoil.

SUMMARY FOR DST NO 1

Initial reservoir pressure (extrapolated) at 1907.5 m MSL	: 317.5 bar (4605 psi)
Formation capacity (1904-1910 m)	: 700 md-ft
Formation thickness	: 6 m (19.7 ft)
Permeability (build-up)	: 35 md
Skin (formation damage)	: 0.75
$\Delta P_{\text{skin}}$ (formation damage)	: 18.3 bar (266 psi)
Radius of investigation	: 180 m (600 ft)
Productivity index	: 1.01 m <sup>3</sup> /day/bar (0.43 STB/day/psi)
PI (without skin)	: 1.11 m <sup>3</sup> /day/bar (0.48 STB/day/psi)
SPI (without skin)	: 0.18 m <sup>3</sup> /day/bar/m (0.024 STB/day/psi/ft)

SUMMARY FOR DST NO 2

Initial reservoir pressure  
at 1816 m (MSL) : 307 bar (4450 psi)

Formation capacity (1809-1852.5 m (MSL)) : 300 000 md-ft.  
Formation capacity (1809-1901 m (MSL)) : 500 000 md-ft.  
Permeability (Darcy's law) : 1500-2000 md

Skin (partial penetration) (1809-1852.5 m) : 34  
Skin (partial penetration) (1809-1901 m) : 65

$\Delta P$  skin (1.flow, partial penetration) : 2.8 bar (40 psi)  
 $\Delta P$  skin (2.flow, partial penetration) : 12.2 - 13.5 bar  
(177-196 psi)

Radius of investigation 1. flow : 580 m (1900 ft)  
Radius of investigation 2. flow : 850 m (2800 ft)

Productivity index : 67-85 m<sup>3</sup>/day  
(29-37 STB/day/psi)

PI (without skin) : 330-720 m<sup>3</sup>/day/bar  
(143-312 STB/day/psi)

SPI (without skin) : 6.1 - 9.6 m<sup>3</sup>/day/bar/m  
(0.81-1.27 STB/day/psi/ft)

SUMMARY FOR DST NO 3

Initial reservoir pressure at 1765 m(MSL)	: 304 bar (4412 psi)
Formation capacity (1760-1773 m MSL)	: 362 500 - 139 000 md-ft.
Formation thickness	: 13 m (42.6 ft)
Permeability (Build-up)	: 8500-3200 md
Permeability (Darcy's law)	: 5200 md
Skin (partial penetration)	: 7.6
Skin (formation damage)	: 17.4
$\Delta P_{\text{skin}}$ (formation damage)	: 1.4 bar (20 psi)
$\Delta P_{\text{skin}}$ (partial penetration)	: 0.6 bar (9 psi)
Radius of investigation	: 600-900 m (2000-3000 ft)
Productivity index	: 45-130 m <sup>3</sup> /day/bar (20-57 STB/day/psi)
PI (without skin caused by partial penetration and formation damage)	: 180-450 m <sup>3</sup> /day/bar (78-194 STB/day/psi)
SPI (without skin caused by partial penetration and formation damage)	: 14-35 m <sup>3</sup> /day/bar/m (1.8-4.6 STB/day/psi/ft)



6: SUMMARY OF RFT

3 runs with RFT was performed.

Run\_1:

Date : 11.7.78  
Purpose : Control of pore pressure.  
Interval : 1497-1707 m MSL (1522-1732 m RKB)

Run\_2:

Date : 27.7 - 28.7.78  
Purpose : Pressure recordings and sampling in the Brent formation.  
Interval : 1749-1968 m MSL (1774-1993 m RKB)  
Sample : 1871 m MSL (1896 m RKB)  
Content of sample: 650 cc oil in 1 gal. chamber  
55 cc oil in 2 3/4 gal. chamber  
The rest mud and mud filtrate.  
Bubblepoint at reservoir conditions:  
221.4 bar (3210 psia).

Run\_3:

Date : 16.8.78  
Purpose : Pressure recordings and sampling in Statfjord formation.  
Interval : 2020.5-2377 m (MSL) (2025.5-2402 m RKB)  
Sample : 2244 m MSL (2269 m RKB)  
Content of sample: Only water, mud and mud filtrate.



8: ANALYSIS OF RFT RESULTS

Correction to recorded pressures:

Balance correction: -57.3 psi.

Correction due to temp. and pressure (150°F, 4500 psi): -2.7 psi.

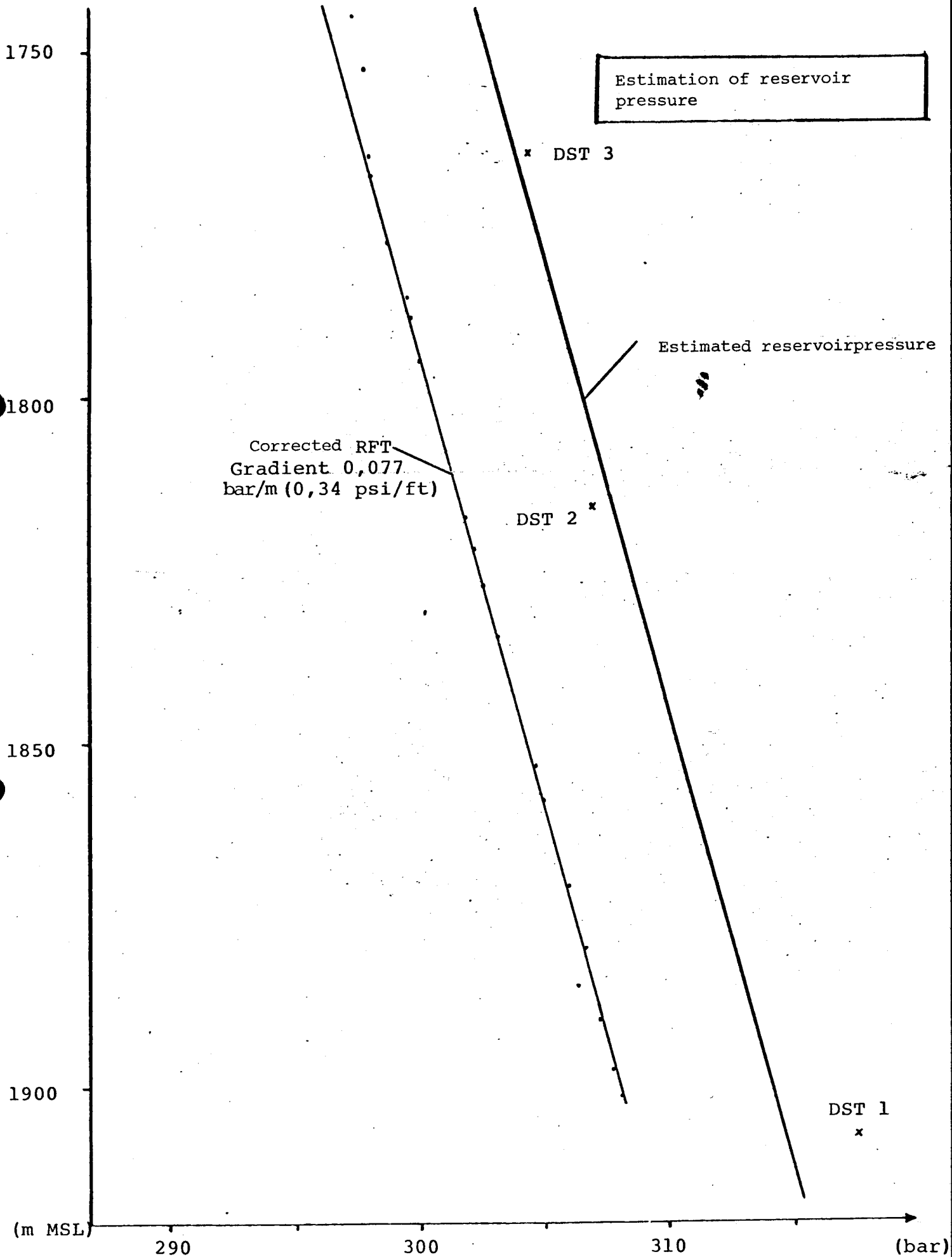
Total correction: -60 psi.

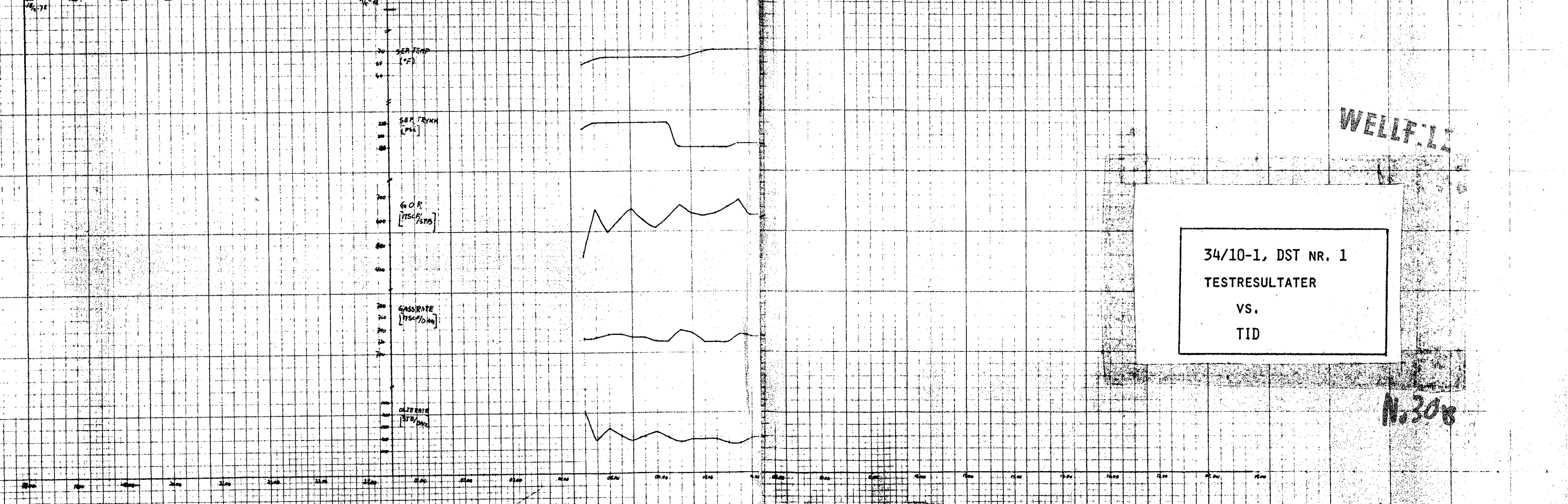
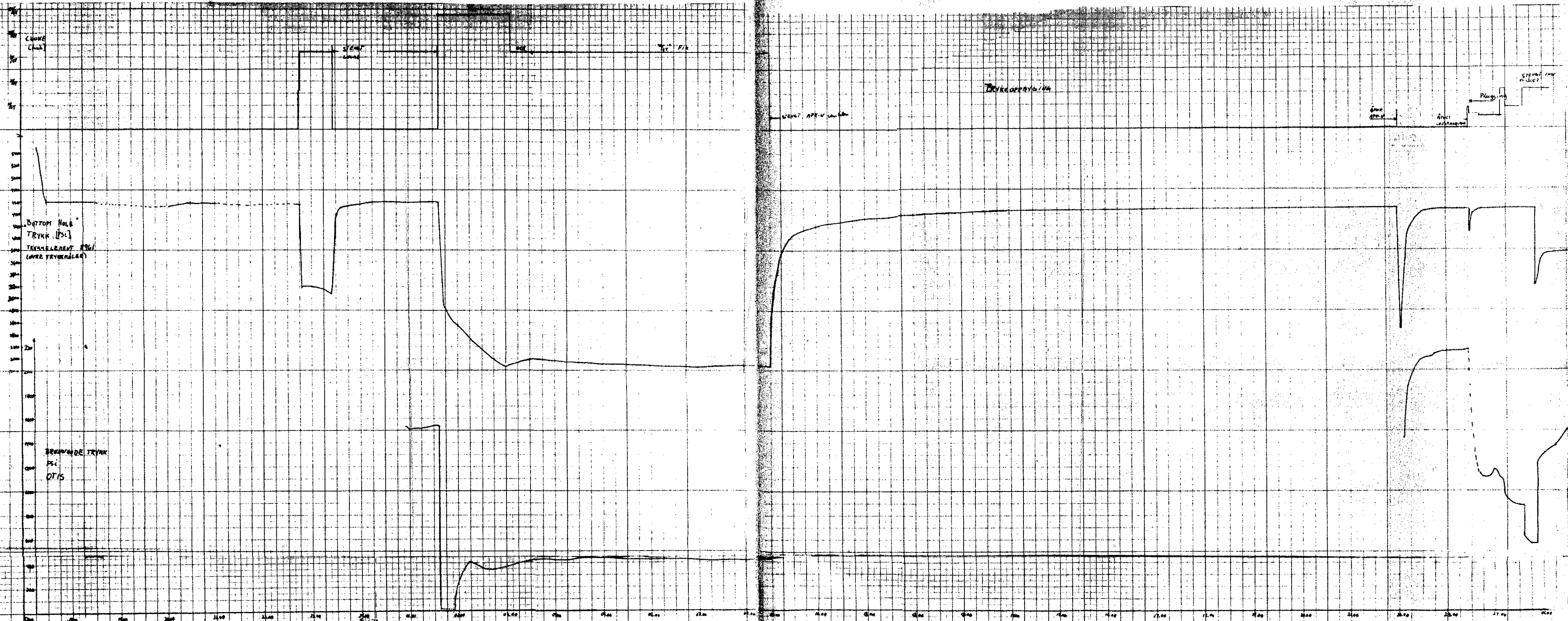
Depth (m MSL)	Corrected press (psi)	Depth (m MSL)	Corr. pressure (psi)
1901.4	4468	1812.5	4370
1897.5	4462	1795	4350
1890.5	4454	1788.5	4345
1885.5	4442	1785.5	4343
1880	4446	1776.5	4331
1871	4437	1768	4321
1858.5	4421	1762	4317
1853.5	4417	1757.5	4310
1843	4404		
1835	4396		
1827.5	4387		
1822	4382		
1817.5	4377		

Pressure gradient 1.12 psi/m.

9: ESTIMATION OF RESERVOIR PRESSURE

It is supposed that the pressure gradient taken from RFT is correct. It is however believed that pressures obtained from DST's (especially 2 and 3) are more correct. In attached fig. pressures from DST and RFT is plotted together with the obtained pressure gradient through the Brent formation.

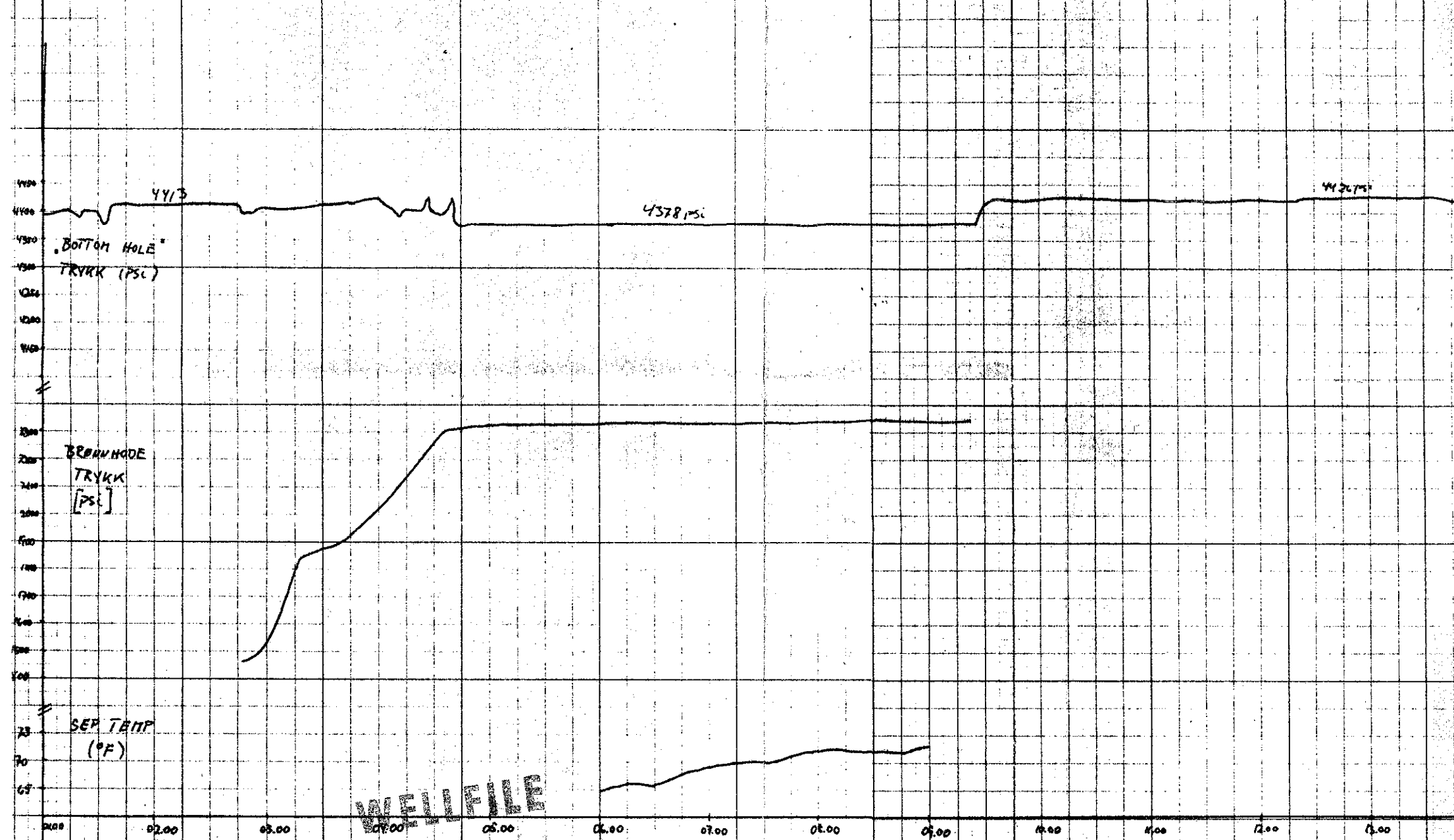
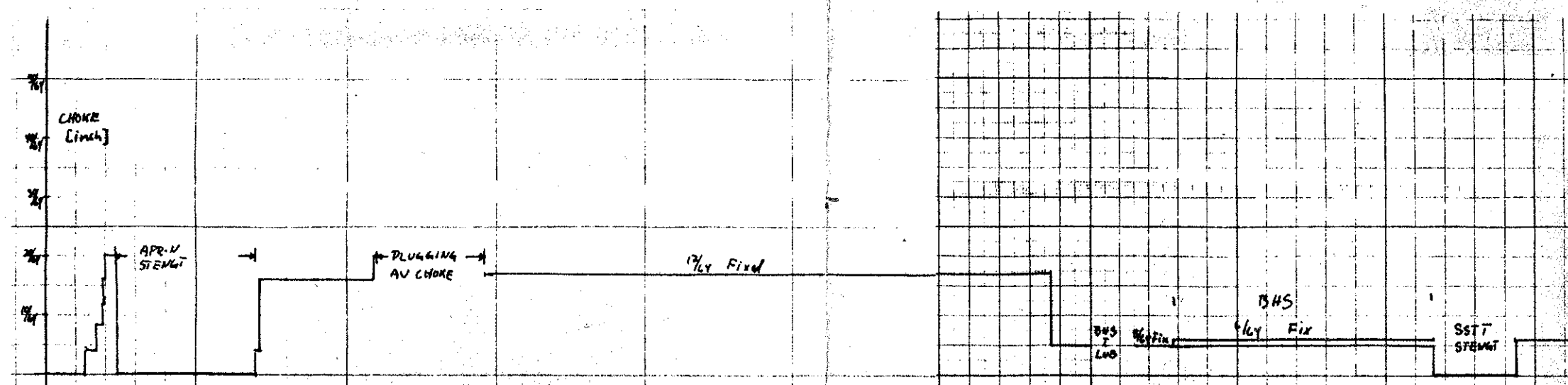




34/10-1, DST NR. 1  
 TESTRESULTATER  
 VS.  
 TID

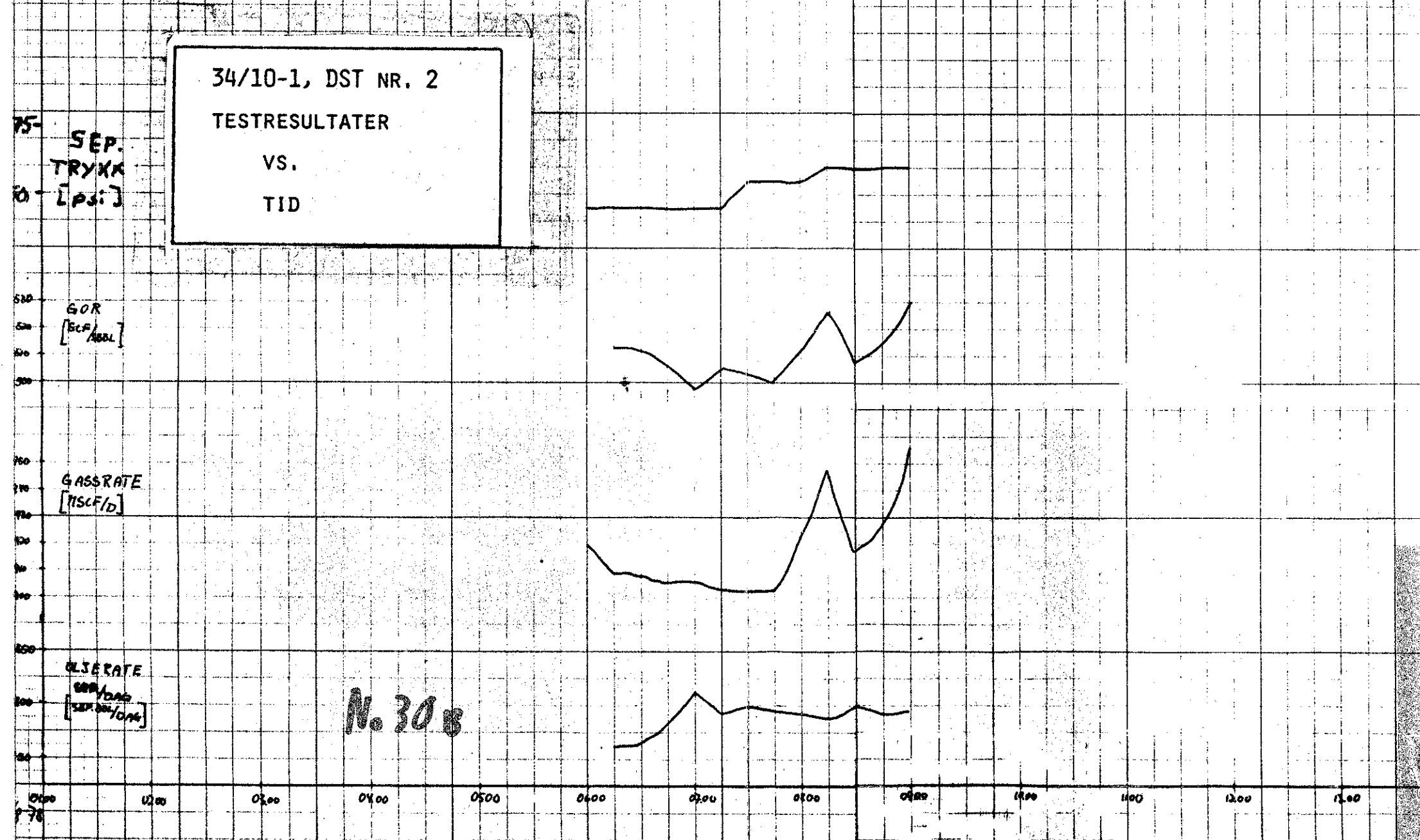
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N.308

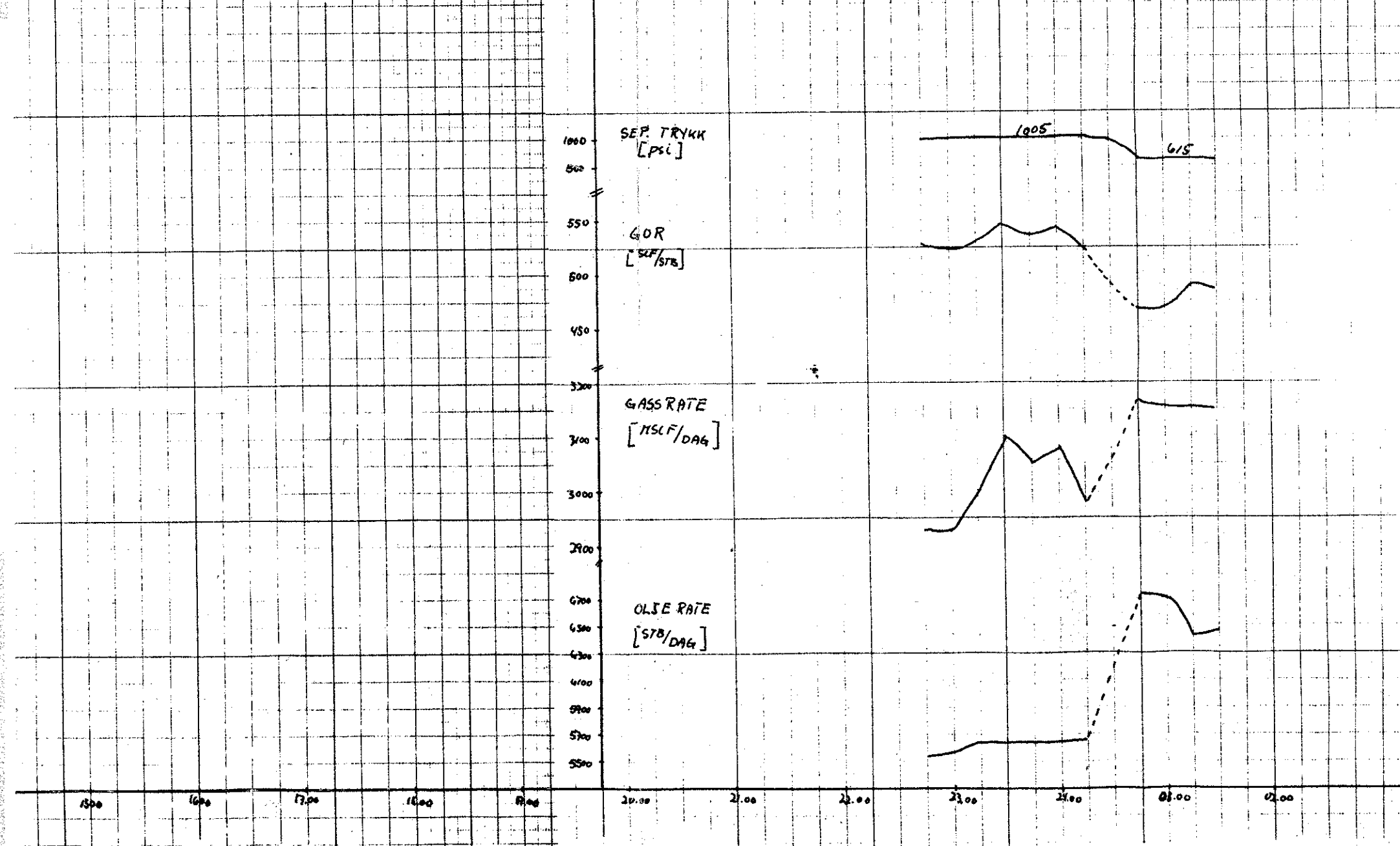
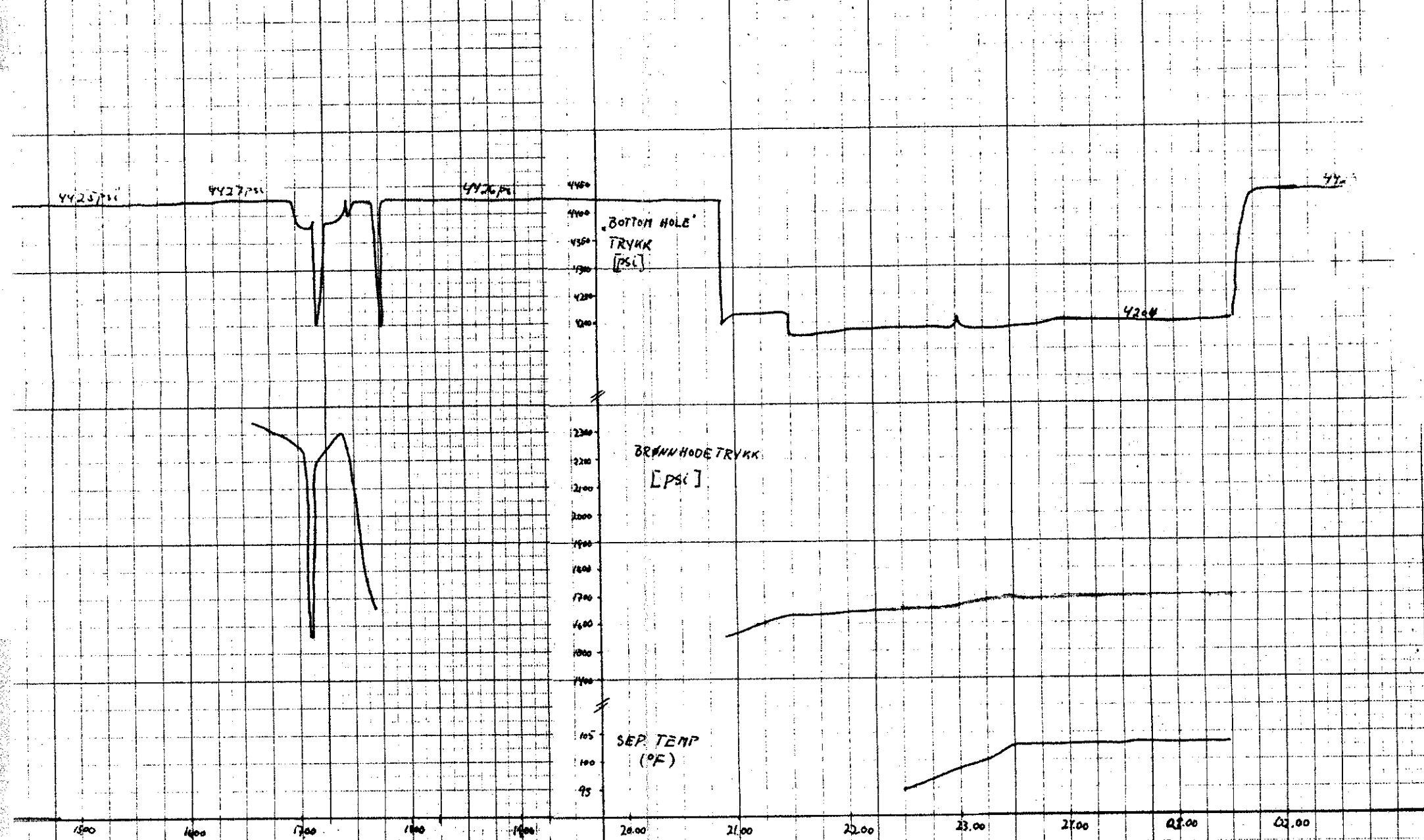
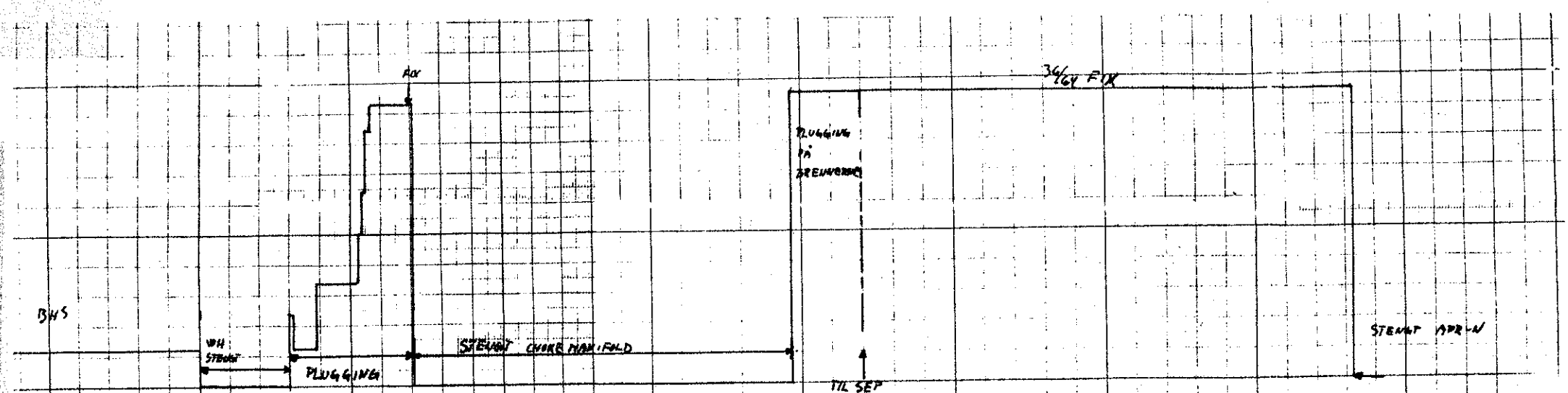


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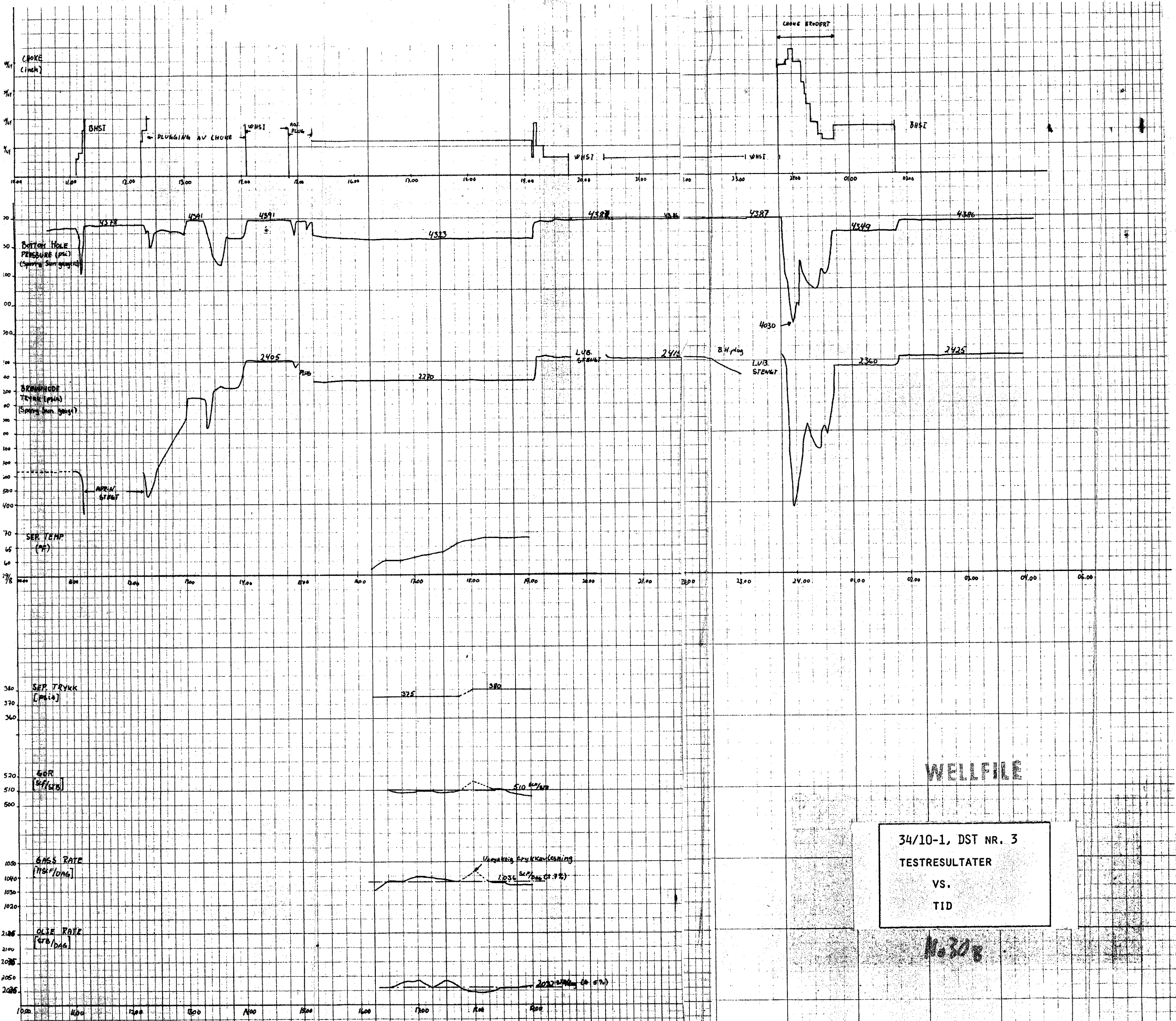
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TID



No. 30 B







34/10-1, DST NR. 3  
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 VS.  
 TID

No 308